FOCUS AND SYNTACTIC SUBORDINATION IN DISCOURSE

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INTRODUCTION

Understanding text requires that the reader integrates knowledge with what is asserted in the discourse, and integrates selected aspects of the discourse with each other (Sanford & Garrod 1994). Examples of such selectivity include the finding that main characters are more accessible for pronominal resolution than secondary characters (Anderson, Garrod & Sanford 1983; Garrod & Sanford 1988), that characters denoted by proper names are more accessible than those denoted by other descriptive noun phrases (Sanford, Moar & Garrod 1988) and that anaphoric resolution is easier with protagonists than with secondary characters (Morrow 1985). Such accessibility patterns may be taken as symptomatic of an underlying selectivity of processing on which the establishment of coherence is based. This paper looks at another candidate for selective processing: the structural syntactic dichotomy between main and subordinate clauses.

Research in linguistics provides compelling evidence for the existence of correlations between syntactic form and discourse context (Hopper & Thompson 1980, Givón (ed.) 1983) Tomlin (ed.) 1987, Fox & Hopper (eds.) 1994, Payne (ed.) 1992, among others). The implications of such correlational findings are that choice of form is not free but rather restricted and these restrictions most likely have an effect on the way linguistic forms are processed in a discourse environment.

While it is often assumed in the psycholinguistic literature that little or no syntactic information finds its way in the long term representation of a text, more recent studies suggest that syntactic structures may indeed affect text processing. McKoon, Ratcliff, Sproat & Ward (1993) have shown that information in more prominent syntactic positions increases the short and long term accessibility of that information compared to less prominent syntactic positions. In their study they compared predicate vs. noun modifier and direct object position vs. prepositional object position.

The present paper examines how and to what extent the structural dichotomy main vs. subordinate clause in complex sentences containing connectives (e.g. *after*, *because* etc.) affects the processing of subsequent discourse. Consider (1) and (2):

> (1) After the porter phoned the building's owner the woman detective investigated the scene of the crime.
> (1') The porter phoned the building's owner after the woman detective investigated the scene of the crime.
> (2) He put the phone back down when he heard the busy signal.

Sentence (2) is coherent and semantically acceptable whether it follows (1) or (1'). However, intuitively it seems that (2) is harder to integrate with (1) than with (1'). In (1) the porter and his actions are presented in the subordinate clause whereas in (1') they are presented in the main clause. Syntactically, the subordinate clause with the connector in initial position is a dependent of the main clause and cannot stand by itself in the discourse. The main clause is syntactically more prominent. Based on our intuitions about the sentences above, our main hypothesis is that structural information in the form of the dichotomy of main vs. subordinate clause is used to help control the attentional focus during discourse comprehension. Attentional focus is selective and we propose that main clauses of complex sentences are given more prominence in subsequent processing than are subordinate clauses, and that therefore structural information about clause type is used in the deployment of processing. If a syntactically more salient position draws more attention than one which is less prominent, the information it presents should be subsequently both more available and more accessible than information contained in a less prominent structure. In this study availability refers to the probability of reference to given information in subsequent continuation, while accessibility is indexed by the ease of anaphoric reference resolution measured during self paced reading.

There is a substantial amount of evidence in the literature about processing differences between main and subordinate clauses. Baker & Wagner (1987) have shown that readers detect false statement more easily in main clauses than in subordinate ones. For their study they used relative clauses as subordinates and concluded that the structural characteristics of sentences correlate with differing processing demands. They describe the main clause as the central focus of the message. Memory experiments have shown that the meaning of a main clause is better maintained but that verbatim recall of a subordinate clause immediately or shortly after hearing a sentence is more accurate (Flores d'Arcais 1978, Townsend & Bever 1978, Smith and McMahon 1970, among others). Townsend & Bever (1978) show that this difference is also apparent during on-line processing when subjects, while reading, are asked to respond to a probe which is semantically related to the verb phrase in the main or subordinate clause. They suggest that the differential accessibility to different levels of representation follows directly from the hypothesis that main clauses are encoded more deeply during listening. While these studies all provide evidence for differential processing of clauses with structural differences one cannot exclude the possibility that readers also pay attention to the order in which the two parts of the complex sentence appear. Gernsbacher (1990) has made the claim that first-mentioned things have an advantage, and has used this as the basis of her Structure Building Theory of comprehension. Using a task in which subjects were presented with a word following a sentence, and instructed to decide whether the word had been present in the sentence, Gernsbacher et al. (1989) found an advantage of First Mention with a probe delay of 1400 msec. With a zero delay, there was an advantage for the most *recent* clause. On this basis, Gernsbacher (1990, p.33) claimed that there is greatest access to the clause being currently processed. However, after the second clause has been processed, the first clause becomes more accessible because it serves as the structural foundation for the whole sentence representation (see also Millis and Just, 1994). Gernsbacher et al (1989) used materials which had main and subordinate clauses, and so this appears to offer *prima facie* evidence against our proposal that main clauses should be more accessible for subsequent multisentence integration.

In addition to structural information, every sentence contains a considerable amount of semantic information and this includes the relationship which holds between the main and the subordinate clause. This is expressed in the type of connective used. For example *after* expresses a temporal relationship in which the event contained in the subordinate clause is said to have occurred before the one presented in the main clause. It is well-known that sentences with temporal connectors are organized in memory in terms of the order in which the events represented in main and subordinate clause occurred in real-time (Clark & Clark 1968, Smith & McMahon 1970, Mandler 1986, among others). However this seems to hold only when the events in the two clauses are not connected semantically (e.g. via a causal or enablement relation), e.g. *He hooted the horn before he swiped the cabbages.* (Clark & Clark 1968). The temporal sequence of semantically unconnected propositions like this is better remembered when the contributing clauses follow the actual order in which their events occurred: i.e. sentences in the order *after/subordinate - main* and *main - before/subordinate* are better remembered than *main - after/subordinate* and *before/subordinate - main.* This facilitation disappears when the clauses are semantically connected via causal or enablement relations (Mandler 1986).

Townsend & Bever (1978) show that differences in the way connectors affect on-line processing of main and subordinate clause is not restricted to temporal relations (see also Bever & Townsend 1979). In general "listeners are sensitive to the possible semantic relationships between clauses and modify their comprehension processes in terms of these semantic relations" (Bever & Townsend, 1979, p.194). Accessibility of meaning vs. literal form is shown to vary depending on the type of relationship holding between the propositions in main and subordinate clause. In the case of a causal relationship the subordinate clause is more deeply processed than in the case of a purely temporal relationship.

All of the above studies concur that main and subordinate clauses are processed differently at the sentence level. None of them however consider the possibility that these processing differences may have lasting effects on our comprehension of subsequent pieces of discourse. However, there is evidence that the dichotomy between main and subordinate is an effective tool in the organization of discourse. Tomlin (1985) shows that subjects report pivotal and important events in the form of main clauses when telling a story based on watching a non-verbal action filled cartoon. Less important events are relegated to various types of subordinate structures. Subjects adhere to this pattern when telling the orally story on-line, and in written form both immediately and delayed after watching the video. In addition, Morrow (1985) shows that the structural dichotomy of main vs. a subordinate clause affects referential anaphoric resolution during subsequent discourse comprehension and interacts with the cue of story protagonist. When the protagonist is identical to the pronominal referent of the main clause subjects resolve the anaphoric reference in a subsequent target sentence by identifying the pronominal referent as being the protagonist. If, however, a subsidiary character is placed in the main clause while the protagonist is involved in the event presented in the subordinate clause, subjects are less likely to resolve the anaphor in the target sentence with the protagonist and show a higher level of uncertainty about their choice.

The results from both studies suggest strongly that the choice of syntactic structure is dependent on the organization of the discourse as a whole. If it is the case that important events are generally presented in a main clause, then surely it is reasonable to assume that main clauses are considered more salient than are subordinate clauses. If so, focal attention is more likely to select the information contained in the main clause rather than the subordinate for deeper processing and as a result the content in the main clause should be both more accessible and more available.

While we expect main clausehood to be a driving force in the control of focus, it is clear that other influences may be operative as well and the question then is how strong a cue main clausehood is compared to other cues including the order of presentation of both clauses in the complex sentence and the type of semantic relationship holding between the main and the subordinate clause as expressed by the connector. We propose to examine these different factors by indexing what is selected to be in focus through a task requiring the production of the next sentence and the integration of a new sentence during reading. In what follows we will compare the results of a continuation experiment which we ran previously (Cooreman & Sanford, in preparation) and a timed reading experiment. We will first present the results of the continuation task.

SENTENCE CONTINUATION

The goal was to examine the effect of clause type (main vs. subordinate) on selective attention and assessing the strength of the expected effect by comparing it with the cues of order of clause (e.g. Gernsbacher, 1990) and connector type (e.g. Bever & Townsend 1979). Subjects were asked to write a continuation to a complex sentence containing a main and a subordinate clause. They were prompted to start their continuation with a pronoun which could refer to the referent in either the main or the subordinate clause. The percentage of referential choice for anaphoric resolution provides a measure of the degree of availability of the information in the clause containing the chosen referent (Garrod and Sanford, 1988). Our hypothesis was that the use of the subordinate clause forces the subject to pay less attention to the information in it rather than the information contained in the main clause and predicts that the referent from the main clause be favored for referential resolution. This expectation should translate in a much higher percentage of the main clause referent to be identified with the pronoun in the continuation.

Because of the difficulty in creating balanced materials using a large number of different connectors to make up one of the independent variables and because of the enormous size of the experimental task this would bring to the subjects, we chose to run the experiment three times, each time using two different connectors. One group of subjects were given lists with the connectors *after* and *before*, one group saw the connectors *when* and *while*, and a third group read sentences with *because* and *since*.

Table 1. Conditions in the continuation task.

After the tenor opened his music score the conductor sneezed three times. He...
The conductor sneezed three times after the tenor opened his music score. He...

The subjects were given a list text fragments consisting of either a complex sentence with a main clause and a subordinate clause preceded by one of the connectors (experimental items) or two independent single clauses (some of the fillers). Each clause contained a different but same gender subject referent. Subjects were instructed to write a sentence which could form a plausible continuation to the text fragment. They were given a pronoun as a prompt to start the sentence and this pronoun could refer back to the subject referent in either the main or the subordinated clause. Table 1 illustrates the 2 conditions for *after*.

The results were calculated in two ways. First, in order to check for clausal order effects we calculated the proportion of times subjects chose the referent from the main clause to identify the pronoun in their continuation. If order is in any way attended to we would expect anaphoric resolution with either the subject of the main or subordinate clause to vary depending on the order in which these clauses are presented. Second, in order to check for the main effect of clause type, we calculated the proportion of times subjects chose the referent of the first clause in the complex sentence as the anaphor for the pronoun. If, as we propose, main clause attracts the focal attention of the reader, then the proportion of times subjects select the referent of the first clause as the anaphor of the pronoun in their continuation should be high when that first clause is the main clause but low when it is the subordinate.

The results for the three sets of connectors are presented in figure 1. For all three sets of connectors, the prediction that selective processing directs more attention to the informational content of the main clause was borne out. For every one of the connectors the main clause referent was the preferred choice by far for the role of subject referent in the continuation sentence: 92.9% of the time for *after/before*, 80.3% for *when/while* and 79.8% for *because/since*. This shows that the propositional content of the main clause is more available than that of the subordinate.

In general, the order in which main and subordinate clause were presented did not make a difference except in the case of one of the causal connectors. In the causal sentences with *because* we find a recency effect: the effect of main clause is weaker when the main clause itself is not presented last in the complex clause, i.e. when it is further removed from the continuation: compare main clause referential continuation 75.2% of the time in main-subordinate order vs. 85.4% in subordinate - main order.

It is slightly puzzling at first glance why we should obtain this effect for *because* and not for *since*. We would like to offer as a potential explanation that the difference between *because* and *since* is due to the difference of strength of the causal relationship established by the connector between the main and the subordinate clause. Townsend & Bever (1978) provided evidence for differential on-line processing between more temporal and more causal connections between clauses. Causal subordinate clauses were more deeply processed than temporal ones and showed higher on-line accessibility to propositional meaning and lower sensitivity to verbatim probes. Our own results from the continuation task seem to point in a similar direction. Both *because* and *since* imply that the event in the subordinate occurs before the one in the main clause. *Because* always establishes a strong causal link between the two clauses it connects but with *since* it is possible to have a mainly temporal reading. Consider:

(3) Since John came home his wife has done nothing but clean the house.

If it is true that causal links invite deeper processing on the sentence level, as Townsend & Bever (1978) show, than it is conceivable that this deeper sentential processing has its effects on subsequent discourse as well. If explicit presence of a causal link forces the reader to pay more attention to the meaning of the subordinate proposition, then it is also possible that this information remains more available to the reader subsequently in discourse. The cue of main clause may become weakened by the heightened amount of attention paid to the propositional content in the purely causal clause. We will come back to this point in the general discussion.

SELF-PACED, TIMED READING TASK

Focus can be assessed not only by measuring referential availability, as in a continuation task, but also by measuring the referential accessibility of an expression through a pronoun. We may operationally define being in focus as being highly accessible through a pronominal anaphor. We assume that the higher degree of attention allocated to the main clause will make it easier to integrate new incoming information in subsequent discourse when this information is coherent with the propositional content of the main clause. By the same token, if attention is sparingly given to the subordinate clause, subsequent discourse material coherent in content with the subordinate will be harder to process. A self-paced timed reading task aimed at assessing the accessibility of referents from main and subordinated clauses. Three groups of subjects were asked to read a series of complex clauses containing an adverbial subordinated clause starting with *after* and *before*, *when* and *while*, or *because* and *since*. The orders main - subordinate and subordinate - main, were both presented. Each complex sentence was followed by a target clause starting with a pronominal anaphor referring unambiguously to the referent in either the main or the subordinate clause. Targets were designed to contain direct references only to the propositional content of the clause containing the intended referent. We hypothesized that when subjects are asked to read a target clause after reading a complex sentence containing a main and an adverbial subordinate clause the average reading times should be faster when the target is coherent with the main rather than with the subordinate. We have to allow for the possibility that more integrative processing of adverbial clauses which are *causally* linked to the main clause weakens the facilitation of main clause structure.

Method

Materials and Design Materials were constructed comprising a complex sentence bearing the connective of interest, a target sentence, and a decision task. The complex sentences contained a main clause and a subordinate clause. For each material, the component clauses contained a subject of the same gender, using the same type of referential description.

For the temporal connectors 48 materials were written. To keep the length of the experiment reasonably short for the subjects we ran it twice using only half of the materials each time. For each run two sets of 24 materials were used for each of the connector pairs, twelve per connector.

For each set of 24 materials we made eight different lists. The materials were created so that swapping the connectors over the materials resulted in plausible but different readings for the complex sentences. So, four of the eight lists contained twelve materials for each of the two connectors used in the design, in the other four the connectors were swapped (with minor adjustments to the materials where necessary). Two other within-subject variables were clausal order and target reference. The two clausal orders refer to the main clause either preceding or following the subordinate clause in the complex sentence. Target reference type depends on whether the target sentence maintains referential and propositional coherence with the main or the subordinate clause of the previous complex sentence. In total then, there were sixteen lists (eight per experimental run) for the temporal connector pairs An example under all four conditions of the experiment is shown in Table 2 for the connector pair *after/before*.

Table 2. Conditions for the timed reading experiment (example for *after/before*)

- **STIMULUS.**
  - a. **main - sub, target coheres with main**
    - **After** : The porter phoned the authorities after the private detective investigated the scene of the crime.
    - **Before** : The porter phoned the authorities before the private detective investigated the scene of the crime.
  - b. **main - sub, target coheres with subordinate**
    - **After** : The private detective investigated the scene of the crime after the porter phoned the authorities.
    - **Before** : The private detective investigated the scene of the crime before the porter phoned the authorities.
  - c. **sub - main, target coheres with main**
    - **After** : After the private detective investigated the scene of the crime the porter phoned the authorities.
    - **Before** : Before the private detective investigated the scene of the crime the porter phoned the authorities.
  - d. **sub - main, target coheres with subordinate**
    - **After** : After the porter phoned the authorities the private detective investigated the scene of the crime.
    - **Before** : Before the porter phoned the authorities the private detective investigated the scene of the crime.
- **TARGET** : He put the phone back down when he heard the busy signal.
- **TASK** : The ______________ was obviously a busy place.
  post office police station

In order that each subject saw a material only once, however, a given subject was presented with 3 materials in each of the 8 within-subject conditions. Each material was seen in each condition by six different subjects.

The targets were matched for length, all within 4-5 characters from the average length. Each target appeared after complex sentences in both orders, with every connector and with every target reference type distributed across subjects.

Twenty-four fillers were distributed in each list of materials in a random fashion. The fillers consisted of two consecutive simple main clauses, followed by a task and a target designed in the same way as for the experimental materials.

For the causal connectors, the same basic design was used but with 32 materials. With these materials we created a total of eight lists. Sixteen materials each were assigned to the connectors *because* and *since* respectively in four lists. The other four lists contained the swapped version: where *because* had been used in the first four lists, now *since* was used to link the main to the subordinate clause and vice versa. The sixteen materials per connector were further subdivided into eight materials per clausal order and four per target type. Sixteen identical fillers were semi-randomly distributed across the lists and consisted of similarly designed complex sentences in equally distributed conditions. The only difference between the experimental and the filler materials was the connector type (i.e. temporal *before*). Same length targets were used as for the temporal connectors.

Subjects A total of 240 students of the University of Glasgow were asked to participate in the experiment. Some were paid, some volunteered. They were randomly assigned in sets of six subjects per experimental list. This means that 96 subjects were used for the sixteen lists with *after/before*, another 96 were distributed over the sixteen lists containing the connectors *when/while*, and finally 48 volunteers were assigned to the eight lists with *because/since*.

Procedure Materials were presented on a 16" computer screen, sentence by sentence. Each material block was separated by the presentation of an asterisk. Subjects were asked to press the middle of three buttons on a button box to proceed from one block of material to the next, and from one sentence to the next. Consecutive button presses measured the reading times for each sentence.

The task which followed the target sentence of each material was designed to ensure subjects were reading for comprehension. Subjects had to choose the appropriate answer to fill in a blank in the task sentence and were instructed to push the left or right button corresponding to the left or right word(s) as the appropriate answer. Subjects were instructed to use their dominant hand to press the buttons and wear their glasses if this was normal practice for them while reading.

Each session was preceded by a practice session in the presence of the experimenter to ensure the subjects understood the task. The practice session consisted of 4 materials which were similar to the experimental items in every way and 2 fillers. In addition, the experimental session itself started with a practice set of a mixture of 4 experimental materials and 4 fillers. The data from these 8 items were not used.

Results and discussion

Errors on questions No subject made more than four errors on the task (less than 11%). We therefore assume that subjects were comprehending the materials adequately.

Target sentence reading times We used a slightly different approach to the analyses of the data with the temporal connectors as opposed to the causal ones. With the sets *after/before* and *when/while*, the reading times were analyzed after all outliers (more than 2 SD away from the mean) were removed and replaced by estimated reading time values based on the overall grand mean reading time for subjects reading the same materials in the same conditions (G), the individual subject's overall mean reading time (S) and the overall reading time across subjects for that item in that condition (I) : replacing value = I + S - G. In any case, no subject had more than 3 outliers. The adjusted data files were subsequently analyzed for reading times of the targets. With the causal connectors we deleted the outliers before calculating the means, making sure no subject had more than 3 outliers and not more than one of these was allowed to occur within the same cell. Replacement subjects were run were necessary.

Per set of connectors two analyses of variance were carried out on the target reading times, one by subjects and one by materials. All analyses contained 3 within variables: connector (2), order (2), and target coherence type (2). The results are presented in Figures 2a, 2b, and 2c.

After and Before Overall targets are read reliably faster when they follow up on main clauses (2759 msec) than when they continue on subordinates (2889 msec): $F1\ (1, 95) = 14.255$, $p < 0.0005$, $MSe = 228896.6$; $F2\ (1, 47) = 14.835$, $p < 0.0005$ $MSe = 109986.5$. There were no order effects and no interactions. (All other F's < 3.4).

When and While The results for these two connectors are quite different from the previous set. First, we see a repeat of the main effect of clause type. Targets referring to main clauses are processed faster (2776 msec) than targets coherent with temporal subordinates (2863 msec). This difference is reliable across both subjects and materials: $F1\ (1, 95) = 6.266$, $p < 0.05$, $MSe = 232780$; $F2\ (1, 47) = 4.353$, $p < 0.05$, $MSe = 167424.1$. The effect of clause type is consonant with the data from the sentence continuation task. However, there are additional complicating features with *when* and *while* which show up as an interaction of order with the main clause effect, and a higher order interaction implicating differences between the two connectors. The interaction *clause type* $\times$ *order* is only reliable by subjects: $F1\ (1, 95) = 4.433$, $p < 0.05$, $MSe = 207990$; $F2\ (1, 47) = 1.932$, p = N.S., $MSe = 239024$. The higher order interaction *clause type* $\times$ *order* $\times$ *connector* is significant over subjects and close to significance for materials with $F1\ (1, 95) = 5.915$, $p < 0.05$, $MSe = 204503$ and $F2\ (1, 47) = 3.841$, $p = 0.056$, $MSe = 157489$.

Figure 2. Average reading times for target sentences

Because and Since With the causal connectors, we obtained no significant differences anywhere. There was no main effect of clause type and there were no order effects or any other interactions. All F's < 3.

The results of this experiment show that with temporal connectors at least, the propositional content of the main clause is more accessible than that of the subordinate clause, as predicted. However, with the causal connectors, there is no effect of main clause. These results are consonant with the findings of Townsend & Bever (1978) for on-line processing of complex sentences with different connectors. They showed that causally linked adverbials are more deeply processed than are temporally linked ones. Our results show that with causal connectors there is no main clause facilitation. In subsequent discourse, the propositional content of the causally connected clause is as accessible as that of the main clause. Targets are read equally fast when they maintain referential and semantic coherence with the causal subordinate clause as they are when referring back to the main clause. While the experiment does not allow direct comparisons between the sets of connectors, the graphs suggest that with causal connectors target sentences are read quite a bit faster (around 2350 msec) while the average reading time is much higher for targets following on temporals (around 2810 msec). This suggests that overall integration of subsequent information is faster after causally connected sentences than after temporal ones.

The higher order interaction *clause type* $\times$ *order* $\times$ *connector* in the case of *when/while* is due to an order effect for the connector *while* which is absent with *when*. This order effect is not merely an effect of recency as targets coherent with the main proposition are read faster only when the main clause is most recent. This is illustrated with a means comparison test between continuing on the main vs. the subordinate proposition in main - subordinate [$df = 1$; $F1 = 0.78$, $p = 0.3782$, $MSe = 145090.02$; $F2 = 0.37$, $p = 0.5478$, $MSe = 72820.17$] and subordinate - main order [$df = 1$; $F1 = 15.23$, $p = 0.0002$, $MSe = 2819548.38$; $F2 = 7.1$, $p = 0.0106$, $MSe = 1410137.76$].

Clearly the influences on reading time are more complex than those influencing sentence continuation patterns as discussed above. These influences are examined as part of the general discussion.

GENERAL DISCUSSION

Our basic question was whether the main clause of a complex sentence would become the focus of subsequent processing. The answer to this question turns out to be rather more complex than we initially had anticipated. What we found is a remarkable dissociation between the free production task and the timed reading task.

The continuation task showed an overwhelming effect of main clause. Subjects were essentially free to continue with whatever they wished, provided it simply seemed to them to fit with the complex sentence in question. There was no additional input for them to integrate with what they had just read. Under these conditions, there was an overwhelming preference for referential continuity with main clause.

The self-paced, timed reading task required subjects to read sentences which either fit with the main or the subordinate clause of a preceding sentences. Here integration of old and new material is called for, and we assumed that the ease of integration is indexed by reading time for that sentence. There was a reliable effect of main clause facilitation only for the temporal clauses. While the main clause effect was the only significant result with the connector set *after/before*, the *when/while* set showed an additional order effect for *while* which suggests that recency has a facilitating effect on the integration of new incoming information with the main but not with the subordinate clause. At this point we can only venture a suggestion as to why the two sets of temporal connectors vary. The influence of order in the case of the *when/while* set of connectors suggests a slight weakening of the effect of main clause. We suspect that this is due to a difference in the construction of a mental representation for sentences containing *after/before* connectors vs. *when/while* connectors. For the first set, two separate points or periods in time must be created in a mental representation, one for the event in the main clause, and one for the event in the subordinate. By setting up two different time frames, *after* and *before* create a "gap" between the events in the main and subordinate clause and as a result heighten the selective focus on the main clause. No new temporal model needs to be created in the case of *when* and *while* because the two propositions in the complex sentence share the same mental space and the events in the main and subordinate clause appear to be linked much closer. The constraints imposed by the semantics of *while* are such that the events in the two clauses of the complex sentence must overlap. (E.g. Heinamaki 1978). The question then is why we do not obtain a similar weakening of the main clause effect with *when*. While the *prototypical* meaning of *when* also places both events in the same temporal space, when in reality has chameleon-like characteristics and can take on the meaning of the other three temporal connectors. Indeed, Moens & Steedman (1988, p.15) produced examples demonstrating just this, as shown in (4):

(4) When they built the bridge...
(a) ...a local architect drew up the plan.
(b) ...they used the best materials.
(c) ...they solved most of their traffic problems.

In (a) the subordinate clause depicts an event after the event in the main clause; in (b) an event which is simultaneous with that in the main clause, and in (c) an event which comes before that in the main clause. If subjects were interpreting when materials as *before*, *after*, or *while*, the mixture could yield noise.

The total lack of any effects with the causal connectors in the timed reading experiment shows that integrating information with a preceding subordinate clause is as easy as it is with a preceding main clause provided they are explicitly causally linked. This suggests strongly that an overtly expressed causal relationship between the main and subordinate clause is a very tight one which invites the reader to process the two propositions to an equal extent. These results extend the findings by Townsend & Bever (1978) for on-line processing to subsequent discourse processing: causally linked subordinate clauses are more deeply processed than are temporal subordinates.

The data on which this paper is based show that the effect of syntactic structure on selective focusing competes with other cues. The strength of these cues varies depending on the discourse environment and the type of processing which is required. The dissociative results obtained from the two tasks described in this paper suggest that these two factors can work in tandem. The results of both experiments show that the main clause effect is at least in competition with clausal order, more specifically with the effect of recency of mention. The strength of this cue is shown to depend in part on the semantics of the connector and in part on the type of processing required of the subjects. During a continuation task there were no other cues available to the reader aside from structural information (main vs. subordinate) and the semantic information contained in the adverbial connector. Even here, the main clause effect does not have the same strength across the board. Not only is the percentage of choice with the main clause referent higher with *after/before* (over 90%) than with *when/while* or with *because/since* (both around 80%) (see figure 1) we also find order (i.e. recency) interacting with the main clause effect in the case of *because*. These results can be interpreted as supporting our suggestion: i. that the need to set up two temporal frames in the mental representation (as in the case with *after* and *before*) heightens the effect of selective focus on the main clause, and ii. that the presence of an explicit causal link between main and subordinate weakens the main clause effect. When the *because* clause is last in the complex sentence, the preference for the referent of the main clause to resolve the pronominal anaphor in the continuation drops significantly. The connector *since* fails to show the same weakening and this may be due to the fact that unlike *because*, *since* does not establish an unambiguously causal relationship between the propositions in the main and subordinate clauses but can also indicate mainly temporal order, as in example (3) above. The latter also supports the findings of Townsend & Bever (1978) that causally linked subordinate clauses are processed differently from temporally linked ones. In addition to the semantics of the connector which establishes the temporal structure of the mental representation and the presence or absence of an explicit causal link between the main and the subordinate clause, the type of processing required of our subjects also affects the strength of selective focusing. When subsequent discourse forces the reader to integrate new incoming information (as in the timed reading task) the main clause effect is weakened. The absence of two temporal frames allows clausal order to affect the target reading times when *while* is used as the clausal connector and the semantic link of causality wipes out any main clause facilitation. Again, these results lead us to concur with Townsend and Bever (1978) that the causal link directs more processing to the subordinate clause.

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