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The Time-Course of Metaphor Comprehension: An Event-Related Potential Study

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ERPs were recorded while subjects were reading short familiar metaphors (e.g., Those fighters are lions), unfamiliar metaphors (Those apprentices are lions), or literal control sentences (Those animals are lions) presented in isolation or preceded by either an irrelevant or relevant context (e.g., They are not idiotic: . . . .'' vs. ''They are not cowardly: Those fighters are lions''). The terminal word of metaphors elicited larger N400 components than did the terminal word of literal sentences (Experiment 1) suggesting that the (incongruous) literal meaning of metaphors was indeed accessed at some point during comprehension. The analysis of the 600–1000 and 1000–1400 latency bands (Late Positive Components) revealed no significant difference between metaphors and literal sentences. The manipulation of metaphor difficulty (Experiments 2 and 3) also failed to reveal any late effect specifically linked to metaphorical processing. Finally, an effect of the preceding sentence context was found in Experiments 3 and 4, as early as 300 ms following the terminal word onset. Overall, these results support a context-dependent account of metaphor comprehension stating that when contextually relevant, the metaphorical meaning is the only one accessed.

INTRODUCTION

Sentences sometimes mean something different from what they say. For example, by saying ''John is a pig,'' one does not mean that John is really a pig, but rather that he shares some property or properties with a pig (e.g., ''being dirty''). These shared properties are classically referred to as the ''ground'' of the metaphor (Richards, 1936). They are assumed to provide the missing link between the subject of the sentence (referred to as the ''topic'' of the metaphor) and the predicate (the ''vehicle'' of the metaphor).

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In this view, understanding a metaphor can be seen as the process by which the metaphor's ground becomes available and sufficiently salient. Several interesting proposals have been made to deal with this question. For example, it has been suggested that the original class-inclusion statement ''X is a Y'' be transformed into an implicit comparison ''X is LIKE a Y'' (Ortony, 1979; Miller, 1979). This view was recently challenged by Glucksberg and Keysar (1990). They argue that a metaphor such as ''John is a pig'' is understood just like a normal class-inclusion statement, the only difference being that the category is assumed to be referred to by means of a prototypical examplar (e.g., a pig) instead of a category name.

The aim of this paper is not to comment directly on these notions. Instead, we would like to focus on the temporal aspects of metaphor comprehension, and more specifically on the time-course of ''literal'' and ''metaphorical'' processes (assuming that such a distinction exists). Three hypotheses have been proposed to account for metaphor comprehension. They will be referred to as (a) the hierarchical hypothesis (stating that the literal meaning of a metaphor is necessarily accessed first), (b) the parallel hypothesis (the metaphorical meaning can be accessed ''directly,'' in parallel with the literal one), and (c) the context-dependent hypothesis (when contextually relevant, the metaphorical meaning is the only one accessed). It is interesting to note that similar hypotheses have been proposed in the connected domain of lexical ambiguity: When ambiguous words are presented, the listener/reader can theoretically access the more frequent meaning first (Hogaboam & Perfetti, 1975; Forster, 1976), all meanings in parallel (Foss and Jenkins, 1973; Swinney, 1979), or the sole meaning which is consistent with the context (Carey, Mehler & Bever, 1970; Van Petten & Kutas, 1987).

As far as metaphors are concerned, a typical example of the hierarchical approach is the so-called three-stage model (Clark & Lucy, 1975) which states that the intended metaphorical meaning cannot be accessed until the literal one has been considered and rejected as incongruous or inconsistent with the context. Further theoretical justifications for this hypothesis are found in the pragmatic tradition (Grice, 1975; Searle, 1979) in which access to the metaphorical meaning is seen as a consequence of the failure to find an appropriate literal meaning for the utterance. Note that the hierarchical hypothesis is consistent with the notion that the original statement is transformed into an implicit comparison (see above). Obviously, such a transformation can only be performed if the literal meaning is available first. Moreover, this transformation will render the literal and metaphorical meanings mutually exclusive, in terms of truth value. For example, ''John is LIKE a pig'' cannot be true if John is (literally) a pig. In this view, the reader/listener will thus have to reject the literal meaning in order to access the metaphorical one (see Keysar, 1989, for a discussion of this point).

The empirical evidence supporting the hierarchical hypothesis relies mainly on observed differences in reading time. For example, Janus and

Bever (1985) obtained longer reading times for metaphorical sentences, as compared to literal ones, in a situation where all the necessary elements for accessing the metaphorical meaning were provided by the context. This suggests that the literal meaning was accessed before the context entered into play. However, in comparable conditions, Ortony, Schallert, Reynolds and Antos (1978) and Inhoff, Lima and Carroll (1984) failed to find any statistically significant difference, which casts some doubt on the relevance of reading time for studying metaphor comprehension. Clearly, the lack of a difference in reading time does not necessarily mean that the mechanisms at play are identical (since different mechanisms may happen to take the same amount of time to be completed). Similarly, a difference in reading time does not necessarily mean that different mechanisms are involved.

Unlike the three-stage model, the parallel hypothesis assumes that metaphors and literal sentences are processed using the same ''cognitive machinery'' (Glucksberg, Gildea and Bookin, 1982) and that the literal meaning does not have to be rejected for the metaphorical one to be accessed. This view is consistent with Glucksberg and Keysar's (1990) model, and more specifically with their claim that the original statement is not ''transformed'' during metaphor comprehension (see above). The notion that the literal metaphorical meanings are mutually exclusive in terms of truth values can also be questioned. For example, in some contexts, ''John is a magician'' can mean that John's job is to be a magician (literal meaning) and at the same time, that John is very good at handling money (metaphorical meaning). In an experiment using this kind of linguistic material, Keysar (1989) obtained shorter comprehension times when both meanings were consistent with the context, as compared to situations where only one meaning was. It can thus be concluded that rejecting the literal meaning is not a necessary step in metaphor comprehension. In this experiment, the metaphorical meaning clearly benefited from the existence of a consistent literal meaning. In order to explain this somewhat paradoxical result, it can be argued, for example, that the metaphorical meaning is derived from the literal one, or possibly from a core meaning (Barsalou, 1982) common to the literal and the metaphorical interpretations.

The parallel hypothesis sounds attractive as long as both meanings are acceptable. What about the situation where the literal meaning is incongruous? The idea that both meanings can coexist and benefit from each other is much harder to defend in this case. However, this does not necessarily mean that the literal meaning is rejected before the metaphorical one is searched for, as stated by the hierarchical hypothesis. A third possibility can be considered, namely, that the context can help in discovering the metaphorical meaning before the incongruous literal meaning has been accessed. This idea was strongly suggested by the results of a stroop-like experiment conducted by Gildea and Glucksberg (1982) in which the subject's task was to

perform a true vs. false judgement about the literal meaning of metaphors, literal sentences, and false sentences without any metaphorical interpretation. When metaphors were presented, the literal meaning was always incongruous, so the expected answer was ''false'' (since the metaphorical meaning was to be ignored). For example, the answer to ''All marriages are iceboxes'' should be ''false,'' despite being metaphorically acceptable. In one condition of the experiment, stimulus sentences were preceded by a short supporting context. For instance, one of the possible contexts for the above example was ''People are cold.'' When metaphors were not preceded by any supporting context, they were judged to be literally false as fast as were control sentences.

In the supporting-context condition, however, decision times were longer for metaphors than for control sentences. This interference effect suggests that context is likely to trigger the search for a metaphorical meaning before the literal meaning has been rejected. Since the metaphorical meaning apparently interfered with the processes responsible for rejecting the literal meaning, it must have been accessed before these processes were completed. However, in this experiment, mean response times were well above the range of normal reading times for this type of sentence. This leaves the possibility that comprehension (including the processes involved in accessing the metaphorical meaning) was already completed when the answer was given, thus explaining why response times were affected by the metaphorical meaning. In this view, the locus of the interference effect can presumably be looked for in some decision stage immediately preceding the subject's response, and not in normal comprehension processes.

The aim of the present experiments was to further examine these three hypotheses. More precisely, it was of interest to determine whether or not a supporting context can, so to speak, ''shortcut'' the literal meaning of an utterance by directly triggering the search for a nonliteral one. Since one of the main problems in studying metaphor comprehension concerns the fact that normal comprehension processes may be contaminated by decision-related processes, we minimized any such decision stage by requiring no behavioral response from the subjects. Instead, we recorded the variations in brain electrical activity while only asking subjects to silently read the sentences for comprehension.

The Event-Related Potentials methodology has been shown to be a useful tool for studying different aspects of language processing, ranging from sensory analysis (mainly reflected by the so-called ''exogeneous'' components occurring within 200 ms after the onset of a stimulus) to semantic integration (mainly reflected by relatively late ''endogeneous'' components; see Fischler and Raney 1991, and Kutas and Van Petten, 1988, for reviews). One endogenous component of the ERPs in particular, the N400, is known to be a sensitive index of language processing. Kutas and Hillyard (1980) showed that an incongruous word at the end of a sentence is associated with a negative

component developing in the 300–600 ms latency band and peaking 400 ms after word onset. Further studies have shown that semantic incongruity per se is neither sufficient nor necessary to elicit the N400. Indeed, N400 decreases in amplitude with one repetition and completely vanishes with two repetitions of the same sentence (Besson, Kutas & Van Petten, 1992). Furthermore, Kutas and Hillyard (1984) found an inverse relationship between N400 amplitude and the probability of occurrence of the sentence terminal word (that is, the probability that a word be given to complete a sentence, or ''Cloze probability''): The lower the cloze probability, the larger the N400. The N400 component thus seems to be a good index of semantic expectancy.

Underlying the use of the ERP methodology was the basic assumption that potentially distinct processing stages would be associated with distinct ERP components (see Meyer, Osman, Irwin and Yantis, 1988, for a detailed description of the inference rules used to associate specific ERP components with specific mental processes). Let us consider access to the literal meaning first. The metaphors used in all four experiments presented here were always literally incongruous (e.g., ''Those fighters are lions''). Thus, insofar as the literal meaning is accessed during metaphor comprehension, large N400 components should be generated by the vehicle of the metaphor (since large N400 components have been shown to be triggered by the presentation of incongruous terminal words). Access to the *metaphorical* meaning should be reflected by modulations of some distinct ERP component(s). The Late Positive Component (LPC), that develops in the 600–1000 ms latency band and is known to be sensitive to elaboration and integration processes (Neville, Kutas, Chesney, & Schmidt, 1986), is a potential candidate. It may be relevant here to note that response times to metaphors are typically longer than one second, ranging from 1000 ms (Keysar, 1989) to 1500 ms (Gildea and Glucksberg, 1983) for various context conditions.

To summarize, if it is true that different processing stages are involved in metaphor comprehension (as stated in the hierarchical hypothesis), one would expect not only an effect on the N400 component, reflecting access to the literal meaning, but also an effect on some later ERP component(s), reflecting access to the metaphorical meaning. By contrast, if the literal meaning does not need to be rejected before the metaphorical meaning is accessed (parallel hypothesis), one can expect the processes responsible for accessing both the literal and the metaphorical meanings to be reflected by ERP modulations in the same latency band. The amplitude of the N400 component may thus be modulated by factors that influence access to the metaphorical meaning, such as the familiarity of the metaphors. Finally, and of most interest for the present purposes, the context-dependent hypothesis predicts direct access to the metaphorical meaning when that meaning is relevant to the preceding context. Consequently, compared to a condition in which no context is presented, one can expect a reduction in N400 amplitude.

GENERAL METHOD

One basic design and procedure was used for all four experiments. Furthermore, the recording system and data analysis were the same across experiments. Variations in the general method are described for each experiment.

Subjects

Subjects were tested individually and were paid for their participation. All subjects were native French speakers from Aix-Marseille University and had normal or corrected-to-normal vision.

Linguistic Material

An original set of 48 French metaphors was selected as a basis for constructing the stimuli of all four experiments (see Appendix). The metaphors were simple literally false class-inclusion statements similar to those used by Gildea and Glucksberg (1983) (Example: ''Those fighters are lions'') and were thus incongruous when interpreted literally. Each one was comprised of five words and were of the form ''Those Xs are Ys.'' The vehicle of the metaphor was thus always the last word of the sentence (mean number of letters = 6.7). Most of the metaphors were derived from familiar expressions such as ''doux comme un agneau'' (as tender as a lamb) or ''muet comme une carpe'' (''mute as a carp''), and were thus relatively familiar. However, we decided to exclude from the experimental set some metaphors that sounded too familiar. The word ''pig,'' for example, is probably as frequently encountered in metaphorical expressions as in literal ones, and, for most subjects, its metaphorical meaning may have become part of the mental lexicon. Obviously, the three-stage model no longer applies in this case (''pig'' would actually act as a multiple-meaning word). On the contrary, *direct* access to the ''metaphorical'' meaning can be expected, with no effect on the Late Positive Component and generation of only a small N400 component.[1] Such a result would be of little theoretical interest. In particular, it would not be possible to infer that the metaphorical meaning is accessed directly (and the literal meaning not accessed) in the case of unfamiliar or new metaphors. A similar problem arose in Gildea and Glucksberg's (1983) study concerning the metaphorical meaning interference effect (see above). Glucksberg et al. (1982) showed that such an interference effect can be obtained even in the absence of context, provided that the metaphors are sufficiently familiar. In order to study the effect of context on metaphor comprehension, Gildea and Glucksberg (1983) were thus led to use a set of metaphors that were relatively hard to understand in isolation.

Procedure

The experiment was controlled by a Compaq 486 personal computer. Sentences were presented one word at a time, in the center of a CRT screen placed 60 cm in front of the subject. Each word was written in lower case and presented for 200 ms, with a stimulus onset asynchrony of 500 ms. The intersentence interval was 2 seconds. Sentence terminal words were presented together with a dot to indicate the end of the sentence. In order to reduce ocular artifacts, subjects were asked to avoid blinking from the onset of the first word until a series

[1] It could be argued that a large N400 component is to be expected in such a situation, due to the necessity of choosing between the two meanings. Note however that Besson and Kutas (1993) did not find any significant difference between the N400 to multiple-meaning words and to single-meaning words insofar as their cloze probability was similar.

of four X's appeared on the screen, two seconds after sentence terminal word onset. Subjects were trained to blink during the intertrial interval. This procedure proved to be useful as, across experiments, only 10% of the trials had to be rejected off-line due to contamination by eye movements or muscle artifacts. Following the instructions, subjects always saw a practice set of metaphoric and literal sentences.

Recordings

EEG was recorded via Ag/AgCl electrodes from 7 scalp sites: three along the midline at Fz, Cz, and Pz (Jasper, 1958) and two lateral pairs on the anterior-temporal (10% of the interaural distance lateral to Cz and 20% of the distance between this point and FPz on the left and right) and posterior-temporal regions (30% of the interaural distance lateral to Cz and 12.5% of the inion-nasion distance posterior to Cz, on the left and right), each referenced to the left mastoid. Eye movements and blinks were monitored via an electrode on the lower orbital ridge relative to the left mastoid. The EEG was amplified by Grass P5 RPS107 amplifiers with a .01 to 30 Hz (half amplitude cutoff) bandpass. The sampling rate was 250 Hz. Electrode impedance never exceeded 3 kOhms.

Data Analysis

ERPs were averaged off-line for a 2200 ms epoch, within each condition for each subject and time-locked to the onset of the sentence terminal word. Unless indicated otherwise, ERP data were analyzed by computing the mean amplitude in selected latency windows relative to a 200 ms pre-final word baseline. To be consistent with previous literature, the N400 was measured in the 300–600 ms range and the LPC, in the 600–1000 ms range. The choice of these latency bands was confirmed by visual inspection. Repeated measures analyses of variance (ANOVAs) were carried out with the Greenhouse-Geisser correction for nonhomogeneity of variance applied where appropriate. Reported are the uncorrected degrees of freedom, the epsilon value, and the probability level after correction.

EXPERIMENT 1

The aim of the first experiment was to test the characteristics of the linguistic materials that would be used in subsequent experiments. Specifically, it was important to determine whether the metaphors selected would indeed elicit N400 components when presented without an accompanying context that would facilitate access to the metaphorical meaning.

Method

Subjects. Twelve subjects (4 women and 8 men, mean age = 22 yrs, range = 20–24) participated in one session that lasted for about one and a half hours. All subjects but one were right-handed according to self-report; one of the right-handed subjects had a left-handed relative in his immediate family.

Materials, design, and procedure. In addition to the 48 ''familiar'' metaphors described in the general method, 48 literal sentences were constructed as controls. Control sentences and metaphors were matched for length and syntactic structure. Moreover, the sentence terminal words were the same for metaphors and control sentences, such that each metaphor could be paired with a corresponding control sentence sharing its final word. While the last word was the vehicle of the metaphors, it was used in its literal meaning in the control sentences. For example, the control sentence ''Those animals are lions'' was derived from the metaphor

''Those fighters are lions.'' Two lists were constructed so that, across lists, each terminal word was presented once in a metaphoric sentence and once in a literal sentence. Each list thus comprised 24 metaphors and 24 control sentences. These 48 sentences were randomly intermixed within each list, and a given subject was presented with one of the two lists depending upon order of arrival in the laboratory. At the beginning of the session, subjects were informed that they would be presented with a series of short sentences which they should read silently for comprehension.

To obtain estimates of the cloze probabilities (Taylor, 1953) of the terminal words, two lists of sentences were constructed. The metaphorical and control sentences were the ones used for the experimental lists, except that the last word of each sentence was missing and was replaced by three dots (e.g., ''Those fighters are . . . ''). Each list was presented to a group of 26 subjects who did not participate in the ERP experiments. They were asked to complete each sentence fragment with the first word that came to mind, to avoid proper nouns and repetitions, and to complete the questionnaire at their own pace but without going back over the list. This task took about half an hour. Overall, the cloze probability of the terminal word was low for both metaphors and control sentences ($p < .03$ and $p < .08$, respectively).

Results and Discussion

As can be seen in Fig. 1, larger N400 components were elicited by terminal words of metaphors than literal control sentences. A two-way ANOVA with sentence type (metaphors vs controls) and electrode (7 levels) as factors showed that the mean amplitude in the N400 latency band was larger for terminal words ending metaphors (−.59 uV) than for control sentences (.55 uV; 300–600 ms: $F(1, 11) = 9.69$, MSe = 5.78, $p < .009$). These components were equally distributed across scalp sites. Neither the effect of electrode location nor the sentence type by electrode interaction was significant ($F(6, 66) = 2.01$, MSe = 4.75, epsilon = .55, $p > .05$ and $F < 1$, respectively). A similar analysis including lateral electrodes only, with anterior/posterior and left/right hemisphere as factors, did not reveal any significant main effects of these two factors, nor any interaction with sentence type. No effect at all was found in the preceding 0–300 ms latency range ($F < 1$ for both the main effect of sentence type and the sentence type by electrode interaction).

The observed difference in N400 amplitude between metaphoric and control sentences suggests that the (incongruous) literal meaning of the metaphors was indeed accessed during metaphor comprehension. This difference cannot be attributed to differences in terminal words' cloze probabilities as they were very low in both cases. The main difference between the two sentence types was that for control sentences, even if the terminal word was unexpected, its meaning was congruous with the sentence context. On the other hand, for metaphoric sentences, the meaning of the terminal word taken literally was always incongruous with the sentence context.

No evidence of specific ''metaphoric'' processing was observed on late ERP components. While the ERPs to control endings were more positive than those to metaphoric endings in the 600–1000 ms latency band, and while this effect was reversed from 1000 ms to the end of the recording

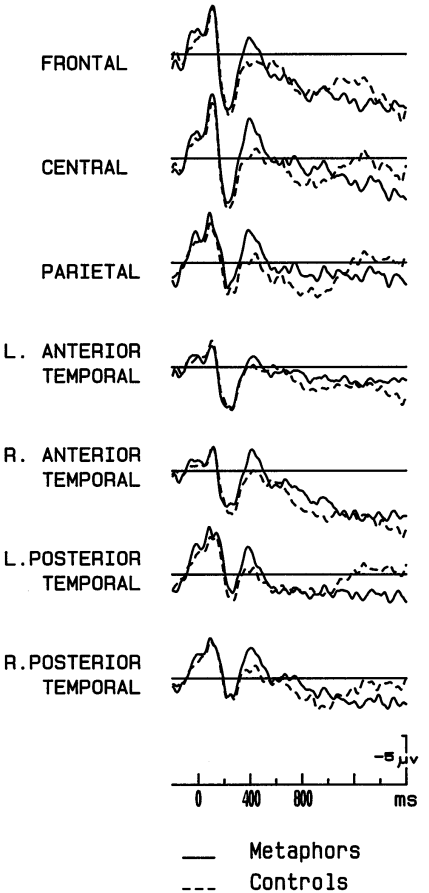

FIG. 1. Grand average ERPs ($N = 12$) for metaphoric and control endings in Experiment 1 (number of trials contributing to the averages (n): for metaphors, $n = 269$; for controls, $n = 261$). In this and subsequent figures, traces corresponding to each recording site are presented and negative is up.

period, these differences did not reach significance. The analysis of variance carried out in these latency bands revealed no significant main effect of sentence type ($F < 1$ in both cases) and no interaction between sentence type and electrode ($F < 1$ and $F(6, 66) = 1.25$, MSe = 4.25, epsilon = .43, $p > .20$).

In order to further examine the influence of metaphoric processing on these late ERP components, familiar metaphors were presented together with unfamiliar metaphors in Experiment 2 (Examples: ''Those fighters are lions'' vs. ''Those apprentices are lions''). Under the hierarchical hypothesis, access to the literal and to the nonliteral meanings corresponds to two distinct pro-

cessing stages, and, assuming that these two stages are reflected by the modulation of distinct ERP components, only late ERP components should be affected by the manipulation of metaphor difficulty. In this framework, the N400 component can be thought to only reflect the processing of the literal meaning, and should not be affected by metaphor difficulty, since the literal meaning is equally incongruous for ''familiar'' and ''unfamiliar'' metaphors. By contrast, under the parallel hypothesis, difficulty in processing the literal meaning on the one hand and the metaphorical meaning on the other should be reflected in the same ERP components. The N400 component in particular should reflect difficulty accessing both meanings, not just the literal one. Thus, one may expect larger N400 components for terminal words of unfamiliar metaphors than of familiar metaphors.

EXPERIMENT 2

Method

Subjects. Twelve subjects (5 women and 7 men, mean age = 22.2 yrs, range = 17–27) participated in one session that lasted for about one hour and a half. All subjects but one were right-handed according to self-report; one of the right-handed subjects had a left-handed relative in his immediate family. None had participated in the previous experiment.

Materials, design, and procedure. The linguistic material was composed of the 48 metaphors used in Experiment 1, plus two additional familiar metaphors. Furthermore, 50 unfamiliar metaphors were derived from the familiar metaphors by scrambling the metaphor topics and vehicles. For example, the two familiar metaphors ''Those fighters are lions'' and ''Those apprentices are jars (clumsy)'' were combined to create an unfamiliar metaphor such as ''Those apprentices are lions.'' Each familiar metaphor was thus paired with an unfamiliar one sharing the same vehicle. Two lists comprised 25 familiar and 25 unfamiliar metaphors and were constructed so that, across lists, each vehicle was presented once in a familiar metaphor and once in an unfamiliar one. In each list, the 50 metaphors were randomly intermixed with 50 new literal filler sentences matched on length and syntactic structure. Thus, each list contained 100 sentences (25 familiar metaphors, 25 unfamiliar metaphors, and 50 literal sentences) and was divided into two blocks of 50 trials. A 10-minute pause was provided between blocks. The procedure was similar to Experiment 1.

Results and Discussion

The results failed to clearly establish an effect of metaphor difficulty, either on the amplitude of the N400 component, or later on. As can be seen in Fig. 2, terminal words were associated with somewhat larger N400 components in unfamiliar (-1.80 uV) than in familiar (-1.30 uV) metaphors. However, results of a two-way ANOVA in the 300–600 ms latency band, including type of metaphors (familiar vs unfamiliar) and electrode (7 levels) as within-subject factors, showed that this difference did not reach significance ($F(1, 11) = 2.64$, MSe = 3.91, $p > .10$). The largest N400 components were observed centro-parietally and over the right hemisphere. The main effect of electrode location was significant ($F(6, 66) = 3.58$, MSe = 8.44, epsilon = .35, $p < .04$). The type of metaphor by electrode interaction was

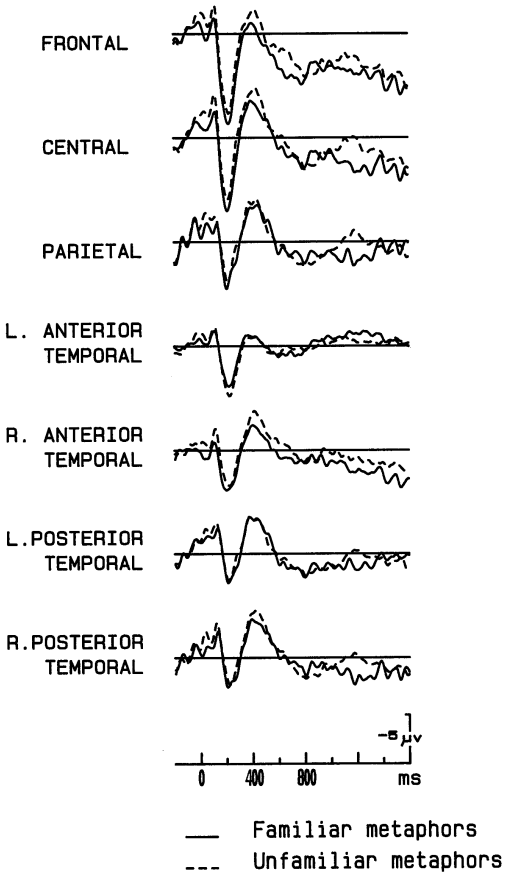

FIG. 2. Grand average ERP ($N = 12$) for familiar ($n = 282$) and unfamiliar metaphors ($n = 278$) in Experiment 2.

not significant ($F(6, 66) = 1.42$. MSe = 1.31, epsilon = .53, $p > .20$). Results of an analysis of midline electrodes only showed that the N400 was significantly larger centro-parietally (Cz = −2.82 uV and Pz = −2.24 uV) than frontally (Fz = −0.42 uV; $F(2, 22) = 5.27$, MSe = 9.11, epsilon = 0.60, $p < .03$). Analysis of the lateral electrodes revealed that the N400 was significantly larger over the right (−2.13 uV) than over the left hemisphere (−1.11 uV; $F(1, 11) = 6.94$, MSe = 3.56, $p < .02$). Neither the main effect of type of metaphor nor the type of metaphor by electrode interaction was significant in the 600–1000 ms, 1000–1400 ms, and 0–300 ms latency bands ($p > .15$ in all cases).

Obviously, no solid conclusion can be drawn from these results. On the one hand, the lack of a clear difference in N400 amplitude is not surprising

if one accepts the view (in keeping with the hierarchical hypothesis) that N400 specifically reflects the processes involved in accessing the literal meaning of metaphors. Indeed, both familiar and unfamiliar metaphors were equivalent as far as their literal meaning was concerned (since the literal meaning was incongruous in both cases). They only differed in regard to the difficulty in finding an acceptable metaphorical meaning. However, the lack of an effect on later ERP components is inconsistent with the hierarchical hypothesis. Finally, the data do not strongly support the parallel hypothesis either, since the difference in N400 amplitude between familiar and unfamiliar metaphors, even if in the expected direction, did not reach significance.

The aim of Experiment 3 was to further examine the time-course of metaphor comprehension when the contrast between the two types of metaphors was strengthened by context manipulation. The same two sets of ''familiar'' and ''unfamiliar'' metaphors that were presented in isolation in Experiment 2 were now preceded by either a relevant or an irrelevant sentence context. Since the aim of this manipulation was to maximize our chances of dissociating two distinct processing stages (if such stages exist), ''familiar'' metaphors were preceded by a relevant context (e.g., ''They are not cowardly: those fighters are lions''), while ''unfamiliar'' metaphors were preceded by an irrelevant context (e.g., ''They are not idiotic: those fighters are squirrels''). The rationale of Experiment 3 was similar to that of Experiment 2. Like metaphor difficulty, context should only affect the metaphorical meaning of sentences. As far as their literal meaning is concerned, both types of context were equally irrelevant. Fighters are not lions, whether cowardly or not. They are not squirrels, whether idiotic or not. If the hierarchical hypothesis is correct, context should only affect some late processing stage, just like metaphor difficulty. The influence of context should consequently be reflected by variations in the late ERP components. Again, if the N400 component is associated with the processing of literal meaning, its amplitude should be unaffected by the manipulation of context. By contrast, the parallel and context-dependent hypotheses predict an immediate influence of context and/or metaphor difficulty on ERPs (the two factors acting in the same direction here), and in particular on the amplitude of the N400 component.

EXPERIMENT 3

Method

Subjects. Twelve subjects (4 women and 8 men, mean age = 24.5 yrs, range = 19–32) participated in one session that lasted for about one and a half hours. All subjects were right-handed according to self-report and three of the right-handed subjects had a left-handed relative in their immediate family. None had participated in previous experiments.

Materials and design. The same 25 familiar and 25 unfamiliar metaphors as in Experiment 2 were presented. However, each metaphoric sentence was preceded by a context sentence ended by a semicolon. All context sentences had the same syntactic structure and contained 5 words. These sentences provided a relevant context for the familiar metaphors (e.g., ''Ils

ne sont pas loquaces: Ces confidents sont des carpes'': They are not talkative: These counselors are carps), and an irrelevant context for the unfamiliar metaphors (e.g., ''Ils ne sont pas obeissants: Ces ingenieurs sont des carpes''; They are not obedient: These engineers are carps). The same literal filler sentences as in Experiment 2 were used and preceded by a relevant context. It could be argued that this kind of context manipulation is likely to affect cloze probabilities as well as processing difficulty, thus potentially introducing a confounded factor in the comparisons. It should be noted, however, that we are specifically interested here in the *locus* of contextual influences (differences expected in either the 300–600 or 600–1000 ms latency bands). Should the (context-dependent) cloze probability of a metaphor's vehicle be shown to specifically affect the LPC component of ERPs, the idea of two distinct processing stages during metaphor comprehension would still be strengthened.

Procedure. The procedure was similar to Experiments 1 and 2. Subjects were informed that they would be presented with a series of short utterances comprised of two parts separated by a semicolon. They were warned that while in some cases the first part of the utterance would help them comprehend the rest of the utterance, in other cases it would hinder comprehension. They were asked to pay attention to both parts of the utterances in order to understand them. Following the instructions, the Ss saw a practice set of 8 trials, half preceded by a relevant context and the other half by an irrelevant context.

Results and Discussion

As can be seen in Fig. 3, the difficulty of metaphorical processing (manipulated here by both metaphor familiarity and context) affected the entire ERP epoch, including the N400 component, and not just the late positive component, as predicted by the hierarchical hypothesis.

Let us consider the 300–600 ms latency band first. A two-way ANOVA, including conditions (familiar vs. unfamiliar) and electrode (7 levels) as factors showed a significant effect of condition ($F(1, 11) = 18.11$, MSe = 11.10, $p < .001$), with larger N400 components for unfamiliar metaphors preceded by an irrelevant context (1.32 uV) than for familiar metaphors preceded by a relevant context (3.50 uV). The distribution of the N400 component was homogeneous across scalp sites. Neither the main effect of electrode location nor the condition-by-electrode interaction was significant ($F(6, 66) = 1.77$, MSe = 12.91, epsilon = .34, $p > .10$ and $F(6, 66) = 1.48$, MSe = 2.27, epsilon = .40, $p > .20$, respectively). A similar analysis, including lateral electrodes only, and with anterior/posterior and left/right hemispheres as factors, did not reveal any significant main effects of these two factors, nor any interaction with sentence type.

The difficulties encountered in processing the metaphorical meaning also modulated the LPC component, with a mean amplitude of 6.14 uV for familiar metaphors preceded by a relevant context vs. 4.27 uV for unfamiliar metaphors preceded by an irrelevant context. The analysis of variance showed a significant effect of condition (600–1000 ms latency band: $F(1, 11) = 7.61$, MSe = 19.29, $p < .01$). The main effect of electrode location was significant ($F(6, 66) = 4.73$, MSe = 21.10, epsilon = .27, $p < .02$). The interaction between conditions and sites was nonsignificant ($F(6, 66) = 1.25$, MSe = 3.16, $p = .30$). Results of post-hoc Tukey (HSD) tests showed that the LPC

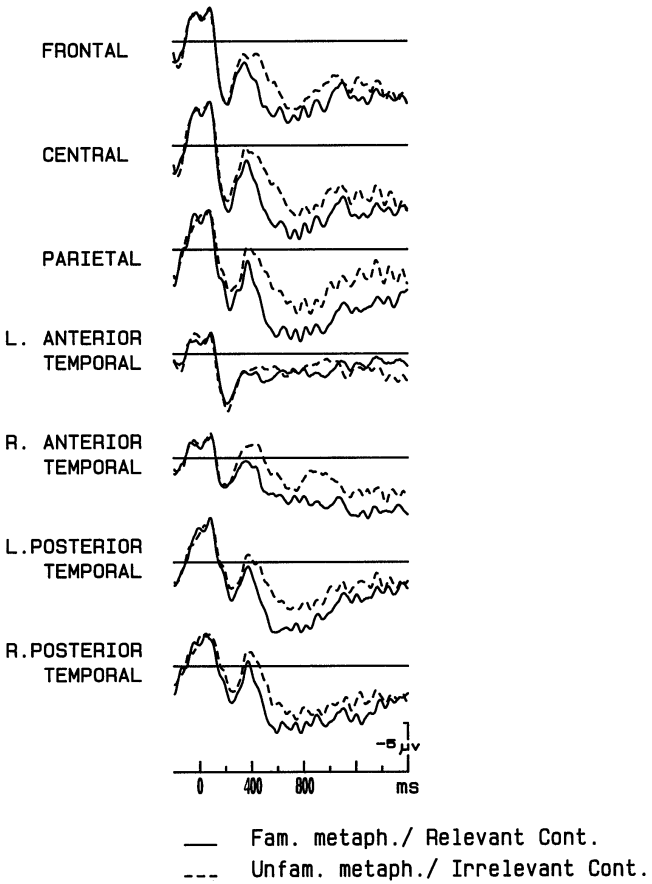

FIG. 3. Grand average ERPs ($N = 12$) for familiar metaphors preceded by a relevant context ($n = 245$) and for unfamiliar metaphors preceded by an irrelevant context ($n = 239$) in Experiment 3.

was smaller at anterior locations (LAT = 1.72 uV and RAT = 3.27 uV) than at the other electrode locations (Fz = 6.53 uV; Cz = 7.27 uV; Pz = 6.91 uV; LPT = 5.41 uV and RPT = 5.35 uV). Finally, ANOVAs carried out in the 1000–1400 ms and 0–300 ms latency bands showed that neither the main effect of condition and electrode location nor the interaction between these two factors was significant.

Considered as a whole the results of Experiment 3 argue against the hierarchical hypothesis. True, the LPC was affected by the manipulation of context and/or metaphor difficulty, as predicted by this hypothesis. However, the finding that the amplitude of the N400 component was also modulated by this manipulation is clearly inconsistent with the notion of two successive

and independent processing steps. This leaves two hypotheses open, namely, the parallel hypothesis stating that both the metaphorical and literal meanings are accessed in parallel, and the context-dependent hypothesis stating that, depending upon the context, the metaphorical meaning is likely to ''short-cut'' the literal one. Experiment 4 was aimed at distinguishing between these two hypotheses by further examining the effect of context on both the N400 and the late positive components during metaphor comprehension.

Unlike Experiment 3 in which the manipulation of context was merely aimed at strengthening the contrast between familiar and unfamiliar metaphors, Experiment 4 specifically focused on the effect of context. In order to obtain a greater contrast between the two context conditions, irrelevant contexts were associated with ''familiar'' metaphors (e.g., ''They are not idiotic: Those fighters are lions''), and relevant contexts with ''unfamiliar'' metaphors (e.g., ''They are not cowardly: Those apprentices are lions''). Moreover, by combining the results of Experiments 2, 3, and 4, it would be possible to independently assess the effect of context on the one hand, and of metaphor difficulty on the other. If the context-dependent hypothesis is valid, a difference between the relevant and irrelevant context conditions should be found on N400 amplitude regardless of the familiarity of the metaphors.

EXPERIMENT 4

Method

Subjects. Twelve subjects (3 women and 9 men, mean age = 24.7 yrs, range = 19–41) participated in one session that lasted for about two hours. All subjects were right-handed according to self-report; one of the right-handed subjects had a left-handed relative in his immediate family. None had participated in previous experiments.

Materials and design. Except for the association of contexts with metaphoric sentences, the linguistic material was the same as in Experiment 3. Unfamiliar metaphors were preceded by a relevant context (e.g., ''They are not cowardly: Those apprentices are lions'') while familiar metaphors were preceded by an irrelevant context (e.g., ''They are not naive: Those fighters are lions''). The same literal filler sentences as in Experiments 2 and 3 were used and were always preceded by a relevant context. The procedure and instructions were similar to those used in Experiment 3.

Results

As can be seen in Fig. 4, somewhat larger N400s were elicited by terminal words ending familiar metaphors preceded by an irrelevant context than unfamiliar metaphors preceded by a relevant context. At most sites this difference lasted until the end of the recording period. A two-way ANOVA, including context (relevant vs irrelevant) and electrode (7 levels) as within-subject factors, showed a significant main effect of context in the 300–600 ms latency band ($F(1, 11) = 4.92$, MSe = 11.61, $p < .04$): the N400 was larger for terminal words ending familiar metaphors (−1.35 uV; irrelevant

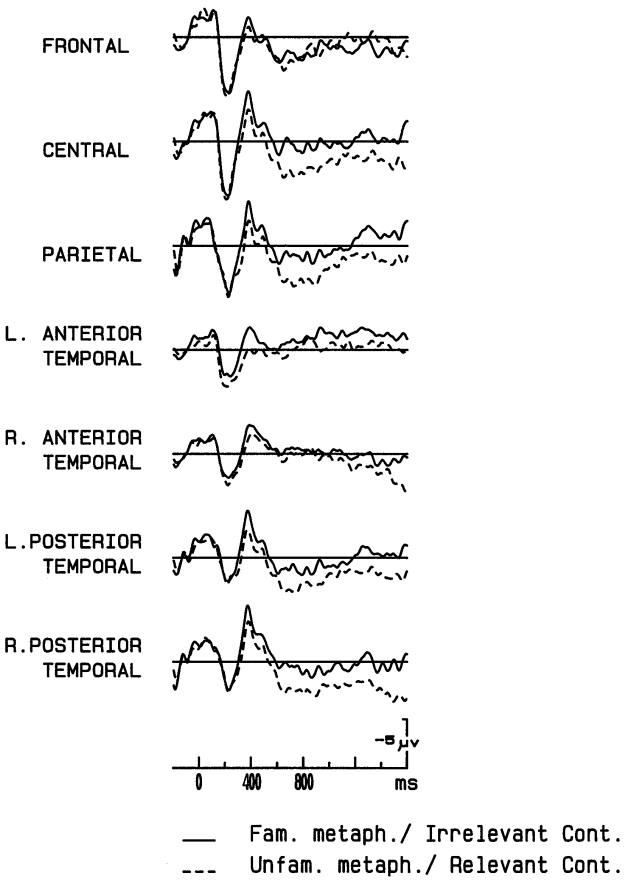

FIG. 4. Grand average ERPs ($N = 12$) for familiar metaphors preceded by an irrelevant context ($n = 261$) and for unfamiliar metaphors preceded by an irrelevant context ($n = 274$) in Experiment 4.

context) than unfamiliar metaphors (−0.18 uV; relevant context). Neither the main effect of electrode location nor the context-by-electrode interaction was significant ($F(6, 66) = 1.81$, MSe = 7.14, $p > .10$ and $F < 1$, respectively). An analysis including anterior/posterior and left/right hemisphere as factors did not reveal any significant difference along the anterior/posterior dimension ($F(1, 11) = 3.44$, MSe = 15.38, $p > .05$) but showed that the N400 was significantly larger over the right hemisphere (−2.13 uV) than over the left (−1.11 uV; $F(1, 11) = 6.94$, MSe = 3.56, $p < .02$).

ANOVAs in the 600–1000 ms latency band also revealed a significant main effect of context ($F(1, 11) = 5.99$, MSe = 6.86, $p < .03$). The LPC was larger in the relevant context condition (1.43 uV) than in the irrelevant

context condition (.12 uV). The LPC was also larger over posterior regions (1.91 uV) than anterior ones (−0.35 uV; $F(1, 11) = 6.27$, MSe = 19.65, $p < .02$). No difference was found between the left and right hemispheres ($F < 1$; see Figure 3). No significant effects were obtained in either the 1000–1400 ms or the 0–300 ms latency band.

Results of Experiment 4 demonstrated a clear effect of context on both the N400 and LPC components, thus providing additional support for the context-dependent hypothesis. The pattern of results in the 300–600 ms latency band is of particular interest here: When preceded by a relevant context, unfamiliar metaphors elicited smaller (not greater) N400 components than familiar metaphors preceded by an irrelevant context.

COMBINED ANALYSES

The influence of context on metaphor comprehension is clearly illustrated by comparing the results of Experiment 4 and Experiment 2 (see Fig. 5). In both experiments, the same metaphoric sentences were presented either in isolation or with a sentence context. A combined analysis of variance was performed on the data of both experiments. The results revealed a significant interaction between metaphor difficulty and experiment in the 300–600 ms latency band ($F(1, 22) = 7.47$, MSe = 57.97, $p < .01$). While the N400s were somewhat larger for unfamiliar than familiar metaphors in Experiment 2, they were larger for familiar than unfamiliar metaphors in Experiment 4 (unfamiliar–familiar in Experiment 2: −.50 uV and in Experiment 4: +1.17 uV; see Fig. 5). The manipulation of context in Experiment 4 thus reversed the pattern of results found in Experiment 2. The interaction between metaphor difficulty and experiment approached significance in the 600–1000 and 1000–1400 ms latency bands ($F(1, 22) = 3.50$, MSe = 55.09, $p < .07$ and $F(1, 22) = 3.33$, MSe = 97.66, $p < .08$) but was not significant in the 0–300 ms latency band ($F(1, 22) = 1.79$, MSe = 21.13, $p > .15$).

In Experiment 4, familiar metaphors were preceded by an irrelevant context, and unfamiliar metaphors by a relevant context, while the reverse was true in Experiment 3. In order to independently assess the respective effects of metaphor difficulty and type of context in both experiments, a combined analysis was performed on the data of Experiments 3 and 4. Except for the 0–300 ms range ($F < 1$), the main difference between experiments was significant in all latency bands (300–600 ms: $F(1, 22) = 7.08$, MSe = 120.50, $p < .01$; 600–1000 ms: $F(1, 22) = 9.46$, MSe = 137.52, $p < .005$; 1000–1400 ms: $F(1, 22) = 7.05$, MSe = 148.73, $p < .01$), with the ERPs being more positive in Experiment 3 than in Experiment 4 (see Fig. 5). This combined analysis did not, however, reveal a significant main effect of metaphor difficulty (300–600 ms range: $F(1, 22) = 1.93$, $p > .15$; 600–1000 ms and 1000–1400 ms: $F < 1$ in both cases).

The effect of context was clearly reflected by a significant interaction be-

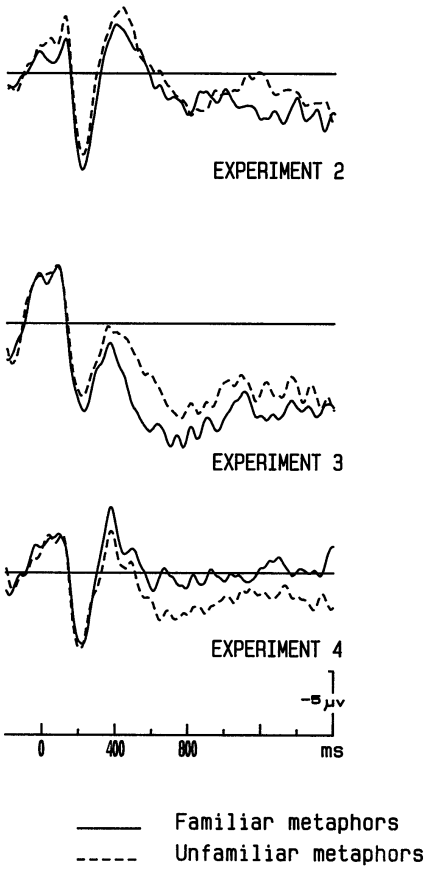

FIG. 5. Comparison of the ERPs recorded at the central site (Cz) for familiar and unfamiliar metaphors in Experiments 2, 3, and 4.

tween experiment and metaphor difficulty in the three latency bands of interest (300–600 ms: $F(1, 22) = 20.81$, MSe = 236.26, $p < .001$; 600–1000 ms: $F(1, 22) = 10.88$, MSe = 232.42, $p < .003$; 1000–1400 ms: $F(1, 22) = 4.06$, MSe = 158.26, $p < .05$). While larger N400s were observed for unfamiliar (1.32 uV) than for familiar (3.50 uV) metaphors in Experiment 3, the reverse pattern was found in Experiment 4 (unfamiliar = −.18 uV vs familiar = −1.35 uV). Moreover, while the LPC was larger for familiar (600–1000 ms: 6.14 uV; 1000–1400 ms: 4.78 uV) than unfamiliar metaphors (600–1000 ms: 4.27 uV; 1000–1400 ms: 3.24 uV) in Experiment 3, the reverse pattern of results was found in Experiment 4 with the larger LPC for unfamiliar (600–1000 ms: 2.00 uV; 1000–1400 ms: 1.08 uV) than familiar metaphors (600–1000 ms: 0.55 uV; 1000–1400 ms: 0.11 uV). The interac-

TABLE 1
Mean Values Recorded over Electrodes in Three Latency Bands for the Relevant-Context, Irrelevant-Context, and No-Context Conditions (Familiar and Unfamiliar Metaphors Combined)

	Latency band		
Context	300–600	600–1000	1000–1400
Relevant	+1.66 (3.40)	+3.78 (4.14)	+2.93 (4.65)
Irrelevant	−.02 (3.47)	+2.19 (4.17)	+1.56 (4.84)
No-context	−1.55 (3.64)	+1.42 (3.92)	+1.20 (4.67)

Note. Standard deviation is indicated between brackets.

tion between experiment and type of context was not significant in the 0–300 ms latency band ($F < 1$).

The results of the combined analysis of Experiments 3 and 4 thus confirm the lack of influence of metaphor difficulty. On the other hand, they demonstrate a large influence of context on metaphor comprehension, with larger N400s and smaller LPCs for irrelevant contexts than for relevant contexts. In order to further examine the effect of context, the mean amplitude values for familiar and unfamiliar metaphors in each latency band were averaged across Experiments 3 and 4.

As shown in the first two lines of Table 1, the mean amplitudes were more positive for relevant than irrelevant context conditions in all three latency bands. Such a difference found as early as 300 ms after terminal word onset demonstrate the early influence of context on metaphor comprehension. The last row in Table 1 corresponds to the no-context condition (Experiment 2), with the averages of the mean amplitude values for familiar and unfamiliar metaphors. The N400 component is larger (i.e., the mean amplitude was less positive) in this control, no-context condition than in the relevant context condition. More interestingly, the N400 component was also larger in the no-context condition than in the irrelevant-context condition. This may result from the fact that, in the context condition, the target words were preceded by more linguistic materials than in the no-context condition. Whatever the reason for the somewhat paradoxical decrease in N400 amplitude in the irrelevant context condition as compared to the no-context condition, it is important to note that there was no context-dependent *increase* in N400 amplitude in any of the experiments. This point will be further discussed in the General Discussion.

GENERAL DISCUSSION

In a series of four experiments, ERPs were used as an index for tracking two potentially distinct stages of metaphor comprehension, namely, (a) accessing the literal meaning and (b) discovering the metaphorical interpreta-

tion. In order to pinpoint the first stage within the pattern of ERPs, a set of literally incongruous metaphors was selected; an effect of the incongruity of the literal meaning was indeed observed in Experiment 1.

It could be argued that the interpretation of this result critically depends on the choice of the initial set of metaphors. The amplitude of the N400 component found in Experiment 1 would probably have been smaller had more familiar metaphors been used. This is a general question which does not concern this experiment only. Metaphors do not form a homogeneous category. There is a continuum from ''lexical'' metaphors, whose meanings are probably stored in the mental lexicon (e.g., ''X is a pig''), to completely new ones. The consequence is that no general account of metaphor comprehension can be proposed. Some metaphors seem to be ''directly'' understood, even when presented in isolation, while others cannot be understood without the help of a least some contextual support (Glucksberg et al., 1982). Another consequence is that the linguistic material has to fit with the goal being pursued. The aim of the present paper was to analyze the time course of literal and metaphorical processes, and metaphors were chosen so that two such stages would be likely to occur. The results of Experiment 1 merely suggest that the set of metaphors we used were not too easy to understand. A similar choice was made by Gildea and Glucksberg (1983) in their stroop-like experiment. They clearly indicate in their paper that the metaphors used were chosen because they were hard to understand when presented in isolation.

Given the effects observed on the N400 component in Experiment 1, the rationale behind Experiments 2 and 3 was to manipulate the difficulty of metaphorical interpretation through metaphor familiarity and context, while keeping the literal meaning constant. The question raised was whether such a manipulation would affect a different component of the ERPs, or whether the N400 would be affected by both the incongruity of the literal meaning and the difficulty of metaphorical processing. All attempts to isolate two distinct processing stages were totally unsuccessful. The manipulation of context led to late effects on the LPC, as expected, thus suggesting that the search for the metaphorical meaning indeed lasted for at least 1000 ms. However, whenever such a late effect was observed, an effect was also observed on N400. This suggests that the search for a metaphorical meaning actually began early in the comprehension process, apparently while the literal meaning was being accessed. This pattern of results seems to argue against the hierarchical hypothesis of metaphor comprehension.

Do we have any evidence allowing us to choose between the other two hypotheses referred to in the introduction, namely the parallel and context-dependent hypotheses? Clearly the manipulation of context had an influence on the amplitude of the N400 component in both Experiments 3 and 4, thus lending some support to the context-dependent hypothesis. It is important to note in this respect that the manipulation of context in Experiment 4 re-

sulted in a complete reversal of the pattern of results as compared to the no-context condition of Experiment 2. The influence of context was also demonstrated in the combined analysis of Experiments 3 and 4 that revealed a significant effect of context on the N400 component, and no effect of metaphor difficulty. More importantly, the effect of context was mainly facilitative (to the extent that it was reflected by a decrease in N400 amplitude). It is clear that the metaphorical meaning was boosted in the relevant context condition (see Table 1). This sole facilitative effect is not sufficient for concluding in favor of the context-dependent hypothesis. Indeed, it is still possible to argue that in the relevant context condition, the literal meaning was accessed as well (the outcome thus being parallel access to both meanings). In order to conclude in favor of the context-dependent hypothesis, one must know whether the literal meaning was actually ''shortcut'' in the relevant context condition. Obviously, the answer to this question depends on the interpretation given to the observed variations in the amplitude of the N400 component. Two positions are possible here: First, N400 can be interpreted as specifically reflecting the processes involved in accessing the literal meaning. According to this view, the smaller N400 component observed in the relevant context condition reflects the fact that the literal meaning was no longer accessed in this condition (in keeping with the context-dependent hypothesis). However, the N400 amplitude can also be thought to depend on the difficulties encountered in processing both the literal and metaphorical meanings (thus supporting the parallel hypothesis).

The two interpretations discussed above make clearly distinct predictions concerning the direction of contextual influences during the early stages of metaphor interpretation. If variations in N400 amplitude reflect the difficulty encountered in processing both the literal and the metaphorical meanings, increasing the difficulty of accessing the metaphorical meaning by providing an irrelevant context should be associated with an increase in N400 amplitude. By contrast, if variations in N400 amplitude are specifically linked to the processes involved in accessing the literal meaning, providing an irrelevant context should not increase N400 amplitude, since the literal, incongruous meaning is not likely to be rendered more incongruous by the context. Thus, the lack of an N400 amplitude increase in the irrelevant context condition provides an argument favoring the view that N400 amplitude is mainly modulated by the degree of incongruity of the literal meaning, and not by the difficulties encountered in accessing the metaphorical meaning, a conclusion that clearly argues against the parallel hypothesis.

Taken together, our results thus provide some argument in favor of the context-dependent approach of metaphor comprehension. However, the fact that *smaller* N400 components were obtained in the irrelevant context condition than in the no-context condition still remains to be explained. Let us assume that the context-dependent hypothesis is correct. There is no reason why metaphorical processing should be facilitated in the irrelevant-context

condition. It thus seems difficult to argue, as we did for the relevant-context condition, that an early nonliteral interpretation was available and shortcut the search for the literal meaning. A context-dependent account would actually lead to predict a lack of difference between the irrelevant-context and the no-context conditions in the 300–600 latency band, and not a decrease in N400 amplitude as we found. This aspect of our results clearly calls for further theoretical elaborations as well as more empirical work.

APPENDIX: METAPHOR SET (''FAMILIAR'' CONDITION)

Ces bébés sont des agneaux.	*Those babies are lambs (sweet)*
Ces bambins sont des anges.	*Those tiny tots are angels (well-mannered)*
Ces dockers sont des armoires.	*Those dockers are chests (big and strong)*
Ces révélations sont des bombes.	*Those scoops are bombs (explosive)*
Ces confidents sont des carpes.	*Those counselors are carps (mute)*
Ces ingénieurs sont des cerveaux.	*Those engineers are brains (clever)*
Ces centenaires sont des chênes.	*Those centenarians are oaks (indestructible)*
Ces pacifistes sont des colombes.	*Those pacifists are doves (gentle)*
Ces matadors sont des coqs.	*Those matadors are roosters (arrogant)*
Ces chomeurs are couleuvres.	*Those unemployed are grass snakes (indolent)*
Ces apprentis sont des cruches.	*Those apprentices are jars (clumsy)*
Ces épargnants sont des écureuils.	*Those savers are squirrels (provident)*
Ces courtisans sont des encensoirs.	*Those courtiers are censers (flattering)*
Ces savants sont des encyclopédies.	*Those sages are encyclopedias (erudite)*
Ces clochards sont des épaves.	*Those bums are shipwrecks (devastated)*
Ces buveurs sont des éponges.	*Those drinkers are sponges (absorbent)*
Ces matrones sont des hippopotames.	*Those matrons are hippopotamuses (fat)*
Ces estivants sont des lézards.	*Those vacationers are lizards (lazy)*
Ces fuyards sont des lièvres.	*Those fugitives are hares (rapid)*
Ces combattants sont des lions.	*Those fighters are lions (brave)*
Ces chercheurs sont des lumières.	*Those researchers are lights (intelligent)*
Ces observateurs sont des lynxs.	*Those observers are lynxes (keen-sighted)*
Ces oeuvres sont des monuments.	*Those works are monuments (impressive)*
Ces opposants sont des mules.	*Those opponents are mules (obstinate)*
Ces vétérans sont des renards.	*Those veterans are foxes (sly)*
Ces sauteurs sont des cabris.	*Those high-jumpers are baby-goats (light-footed)*
Ces tacots sont des casseroles.	*Those jalopies are pots and pans (noisy)*
Ces flambeurs sont des cigales.	*Those gamblers are cicadas (wasteful)*
Ces coureurs sont des fusées.	*Those racers are rockets (fast)*
Ces sorcières sont des guenons.	*Those witches are female apes (ugly)*
Ces controleurs sont des horloges.	*Those controllers are clocks (regular)*
Ces danseuses sont des libellules.	*Those ballerinas are dragonflies (graceful)*
Ces paresseux sont des marmottes.	*Those lazybones are marmots (sleepy)*
Ces gringalets sont des moustiques.	*Those small men are mosquitos (small and light)*
Ces novices sont des oies.	*Those novices are geese (naive)*
Ces ermites sont des ours.	*Those hermits are bears (unsociable)*
Ces commères sont des pies.	*Those gabbers are magpies (talkative)*
Ces sentinelles sont des piquets.	*Those sentries are posts (stiff)*
Ces goinfres sont des porcs.	*Those gluttons are swine (dirty)*
Ces gymnastes sont des ressorts.	*Those gymnasts are springs (energetic)*
Ces répétiteurs sont des robots.	*Those tutors are robots (mechanical)*

Ces procureurs sont des rocs.	*Those prosecutors are rocks (inflexible)*
Ces espions sont des serpents.	*Those spies are snakes (tricky)*
Ces dormeurs sont des souches.	*Those sleepers are logs (inert)*
Ces gardes sont des statues.	*Those guards are statues (motionless)*
Ces attaquants sont des tanks.	*Those attackers are tanks (destructive)*
Ces manuscrits sont des torchons.	*Those manuscripts are rags (illegible)*
Ces flâneurs sont des tortues.	*Those dawdlers are turtles (slow)*
Ces acrobates sont des tourbillons.	*Those acrobats are whirlwinds (breathtaking)*
Ces passionnés sont des volcans.	*Those lovers are volcanos (hot-blooded)*

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