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Finding the Locus of Semantic Satiation: An Electrophysiological Attempt

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The present study examined the effect of massed repetition of an initial category name upon the subsequent semantic categorization of a target word by means of an electrophysiological measure of semantic processing: the N400. Results showed the classic N400 effect, whereby evoked potentials were more negative for targets that were not members of the repeated category than for member targets. Moreover, repetition of the category name led to an increased and sustained positivity. The N400 effect was not modified, however, by repetition. Hence, insomuch as the N400 reflects meaning integration processes, these results do not support the hypothesis that massed repetition exerts its influence at the level of meaning integration.

INTRODUCTION

What is the effect of massively repeating a word upon the subsequent retrieval of the meaning of that word? Despite numerous studies dealing with this question, a clear-cut answer has yet to be provided. As brought out in

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an early, extensive review of the ‘‘semantic satiation’’ phenomenon (Esposito & Pelton, 1971), the experimental evidence obtained up to then was neither homogeneous nor wholly convincing. In their review, the authors point out not only the inconsistency of results across, and even within, studies, but also various flaws and limitations of the studies they cite. The conclusion of this review, which assessed several methods of measuring the semantic satiation phenomenon, across a large number of studies, was that there was inconclusive evidence to sustain the idea that massed repetition leads to the loss of meaning of a repeated word. The authors further suggest that the subjective reports of loss of meaning are secondary to the real cause of the phenomenon, such being the perceptual reorganization of the repeated word. That is, the continuous verbal repetition of a word would entail the transformation, or reorganization, of this perceptual unit, into something which itself is meaningless to the subject.

The effect of the Esposito and Pelton (1971) review of the semantic satiation literature was, as highlighted by Smith and Klein (1990), to apparently quell interest in the matter for several years. However, with the research on the spread of semantic activation within the lexicon (Meyer & Schvaneveldt, 1971; Neely, 1977a) came a renewal of interest for semantic satiation. Cohene, Smith, and Klein (1978) ran three experiments which aimed at looking for semantic satiation in primed lexical decision. The underlying logic, first brought out by Neely (1977b), was that if semantic satiation inhibits access to the meaning of the repeated word, then the priming advantage found when the target is preceded by a single presentation of a related prime word (compared to an unrelated prime) should be reduced when the prime is repeated massively. This prediction did not bear out, however. Cohene et al. (1978) found, as did Neely (1977b), that numerous repetitions of the prime word (during a 30-sec time period) did not reduce the priming advantage produced by a single repetition of the prime. From their results, Cohene et al. (1978) concluded that repeating a word does not lead to a loss of meaning of the word. They argued, in similar fashion to Esposito and Pelton (1971), that what is fatigued is the internal representation of the word, which, due to continuous repetition, undergoes a transformation such that it no longer corresponds to the original input. In both of these studies (Cohene et al., 1978; Esposito & Pelton, 1971), the authors concluded that the feeling of loss of meaning of a repeated word is a secondary phenomenon, linked to task demands.

In more recent studies, however, this conclusion has been questioned (Pynte, 1991; Smith, 1984; Smith & Klein, 1990). Smith (1984) examined the effect of massed repetition on category membership decisions and on the magnitude of priming in a lexical decision task. As in previous studies which examined these two tasks independently, Smith found that massed repetition (30 vs. 3 repetitions) slowed category membership decisions, but did not affect the magnitude of the priming effect in lexical decision. The author argued that the discrepancy between the results obtained for these two tasks may be linked to the appropriateness of the lexical decision task as an index of meaning retrieval. That is, lexical decisions can theoretically be made without accessing the meaning of a word (see also Balota & Chumbley, 1984), and also without reference to a preceding prime word. Neither of these assumptions can be maintained for the category membership task. It is of interest to note, however, that in Smith's (1984) study, support for semantic satiation was not as strong as it might have been in the category membership task. In this task, the effect of repetition was apparent only when the target was a member of the category. Repetition of the category did not slow negative responses. As such, it is possible that what produced the effect of inhibition to the target was some type of predictive and/or rehearsal process pertaining to the target (cf. Blaxton & Neely, 1983). For example, if subjects covertly rehearsed a set of typical exemplars during repetition, this would produce inhibition in the instance that the target was a member but not one of those rehearsed by the subject. In such case, the effect of ''semantic satiation'' would be linked to the target and not to the repeated word.

Smith's (1984) study left two issues unresolved. First, why is semantic satiation found in a category membership task but not in primed lexical decision? Second, is the effect of repetition found in category membership tasks truly semantic satiation, or is it due to some strategic rehearsal process linked to the target? Pynte (1991) addressed the latter question by manipulating the strength of association between the category name and target exemplar, in a classic semantic satiation task (i.e., 3 vs. 30 repetitions of a category name, followed by a target word to be classified). Pynte's results showed the typical effect, whereby repetition of the category slowed classification times of targets; however, this effect was true for positive and negative responses alike. This result differs from those of Smith (1984), and of Smith and Klein (1990), who found that the effect of repetition on response time was restricted to positive responses. Moreover, the effect of repetition in Pynte's (1991) study was found for both strong and weak members of the category (e.g., ''animal–dog'' and ''animal–fox''). This weakens the hypothesis that the satiation effect is due to a predictive guessing strategy, whereby subjects generate a few, highly typical members of the category while repeating the category. Pynte (1991) argued, to the contrary, that the effect of ''semantic satiation'' is linked to the controlled access to the meaning of the prime. That is, following repetition, when the subject attempts to reaccess the meaning of the category in order to make the category judgement concerning the target, the intentional access of the prime is temporarily blocked by repetition. This would explain why repetition does not affect semantic priming in the primed lexical decision task, because there is no need to reaccess the prime word to make a lexical decision to the target. In the category judgement task, however, the subject does have to consider the meaning of the prime.

Smith and Klein (1990) directly addressed the question of why semantic satiation occurs in a category membership task and not in primed lexical decision. In a first experiment, they rendered the meaning of the repeated category name irrelevant, while still having subjects perform a categorical decision. That is, subjects repeated a category name (e.g., flower) and then had to decide whether a pair of target words belonged to the same category or not, independently of whether they belonged to the repeated category (e.g., ''rose–daisy'' and ''truck–bus'' both elicited positive responses). The results showed that repetition slowed response times to target pairs that were members of the repeated category (rose–daisy), but not to pairs that belonged to another category (truck–bus). From these results, Smith and Klein argued that semantic satiation occurs even when the repeated category is irrelevant and as such that it is not the conscious processing of the category that differentiates the category membership task from the primed lexical decision task. However, it can be noted that in order to determine whether two words of a pair belong to the same category, the subject must indeed access the category. Otherwise stated, the ''irrelevance'' of the repeated category in the first experiment of Smith and Klein (1990), and thus their conclusion is in fact questionable. On the other hand, Pynte's hypothesis that semantic satiation is linked to the controlled access of the repeated category can account for these results, by assuming that access (to the category) would be blocked for pairs belonging to the repeated category but not for pairs belonging to another category.

From the ensemble of studies of the semantic satiation phenomenon conducted since the Esposito and Pelton (1971) critical review, the following conclusions can be drawn. First, the phenomenon does seem to exert a robust effect on the speed of categorical judgements (Pynte, 1991; Smith, 1984; Smith & Klein, 1990). Moreover, this effect does not appear to be linked to a strategic guessing or rehearsal process pertaining to the target word (Pynte, 1991), but can be said to be linked to the repeated word itself (i.e., the category name). The effect of semantic satiation does not, apparently, affect the magnitude of priming in a primed lexical decision task (Cohene et al., 1978; Neely, 1977b; Smith, 1984). The most parsimonious account of the combination of these results appears to be that massed repetition of a word leads to the temporary blocking of the access to the meaning of that word. This would explain both why the effect is found for categorical judgements, which involve accessing the meaning of the repeated word, and why it is not found for primed lexical decision, since there is no need to reaccess the meaning of the prime in order to make a lexical decision.

The present experiment aimed at further studying the semantic satiation phenomenon, using an electrophysiological approach. Event-related potentials (or ERPs) allow a noninvasive and direct measure of the variations in the brain's electrical activity, time-locked to the presentation of a specific event. As such, they have provided important information regarding the nature and time course of the processes involved in linguistic processing (see

Kutas & Van Petten, 1988; Fischler & Raney, 1991; Garnsey, 1993, for extensive reviews). One component of the ERPs, in particular, the N400, first described by Kutas and Hillyard (1980), has been widely studied in psycholinguistic experiments. Results have shown that the N400 is a good index of semantic processing. More specifically, N400 amplitude is modulated by the degree to which a word is expected relative to the preceding linguistic context (be it a sentence or a single word). Words which are semantically unrelated, unexpected, or incongruous relative to a preceding prime word or sentence context are associated with larger N400 components than are expected, congruous, or primed words (Bentin, McCarthy, & Wood, 1985; Boddy, 1986; Brown & Hagoort, 1933; Fischler, Bloom, Childers, Roucos, & Perry, 1983; Holcomb, 1988; Holcomb & Neville, 1990; Kutas & Hillyard, 1984, 1989; Rugg, 1985, 1987). It has been argued that the N400 reflects semantic integration, that is, the process by which the meanings of words are integrated to form a coherent mental representation (Besson & Kutas, 1993; Brown & Hagoort, 1993; Halgren & Smith, 1987; Holcomb, 1993; Rugg, 1990).

Although to our knowledge, ERPs have not yet been used to investigate the semantic satiation effect, it is immediately apparent from the above-stated results that the N400 component can provide important insights into this phenomenon. A semantic categorization task was used in the present experiment, in which a category name (e.g., ‘‘bird’’) was repeated aloud either 3 or 30 times and was then followed by a target word that either did or did not belong to the repeated semantic category (e.g., ‘‘robin’’ vs. ‘‘chair’’). Based on previous results (Bentin et al., 1985; Boddy, 1986; Brown & Hagoort, 1933; Holcomb, 1988; Holcomb & Neville, 1990; Kutas & Hillyard, 1989), we expected the N400 to be reduced for words that belonged to the semantic category compared to those than did not. This prediction pertains when the category was repeated 3 times, which is closest to typical conditions of presentation in N400 studies. Of particular interest is what happens when the category is repeated 30 times. If, as suggested by Smith (1984) and Smith and Klein (1990), semantic satiation exerts its influence at the level of integration of a word’s meaning, or if, as proposed by Pynte (1991), controlled access to the meaning of the category is inhibited after 30 repetitions, then N400 amplitude should not differ as a function of the target word’s status following 30 repetitions of the category. In other words, if the meaning of the category is lost or ‘‘satiated’’ after 30 repetitions, whether the target word does or does not belong to the semantic category is no longer relevant, and similar N400 components should be elicited for member and nonmember targets. One would thus expect the N400 effect (i.e., the difference between member and nonmember targets) to be smaller after 30 than after 3 repetitions. This hypothesis leads one to predict a localized effect of semantic satiation on the N400 component, which typically develops in the 300- to

600-ms latency band after target onset. However, as mentioned previously, other authors have suggested that the semantic satiation phenomenon may reflect aspects of perceptual processing rather than semantic processing difficulties (Cohene et al., 1978; Esposito & Pelton, 1971; Esposito, 1987) and/or memory retrieval (Tyson & Fleming, 1987). As such, while repetition of the category may affect the early components associated with perceptual processing (Hillyard & Picton, 1987) or the late components associated with aspects of memory (Kutas, 1988), it should not affect N400. That is, if meaning integration occurs in similar fashion following 3 and 30 repetitions of the target, then the amplitude of the N400 effect should not differ as a function of repetition. The present experiment was designed to test these alternative hypotheses.

METHOD

Subjects. Twenty-three subjects (9 women, 14 men; mean age = 21 years, range = 19–26 years) were tested individually and were paid for their participation in a single session that lasted approximately 2 hr. All subjects but one were right-handed according to self-report, and none of the right-handed subjects had a left-handed relative in their immediate family. All subjects were native French speakers from Aix-Marseille University and had normal or corrected-to-normal vision. Data from seven subjects were discarded from subsequent analyses because of technical problems mainly linked to the perturbation of the EEG due to the vocal response required from the subject.

Materials and design. The stimuli comprised 68 category names and the first or second highest exemplar from each category. Four different production norms were used (Battig & Montague, 1969; Rosch, 1975; Tourette, 1979; Uyeda & Mandler, 1980). A trial consisted of an initial category name (e.g., ''flower'') followed by a target word that either did or did not belong to the initial category name (e.g., ''rose,'' ''table'') The category name comprised 3 to 10 letters (mean length = 7) and the target words comprised 3 to 12 letters (mean length = 6.2). All stimulus materials were presented in French. Two lists were constructed. In each list, half of the category name–target word pairs were category–exemplar pairs (i.e., semantically related) and half were mismatched (i.e., semantically unrelated). Furthermore, half of the category names were repeated 3 times and the other half 30 times. Word pairs were counterbalanced across lists so that targets preceded by a related category name in List 1 were preceded by an unrelated category in List 2, and category names repeated 3 times in List 1 were repeated 30 times in List 2, and vice versa. Subjects were presented with one of the two lists, depending upon their order of arrival in the laboratory. For each list, two different pseudorandom orders of presentation of the word pairs were used, with the restriction that no more than three trials belong to the same condition. The experiment comprised two blocks, with half of the trials being presented in each block. Within each block, half of the words pairs were semantically related and the other half were unrelated, half of the category names were repeated 3 times and the other half 30 times. In addition to the experimental trials, eight trials (two of each type) were used for practice in an initial training block at the beginning of the experiment.

Procedure. Words were written in lowercase (including diacritics where appropriate) and were presented in the center of a CRT screen placed 60 cm in front of the subject. The timing within a trial was as follows. The category name appeared on the screen together with the number 3 or 30 above it, which indicated to the subject how many times s/he had to repeat the category aloud. This number was then decremented by one every second which indicated to the subject the pace at which s/he should repeat the category. When the subject had repeated

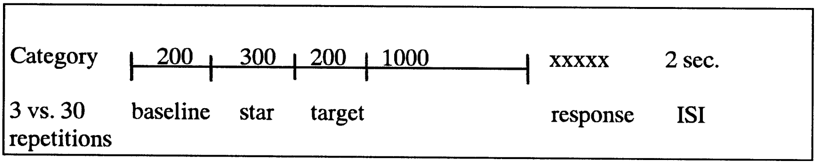

DIAGRAM 1. Time sequence of events.

the category either 3 or 30 times, a star appeared on the screen for 300 msec, signaling the end of repetitions. The star was immediately followed by a target word, presented for 200 msec, that did or did not belong to the initial category. A row of Xs was then presented 1200 msec after word onset, and subjects were asked to press a key under their right index finger if the word belonged to the category and the key under their left index finger if it did not (see Diagram 1). Response to the target was delayed to avoid motor activity associated with the manual response from contaminating the ERP to the target. Subjects were asked to avoid blinking from the onset of the star until the row of Xs appeared on the screen, and they were trained to blink during a 2-sec intertrial interval. Following the giving of instructions, subjects saw a practice set of 8 trials. The experiment was controlled by a Compaq 486 personal computer.

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 over anterior–temporal (10% of the interaural distance lateral to Cz and 20% of the distance between this point and FPz on the left and on the 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 on the right), each referred to the left mastoid. Eye movements and blinks were monitored via an electrode on the lower orbital ridge referred to the left mastoid. The EEG was amplified by Grass P5 RPS107 amplifiers with a 0.01- to 30-Hz (half-amplitude cutoff) bandpass. The sampling rate was 250 Hz. Approximately 10% of the trials were contaminated with eye movements or muscle artifacts; these were rejected off-line. Total number of trials entered into analyses were 231, 225, 232, and 236, for positive and negative targets in the 3-repetition condition and 30-repetition condition, respectively. Electrode impedances never exceeded 3 kOhms.

Data analysis. ERPs were averaged off-line for a 1700-msec epoch, within each condition for each subject, and time-locked to the onset of the star. The ERP data were analyzed by computing the mean amplitude in selected latency windows relative to a baseline computed within the 200 msec that preceded the presentation of the star. In line with previous literature, the N400 component was measured in the 300- to 600-msec range. Repeated measures analyses of variance (ANOVAs) were carried out, with the Greenhouse–Geisser correction for inhomogeneity of variance applied where appropriate. Reported below are the uncorrected degrees of freedom, the epsilon value, and probability level following correction.

RESULTS

As can be seen in Fig. 1, the ERPs elicited by the target words were more positive after 30 than after 3 repetitions of the prime. This effect was present from the onset of the target word until the end of the recording period, for both ‘‘yes’’ and ‘‘no’’ responses. Furthermore, as can be seen in Fig. 2, large negative components, in the 300- to 600-msec latency band, were associated

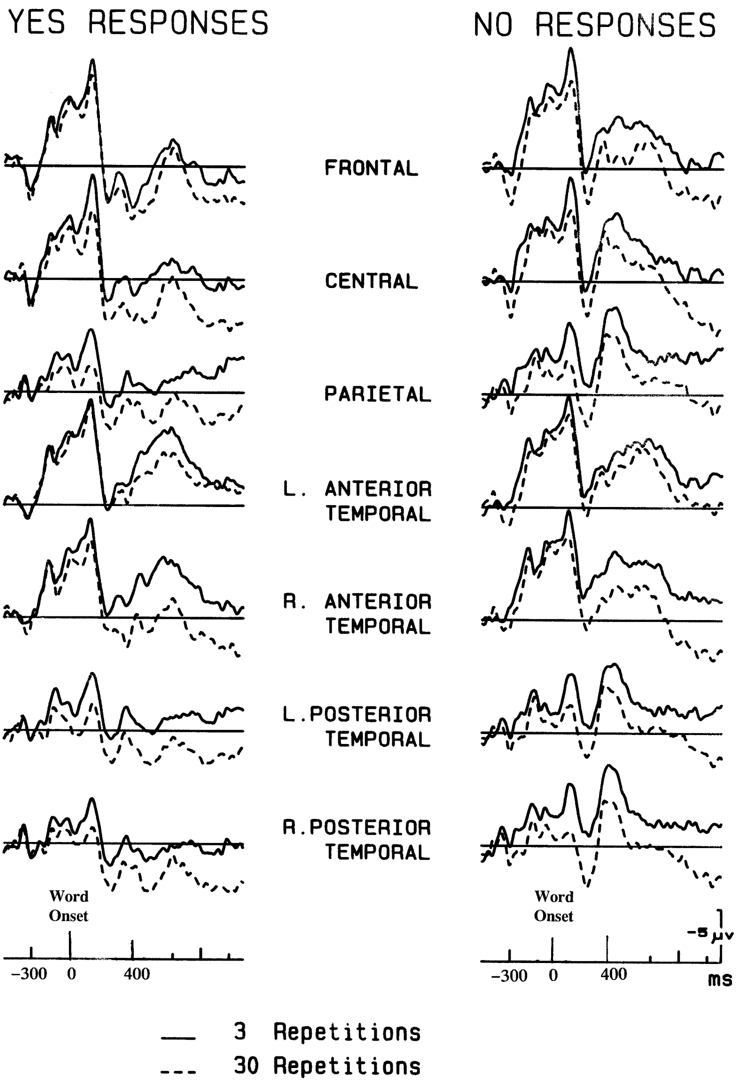

FIG. 1. Grand average ERPs ($N = 16$) for target words that did (Yes responses) or did not (No responses) belong to the semantic category defined by the prime word that was repeated 3 or 30 times (number of trials contributing to the averages (n)): for Yes responses, 3 repetitions $n = 222$ and 30 repetitions $n = 225$; for No responses, 3 repetitions $n = 229$ and 30 repetitions $n = 234$). Traces corresponding to each recording site are presented and negative is up.

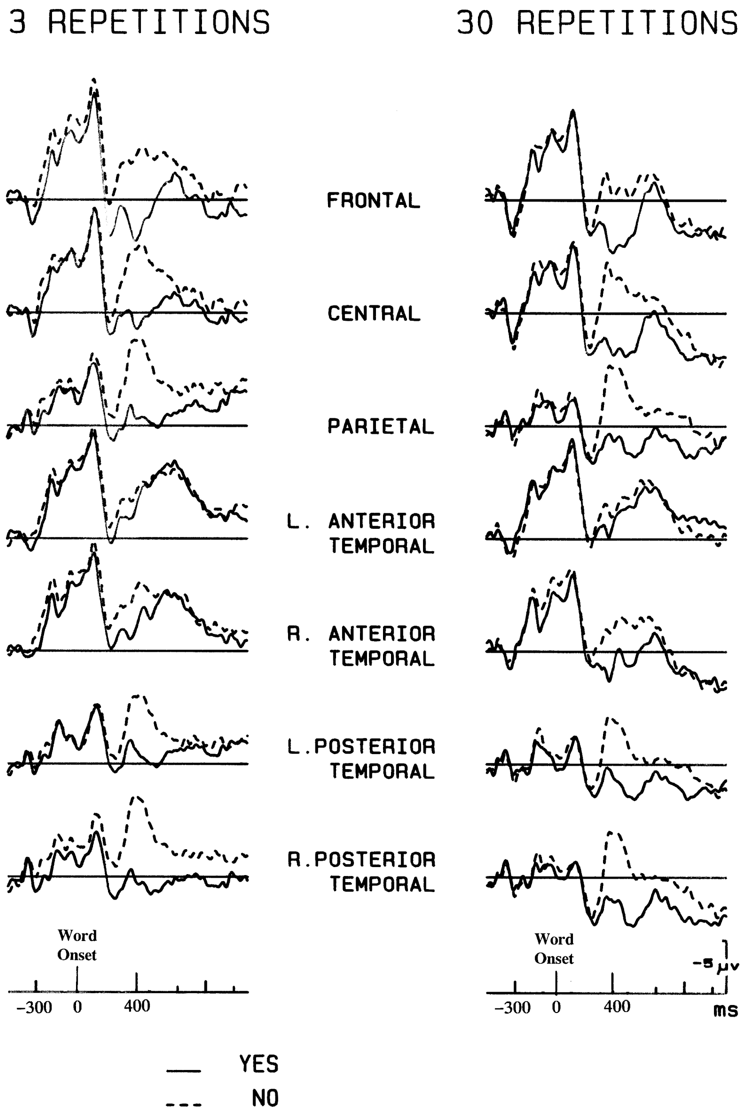

FIG. 2. Grand average ERPs ($N = 16$) for target words when the prime was repeated 3 times or 30 times. Overlapped are the ERPs to the target word that did (Yes responses) or did not (No responses) belong to the semantic category defined by the prime word.

with target words that did not belong to the semantic category repeated by the subject in both the 3- and the 30-repetition conditions.

Three-way ANOVAs, including repetition (3 vs. 30), response type (Yes vs. No), and electrode (7 levels) as factors, were performed in successive latency bands, in order to assess the significance of these effects. Only trials in which correct responses were given were included in the averages. Results obtained in the 0- to 300-msec latency band, that is during the 300-msec interval following the last repetition of the category name (i.e., during the presentation of the star), revealed only a main effect of electrode location ($F(6, 90) = 5.70$, MSe = 16.40, epsilon = .36, $p < .008$). This effect reflects the fact that the ERPs were more negative over frontal and central locations (−3.29 and −2.85 μV, respectively) than over parietal locations (−1.79 μV; $F(2, 30) = 4.30$, MSe = 8.96, $p < .02$) and over anterior temporal (−3.87 μV) than posterior temporal locations (−1.13 μV; $F(1, 15) = 10.50$, $p < .01$).

Analysis of the N1–P2 complex (i.e., the first negative–positive biphasic complex associated with perceptual processing) elicited by the target word (0–300 msec following word onset) showed significant main effects of repetition and electrode location ($F(1, 15) = 6.30$, MSe = 78.62, $p < .02$, and $F(6, 90) = 5.23$, MSe = 37.65, epsilon = .43, $p < .004$, respectively). The mean amplitude of the ERPs in this latency band was more positive after 30 (−1.89 μV) than after 3 repetitions (−3.99 μV; see Fig. 1). Moreover, ERPs were more negative over frontal and central locations (−4.05 and −3.05 μV, respectively) than parietal locations (−1.56 μV; $F(2, 30) = 3.83$, MSe = 26.34, $p < .03$) and over anterior temporal (−4.93 μV) than posterior temporal locations (−1.05 μV; $F(1, 15) = 10.20$, $p < .01$). Neither the effect of response type nor the repetition by response type interaction reached significance ($F(1, 15) = 1.22$, $p > .25$, and $F < 1$, respectively).

Peak-to-peak analyses were also performed in order to determine whether the amplitude of the N1–P2 complex was significantly reduced following 30 repetitions of the initial category name. Results showed that neither the main effect of repetition nor the repetition by electrode sites interaction were significant ($F < 1$ and $F(1, 15) = 2.37$, MSe = 5.22, epsilon = .55, $p = .08$).

Analysis of the N400 component in the 300- to 600-msec latency band following target word onset showed significant main effects of both repetition and response type ($F(1, 15) = 8.03$, MSe = 90.02, $p < .01$, and $F(1, 15) = 21.71$, MSe = 94.35, $p < .001$, respectively). The N400 component was smaller following 30 (−0.31 μV) than following 3 repetitions (−2.85 μV), as well as for target words that belonged to the semantic category (Yes responses, 0.56 μV) than for target words that did not (No responses, −3.72 μV; see Figs. 1 and 2). The interaction between the effects of these two factors was not significant ($F < 1$). That is, the difference between ''yes'' and ''no'' responses (i.e., the N400 effect; see Fig. 3) was not affected by

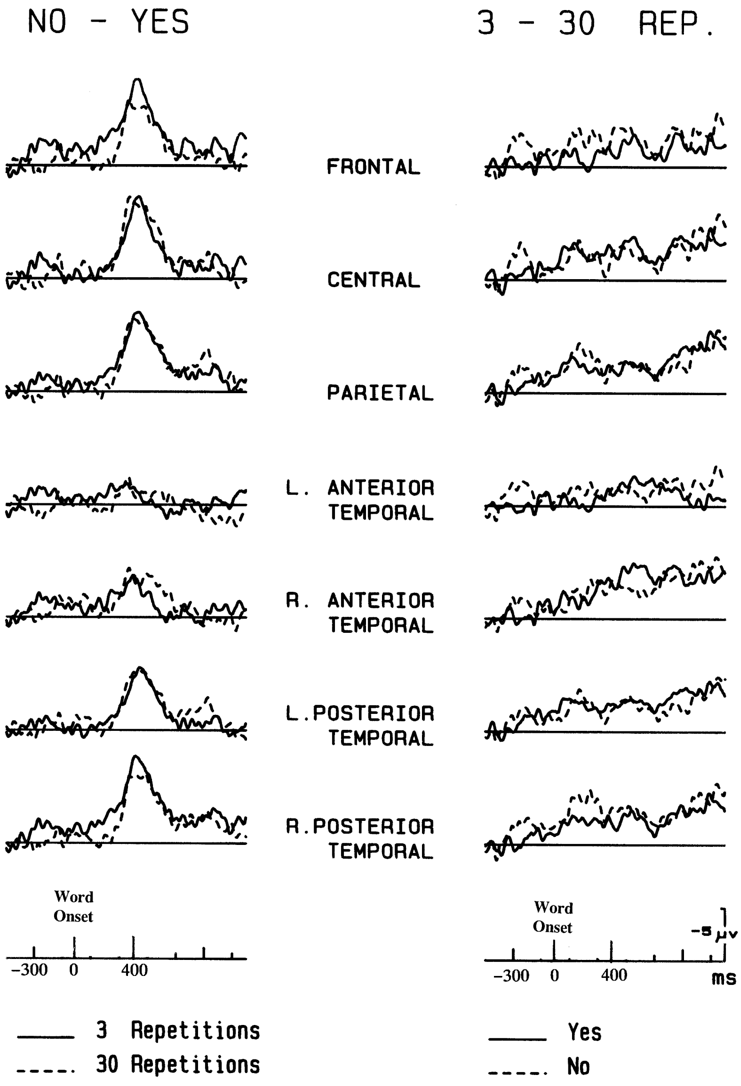

FIG. 3. Difference waves. The effect of response type (target word did not belong–target word did belong to the category defined by the prime) is illustrated in the left column. The effect of number of prime repetitions (3–30) is illustrated in the right column.

repeating the category name.[1] Neither the main effect of electrode location, nor the repetition × electrode interaction was significant ($F(6, 90) = 1.29$, $p > .20$, and $F < 1$, respectively), but the response type × electrode interaction was significant ($F(6, 90) = 10.42$, MSe = 4.43, epsilon = .43, $p < .001$). Topographical analysis revealed that the N400 effect was larger posteriorly (−4.21 μV) than anteriorly (−2.67 μV; $F(1, 15) = 15.91$, MSe = 8.44, $p < .001$) and was larger over the right (−4.89 μV) than the left hemisphere (−2.00 μV; $F(1, 15) = 7.32$, MSe = 5.28, $p < .02$; see Fig. 3), which is in line with previous results.

In order to analyze the late positivity associated with both Yes and No responses, which was larger when the category name was repeated 30 times, ANOVAs were performed from 600 msec following target word onset to the end of the recording period (i.e., 1200 msec post-word-onset). Results of this analysis revealed a main effect of repetition ($F(1, 15) = 6.06$, MSe = 164.71, $p < .03$), due to ERPs being more positive when the category was repeated 30 times (.94 μV) than when it was repeated 3 times (−2.04 μV). No other effects approached significance.

DISCUSSION

The present experiment revealed two effects. First, we obtained an effect of semantic congruity localized in the 300- to 600-msec latency band following target onset. Evoked potentials were more negative in this latency band when the target did not belong to the repeated semantic category than when it did. Second, we found a large repetition effect, which extended over the entire recording period, whereby ERPs were more positive following 30 than 3 repetitions of the initial category name. The functional significance of these effects as well as their implications for the alternative interpretations of the semantic satiation phenomenon presented in the introduction will be considered in the following discussion.

The finding of larger negative components (N400) in response to target words that did not belong to the initial semantic category than to target words that did is in line with previous findings in the literature (Bentin et al., 1985; Nobre & McCarthy, 1994; Polich, 1985). Note that it could be argued that the N400 effect reported here reflects only the decisional aspects of processing, and not the semantic analysis of the target, since target words that did not belong to the repeated semantic category were associated with negative responses while target words that did belong to the semantic category

[1] As can be seen on Fig. 3, the N400 effect seems to start earlier (around 380 msec) and to be of slightly larger amplitude after 3 than after 30 repetitions at some scalp sites. Thus, ANOVAs were conducted on the difference waves as well. The N400 effect was measured in the 380- to 640- and 400- to 600-msec latency bands, where it seemed maximum. Neither the main difference between 3 and 30 repetitions, nor the repetition by electrodes reached significance, however ($F < 1$ in both cases).

were associated with positive responses. It is unlikely that our results are due only to decisional processes; however, since the present effect is very similar, in amplitude, latency, and scalp distribution, to the N400 effect reported in the literature when no decision is required from the subjects (cf. Bentin et al., 1985; Kutas & Hillyard, 1980, 1984; Kutas, Van Petten, & Besson, 1988; Holcomb, 1988, 1993; Holcomb & Neville, 1990; Rugg, 1985, 1990). Furthermore, within-subjects comparison of the N400 effect in sentence contexts and in word pairs has shown that the two effects are very similar (Kutas, 1993). Thus, our results are in line with the two main interpretations of the functional significance of the N400; that is, the N400 may reflect either word expectancy as a function of the preceding context or the ease of integration of a word with its preceding context (whether such be a word or an entire sentence; Besson & Kutas, 1993; Brown & Hagoort, 1993; Halgren & Smith, 1987; Holcomb, 1993; Rugg, 1990).

The second effect found in the present study was a large repetition effect, whereby ERPs were more positive following 30 than 3 repetitions of the initial category name. The effect of repetition was found in like manner for ''yes'' and ''no'' responses, and it extended over the entire recording period. Note that this large and extended effect of repetition of the initial category name on the ERPs to the target is in marked contrast to the effect of semantic congruity (or response type), which was very localized in the typical 300- to 600-msec latency band following target onset. The significance of this enhanced positivity for targets following a repeated category is not yet clear. In previous ERP studies involving the repetition of linguistic material, enhanced positivities have been reported for repeated compared to new material (Besson, Kutas, & Van Petten, 1992; Besson & Kutas, 1993; Halgren & Smith, 1987; Karayanidis, Andrews, Ward, & McConaghy, 1991; Mitchell, Andrews, & Ward, 1993; Rugg, 1985, 1987, 1990; Smith & Halgren, 1989; Van Petten, Kutas, Kluender, Mitchiner, & McIssac, 1991). These repetition effects have been observed both early in the recording period (200- to 300-msec epoch) and, more systematically, in later epochs (Late Positive Component: Besson et al., 1992; Besson & Kutas, 1993; Mitchell et al., 1993; Rugg, 1985, 1987, 1990; Van Petten et al., 1991). It has been proposed that the enhanced amplitude of the late positive components with repetition is linked with memory processes and could reflect access to lexical memory (Rugg & Nagy, 1987), ''relative familiarity'' (Rugg, 1990; Rugg & Doyle, 1992), elaboration of the appropriate episodic memory trace (Besson & Kutas, 1993), or semantic and episodic retrieval processes (Van Petten et al., 1991). It is important to underline, however, that the repetition effects reported in previous experiments were linked to the repetition of the target itself. In the present study, it was not the target, but the stimulus preceding the target (i.e., the category name) which was repeated and which produced an effect on the ERP traces to the target. What is more, in previous studies the target (whether such be a word or an entire sentence) was generally repeated once, whereas we examined the effect of numerous repetitions (30) of the initial category name. As such, caution should be exercised before assuming a relationship between the positivity found in the present study and that reported in previous studies.

The long-lasting positivity associated with massed repetition of the initial category for both ''yes'' and ''no'' responses may reflect processes different from those associated with target word repetition. Two possibilities should be considered. It may be that the enhanced positivity following 30 compared to 3 repetitions of the category name reflects different brain activation states. Fatigue, or a decrease in attention, may have resulted from the multiple repetitions. This possibility does not seem likely, however. First, consider the mean amplitude in the 0–300 msec following target onset, which was more positive after 30 than after 3 repetitions. If this difference reflected differences in brain activation, one would expect the amplitude of the N1–P2 complex to differ in the two conditions. Analysis of the peak-to-peak amplitude of the N1–P2 complex to the target did not reveal this to be the case, however. This clearly shows that the mean amplitude difference found in this latency band results from an overlap with an ongoing positivity rather than from a real decrease in the amplitude of the N1–P2 complex. Second, as illustrated by the difference waves between ''yes'' and ''no'' responses (see Fig. 3), the amplitude and latency of the N400 effect was not different after 30 than after 3 repetitions of the category name. The second possibility is that the increased, sustained positivity found after 30 repetitions reflects a carryover from ERP effects linked with the massed repetition of the initial category name. It is difficult to address this question directly, since one cannot easily record ERPs while subjects perform a naming task. One way to indirectly assess the influence of such carryover effects would be to vary the number of category name repetitions and observe whether the amplitude of the positivity to the target varied as a function of this manipulation.

Of particular interest to the present study was to determine whether massed repetition of the category name would modulate the amplitude of the N400 effect. It was hypothesized that, if semantic satiation inhibits the integration of (Smith, 1984; Smith & Klein, 1990) or the controlled access to (Pynte, 1991) the meaning of the category name, such that its meaning is lost after 30 repetitions, similar N400s should be elicited by target words that belong and do not belong to the category. Thus, the N400 effect should be smaller after 30 than after 3 repetitions of the category name. Our results showed a hint of an effect: at frontal, anterior–temporal, and right posterior–temporal locations, the N400 effect seemed to start earlier and to be of slightly larger amplitude after 3 than after 30 repetitions (see Fig. 3). The statistical analysis did not reveal these effects to be significant, however. As such, our results lend little support to the hypothesis that massed repetition exerts its influence at the level of meaning integration, or otherwise stated, that it leads to the semantic satiation of the repeated word. Of course, this conclusion holds only inasmuch as the N400 effect reflects the mechanisms assumed to be affected by massed repetition, that is, the access to the meaning of the word and/or meaning integration processes.

In conclusion, the present results replicate the typical finding of a localized effect of semantic congruity on the N400 component in the 300- to 600-msec latency band poststimulus onset. Moreover, repetition was associated with a sustained positivity that may reflect carryover effects due to the massed repetition of the category name. The functional significance of this positivity should be examined in further experiments. Most importantly, the amplitude of the N400 effect did not differ following 3 and 30 repetitions of the repeated category name. Thus, it seems that the meaning of the prime was accessed and exerted its influence on the processing of the following word.

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