

## **Activation of Political Attitudes: A Psychophysiological Examination of the Hot Cognition Hypothesis**

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*The recording of event-related potentials (ERPs) in the brain has allowed for a better understanding of human sensory and cognitive processing. This technique may also prove useful in studying implicit social attitudes and their effects on information processing. Here, ERPs were used in a study of "hot cognition" in the context of political concepts. Hot cognition, as applied to the political domain, posits that all sociopolitical concepts that have been evaluated in the past are affectively charged, and that this affective charge is automatically activated from long-term memory within milliseconds of presentation of the political stimulus. During an evaluative priming task, ERP recordings showed that affectively incongruent prime/target pairs elicited an enhanced negativity with a peak latency of about 400 milliseconds relative to affectively congruent prime/target pairs. These differences suggest that automatic, implicit evaluations were made in response to strongly positive and negative political stimuli, and that these evaluations affected the subsequent processing of a high-valence adjective. Therefore, it appears that the emotional valence of a political prime is stored along with the concept itself, and that an affective response becomes active upon mere exposure to the political stimulus.*

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**KEY WORDS:** ERP, Affective Priming, Affect, Hot Cognition

In this paper we report the results of an experiment that used event-related potentials (ERPs) to test the "hot cognition" hypothesis that underlies the on-line processing model of evaluation of political stimuli. The hot cognition hypothesis posits that all sociopolitical concepts a person has evaluated in the past become affectively charged—positively or negatively, strongly or weakly. Later, when

thinking about or called on to evaluate a stimulus—for example, a political leader (Lodge, Steenbergen, & Brau, 1995), group, or issue (Lodge & Taber, 2002)—this affective charge is spontaneously activated from long-term memory and integrated to an updated summary tally, and thereby colors all subsequent cognitive and evaluative judgments about that stimulus (Taber & Lodge, 2000). Implicit in the hot cognition hypothesis is that all sociopolitical representations in long-term memory (Bargh, Chaiken, Govender, & Pratto, 1992), or at any rate most of them (Fazio, Sanbonmatsu, Powell, & Kardes, 1986), can be and typically are activated spontaneously on mere exposure to the stimulus (Bargh, 1994).

The spontaneous activation of affect has been demonstrated in several paradigms, including judgment (Greenwald & Banaji, 1995), attitude formation (Betsch, Plessner, Schwieren, & Gutig, 2001), the expression of attitudes (Bargh, 1994; Fazio et al., 1986), stereotyping (Devine, 1989; Dovidio, Evans, & Tyler, 1986), self-esteem (Greenwald & Pratkanis, 1984), evaluations of political candidates, issues, groups, and symbols (Lodge & Taber, 2000; Taber & Lodge, 2000), and other aspects of social cognition (see Bargh, 1997; Greenwald & Banaji, 1995).

### *The Underlying Model of Hot Cognition*

To set the hot cognition hypothesis in perspective, let us briefly review the cognitive architecture underlying these information-processing mechanisms (Lodge & Taber, 2000; Taber, in press). A cornerstone of any model of political reasoning is the citizen's preexisting knowledge and predilections. These long-term factors, functionally speaking, require a vast long-term memory (LTM) for storing facts, beliefs, and predispositions, and a mechanism for "moving" one's knowledge about leaders, parties, and issues from LTM into working memory (WM), where it can be attended to (Rumelhart & Norman, 1988; Sanford, 1986). Attention is very limited, perhaps to the magic number  $7 \pm 2$  bits or chunks of information (Miller, 1956), hence the need for heuristics and other simplifying mechanisms for thinking and reasoning.

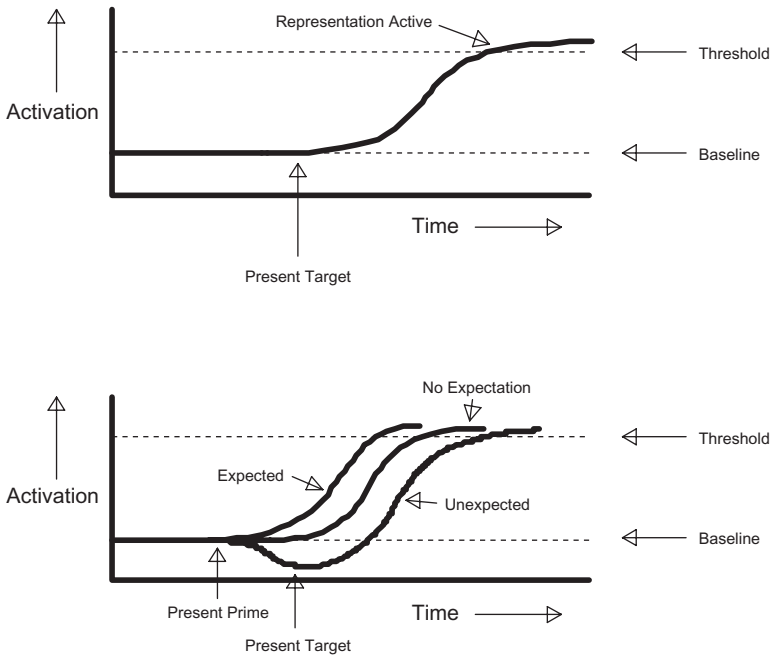
LTM is organized associatively, and it is useful to think of knowledge structures metaphorically in LTM as a configuration of *nodes* linked to one another in a network of associations [or, if you prefer, as neurons "bundled" together by weighted connections (Read & Miller, 1998; Smith, 1996)]. If we were able to tap a citizen's complete political knowledge structure, there might be tens of thousands of nodes (among them, for example, one for George W. Bush) with a complex network of associations (for Bush, these may include his demographics, his stands on issues, perceived traits, and maybe an inferential abstraction or two—e.g., that he is conservative). Many links represent beliefs, or what Judd and Krosnick (1989) called "implicational relations," the strength of which will vary. Moreover, memory objects vary in *accessibility*—the ease with which a stored concept lying dormant in LTM can be retrieved into WM.

A serious problem with this classic model of cognitive information processing is its inability to account for the role of affect. Taking a lead from Fazio and his colleagues (Fazio, Jackson, Dunton, & Williams, 1995; Fazio et al., 1986; Fazio & Williams, 1986; see also Fiske, 1981; Sears, Huddy, & Schaffer, 1986), we view all objects in LTM that represent sociopolitical concepts as *affect laden*, with this affect varying along two dimensions: valence and strength. That is, sociopolitical objects in LTM are directly linked to evaluative tags, or summary judgments of the objects, on the basis of past evaluative processing. Our hot cognition hypothesis—following Abelson’s (1963) lead, and building directly on this architecture and on the theoretical and empirical work described above—asserts that the affect associated with sociopolitical objects in LTM will come automatically to mind (i.e., enter WM) along with the object itself.

But how is information moved from LTM into WM? *Spreading activation* provides the mechanism. A node in LTM switches from dormancy to a state of readiness with the potential to be moved into WM when it receives activation, either because it is a direct object of thought processes or because it is closely linked to an object of thought. The top panel of Figure 1 (adapted from Barsalou, 1992, p. 46) depicts the activation process, with the  $y$  axis representing the level of activation of a given node in LTM and the  $x$  axis representing time in milliseconds (ms). The rise time from dormant state to activation threshold is almost instantaneous (100 to 200 ms). Although Figure 1 does not show this, activation also decays quite rapidly, so that a given node will drop back to baseline in about 1 second if there is no further source of activation.

Imagine a person reading about President Bush in a newspaper headline. Without perceptible effort, the concept BUSH becomes activated and pops into consciousness; even more important for our purposes, activation spreads along the network of links to related concepts, thereby “priming” strong semantic associations of BUSH (he is a REPUBLICAN) as well as beliefs (he opposes TAXES). For a few hundred milliseconds, these associated concepts remain in a heightened state of arousal; any additional activation will likely push them over the activation threshold and into WM.

It may be useful to think of priming through spreading activation as producing *preconscious* expectations. The bottom panel of Figure 1 shows the activation of associations under different priming conditions. Consider again the activation of the concept BUSH from a newspaper headline. As noted, concepts associated with BUSH in LTM also receive activation, thereby raising them near the threshold, so that any subsequent processing that passes activation to these energized concepts will likely drive them over the threshold. In a sense, primed associations (perhaps Bush’s Republican label or his stand on gun control) are “expected” (uppermost of the three curves), so that it takes substantially less processing to activate them. In short, they have a better chance of getting into WM, of being processed faster, and thereby of “framing” the perception, recognition, and interpretation of subsequent information.



**Figure 1.** Activation of a node in LTM.

Conversely, spreading activation can *inhibit* the processing of *unexpected* categories (lowermost curve). When a concept from an unexpected category is encountered unexpectedly, more bottom-up processing is necessary before it may pass the threshold and enter WM. If the word “walnut” was processed initially, this would inhibit the recognition of semantically unrelated concepts (such as REPUBLICAN), which would take more time and effort to process.

We also posit a control or “baseline” condition (middle curve) in which no expectations are created by a prime. The nonword BBB, for example, which conveys no semantic expectations, would neither facilitate nor inhibit the recognition and categorization of subsequent concepts.

To turn the notion of hot cognition from postulate to hypothesis, we adapted the experimental paradigm developed by Fazio and his colleagues (1986) for empirically testing the premise that affect is directly tagged to its conceptual node and “travels” with it into WM automatically upon the mere exposure of the concept. Fazio’s attitude-priming paradigm is a spinoff of the classic lexical decision paradigm: An experimental subject sees a “prime” word (e.g., “BIRD”) flashed on a computer screen for 200 ms, followed 100 ms later—*when the prime*

word's activation is at its peak—by a second word, a “target” stimulus (e.g., “robin,” “rose,” “binor”), which remains on screen until the subject makes a response (typically by pressing one button “as fast as possible without making too many errors” if the target is a legal English word, another button if it is not). Note that the subject is *not* asked directly whether the target is associated with the prime. Rather, an inference about whether the target and prime are linked in the person's LTM is made on the basis of reaction times recorded while performing the *unrelated* (word/not-a-word) task. These and similar cognitive priming paradigms produce robust effects (Collins & Loftus, 1975). Moreover, these cognitive associations are automatic; they are generated spontaneously and cannot be easily suppressed (Neely, 1976, 1977).

But what about affect? The hot cognition hypothesis posits that affect is also primed along with the concept. To test the hot cognition hypothesis, we adapted the attitude-priming paradigm developed by Fazio et al. (1986) and Bargh (1997) to the political domain (Figure 2). Here, as in the cognitive priming paradigm, we expose subjects to a prime and then present a target word, but in this variant of the paradigm, their task is to press one of two buttons labeled [+] and [-] to indicate (“as fast as possible without making too many errors”) whether the target word has a positive or negative connotation. On each trial the name of an attitude object (e.g., COCKROACH) is presented for 200 ms on a computer screen, followed by a blank-screen interval of 100 ms; the elapsed time from the onset of

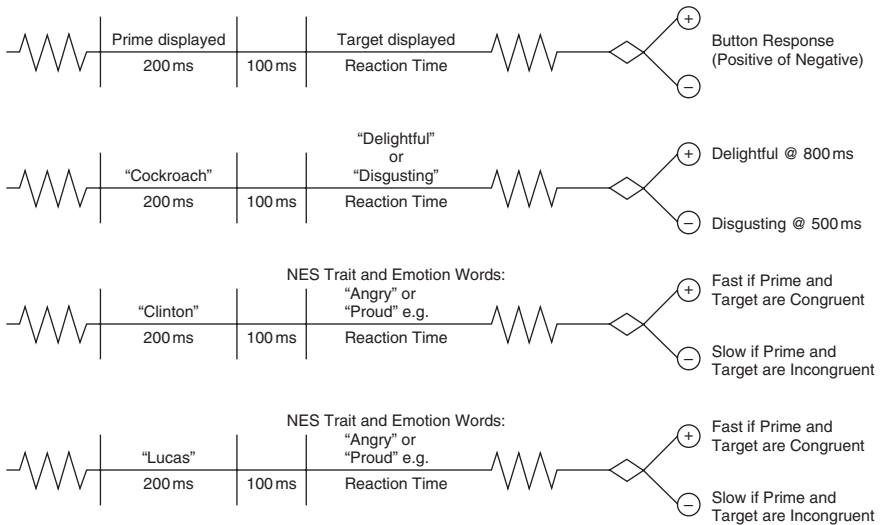


Figure 2. Attitude-priming paradigm and examples of its use.

the prime to the onset of the target, in this case 300 ms—when the priming effect is at its peak—is called the stimulus onset asynchrony (SOA) and is often varied as an experimental manipulation to distinguish automatic from conscious processing. Then a target word—chosen for its unambiguous positive or negative connotation—is presented. The subject’s task is to indicate by a button press whether the target word is “good” or “bad” in meaning. The latency time from onset of target word to the subject’s response is recorded. As described by Bargh et al. (1992),

The logic of the design was that to the extent that presentation of the attitude object name activated the evaluation associated with the attitude object, this evaluation (good or bad) would then influence how quickly subjects could correctly classify the target adjective as positive or negative in meaning. If the adjective was of the same valence as the attitude object prime, responses should have been faster (i.e., facilitated) relative to a baseline response. . . . Conversely, if the adjective and prime were of opposite valence, responses should be slower. The time from the onset of the prime word to the onset of the target word (300 ms) is a critical feature of this priming paradigm as it is too brief an interval for [subjects] to develop an active expectancy or response strategy regarding the target adjective that follows; such conscious and flexible expectancies require at least 500 ms to develop, and to influence responses in priming tasks (Neely, 1977; Posner & Snyder, 1975). Given an SOA (interval from prime to target) of 300 ms, then, if presentation of an attitude object prime influences response time to a target adjective, it can only be attributed to an automatic, unintended activation of the corresponding attitude. (p. 894)

For example, if COCKROACH is the prime and the target word is “disgusting,” we would expect facilitation—a relatively fast response time (about 500 to 600 ms) to say “disgusting,” a negative word—because the prime and target are *affectively congruent*. Conversely, if the target word is “delightful,” we would expect inhibition—a slower response time (about 800 ms on average) to say “delightful,” a positive word—because the association is *affectively incongruent*. Note again that this is a *nonreactive measure*: The subject’s task is not to say whether the target word describes the prime word, but rather to simply indicate whether the target word is positive or negative, *not* whether the word is semantically associated. This is a strong test for discerning whether affect is spontaneously activated along with the concept itself.

In series of experiments, Lodge and Taber (2000) gave subjects a campaign brochure for a hypothetical congressman, William Lucas. In addition to his picture, the brochure presented details of his background and experience as well as his strong position on the death penalty (pro for half the subjects, con for the others). After reading the brochure, subjects participated in a classical sentence

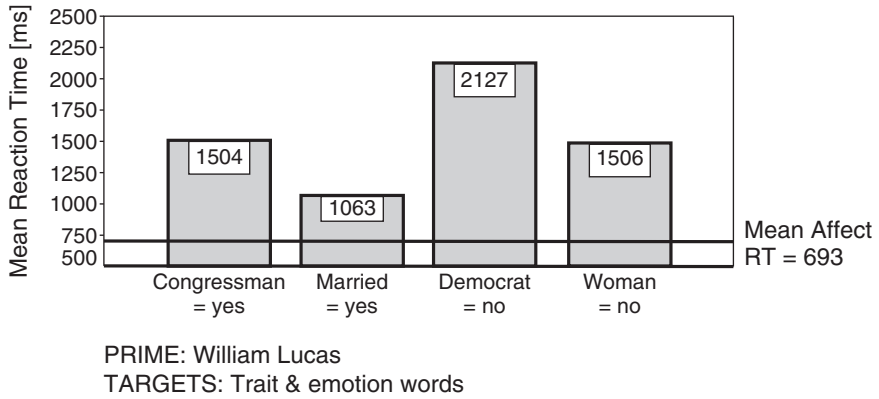


Figure 3. Response times for knowledge and affective responses for candidate William Lucas.

verification task in which they indicated by a true/false button response whether Lucas was, for example, a Republican, a woman, or anti-death penalty. The subjects also participated in an attitude-priming task where LUCAS preceded such target adjectives as “delightful,” “disgusting,” “angry,” and “sad.” Figure 3 shows reaction times for the cognitive true/false responses to the single-word targets “congressman,” “Democrat,” “married,” and “woman,” as well as the mean reaction time to the single-word affective targets in the attitude-priming task. On average, it took subjects less than 700ms to make an affective response, about twice as fast as the time to verify a cognitive association. This finding was interpreted by Lodge and Taber as supporting the hot cognition hypothesis; moreover, it may reflect what Zajonc (1984) called “the primacy of affect” (Murphy & Zajonc, 1993): Affect comes to mind faster than the cognitive associations thought to cause the affective response.

Although these and other behavioral measures (e.g., the Implicit Association Test; Greenwald & Banaji, 1995) have proven valuable in validating the hot cognition hypothesis, in this paper we turn to a more direct, neurophysiological test of this hypothesis.

*The ERP Paradigm*

ERPs are patterned voltage changes in the ongoing electroencephalogram (EEG) that are time-locked to specific processing events. By averaging the brain’s electrical response to a particular class of events, conclusions can be drawn about the populations and timing of neurons being recruited for sensory and cognitive processes associated with these events.

Early ERP research in the cognitive domain focused on the technique's ability to reflect the temporal sequence of information-processing operations. One of the first successful applications of ERP research was the development of the "oddball" paradigm, which produces a particular component, called "P300," that is thought to reflect memory-updating processes (Donchin, 1981). In a simple oddball experiment, there are two distinct types of stimuli—for example, two distinct auditory tones, one with a high probability of occurrence (the "frequent" stimulus), the other with a very low probability of occurrence (the "rare" stimulus). On averaging the ERPs to rare events, the result is an enhanced positive component occurring between 200 and 500 ms after stimulus presentation, which is of largest amplitude over the centroparietal region of the scalp.

The amplitude of the P300 component elicited by rare events has been shown to vary as a function of probability and event saliency. Thus, the amplitude of the P300 component is enhanced for rare stimuli that are remarkably different from the frequent stimuli, and also for rare stimuli that have a very low frequency of occurrence (Squires, Squires, & Hillyard, 1975). Furthermore, the elicitation of a P300 component does not require an explicit categorization process, as P300 components may be elicited even when subjects are unwilling to explicitly report information (Farwell & Donchin, 1991). One theory argues that the enhanced P300 for rare events represents a biological marker of context updating. Therefore, the processing of categorically inconsistent stimuli is thought to exert greater processing demands in order to allow for an updating of the current representation of the environment (Donchin & Coles, 1988).

Cacioppo, Crites, Berntson, and Coles (1993) demonstrated the utility of the classic P300 component in attitude research by using it as an index of attitude registration. These authors speculated that because implicit attitudes are suspected to play a major role in information processing, it might be possible to use the P300 component to elucidate this role. Cacioppo et al. used a modified oddball paradigm in which positive and negative words were presented sequentially in a series of six. In addition, the experiment was balanced, so that half of the sequences contained positive words as the frequent event with negative words being rare, and the other half used negative words as the frequent event with positive words being rare. This is a "modified oddball paradigm" in that the traditional oddball paradigm does not break up the presentations into short sequences of events.

Another modification to the oddball paradigm that was introduced by Cacioppo et al. (1993) was the position of the rare event. In each series of six stimuli, a rare stimulus never occurred within the first three stimuli. This was to encourage subjects to first generate a positive or negative context and thereby ensure that rare events were perceived as categorically different from the frequent events. The subjects in this experiment were asked to count how many positive or negative events occurred in each sequence and to report the count at the end of the sequence. The results indicate that the rare events did elicit an enhanced



positivity between 500 and 700 ms after event presentation. Therefore, the results of this initial study with the modified oddball approach are consistent with a wealth of research investigating the utility of the P300 component as a tool for understanding information-processing procedures.

Cacioppo, Crites, Gardner, and Berntson (1994) followed the initial development of the evaluative oddball paradigm with a study that showed the P300 component to vary as a function of trait extremity. Specifically, highly and moderately evaluatively inconsistent traits evoked a larger P300-like component than did mildly inconsistent or evaluatively consistent traits. This finding suggests that P300 amplitude in this paradigm is an index of the evaluative consistency of each trait with the valence of the context in which it is presented.

Crites, Cacioppo, Gardner, and Berntson (1995) provided evidence that the evoked P300-like component varies as a function of attitude registration as opposed to attitude report. In this study, participants were asked in various conditions to misreport their attitudes toward target incongruent adjectives. Even when participants misreported the information, Crites et al. found enhanced P300-like components to be evoked by evaluatively incongruent trait words. The results suggest that the enhanced amplitude of the component elicited by evaluatively incongruent trait adjectives reflects a categorization process, independent of the subsequent response.

Another widely studied ERP component that might have potential application to the study of implicit social attitudes is the N400 component. The N400 component was first described by Kutas and Hillyard (1980), who observed a negative deflection, peaking around 400 ms, to words that are semantically incongruent with the context of a sentence (e.g., "I like my coffee with cream and *dog*"). The N400 is believed to reflect the relative ease with which word meaning can be placed within the context of a sentence. Therefore, every word in a sentence (presumably) elicits an N400 component, but words that are semantically incongruent with the sentence context elicit a much larger N400 component.

The N400 component has also received some treatment in semantic priming research. The seminal works concerning the semantic priming paradigm focused on latency differences in lexical decision tasks. Neely (1977) used a priming procedure in which a target word, preceded by a prime, was to be judged as a word or nonword. The results indicated that concepts associated with the prime are automatically activated from memory upon presentation, and subsequently may facilitate the responses to semantically related words. For example, using a category label "bird" as a prime facilitates the response to "robin" as a word. The results from Neely's experiment and many others seemed to fit the model of spreading activation processes in semantic processing.

The semantic priming paradigm has been used occasionally in ERP research. Bentin, McCarthy, and Wood (1985) observed a pronounced N400 component evoked by target words that were either semantically unrelated or only moderately related to the prime. Furthermore, the unrelated words elicited a more

pronounced N400 component than those that were moderately related. Some debate still remains about the processes that this enhanced N400 component reflects. One prevailing theory is that in the semantic priming paradigm the N400 occurs when semantic facilitation is not possible, rather than as a result of semantic inhibition (Holcomb, 1988). Whatever the underlying mechanism, the N400 component has been shown to be a reliable component, elicited by targets that are unrelated to their primes. Thus, the ERP results with semantic priming support the behavioral results with the classic cognitive priming paradigm, and they open the way to address questions such as whether facilitation occurs when the connotation of the primed attitude object matches the connotation of the target, or whether inhibition occurs when the connotations of the prime and target are not congruent.

Central to our efforts here, the behavioral attitude-priming paradigm has shown a reliable significant interaction between the valence of the prime and the valence of the target (Bargh et al., 1992; Fazio et al., 1986; Giner-Sorolla, Garcia, & Bargh, 1999; Greenwald, Klinger, & Liu, 1989; Hermans, De Hower, & Eelen, 1994). Because the behavioral effects observed in the affective priming paradigm are similar to those found in the original semantic priming paradigms, we reason that the affective priming paradigm should elicit an N400 component when the target valence differs from the prime valence. If an N400 component is elicited by a target stimulus that is affectively incongruent with that of the prime, we hypothesize that the passive reception of the prime is sufficient to activate a learned positive or negative judgment, which subsequently will affect the processing of the target stimulus. If so, the enhanced N400 component would provide physiological evidence that (i) an implicit attitude is activated by mere presentation of an attitude object, even when the task does not demand such an evaluation, and (ii) this evoked attitude will affect the subsequent evaluative processing of the target stimulus. Furthermore, the presence of significant effects would demonstrate the utility of scalp-recorded ERPs as a dependent measure of attitude registration.

The purpose of the current project was to test the notion that attitudes toward political leaders, groups, issues, and ideas are spontaneously activated by the presentation of a political stimulus. To test this notion, we recorded ERPs while participants were engaged in a political attitude-priming paradigm. Participants first took part in a reaction-time pretest to determine their attitude toward political leaders, groups, and issues. The fastest latencies, used to select the strongest positive and negative responses, served as primes in the subsequent priming procedure. The target words for the priming procedure were high-valence positive and negative personality characteristics that were chosen on the basis of normative data (Anderson, 1955). Our major hypothesis in this experiment was that incongruent prime/target pairs would elicit a larger N400 component than congruent prime/target pairs. If the N400 component is indeed enhanced for incongruent prime/target pairs, it can be assumed that evaluations regarding the political primes were activated spontaneously, even though the experimental task did not

call on subjects to make an evaluation of the prime or target concepts. Such a finding provides physiological evidence for the hot cognition hypothesis.

## Method

### *Participants*

Fourteen (8 female) graduate students from the State University of New York at Stony Brook volunteered for participation in the experiment and gave informed consent. All had normal or corrected-to-normal vision. The data of three participants (2 female) were excluded from the final analysis because of excessive eyeblinks during the ERP recordings. Those whose data were included ranged in age from 22 to 39, with a mean age of 27.

### *Stimuli and Procedure*

Two days before the experimental session, participants took part in a computerized prime-selection phase. In this pretest, participants viewed 37 political attitude objects (see the Appendix) and indicated as quickly as possible whether they felt positively or negatively about the political stimulus. The participants indicated their attitudes by pressing one of two keys on a standard keyboard, one labeled “positive” and the other labeled “negative.” The order in which the words appeared on the screen was randomized. A commercially available stimulus presentation program recorded the latency of response. Each participant took the pretest twice, with the stimuli in different orders. When a participant responded differently to the same stimulus in the two runs, that stimulus was discarded. Finally, the response latencies from the two runs were added together for each of the remaining political attitude objects, forming a composite latency score for each object. Similar to the procedures of Fazio et al. (1986), the five strongest positive and five strongest negative political attitude objects were selected on the basis of the shortest response latencies. These served as the primes in the experimental task for that participant.

For the experimental session, we constructed a list of 15 adjectives that were clearly positive (e.g., “honest,” “attractive”) and 15 adjectives that were clearly negative (e.g., “cruel,” “vulgar”). These served as the targets in the priming task. Participants were instructed that the experimental task would involve making a valence (positive or negative) judgment for each target word. They were also told that immediately before each of the target words, there would be a “memory” word presented quickly on the screen. These memory words were the five positive and five negative political attitude objects that had been selected on the basis of the results of each participant’s pretest. During the test phase, it was possible that participants could simply ignore the prime and still respond to the target automatically. To ensure that participants would not adopt this potentially confound-

ing strategy, we told them that they might be tested on the memory words after the experimental procedure. The design was balanced so that each prime appeared six times (paired with a negative target three times and a positive target three times), and each target appeared twice, preceded once by a positive prime and once by a negative prime. The primes were randomized before creating the unique sequence file for each participant, so that the strongest primes wouldn't always occur with the same target adjectives.

On each trial, a prime was presented for 150 ms, followed by a 100-ms interval before the onset of the target. Therefore, the stimulus onset asynchrony (SOA) was 250 ms. The target word remained on the screen for 1,000 ms and was followed by an upper-case "R," which signaled the participant to make a valence judgment for the target word. The delay before responding was included to minimize muscle artifact and motor potentials in the ERP. There was a 1,000-ms delay from the occurrence of the response to the onset of the next prime. Stimuli on the LCD screen were presented in red 48-point Arial font and appeared on a black background. The participant's eyes were about 24 inches from the stimulus display.

*EEG and EOG recording.* The EEG was recorded from Ag/AgCl electrodes attached at three midline scalp locations: F<sub>Z</sub>, C<sub>Z</sub>, and P<sub>Z</sub> (according to the International 10–20 system). The EEG from all active electrodes was referenced to the right mastoid. The ground electrode was placed on the left mastoid. The vertical electro-oculogram (EOG) was recorded from an electrode above the right eye, referenced to the right mastoid. All impedances were held under 10 ohms. The EEG was recorded with a bandpass of 0.1 to 30 Hz and a gain of 1,000. The EEG was digitized at 1,000 Hz.

The evoked potentials were analyzed off-line, with a time base from 100 ms before the presentation of the prime until 800 ms after the target, for a total epoch of 1,100. Epochs with ocular artifact were excluded from further analyses. Separate averages were then constructed for congruent prime/target pairs and incongruent prime/target pairs.

## Results

Figure 4 compares the ERPs evoked by congruent and incongruent prime/target pairs. (These ERPs are the grand averages of the ERPs of all individual participants.) Until about 250 ms after the onset of the target stimulus (i.e., 500 ms after the onset of the prime), the ERPs are highly similar. At about 250 ms, the ERPs diverge. The ERPs evoked by the targets that are affectively incongruent with their primes show a negative component not seen in the ERPs evoked by the congruent targets. This is labeled "N400" in the figure, consistent with the label applied to a similar component in semantic incongruity paradigms. (Note that the latency of the component varies, depending on the specific circumstances.)

Prior research indicates that the N400 component shows the greatest amplitude at centroparietal electrodes and has a peak latency of about 400 ms after the

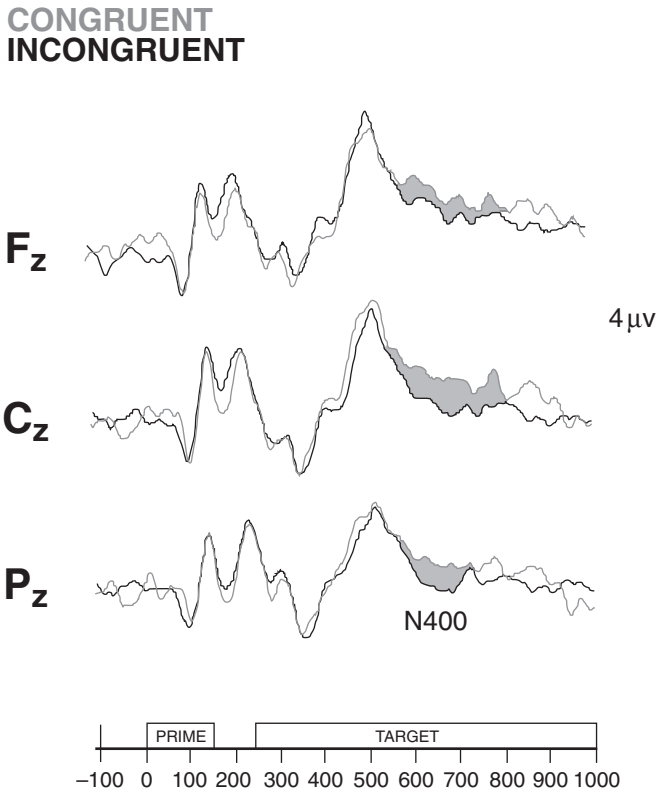
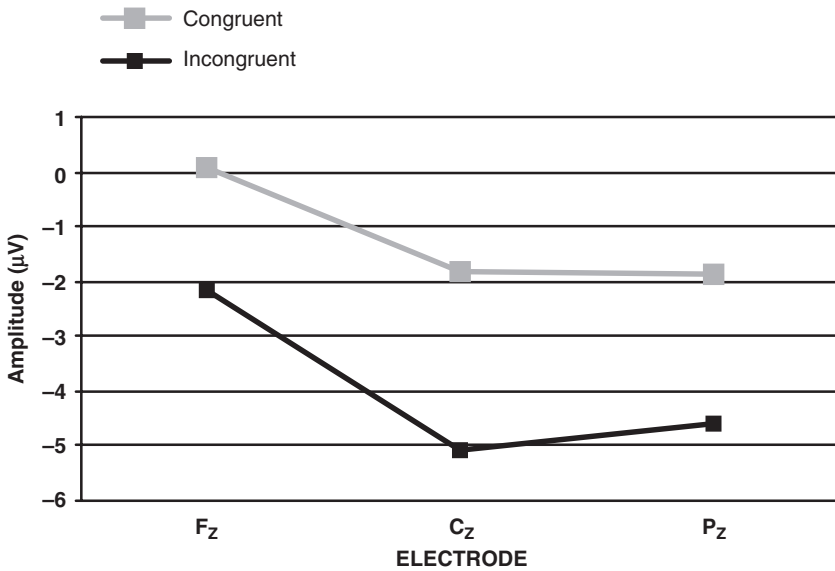


Figure 4. ERPs to congruent and incongruent prime/target pairs.

onset of an incongruous word. The current findings are consistent with the previous findings. To quantify the effect and to test the a priori hypotheses that targets that were incongruent with the prime would evoke an N400 that was largest posteriorly, we located the largest negative potential at P<sub>z</sub> between 570 and 710ms after the onset of the prime for each participant. Amplitudes for the N400 component at all electrode sites were measured at this latency. Because there were too few trials to analyze the ERP data for every positive/negative × congruent/incongruent cell mean, the positive/negative valence conditions were collapsed to form two conditions: congruent and incongruent. A 4 (electrode) × 2 (condition) within-subjects analysis of variance was used, with the amplitude of the N400 component serving as the dependent measure in the analysis. Greenhouse-Geisser epsilons were used to adjust the degrees of freedom because of the possibility of violating the sphericity assumption. The results are shown in Figure 5. There was a significant main effect for condition [ $F(1, 10) = 8.55, p < .05$ ]. This main effect



**Figure 5.** Mean amplitudes of the N400 component for each target type at the three electrode sites.

revealed a larger negative amplitude for incongruent prime/target pairs ( $M = -2.36\mu\text{V}$ ) than for congruent prime/target pairs ( $M = -0.633\mu\text{V}$ ). There was also a significant main effect for electrode site [ $F(3, 15) = 6.66, p < .05$ ]. Finally, there was a significant interaction between electrode and condition [ $F(3, 15) = 8.56, p < .01$ ]. For the incongruent condition, a follow-up comparison revealed a larger negative amplitude at C<sub>Z</sub> than at F<sub>Z</sub> [ $F(1, 10) = 6.98, p < .05$ ]. Comparisons between F<sub>Z</sub> and P<sub>Z</sub> and between C<sub>Z</sub> and P<sub>Z</sub> failed to reach significance.

To evaluate for possible differences in P300 amplitude, we performed a 4 (electrode)  $\times$  2 (condition) within-subjects analysis of variance. The largest positive potential at P<sub>Z</sub> between 400 and 750ms after the onset of the prime was located for each participant. Amplitudes for the P300 component at all electrode sites were measured at this latency. The main effect for condition was not significant [ $F(1, 10) = 0.9, p > .1$ ], nor was the main effect for electrode [ $F(3, 19) = 0.5, p > .1$ ]. Finally, the interaction between electrode and condition was not significant [ $F(3, 14) = 1.28, p > .1$ ].

## Discussion

Many semantic priming studies have shown that behavioral responses to a target word are faster when that word is primed by related, congruent concepts. Recently the priming paradigm was extended to the study of the affective impact

of words. These studies (e.g., Bargh, 1997; Fazio et al., 1986) suggest that words automatically activate affective associations as well as semantic associations. Lodge and Taber (2002) extended the affective and semantic priming research into the political domain. Our results support the concept of hot cognition and open the way for more detailed studies of the on-line processing of political concepts.

Incongruent prime/target pairings were shown to elicit a negative ERP component peaking around 400ms after the onset of the target stimulus (see Figure 4). This component closely resembles the N400 component that has been extensively studied in the semantic domain, where it is thought to reflect the brain's reaction to semantic incongruity (Kutas & Hillyard, 1980). The first important implication of our results is that affective, as well as semantic, incongruity can produce an N400. It remains to be seen whether the semantic and affective N400s are identical in their neural substrates and functional properties.

Our study did not reveal any differences in the P300 component between congruent and incongruent prime/target pairs. The lack of a difference in P300 amplitude between experimental conditions can be attributed to the methodological design of the experiment. As mentioned above, the amplitude of the P300 component has been shown to vary as a function of event probability and event saliency (Squires et al., 1975). The present experiment did not include a probability manipulation, as there were equal numbers of congruent and incongruent pairs and of positive and negative targets. Moreover, because each target was a high-valence word, it would not be expected that any one particular target would be more salient than the others. Cacioppo et al. (1993) found significant differences in P300 amplitude for rare target words that were incongruent with valence to the words in the series. In that case, the change in valence with the appearance of the target word was a rare event. It was most likely also very salient because of its difference from the rest of the stimulus set. Therefore, the differences in P300 amplitude in the Cacioppo et al. (1993) study are not surprising, given the literature on the functional determinants of the P300. The present study did not contain probability or saliency manipulations, and therefore it is not surprising that P300 amplitude differences were not observed.

The results further demonstrate the utility of scalp-recorded ERPs for the measurement of spontaneous activation of implicit attitudes. The N400 component proved to be sensitive to spontaneous evaluative processing in the priming paradigm. ERP recordings provide several major advantages for the study of cognition and affect. First, the ERP directly reflects the activation of populations of neurons involved in the processing of information. Thus, it is possible to ask whether automatic affective and semantic activations involve the same brain areas. Second, the ERP consists of a temporal series of components whose timing reflects the timing of the underlying processes. ERPs might well prove useful in testing Zajonc's hypothesis on the primacy of affect—determining whether semantic or affective activation occurs first. The technique also can be used to address questions about how semantic and affective processing interact with each

other. Third, ERP recordings allow for an unobtrusive, non-invasive glimpse into ongoing information processing. For example, if an affect-laden political term were embedded in a sentence that the subject is asked to read and comprehend in normal fashion, and we require a behavioral response to that term (e.g., a button press) to assess the affective response, this would disrupt the normal processing of the sentence. With ERP recordings, by contrast, we can index the subject's evaluative reaction to the term without requiring a behavioral response and without the subject's awareness.

On a less methodological level, the current results from ERPs support the behavioral evidence for hot cognition. It has been speculated that affective evaluations are stored in memory for all political concepts that have been repeatedly evaluated in the past, and that these affective responses are automatically elicited when the concept is activated in memory. Here, we found that implicit evaluations were made in response to strongly positive and negative political stimuli, and that these evaluations affected the brain's response to the high-valence concept that followed. This suggests that the emotional evaluation is stored with the concept—that is, political terms are indeed “hot.”

It is perhaps less surprising that political terms are hot than that they can affect the processing of subsequent semantically *unrelated* political *and* nonpolitical words. Whereas semantic activation is thought to spread in a network of semantically associative concepts, we find—as others have recently found—an automatic affective incongruence effect for semantically unrelated concepts. For every positively or negatively valenced word in one's vocabulary, the set of similarly valenced words must be enormous. Although we have not yet identified the neural mechanisms by which the processing of all of these words could be automatically facilitated, the social-psychological-neurological implications are great in implying the interdependence of thought and feeling.

#### APPENDIX: Political Primes

|                 |                   |                    |
|-----------------|-------------------|--------------------|
| Clinton         | George Washington | Free speech        |
| Gore            | Democrat          | Death penalty      |
| Giuliani        | Republican        | Peace              |
| George W. Bush  | Politician        | Flag               |
| Hillary         | Pro-life          | Parade             |
| Hitler          | Pro-choice        | Swastika           |
| Lincoln         | NRA               | Terrorists         |
| Kennedy         | NAACP             | Affirmative action |
| Pataki          | African Americans | Welfare            |
| Bloomberg       | Arabs             | Gun control        |
| Mark Green      | Jews              | Counterterrorism   |
| Osama bin Laden | Americans         |                    |
| Colin Powell    | Taxes             |                    |



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## REFERENCES

- Abelson, R. P. (1963). Computer simulation of "hot cognitions." In S. Tomkins & S. Messick (Eds.), *Computer simulation and personality: Frontier of psychological theory* (pp. 277-298). New York: Wiley.
- Anderson, N. H. (1955). Likableness ratings of 555 personality trait words. *Journal of Personality and Social Psychology, 9*, 272-279.
- Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, efficiency, intention, and control in social cognition. In R. S. Wyer Jr. & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1-40). Hillsdale, NJ: Erlbaum.
- Bargh, J. A. (1997). The automaticity of everyday life. In R. S. Wyer Jr. (Ed.), *The automaticity of everyday life: Advances in social cognition, vol. 10* (pp. 1-61). Mahwah, NJ: Erlbaum.
- Bargh, J. A., Chaiken, S., Govender, R., & Pratto, F. (1992). The generality of the automatic attitude activation effect. *Journal of Personality and Social Psychology, 62*, 893-912.
- Barsalou, L. (1992). *Cognitive psychology: An overview for cognitive scientists*. Hillsdale, NJ: Erlbaum.
- Bentin, S., McCarthy, G., & Wood, C. C. (1985). Event-related potentials, lexical decision and semantic priming. *Electroencephalography and Clinical Neurophysiology, 60*, 343-355.
- Betsch, T., Plessner, H., Schwieren, C., & Gutig, R. (2001). I like it but I don't know why: A value-account approach to implicit attitude formation. *Personality and Social Psychology Bulletin, 27*, 242-253.
- Cacioppo, J. T., Crites, S. L., Berntson, G. G., & Coles, M. G. H. (1993). If attitudes affect how stimuli are processed should they not affect the event-related brain potential? *Psychological Science, 4*, 108-112.
- Cacioppo, J. T., Crites, S. L., Gardner, W. L., & Berntson, G. G. (1994). Bioelectrical echoes from evaluative categorizations: I. A late positive brain potential that varies as a function of trait negativity and extremity. *Journal of Personality and Social Psychology, 67*, 115-125.
- Collins, A. M., & Loftus, E. F. (1975). A spreading activation theory of semantic processing. *Psychological Review, 82*, 407-428.
- Crites, S. L., Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1995). Bioelectrical echoes from evaluative categorizations: II. A late positive brain potential that varies as a function of attitude registration rather than attitude report. *Journal of Personality and Social Psychology, 68*, 997-1013.
- Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56*, 5-18.
- Donchin, E. (1981). Surprise! . . . surprise? *Psychophysiology, 18*, 493-513.
- Donchin, E., & Coles, M. G. H. (1988). Is the P300 component a manifestation of context updating? *Behavioral and Brain Sciences, 11*, 354-356.
- Dovidio, J. F., Evans, N., & Tyler, R. B. (1986). Racial stereotypes: The contents of their cognitive representations. *Journal of Experimental Social Psychology, 22*, 22-37.
- Farwell, L. A., & Donchin, E. (1991). The truth will out: Interrogative polygraphy ("lie detection") with event-related brain potentials. *Psychophysiology, 28*, 531-547.

- Fazio, R. H., Jackson, J. R., Dunton, B. C., & Williams, C. J. (1995). Variability in automatic activation as an unobtrusive measure of racial attitudes: A bona fide pipeline? *Journal of Personality and Social Psychology*, *69*, 1013–1027.
- Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology*, *50*, 229–238.
- Fazio, R. H., & Williams, C. (1986). Attitude accessibility as a moderator of the attitude-perception and attitude-behavior relations: An investigation of the 1984 presidential election. *Journal of Personality and Social Psychology*, *51*, 505–514.
- Fiske, S. T. (1981). Social cognition and affect. In J. Harvey (Ed.), *Cognition, social behavior, and the environment* (pp. 227–264). Hillsdale, NJ: Erlbaum.
- Giner-Sorolla, R., Garcia, M. T., & Bargh, J. A. (1999). The automatic evaluation of pictures. *Social Cognition*, *17*, 76–96.
- Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review*, *102*, 4–27.
- Greenwald, A. G., Klinger, M. R., & Liu, T. J. (1989). Unconscious processing of dichoptically masked words. *Memory and Cognition*, *17*, 35–47.
- Greenwald, A. G., & Pratkanis, A. R. (1984). The self. In R. S. Wyer Jr. & T. K. Srull (Eds.), *Handbook of social cognition* (pp. 129–178). Hillsdale, NJ: Erlbaum.
- Hastie, R., & Park, B. (1986). The relationship between memory and judgment depends on whether the judgment task is memory-based or online. *Psychological Review*, *93*, 258–268.
- Hermans, D., De Hower, J. D., & Eelen, P. (1994). The affective priming effect: Automatic activation of evaluative information in memory. *Cognition and Emotion*, *8*, 515–533.
- Holcomb, P. J. (1988). Automatic and attentional processing: An event-related brain potential analysis of semantic priming. *Brain and Language*, *35*, 66–85.
- Judd, C. M., & Krosnick, J. A. (1989). The structural basis of consistency among political attitudes: Effects of political expertise and attitude importance. In A. Pratkanis, S. Brecker, & A. Greenwald (Eds.), *Attitude structure and function* (pp. 99–128). New York: Erlbaum.
- Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science*, *207*, 203–205.
- Lodge, M., McGraw, K., and Stroh, P. (1989). An impression-driven model of candidate evaluation. *American Political Science Review*, *83*, 399–414.
- Lodge, M., Steenbergen, M., & Brau, S. (1995). The responsive voter: Campaign information and the dynamics of candidate evaluation. *American Political Science Review*, *89*, 309–326.
- Lodge, M., & Taber, C. S. (2000). Three steps toward a theory of motivated political reasoning. In A. Lupia, M. McCubbins, & S. Popkin (Eds.), *Elements of reason: Cognition, choice and the bounds of rationality* (pp. 183–213). Cambridge: Cambridge University Press.
- Lodge, M., & Taber, C. S. (2002). *Automatic affect for political candidates, parties, issues and symbols: An experimental test of the hot cognition hypothesis*. Manuscript submitted for publication.
- Miller, G. A. (1956). The magical number seven plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*, 81–97.
- Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology*, *64*, 723–739.
- Neely, J. H. (1976). Semantic priming and retrieval from lexical memory: Evidence for facilitatory and inhibitory processes. *Memory and Cognition*, *4*, 648–654.
- Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General*, *106*, 226–254.

- Posner, M. I., & Snyder, C. R. (1975). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola Symposium* (pp. 55–85). Hillsdale, NJ: Lawrence Erlbaum, Publishers.
- Read, S. C., & Miller, L. J. (Eds.) (1998). *Connectionist models of social reasoning and social behavior*. Mahwah, NJ: Erlbaum.
- Rumelhart, D., & Norman, D. (1988). Representation in memory. In R. Atkinson, R. Herrnstein, G. Lindzey, & R. Luce (Eds.), *Handbook of experimental psychology* (pp. 197–246). New York: Wiley.
- Sanbonmatsu, D. M., & Fazio, R. H. (1990). The role of attitudes in memory-based decision making. *Journal of Personality and Social Psychology*, *59*, 614–622.
- Sanford, A. J. (1986). *The mind of man: Models of human understanding*. New Haven, CT: Yale University Press.
- Sears, D. O., Huddy, L., & Schaffer, L. (1986). A schematic variant of symbolic politics theory, as applied to racial and gender equality. In R. Lau & D. Sears (Eds.), *Political cognition* (pp. 159–202). Hillsdale, NJ: Erlbaum.
- Smith, E. (1996). What do connectionism and social psychology offer each other? *Journal of Personality and Social Psychology*, *70*, 893–912.
- Squires, N. K., Squires, K. C., & Hillyard, S. A. (1975). Two varieties of long-latency positive waves evoked by unpredictable auditory stimuli in man. *Electroencephalography and Clinical Neurophysiology*, *38*, 387–401.
- Taber, C. S. (in press). Information processing and public opinion. In D. O. Sears, L. Huddy, & R. L. Jervis (Eds.), *The handbook of political psychology*. London: Cambridge University Press.
- Taber, C. S., & Lodge, M. (2000, September). *Motivated skepticism in the evaluation of political beliefs*. Paper presented at the annual meeting of the American Political Science Association, Washington, DC.
- Zajonc, R. B. (1984). On the primacy of affect. *American Psychologist*, *39*, 117–123.