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EVENT-RELATED BRAIN POTENTIALS AND SOCIAL COGNITION: ON USING PHYSIOLOGICAL INFORMATION TO CONSTRAIN SOCIAL COGNITIVE THEORIES

Bruce D. Bartholow
University of Missouri

Recent years have witnessed a surge of interest in using various psychophysiological methods to study a wide range of social psychological phenomena. This article reviews research in which a particular psychophysiological measure—the event-related brain potential (ERP)—has been used to augment traditional behavioral measures of social cognition, thereby providing more comprehensive assessment of underlying brain processes that give rise to observed behavioral effects. More specifically, the aim of this article is to outline a particular approach to using ERPs in social cognition aimed at using information derived from neurocognitive responses to limit the theoretical mechanisms that can be said to account for overt behaviors. In other words, as with all physiological measures, the ERP technique should be used in social cognition as a tool for understanding the psychological mechanisms driving behavioral outcomes, not as an end unto itself.

> "Given that cognitive processes are implemented by the brain, it seems to make sense to explore the possibility that measures of brain activity can provide insights into their nature." (Rugg & Coles, 1995, p. 27)

For decades, the influence of various cognitive processes on social behavior has been a major focus of research for social psychologists. Despite some views to the contrary (see Berkowitz & Devine, 1995), a number of influential thinkers in the field have concluded that social psychology always has been cognitively oriented—or, at least, has been for a very long time (see Fiske & Taylor, 1991; Ostrom, 1984; Ross & Nisbett, 1991). Like other cognitive scientists, cognitively-oriented

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Correspondence concerning this article should be addressed to Bruce D. Bartholow, Department of Psychological Sciences, 210 McAlester Hall, University of Missouri, Columbia, MO 65211.
E-mail: BartholowB@missouri.edu.

experimental social psychologists have devised clever paradigms to enable inferences about the influence of cognitive processes on observed behavioral outcomes. Many such paradigms have relied upon dependent measures such as response latency, error rates, and various person memory assessments (e.g., recall). Such paradigms have been important for establishing both the effects of environmental manipulations on social information processing and the limits of the social-cognitive system. Still, reliance on such outcomes presents a number of thorny problems for theorists to resolve.

The purpose of this article is to present a case for the use of psychophysiological measures, particularly the event-related brain potential (ERP), to more directly observe the cognitive and affective processes underlying behavioral responses in social-cognitive paradigms. Of importance, however, the purpose of this paper is not to argue that traditional behavioral measures should be abandoned in favor of psychophysiological ones. Rather, psychophysiological measures should be used, when possible, to augment behavioral responses, thereby providing a more comprehensive assessment of the various levels of analysis required to fully understand social behavior (see Ochsner & Lieberman, 2001).

Before continuing, however, it is important to acknowledge that although recent years have witnessed a major surge of interest in using measures of physiological activity (particularly neural activity) to understand processes that give rise to social behavior (see Harmon-Jones & Beer, 2009; Harmon-Jones & Winkielman, 2007), this idea is not new. Systematic use of measures of physiological processes to infer processes that affect social behavior can be traced back at least to the mid-1950s, when Rankin and Campbell (1955) first demonstrated that White research participants showed larger skin conductance responses when in the presence of a Black compared to a White experimenter. This work sparked a number of other studies using similar procedures to measure implicit racial prejudice (e.g., Porier & Lott, 1967; Vidulich & Krevanick, 1966). Work by these and other pioneers in the field of social psychophysiology (see Wagner & Manstead, 1989) laid the groundwork for the currently burgeoning interest in systematic integration of theory and empirical observations at the social, cognitive and neural levels of analysis (see Cacioppo, Berntson, Sheridan, & McClintock, 2000; Ochsner & Lieberman, 2001).

CONCERNS OVER INFERRING COGNITIVE EVENTS FROM BEHAVIORAL MEASURES

Response time (RT) and response accuracy arguably represent the most well-worn tools in the social-cognitive researcher’s toolbox. Assuming some basic assumptions are met (see Bassili, 2001; Fazio, 1990), these outcomes generally are quite easy to measure reliably with modern computers and software, and when used appropriately can permit investigation of processes believed to be implicit or automatic more readily than can self-report measures (see Bargh & Chartrand, 2000). Still, reliance on behavioral measures alone places frustrating limits on the inferences that can be drawn about social cognition. RT provides a ready example. The time it takes for a research participant to press a response key following the onset of a target stimulus reflects a complex combination of perceptual, cognitive/affective, and motor operations (e.g., Coles, Smid, Scheffers, & Otten, 1995), only some of which may be of theoretical interest. Put more simply, behavioral measures represent the outcome of a set of cognitive (and other) processes performed on stimuli of interest, but are not themselves direct measures of those processes.

In addition to their relatively indirect nature, behavioral measures are limiting in terms of their ability to reveal specifics concerning the structure of the information-processing system (e.g., the extent to which the system operates in a discrete, stage-like manner or some other manner). This problem is particularly relevant to theoretical models that make assumptions concerning the timing of various mental events, what cognitive psychologists refer to as *mental chronometry* (see Meyer, Osman, Irwin, & Yantis, 1988; Posner, 1978). This approach refers to the use of RT data to infer the dynamics of information processing (i.e., duration of particular mental operations) and the architecture of the information processing system. The most basic assumption underlying this approach is that the longer it takes for a response to a given stimulus to be emitted, the longer it must have taken for the underlying processing of that stimulus to unfold. Another, related assumption is that differences in reaction time associated with various experimental manipulations reflect differences in the duration of one or more discrete information processing steps or stages. For example, in the classic Sternberg additive factors method (see Sanders, 1990; Sternberg, 1969), if two manipulations—say, stimulus discriminability and stimulus-response compatibility—produce independent effects on RT with no interaction, the factors can be said to be additive, affecting different stages of processing.

However, use of this method relies on a number of assumptions that are not always met. For example, information transmission between stages of processing is assumed to occur in a discrete, all-or-none fashion. This idea relies on an additional assumption that no two stages are activated simultaneously, but rather later stages cannot be engaged until earlier stages have been completed. However, evidence against this assumption has been provided by studies showing that partial information about a stimulus can be used to prepare a response, indicating that the response output stage is active while the stimulus is still be processed by the evaluation/categorization stage (see Coles et al., 1995; Ratcliff, 1978). Although advances in modeling RT data (e.g., Ratcliff, 1978, 1985) have loosened some of these assumptions, such models still suffer from indirectness in representing relevant, underlying processes.

This particular issue has important implications for understanding numerous effects in social cognition. For example, spreading activation model assumptions (e.g., Collins & Loftus, 1975; Neely, 1977) often are applied to interpret the findings of stereotype-priming tasks, in which responses to stereotype-incongruent targets are assumed to be slower than responses to stereotype-congruent targets because it takes longer for the stimulus evaluation process to complete in the former condition (i.e., it takes longer for activation to spread from the race category to a stereotypically-unrelated attribute), thereby delaying the activation of the response. Applying this model also assumes a discrete stage notion of processing, in which the stimulus evaluation process is assumed to be completed before response activation processes can begin. As will be discussed in detail in a subsequent section, the assumption that the response preparation process was simply delayed in one condition relative to the other is not always valid, and therefore the application of a simple spreading of activation model to explain such data is not always warranted.

ERPS AND COGNITION

Fortunately, measures of physiological activity provide a number of advantages for understanding the structure of the information processing system and the ways in which experimental manipulations often used in social-cognitive research influence it. In particular, the ERP can be quite useful in determining the extent to which stimulus conditions influence different aspects of information processing, the relative temporal ordering of those processes, and how they give rise to observable behavioral responses. ERPs reflect the electrical activity generated by the firing of groups of (primarily cortical) neurons in response to stimulus and response events (see Fabiani, Gratton, & Federmeier, 2007). Of particular relevance for the current discussion, a number of components of the ERP (i.e., positive and negative voltage deflections) have been associated with specific information-processing operations, and the excellent temporal resolution of ERP responses (on the order of milliseconds) provides precise estimates of the timing of those operations (for further discussion of the acquisition, processing, and quantification of ERP data, see Amodio & Bartholow, in press; Bartholow & Amodio, 2009; also see Luck, 2005).

ERPs have a number of desirable properties for elucidating the mechanisms of social cognition. First, in contrast to discrete behavioral outcomes (e.g., correct vs. incorrect button press) the ERP is a dynamic measure, which can reveal the timecourse of information processing as it unfolds in real time. This property can be extremely valuable for addressing theoretical questions concerning potentially rapidly-changing responses. For example, Olson, Roese, and Zanna (1996) theorized that initial reactions to unexpected information about others (i.e., expectancy violations) will always be negative, even if the violating information itself is positive, because unexpectedness is unpleasant (Mandler, 1990). Olson et al. posited that subsequent reactions can become positive once the perceiver has had time to consider the implications of the violating information. Due primarily to the limitations of behavioral measures to inform this issue, Bartholow, Fabiani, Gratton, and Bettencourt (2001) used a combination of ERP and electromyographic measures and found that, in fact, initial reactions (within 100 ms) to expectancy violations are not uniformly negative, but depend on the valence of the violating information. This theoretical question would have been very difficult to test using behavioral measures alone.

Second, ERPs provide a means to separate the influence of various components of the information-processing system thought to determine the behavioral responses typically recorded in social cognition paradigms. For example, ERP measures can be used to determine the extent to which a particular stimulus captures attention (e.g., Hillyard & Anllo-Vento, 1998), as well as whether that attention is maintained or reoriented slightly later in processing (e.g., Hopfinger & Mangun, 2001; Hopfinger & Ries, 2005). Also, as will be discussed in more detail shortly, ERPs allow separate indices of stimulus evaluation and response activation processes, as well as the extent to which each is responsible for (i.e., mediates) behavioral outcomes such as response latency. Of course, it is important to bear in mind that relations between physiological signals and psychological processes are rarely one-to-one (see Cacioppo & Tassinary, 1990).

Third, along with the event-related optical signal (EROS; see Gratton & Fabiani, 2001), the ERP represents one of the only available direct measures of the neural events underlying information-processing operations. As mentioned previously, behavioral responses represent the outcome of a host of information processing activities involving both brain (i.e., neural) and bodily (i.e., muscle) responses. In contrast, ERPs directly index neural responses that underlie particular cognitive and affective/motivational processes of interest. This property of the ERP also distinguishes it from other brain imaging methods, such as fMRI. Specifically, whereas ERPs represent direct measures of the electrical activity generated by the firing of groups of neurons, fMRI signals (particularly the blood-oxygen level dependent or BOLD signal) reflect hemodynamic (i.e., blood flow) responses in neural tissue occurring after that tissue was activated. Thus, technically, fMRI does not directly measure neural activity, but rather relies on the inference that oxygenated blood flows to parts of the brain that recently have been active. Also, given the relative sluggishness of the hemodynamic response, activity measured by fMRI appears roughly 4-6 seconds after the neural structures of interest have responded to a particular stimulus or response event.

A number of specific ERP components have been shown to reflect information processing operations of interest to social cognition.[1] First, the P3 (or P300) component, a prominent, positive deflection in the waveform typically peaking between 300-600ms following stimulus onset, is thought to reflect processes related to stimulus evaluation (see Nieuwenhuis, Aston-Jones, & Cohen, 2005). In particular, the peak latency of the P3 is known to reflect the speed or ease with which evaluative categorization occurs (e.g., see Coles et al., 1995; Kutas, McCarthy, & Donchin, 1977; McCarthy & Donchin, 1981). The amplitude of the P3 has been associated with updating of templates in working memory (e.g., Donchin & Coles, 1988), and, when stimuli are particularly motivationally salient, with the extent to which approach and avoidance motivational states are engaged (see Ito, Larsen, Smith, & Cacioppo, 1998; Schupp et al., 2000). These properties make the P3 useful for testing a broad range of hypotheses in social cognition, such as the effects of expectancy violation on processing of behavioral information about others (see Bartholow et al., 2001) and testing differences between intentional and spontaneous trait or goal inferences (Van der Cruyssen, Van Duynslaeger, Cortoos, & Van Overwalle, 2009; Van Duynslaeger, Van Overwalle, & Verstraeten, 2007).

Another stimulus-locked component that recently has been investigated in a number of social-cognitive domains is the N2 (or N200), a prominent negative-going deflection typically most prominent at frontal or fronto-central scalp locations and peaking around 200-300 ms post-stimulus. The N2 most frequently has been associated with the hypothesized conflict-monitoring function of the anterior cingulate cortex (ACC; see Botvinick, Braver, Barch, Carter, & Cohen, 2001; van Veen

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[1] A complete review of all relevant ERP components is beyond the scope of this article. For a more detailed accounting of ERP components and their relevance for social psychological research, see Amodio and Bartholow (in press) or Bartholow and Amodio (2009). Also, it should be noted that the correspondence between observed deflections in ERP waveforms and the nature of the underlying brain activity that generates them often is complicated, and can sometimes lead to confusion between the “observed” components, as described here, and the latent components that contribute to them. For more discussion of this issue and alternative statistical treatments of ERP data meant to uncover the latent structure of the waveforms (e.g., principal component analysis), see Luck (2005) (see also Bernat, Williams, & Gehring, 2005; Makeig et al., 1999).

& Carter, 2002a). Specifically, in situations where a given stimulus activates multiple, competing responses simultaneously, the ACC seems responsible for detecting and dealing with that conflict (see Botvinick et al., 2001), possibly by determining which of several motor controllers (i.e., brain structures responsible for activating particular motor responses, such as pressing a button using the left vs. the right hand) should be permitted to produce a response (see Holroyd & Coles, 2002). As will be reviewed shortly, this issue has become important for understanding performance on a host of social-cognitive tasks that appear to elicit response conflict. In addition, the N2 recently has been associated with enhanced processing of ingroup relative to outgroup targets (e.g., Dickter & Bartholow, 2007, in press; Ito & Urland, 2003, 2005; Kubota & Ito, 2007; Willadsen-Jensen & Ito, 2008). The extent to which the mechanisms leading to enhanced N2 during response conflict and ingroup categorization remains unclear (but see Dickter & Bartholow, 2010).

The lateralized readiness potential (LRP) has great potential to illuminate response-related processes important for performance on social-cognitive tasks. The LRP reflects neural activity in premotor and motor cortex (see Brunia, 1988; Requin, 1985) associated with preparing and generating behavioral responses (see Coles, 1989; Coles et al., 1995), and therefore provides a direct index of the extent to which experimental factors influence response activation and output. Moreover, the LRP is a temporally dynamic measure, and therefore can show whether response activation differs over time. Thus, in tasks involving two response options mapped to left and right hands, the polarity of the LRP can reveal which response was activated (e.g., correct vs. incorrect) at a given moment in time, as well as whether the response initially activated in motor cortex changes prior to behavioral emission of the response. These features make the LRP an ideal tool for determining whether differences in observed behavior (e.g., RT) in social-cognitive tasks stem from differing response activation dynamics. For example, in tasks involving a prime followed by an imperative stimulus, measuring the LRP permits estimation of the extent to which a given response was prepared by the prime, even before the target stimulus appeared (see Coles et al., 1995).

The negative slow wave (NSW) also is of interest for social cognition research. This component typically is most prominent over central or fronto-central electrode locations and develops relatively late in the stimulus-locked epoch, after the P3 has resolved. The NSW has been associated with the implementation of self-regulatory cognitive control processes such as those required for inhibiting responses (Bartholow, Dickter, & Sestir, 2006) or overcoming cognitive conflict such as that occurring on incongruent trials in a Stroop task (e.g., Curtin & Fairchild, 2003; West & Alain, 1999). Thus, the NSW is thought to reflect the engagement of top-down control and expectancy processes occurring just after a difficult trial that prepare an individual to respond with greater care on an upcoming trial.

In addition to these stimulus-related ERP components, a number of response-related components also can provide information for testing theories in social cognition. Primarily, the widely-studied error-related negativity (ERN) component, which develops concurrently with the onset of a behavioral response (peaking around 50-80 ms post-response) and generally is larger for incorrect than for correct responses, has been quite useful in recent years for understanding cognitive control processes, particularly related to racial stereotyping (see Amdio, Devine, & Harmos-Jones, 2008; Amodio et al., 2004, 2006). Like the stimulus-locked N2, the ERN is believed to emanate from the ACC, and to reflect aspects of conflict-related processing (see Yeung, Botvinich, & Cohen, 2004) related to the so-called evaluative component of cognitive control (see Botvinick et al., 2001). The fact that the ERN occurs primarily with response errors initially led to the notion that the ERN reflected the activity of an error-detection mechanism (see Falkenstein, Hohnsbein, Hoormann, & Blanke, 1991; Gehring, Goss, Coles, Meyer, & Donchin, 1993). However, more recent reports of ERN-like activity on correct response trials under some conditions (see Bartholow et al., 2005; Vidal, Hasbroucq, Grapperon, & Bonnet, 2000) have led to the hypothesis that the ERN reflects a more general process associated with conflict monitoring (Botvinick et al., 2001; Yeung et al., 2004), or an affective reaction to an unexpected or unwanted response, such as an error (Bartholow & Henry, 2010; Bush, Luu, & Posner, 2000), which functions in part to recruit other mechanisms of top-down control (e.g., Botvinick et al., 2001; Yeung et al., 2004).

Considered together, these features make the ERP a useful tool both for testing hypotheses about the role of specific aspects of information processing in producing social behavior, and more generally in probing the structure of the information processing system. Of course, a complete accounting of the application of ERP measures in social cognition is beyond the scope of this article (see also Amodio & Bartholow, in press). The brief overview presented in the following sections is meant to illustrate some of the ways in which ERP data, combined with traditional behavioral outcomes, have been used in recent years to test and advance theory in social cognition.

In reviewing ERP studies of selective attention, Mangun and Hillyard (1995) explained how physiological information can be used to constrain theories about cognition. Specifically, using what is known about the meaning of particular physiological signals, researchers can infer the involvement (or lack thereof) of theorized processes in response to experimental manipulations. In cases where two theories make competing predictions concerning the involvement of some underlying mechanism, ERPs can provide evidence as to whether that mechanism was engaged during stimulus processing, even if the theories in question predict similar behavioral responses. The work reviewed here exemplifies this tradition as applied to social cognition.

IDENTIFYING THE LOCUS OF EXPERIMENTAL EFFECTS

At a very basic level, the question of specifying the theoretical mechanisms responsible for observed responses in social cognition paradigms can be addressed by identifying the locus of the effects of experimental manipulations within the information processing system. As discussed at length by others (e.g., Coles et al., 1995), this endeavor represents one of the most important contributions made by ERP research. ERPs recently have been applied to address questions of this kind in several domains of social-cognitive inquiry, and in some cases findings have challenged some long-standing assumptions concerning the mechanisms underlying time-tested, robust experimental effects.

Affective Priming. One such example involves specifying the locus of the *affective congruency effect*, often cited as evidence of the automatic activation of attitudes. As first demonstrated by Fazio, Sanbonmatsu, Powell, and Kardes (1986), the valence of a given positive or negative word is categorized more quickly when that word is preceded by a prime of the same valence (i.e., *congruent trials*) than when preceded by a prime differing in valence (i.e., *incongruent trials*; for a review see Klauer & Musch, 2003). Early explanations of the affective congruency effect (e.g., De Houwer & Hermans, 1994; Fazio et al., 1986; Hermans, De Houwer, & Eelen, 1994) focused on (presumably automatic) spreading activation processes similar to those occurring in semantic priming (e.g., Collins & Loftus, 1975; Neely, 1977). In this model, processing of the prime is believed to activate evaluative constructs in long-term memory, and this activation is believed to spread relatively quickly to other constructs similar in valence (e.g., positive prime words activate positive constructs), compared to constructs differing in valence. This difference in evaluative spreading of activation is thought to be reflected in the shorter response latencies typically observed on congruent versus incongruent trials. In other words, according to this model the locus of the observed affective congruency effect is in the evaluative categorization process.

More recent explanations of the affective congruency effect have focused instead on conflict of the kind typically associated with the Stroop color-naming task (see MacLeod, 1991). A number of behavioral studies have provided evidence supporting this general notion (see De Houwer, Hermans, Rothermund, & Wentura, 2002; Gawronski, Deutsch, & Seidel, 2005; Klauer & Musch, 2002; Klinger, Burton, & Pitts, 2000; Wentura, 1999), but have not convincingly demonstrated whether that conflict occurs at the level of stimulus evaluation (e.g., Abrams, Klinger, & Greenwald, 2002; Klauer & Musch, 2003; Klauer, Musch, & Eder, 2005) or in response selection and execution (e.g., Klinger et al., 2000; Wentura & Rothermund, 2003).

Fortunately, ERPs provide a means for separately estimating the influence of experimental manipulations on the evaluative categorization and response output processes, and the ERP literature provides a precedent for testing exactly this kind of question. For example, previous research has shown that, although response latencies are delayed on incongruent Stroop trials (relative to congruent trials) they do not produce a delay in P3 latency (Duncan-Johnson & Kopell, 1981). This finding, coupled with evidence that the P3 is independent of response-related processes (e.g., Crites, Cacioppo, Gardner, & Berntson, 1995; Magliero, Bashore, Coles, & Donchin, 1984; McCarthy & Donchin, 1981), suggests that Stroop interference does not arise from conflict during stimulus evaluation.

Unlike the P3, the LRP is largely insensitive to stimulus evaluation parameters (see Coles et al., 1995). Thus, the LRP can show whether, for example, prime stimuli activate responses prior to the onset of subsequent target stimuli, and if so, whether those responses conflict with responses elicited by targets on incongruent trials, regardless of the evaluative properties (e.g., affective match vs. mismatch) of the prime and target.

If so, the conflict inherent on incongruent trials should be reflected in the amplitude of the N2 component following target onset. As reviewed previously the N2 is believed to reflect the conflict monitoring function of the ACC (see Botvinick et al., 2001; van Veen & Carter, 2002a). The N2 tends to be larger on trials involving conflict between competing response representations, such as incongruent Stroop trials (e.g., Liotti, Woldorff, Perez, & Mayberg, 2000). Although the extent to which the N2 is sensitive to conflict arising from both competing response activations and competing stimulus evaluations is debated (see Wendt, Heldmann, Munte, & Kluwe, 2007), the current weight of the evidence points to the N2 responding

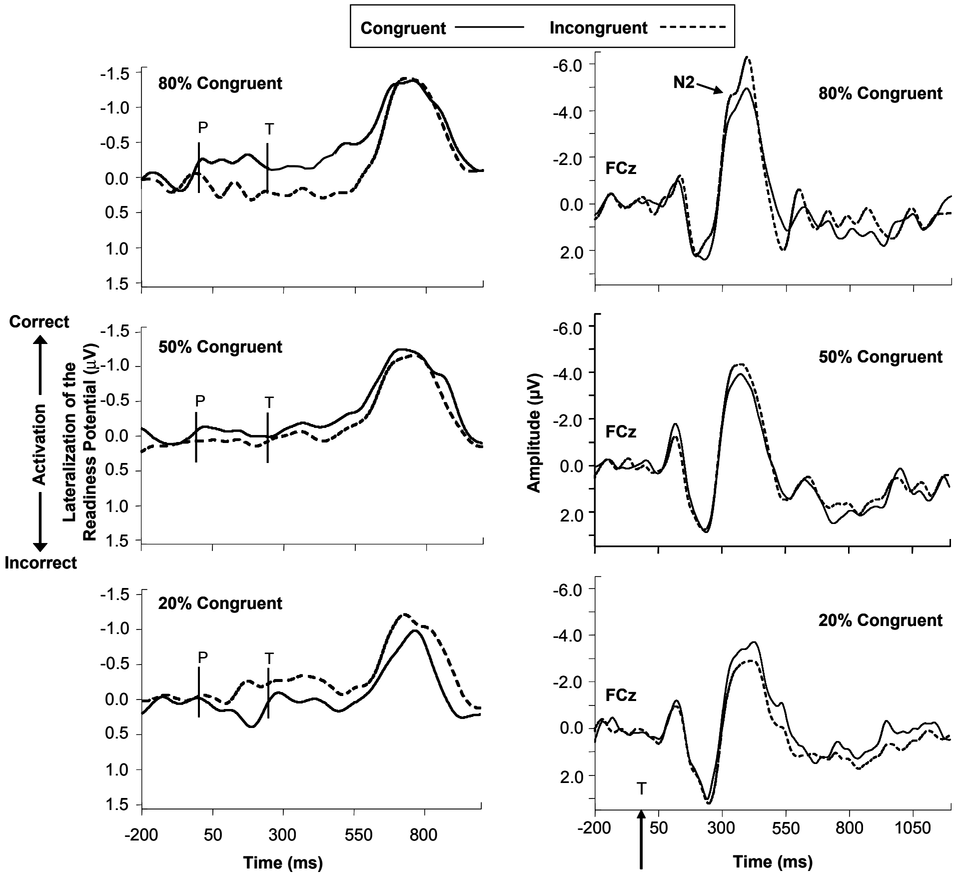

FIGURE 1. ERP waveforms showing the lateralized readiness potential (LRP) measured from electrodes C3 and C4 (left panel) and the N2 component measured at electrode FCz (right panel) as a function of target congruence and the probability of congruent trials. Vertical marks on the LRP waveform labeled "P" and "T" represent the time of prime and target onset, respectively. Of primary interest here was the amplitude of the LRP between prime onset and target onset, which indicates relative response activation elicited by the primes. The vertical arrow (and "T") on the timeline for the N2 represent target onset. Adapted from Bartholow et al. (2009a).

primarily to response-related conflict (see Kopp, Rist, & Mattler, 1996; van Veen & Carter, 2002b; van Veen, Cohen, Botvinick, Stenger, & Carter, 2001).

Recently, Bartholow and colleagues (2009) investigated the locus of the affective congruency effect using ERPs. Participants completed a variation of the standard evaluative decision task (e.g., Fazio et al., 1986) in which the probability of congruent versus incongruent trials differed across trial blocks (see also Klauer, Rossnagel, & Musch, 1997; Spruyt, DeHouwer, Helmans, Eelen, 2007) while ERPs were recorded. Bartholow et al. reasoned that, if the locus of the affective congruency effect is in the evaluative categorization process, then the latency of the P3 component should be delayed on incongruent versus congruent trials and the behavioral congruency effect in RT should be associated with this neural index of stimulus evaluation. If instead the effect derives from response conflict, then P3 latencies should be similar on congruent and incongruent trials, but the LRP should indicate response activation following prime onset that conflicts with the response required by the target on incongruent trials.

The behavioral data from this experiment replicated previous studies showing that the size of the affective congruency effect varies along with the proportion of congruent trials (e.g., Klauer et al., 1997; Spruyt et al., 2007). More importantly, the ERP data provided the first direct evidence for the locus of this effect within the information-processing system. First, the latency of the P3 component was unaffected by both congruence and the congruence x probability cross-product, suggesting that the locus of the behavioral congruency effect was not in the stimulus evaluation process. Second, however, both the LRP and N2 amplitudes were modulated by congruence and probability in a manner consistent with predictions. As shown in Figure 1 (left panel, top), when congruent trials were highly probable participants began to preferentially activate the congruent target response before the target appeared (e.g., activating the positive response to positive primes), as indicated by the relatively negative amplitude of the LRP for congruent trials compared to incongruent trials. Thus, when the target was actually incongruent, the response required by the target conflicted with the response preactivated by the prime, a classic case of response conflict. Detection of this conflict by the ACC is evident in the amplitude of the N2 component following target onset (see Figure 1, right panel, top). These effects were smaller, though still evident, when congruence probability was .50. As predicted, though, when congruent trials were highly improbable participants appeared to activate the incongruent response at prime onset (Figure 1, left panel, bottom), leading to enhanced conflict for *congruent* relative to incongruent trials (Figure 1, right panel, bottom). Finally, covariance analyses showed that variation in behavioral responses (RT) was dependent on variations in both LRP and N2 amplitudes, indicating that individual differences in the size of the affective congruency effect were associated with brain activity reflecting the extent to which conflicting responses were activated on incongruent trials.

The findings from this study are important in three primary respects. First, the N2 and LRP data are consistent with the notion that responses to attitude-related stimuli can be strategically controlled and are not predestined on the basis of automatic spreading of activation (cf. Fazio et al., 1986). Second, response activation and conflict are not driven simply by whether primes and targets share an evaluative category. Rather, conflict varied primarily as a function of whether the response required by the target was predictable from the prime. Third, this study showed that behavioral affective congruency effects can be predicted from neural measures of response activation and conflict, providing direct evidence of the involvement of these processes in affective priming. Together, these data indicate the usefulness of ERP data for constraining theoretical models about affective priming, strongly suggesting that, at least when measured using an evaluative decision task (Fazio et al., 1986), the affective congruency effect stems primarily from response-related processes, and not from stimulus evaluation.

Stereotype Priming. ERPs also have proven useful for specifying the locus of experimental effects in racial stereotype priming paradigms. Stereotype priming occurs when presentation of a racial category cue (e.g., a Black man’s face) facilitates responses to any of a number of stereotype-consistent target stimuli, such as words (e.g., violent) or objects (e.g., a handgun) associated with stereotypic traits, relative to stereotype-inconsistent target stimuli. Numerous studies have shown evidence for priming effects of this kind (e.g., Devine, 1989; Dovidio, Evans, & Tyler, 1986; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Fazio, Jackson, Dunton, & Williams, 1995; Lepore & Brown, 1997; Macrae, Stangor, & Milne, 1994; Payne, 2001, 2005; Wheeler & Petty, 2001). Similar findings have emerged when stereotype-consistent context information facilitates categorization of targets into racial groups (e.g., Livingston & Brewer, 2002; Richeson & Trawalter, 2005).

As with the affective priming effects reviewed previously, questions recently have been raised concerning whether such stereotype priming effects largely stem from evaluative categorization processes, response output processes, or some combination. Specifically, whereas traditional models have emphasized the accessibility of automatic associations in long-term memory (i.e., between racial categories and evaluative constructs) in determining stereotype priming effects and other, similar forms of bias expression (e.g., Dovidio, Evans, & Tyler, 1986; Fazio, Jackson, Dunton, & Williams, 1995; Greenwald et al., 2002; Macrae & Bodenhausen, 2000), a number of recent models have outlined an important role for response conflict and other processes related to cognitive control in explaining such effects (e.g., Amodio et al., 2004; Conrey, Sherman, Gowronski, Hugenberg, & Groom, 2005; Payne, 2005; Sherman et al., 2008). ERPs recently have been used to investigate the extent to which particular underlying cognitive processes are engaged and influence behavioral responses in stereotype priming tasks.

The specific role of response conflict and evaluative categorization processes in a racial categorization task recently was investigated by Bartholow and Dickter (2008). In their experiment, Bartholow and Dickter (2008) had participants complete a modified version of the Eriksen flanker task (e.g., Eriksen & Eriksen, 1974) in which they categorized the race of central targets (Black or White) flanked on four sides by trait words associated with common stereotypes for Blacks and Whites. Thus, similar to primes in a typical priming task, the flanker words were irrelevant distracters that participants were instructed to ignore. Also, as in several previous studies using flanker tasks (e.g., Bartholow et al., 2005; Gratton, Coles, & Donchin, 1992) and evaluative decision tasks (e.g., Bartholow et al., 2009; Spruyt et al., 2007), the proportion of *compatible trials* (i.e., trials in which flanker words and target race were stereotype-consistent) to *incompatible trials* (i.e., trials in which flanker words and target race were stereotype-inconsistent) was systematically varied across trial blocks.

Behavioral results showed that categorization responses were faster on compatible trials than on incompatible trials (i.e., the so-called compatibility effect), but only when compatible trials were more probable, similar to Bartholow et al.'s (2009) affective congruency findings. Importantly, the latency of the P3 component of the ERP indicated no difference in the speed or ease with which incompatible and compatible trials were evaluated in the brain. However, the LRP component revealed key differences in response activation dynamics occurring on incompatible versus compatible trials, but again only during mostly-compatible trial blocks (i.e., when compatible trials were highly probable). Specifically, as shown in Figure 2 (left panel), the small positive dip in the LRP waveform occurring around 50 ms after onset of the stimulus arrays on incompatible trials shows that participants tended to initially activate the incorrect categorization response (e.g., preparing to press the White response button on a Black target trial) on incompatible trials, which appeared to delay activation and execution of the correct response. This finding suggests that participants were relying on the stereotypicality of the flank-

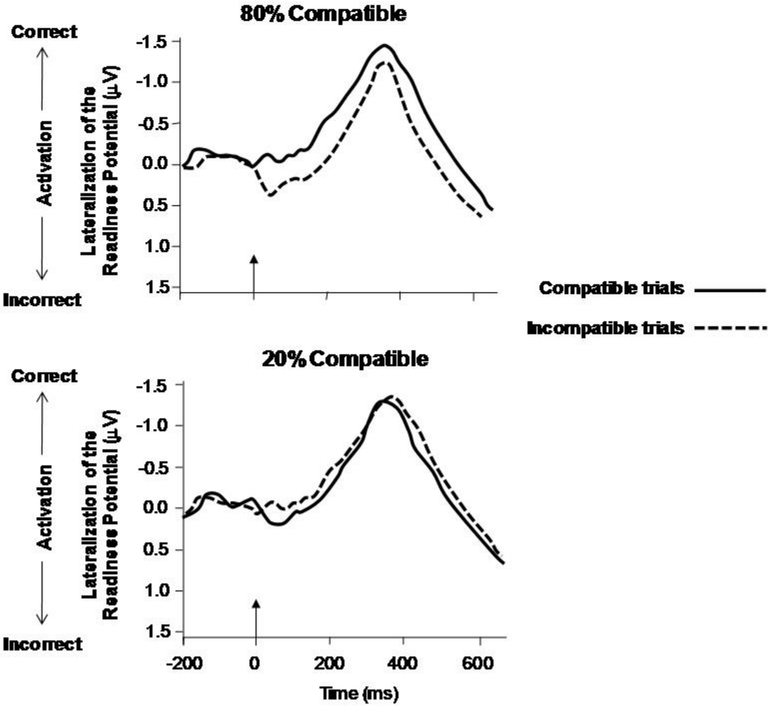

FIGURE 2. Lateralized readiness potential (LRP) waveforms derived from electrodes C3 and C4 for compatible (Compat) and incompatible (Incompat) trials in the 80% compatible and 20% compatible blocks (from Bartholow & Dickter, 2008). The arrow at time 0 indicates stimulus array onset. The formula used to derive the LRP is applied with reference to the correct response hand in each condition, such that negative (upward) deflections reflect preferential activation of the correct response, whereas positive (downward) deflections indicate preferential activation of the incorrect response. The positive "dip" occurring around 50 ms post-stimulus for incompatible trials in the 80% compatible condition indicates initial activation of the incorrect categorization response prior to activation and execution of the correct response.

er words to inform their categorization responses during the mostly-compatible trial blocks. Supporting this interpretation, correlational analyses showed that the size of this LRP dip was significantly associated with the size of the behavioral compatibility effect in RT. These findings suggest that the compatibility effect seen in the RTs was due not to differences in the evaluative categorization of incompatible relative to compatible trials, which would be expected if a spreading activation mechanism was driving the effect, but to heightened response conflict.

ERPs have been used in other, related work to investigate the influence of specific aspects of cognitive control on the expression and control of race bias. For example, Amodio and colleagues (e.g., Amodio et al., 2004, 2006, 2008) have conducted several studies in which participants completed the Weapons Identification Task (WIT; Payne, 2001), a priming task in which briefly-presented images of White and Black men's faces precede images of tools and guns that must be identified very quickly via button presses, while ERPs were recorded. Amodio and colleagues have been particularly interested in the size of the ERN elicited on Black-tool errors (i.e., mistakenly categorizing a tool as a gun on black-prime trials) as an indication of the extent to which participants experience conflict when

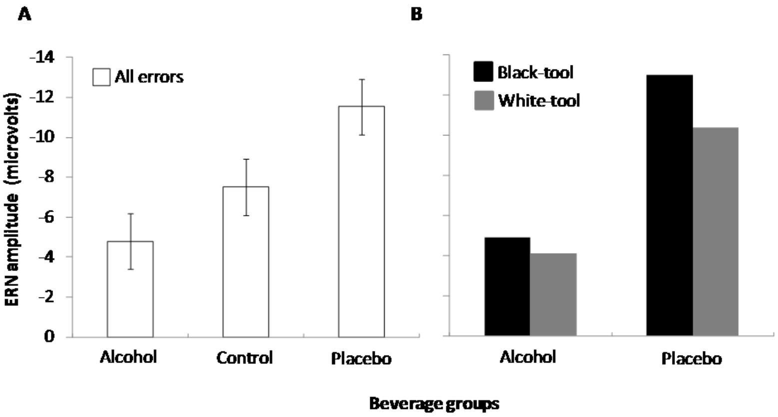

FIGURE 3. Panel A: Mean ERN amplitude (collapsed across all error types) as a function of beverage group. Means for all 3 groups differed reliably from one another (ps < .01). Panel B: Mean ERN amplitude for errors indicative of race bias (Black-tool trials) and errors not associated with race bias (White-tool trials) for the alcohol and placebo groups. Black-tool errors elicited reliably larger ERNs in the placebo group; this effect was not significant in the alcohol group. From Bartholow et al. (2009b).

expressing unintended race bias, and in whether participants utilize these error experiences to increase their response control in the task.

Amodio et al.'s (2004, 2006, 2008) experiments consistently have shown that errors indicative of race bias (i.e., black-tool errors) elicit larger ERNs than other types of errors, and that larger ERNs on race-bias trials are predictive of better response control in the task overall, indicating a functional role for the processes reflected in the ERN in the self-regulation of bias. Together, these findings suggest that people are aware of the unwanted influence of stereotypes on their behavior but simply have difficulty controlling their responses in some contexts (especially when time pressure is high), and that certain forms of motivation to control race bias are manifest in heightened activity of the evaluative control function in the ACC.

Recently, Bartholow, Henry, Lust, Saults, and Wood (2010) also measured ERNs during a WIT as a way to test hypotheses concerning effects of alcohol on error processing. Informed by research suggesting that alcohol impairs the evaluative control function of the ACC by reducing the brain's capacity to detect errors (Ridderinkhof et al., 2002), Bartholow et al. (2010) were interested in how alcohol consumption would influence expression of race bias in the WIT and the neural manifestation of this process reflected in the ERN. Like Amodio et al. (e.g., 2004), Bartholow et al. expected to find that Black-tool errors would elicit larger ERNs than other kinds of errors; like Ridderinkhof et al. (2002), Bartholow et al. expected alcohol to reduce ERN amplitude and to interfere with typical post-error behavioral adjustment. However, unlike both of these other groups, Bartholow et al. hypothesized that the ERN reflects an affective/motivational response to errors (see Bush et al., 2000), and that alcohol reduces the ERN not because of impaired error detection but because of the drug's known capacity to reduce negative affect (see Greely & Oei, 1999).

In their experiment, Bartholow et al. (2010) had participants consume an alcohol beverage, a placebo beverage or a control beverage (plain tonic) prior to completing the WIT. As expected, behavioral findings indicated that participants in the alcohol group made more race-bias errors than participants in the other groups. The primary ERN findings from this study are shown in Figure 3. As expected, alcohol significantly reduced the ERN relative to the other groups (Ridderinkhof et al., 2002); somewhat surprisingly, consuming the placebo enhanced the ERN relative to the control beverage (see Figure 3a). Also, whereas the ERN was larger for race bias errors than for other errors in the placebo group, this difference was not seen in the alcohol group (see Figure 3b). Most pertinent to their hypotheses, trial-by-trial response accuracy judgments (see also Payne, Shimuzu, & Jacoby, 2005) showed that alcohol did not reduce participants' ability to recognize when they had made an error (cf. Ridderinkhof et al., 2002). Also as predicted, alcohol participants reported significantly less negative affect post-drinking relative to baseline. More importantly, post-drinking changes in self-reported negative affect significantly mediated the effects of beverage on the ERN. Viewed within the context of theory suggesting that the ERN reflects a form of distress over the conflict inherent in committing an error (see Bush et al., 2000), these data suggest that race bias errors are particularly distressing relative to other errors, and that experiencing that distress is an important factor in determining the extent to which self-regulatory control processes will be engaged following errors (see Bartholow & Henry, 2010).

According to theory (Botvinick et al., 2001), once conflict is detected by the evaluative component of cognitive control (mediated by the ACC), this process signals a second, regulative control component (mediated by dorsolateral prefrontal cortex) that increased control is needed (see Kerns et al., 2004). ERPs also have been used to investigate the role of this regulative component of cognitive control in stereotype-based responding. Relying on a substantial literature indicating that alcohol impairs regulative control (e.g., Casbon, Curtin, Lang, & Patrick, 2003; Curtin & Fairchild, 2003; Fillmore & Vogel-Sprott, 1999), Bartholow et al. (2006) randomly assigned participants to consume a high dose (0.72 g/kg), low dose (0.40 g/kg) or placebo (0.04 g/kg) alcohol beverage prior to completing a modified, go-stop stereotype priming task (Dovidio et al., 1986). In this task, participants were asked to indicate as quickly as possible whether trait words (some were stereotypic and some were counter-stereotypic) could be used to describe Black and White faces (primes), but on 25% of the trials (i.e., stop trials) a red X appeared shortly after the onset of the trait word, signaling participants to withhold their response. The data of primary interest in this experiment were the number of inhibition errors made across trial types (i.e., stereotype-consistent and stereotype-inconsistent) as a function of beverage group, and the amplitude of the NSW component of the ERP (reflecting engagement of regulative cognitive control).

As shown in Figure 4a, the behavioral data show that whereas errors on stereotype-inconsistent (SI) trials were not significantly affected by beverage, errors on stereotype-consistent (SC) trials increased significantly as a linear function of alcohol dose. Moreover, inhibition failures were more likely on SC than SI trials only in the higher-dose alcohol condition. These data are consistent with the idea that alcohol specifically impairs regulation of habitual, prepotent responses (see also Curtin & Fairchild, 2003), in this case, those associated with racial stereotypes. NSW amplitudes were used to test two hypotheses concerning the role of regulatory control in race-biased responding. First, if the NSW reflects implementation of regulative control processes, and if the inhibition error data reflect impairment of this control, the NSW should be larger overall in the placebo group (who showed the fewest inhibition errors) than in the high-dose alcohol group (who showed

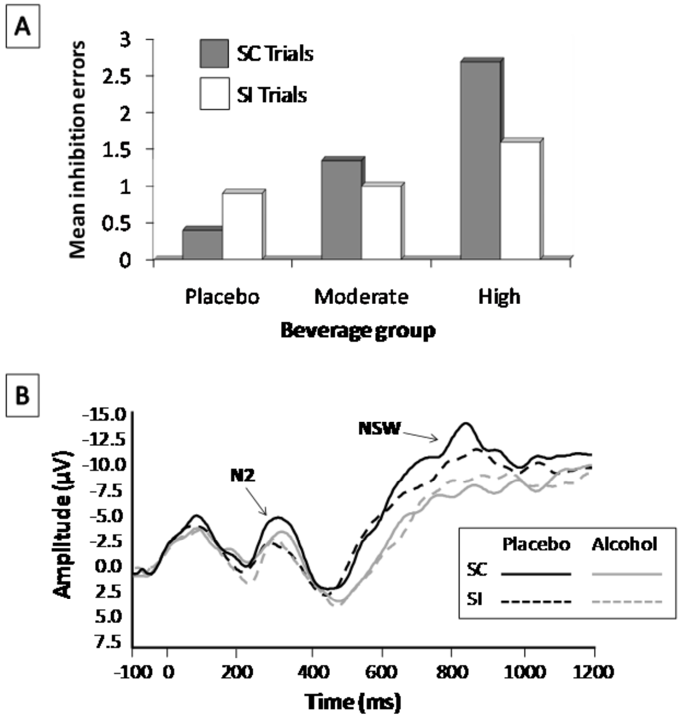

FIGURE 4. Panel A: Mean numbers of inhibition errors on stereotype-consistent (SC) and stereotype-inconsistent (SI) trials as a function of beverage group (from Bartholow et al., 2006). Whereas errors on SI trials did not differ across beverage groups, errors on SC trials increased linearly with alcohol dose. Panel B: ERP waveforms showing the negative slow wave (NSW) component measured at electrode Cz on successfully inhibited "stop" trials as a function of trial type for those in the placebo and high-dose alcohol groups. Time zero represents the onset of the stop signal.

the most errors). This pattern is evident in Figure 4b. Second, to the extent that inhibition of prepotent, race-biased responses requires greater implementation of regulatory control than does inhibition of responses not associated with bias, the NSW should be larger for SC stop trials than for SI stop trials in the placebo group. Again, the data were consistent with this notion: placebo participants showed larger NSW amplitudes on SC than SI trials, but high-dose alcohol participants did not. Furthermore, correlational analyses showed strong inverse associations between the size of the NSW, particularly at frontal electrodes, and the number of bias-related (SC) inhibition errors participants made.

In the spirit of understanding how ERPs can be used to augment behavioral measures in constraining theories about social behavior, it is important to consider differing possible interpretations of the inhibition error data reported by Bartholow et al. (2006) and whether the ERP data can provide any resolution. At least 3 possible explanations could be entertained. First, it could be that alcohol increases stereotypic responding by increasing the accessibility of associations in long-term memory between racial categories and stereotypic traits. Such an explanation would be consistent with numerous contemporary models of race bias that emphasize individual differences in construct accessibility (e.g., Fazio et al., 1995; Greenwald et al., 2002). As already discussed, the latency of the P3 component can be used to infer how quickly a stimulus is evaluatively categorized. Thus, if alcohol increased construct accessibility, this should be reflected in decreased latency of the P3. However, alcohol had no effect on P3 latency in this study (for more details see Bartholow et al., 2006).

A second possibility is that alcohol might intensify initial activation of responses, thereby making inhibition more difficult on stop trials. Two findings in Bartholow et al.'s (2006) data suggest that this was not the case. First, RTs on go trials were unaffected by beverage type; had alcohol increased response activation one might expect faster RTs for the alcohol group on go trials. Second, the amplitude of the N2 component elicited on stop trials, reflecting the degree of conflict between an activated response and the need to withhold that response (see Bruin, Wijers, & van Staveren, 2001), did not differ across beverage groups (see Figure 4b); if alcohol had increased initial response activation, the N2 on stop trials would be expected to be larger in the alcohol group than the placebo group.

Finally, it could be that alcohol interferes with the ability to inhibit responses once they are activated. This explanation seems most consistent with the data, in that components associated with construct accessibility (P3) and response activation conflict (N2) were unaffected by alcohol, but the component most closely linked to implementation of control (NSW) was significantly reduced by alcohol. Further support comes from Sherman et al. (2008), who reanalyzed the inhibition error data from this experiment using formulas in their Quad model. Their analyses indicated that, compared to the placebo beverage, the alcohol beverage impaired the parameter associated with overcoming bias but had no effect on the activation, detection, or guessing parameters. Thus, consistent with the argument put forth by Bartholow et al. (2006), these findings indicate that alcohol has no effect on the activation of stereotypic associations, but rather interferes with the ability to regulate relevant responses once those associations are activated.

In sum, in each of the studies just described, understanding the psychological locus of observed behavioral effects was greatly facilitated by the use of ERPs. In the case of the affective congruency effect, for example, measurement of ERPs allowed a glimpse of the neural mechanisms in motor cortex driving the activation of responses on congruent and incongruent trials. These data provided the first direct evidence that response activation begins at prime onset, before targets even appear, and that conflict between that response tendency and the response required by the target contributes importantly to RT differences between congruent and incongruent trials. More importantly, perhaps, these data help to constrain theories concerning the mechanisms responsible for well-known effects in social cognition.

CONTINUOUS FLOW VERSUS DISCRETE STAGE PROCESSING MODELS

Thus far, I have presented examples of the ways in which ERPs have been used to identify the locus of experimental effects within the information processing system. But the structure and functioning of that system also has been the subject of considerable debate and scientific inquiry (e.g., Eriksen & Schultz, 1979; Miller, 1988), and ERPs have proven useful for investigations of this kind as well (e.g., Coles et al., 1995; Miller & Hackley, 1992). In particular, ERPs have been used to test the extent to which different elements of processing unfold in discrete stages as opposed to emerging in a more continuous manner (e.g., Miller, 1983, 1988; Sanders, 1990). As noted previously, discrete stage theorists posit that a given downstream aspect of processing (e.g., response activation) cannot be initiated until all ostensibly upstream processes (e.g., stimulus evaluation) have been completed.

In contrast to a discrete stage approach, continuous flow models of information processing assume that multiple processes operate in parallel, and that information about a given stimulus (e.g., its identity, category membership, etc.) accumulates over time. An important consequence of this assumption is that response selection and preparation can be initiated prior to full and complete evaluation of the stimulus. Numerous ERP studies have provided evidence supporting this assumption (e.g., Coles, Gratton, Bashore, Eriksen, & Donchin, 1985; Coles, Gratton, & Donchin, 1988; DeJong, Wierda, Mulder, & Mulder, 1988; Miller & Hackley, 1992; Miller & Schroter, 2002; Smid, Lamain, Hogeboom, Mulder, & Mulder, 1991). For example, it is clear that response preparation and activation (generally measured with the LRP), and even response execution (indicated by increased muscle activity in the forearm of the responding hand), can be initiated prior to the completion of stimulus evaluation, as reflected in the latency of the P3 component (e.g., Coles et al., 1985).

A seminal study by Gratton et al. (1992) nicely illustrates the use of LRP and other ERP components to test the hypothesis that response preparation and activation can be initiated on the basis of partial, incomplete information about a stimulus. Gratton et al. had participants complete a version of the Eriksen flanker task (Eriksen & Eriksen, 1974), in which a central target letter is flanked by other letters that either elicit the same response as the target (i.e., compatible trials; HHHHH) or the opposing response (i.e., incompatible trials; SSHSS). Gratton et al. also manipulated the proportion of compatible to incompatible trials across trial blocks (25%, 50%, and 75% compatible trials) in order to test how expectancy-based response strategies affect both task performance and the transmission of information during stimulus processing. The authors found that the typical compatibility effect (i.e., longer RTs on incompatible vs. compatible trials) was strongly affected by the probability manipulation, being much larger during the mostly-compatible trial blocks. The ERP data indicated that this effect was driven by differences in the strength of response activation early in processing, prior to full evaluation of stimulus arrays. Specifically, the LRP data showed that participants were likely to base initial response preparation on a cursory examination of the stimulus arrays driven largely by the relative number of a given type of stimulus (e.g., the number of Hs present in the array), regardless of their status as target or nontarget. As evaluation of the arrays progressed, participants appeared to adjust their response activation accordingly if, for example, they initially had begun to activate the incorrect response (e.g., if the target was actually an S).

These issues also have parallels in the social cognition. For example, consider Bartholow et al.'s (2009) affective priming study, described previously. In that study the LRP data showed evidence of initial response preparation following onset of the prime words, before the target words had even appeared. The amplitude of the N2 component paralleled the LRP, indicating greater conflict on trials for which the response prepared following prime onset was opposed to the one required by the target, regardless of whether prime and target were affectively congruent (see Figure 1). Given that the LRP and N2 components both temporally precede the P3 component, some might argue that these ERP data are logically inconsistent with the idea that the P3 represents stimulus evaluation whereas the N2 reflects response conflict. Indeed, assuming a discrete stage model of the processing system, in which a response cannot be initiated before stimulus evaluation is completed, would suggest such an argument. However, Bartholow et al.'s data are perfectly in-line with continuous flow models that assume partial information transmission between processing stages. Particularly in paradigms in which a relevant prime stimulus precedes the imperative target stimulus, the likelihood that a given response will be initiated prior to complete target evaluation is quite high. As target evaluation begins, if it becomes clear that the response initially prepared (i.e., based on the prime) is not the correct one, this initial response-related activity will conflict with subsequent efforts at corrective action initiated in medial-frontal cortical areas (e.g., the ACC) associated with conflict monitoring and reflected in larger N2. Importantly, assuming a continuous flow model of information transmission provides a more parsimonious accounting of the data and, moreover, of the affective congruency effect more generally.

These processes appear to work in a similar manner when both targets and nontarget stimuli (i.e., distracters or primes) appear simultaneously rather than sequentially. In other words, a sequential presentation is not necessary for initial response preparation to be initiated prior to a complete evaluation of the target. Data from the racial categorization study reported by Bartholow and Dickter (2008) provide a relevant example. In that study, participants were shown target faces varying by race (White or Black) that were flanked on 4 sides by stereotype-related words, and the probability of compatible trials (those in which target race and flanker words were stereotype-congruent) was manipulated across trial blocks. In the mostly-compatible trial blocks, the LRP data indicated that on incompatible trials participants initially tended to activate the incorrect response prior to activating the correct response (see Figure 2, top panel). This dynamic response activation pattern suggests, again, that responses can be prepared before a stimulus has been fully evaluated. In this case, initial response activation apparently was based on analysis of the context provided by stereotype-related words. As previously demonstrated by Gratton et al. (1992), when the probability is high that evaluating context information will aid in generating the correct response, it makes sense for participants to broaden their focus of attention to include the more numerous flankers as well as the target. Once evaluation proceeds beyond that initial, cursory evaluation (i.e., once target race was recognized), participants appear to reverse course on incompatible trials and ultimately produce the correct response. Thus, even when context information appears simultaneously with a target, and even when that context information is not directly mapped to a valid task response, participants appear to initiate responses on the basis of partial stimulus evaluation. Importantly, even the response generation process is not a discrete, all-or-none proposition, as seen in these and other LRP data indicating a dynamic, fluid process informed by both expectations and accumulating evidence of target identity.

CONCLUSIONS

At the outset, I stated the aim of this article as illustrating how ERPs can be used to constrain theories pertaining to social-cognitive phenomena. I attempted to do so by reviewing the findings of several recent experiments in which ERP data, coupled with relevant behavioral findings, were used to identify the locus of experimental effects within the information-processing system, and by discussing how ERPs have been instrumental in refining understanding of how the system is structured. The ultimate aim of this article was to inspire future researchers to consider ways in which the methods of cognitive neuroscience, ERPs or otherwise, can be used as tools to a further understanding of social behavior rather than as ends unto themselves. That is, researchers risk the tail wagging the dog if they allow trends in measurement technology to drive their research questions, rather than allowing their research questions to determine which technologies—from self-report to behavioral measures to neural responses—should be utilized.

It also is important to note that the rather thin slice of the literature reviewed here is by no means intended to represent a complete accounting of the ways in which ERPs (and other psychophysiological measures) are useful for furthering theory in social cognition. For example, researchers interested in understanding processes that theoretically are posited to unfold very quickly (e.g., initial attention orienting) could use ERPs to test the effects of various experimental manipulations on those processes, regardless of whether the data could be used to differentiate between various conceptual or theoretical models. Additionally, ERPs can be very useful for tackling certain research questions that do not involve either identifying the locus of experimental effects or the function and structure of the information-processing system, such as how quickly one type of stimulus is differentiated from another (e.g., ingroup vs. outgroup faces; see Ito & Urland, 2003, 2005), the extent to which socially- or motivationally-relevant stimuli engage some aspect of processing (e.g., positive vs. negative images; Ito et al., 1998), or how the same stimulus elicits different levels of processing depending upon the context in which it appears (e.g., expectancy-consistent vs. -inconsistent information; Bartholow et al., 2001; Van Duynslaeger et al., 2007). In these and many other cases besides, the ERP technique can provide valuable insights into social cognition and social behavior.

REFERENCES

Abrams, R. L., Klinger, M. R., & Greenwald, A. G. (2002). Subliminal words activate semantic categories (not automated motor responses). *Psychonomic Bulletin and Review, 9*, 100-106.

Amodio, D. M., & Bartholow, B. D. (in press). Event-related potential methods in social cognition. In A. Voss, C. Stahl, & C. Klauer (Eds.), *Cognitive Methods in Social Psychology*.

Amodio, D. M., Devine, P. G., & Harmon-Jones, E. (2008). Individual differences in the regulation of intergroup bias: The role of conflict monitoring and neural signals for control. *Journal of Personality and Social Psychology, 94,* 60-74.

Amodio, D. M., Harmon-Jones, E., Devine, P. G., Curtin, J. J., Hartley, S. L., & Covert, A. E. (2004). Neural signals for the detection of unintentional race bias. *Psychological Science, 15,* 88-93.

Amodio, D. M., Kubota, J. T., Harmon-Jones, E., & Devine, P. G. (2006). Alternative mechanisms for regulating racial responses according to internal vs. external cues. *Social Cognitive and Affective Neuroscience, 1*, 26-36.

Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personali-*

ty psychology (pp. 253-285). Cambridge, UK: Cambridge University Press.

Bartholow, B. D., & Amodio, D. M. (2009). Using event-related brain potentials in social psychological research: A brief review and tutorial. In E. Harmon-Jones & J. S. Beer (Eds.), *Methods in social neuroscience* (pp. 198-232). New York: Guilford Press.

Bartholow, B. D., & Dickter, C. L. (2008). A response conflict account of the effects of stereotypes on racial categorization. *Social Cognition, 26,* 273-291.

Bartholow, B. D., Dickter, C. L., & Sestir, M. A. (2006). Stereotype activation and control of race bias: Cognitive control of inhibition and its impairment by alcohol. *Journal of Personality and Social Psychology, 90*, 272-287.

Bartholow, B. D., Fabiani, M., Gratton, G., & Bettencourt, B. A. (2001). A psychophysiological analysis of cognitive processing of and affective responses to social expectancy violations. *Psychological Science, 12,* 197-204.

Bartholow, B. D., & Henry, E. A. (2010). Response conflict and affective responses in the control and expression of race bias. *Social and Personality Psychology Compass, 4*, 871-888.

Bartholow, B. D., Henry, E. A., Lust, S. A., Saults, J. S., & Wood, P. K. (2010). *Alcohol effects on performance monitoring and adjustment: I, Affect modulation and impairment of evaluative cognitive control.* Manuscript submitted for publication.

Bartholow, B. D., Pearson, M. A., Dickter, C., Sher, K. J., Fabiani, M., & Gratton, G. (2005). Strategic control and medial frontal negativity: Beyond errors and response conflict. *Psychophysiology, 42,* 33-42.

Bartholow, B. D., Riordan, M. A., Saults, J. S., & Lust, S. A. (2009). Psychophysiological evidence of response conflict and strategic control of responses in affective priming. *Journal of Experimental and Social Psychology*, *45*, 655-666.

Bassili, J. N. (2001). Cognitive indices of social information processing. In A. Tesser & N. Schwartz (Eds.), *Blackwell handbook of social psychology: Intraindividual processes* (pp. 68-88). New York: Wiley.

Berkowitz, L., & Devine, P. G. (1995). Has social psychology always been cognitive? And what is cognitive anyhow? *Personality and Social Psychology Bulletin*, *21*, 696-703.

Bernat, E. M., Williams, W. J., & Gehring, W. J. (2005). Decomposing ERP time–frequency energy using PCA. *Clinical Neurophysiology, 116*, 1314-1334.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108*, 624-52.

Bruin, K. J., Wijers, A. A., & van Staveren, A. S. J. (2001). Response priming in a go/nogo task: Do we have to explain the go/nogo N2 effect in terms of response activation instead of inhibition? *Clinical Neurophysiology, 112*, 1660-1671.

Brunia, C. H. M. (1988). Movement and stimulus preceding negativity. *Biological Psychology*, *26*, 165–178.

Bush, G., Luu, P., & Posner, M. L. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences, 4*, 215-222.

Cacioppo, J. T., Berntson, G. G., Sheridan, J.F., & McClintock, M. K. (2000). Multi-level integrative analyses of human behavior: Social neuroscience and the complementing nature of social and biological approaches. *Psychological Bulletin, 126*, 829-843.

Cacioppo, J. T., & Tassinary, L. G. (1990). Psychophysiology and psychophysiological inference. In J. T. Cacioppo & L. G. Tassinary (Eds.), *Principles of psychophysiology: Physical, social, and inferential elements* (pp. 3-33). New York: Cambridge University Press.

Casbon, T. S., Curtin, J. J., Lang, A. R., & Patrick, C. J. (2003). Deleterious effects of alcohol intoxication: Diminished cognitive control and its behavioral consequences. *Journal of Abnormal Psychology, 112*, 476-487.

Coles, M. G. H. (1989). Modern mind-brain reading: Psychophysiology, physiology, and cognition. *Psychophysiology, 26*, 251–269.

Coles, M. G. H., Gratton, G., Bashore, T. R., Eriksen, C. W., & Donchin, E. (1985). A psychophysiological investigation of the continuous flow model of human information processing. *Journal of Experimental Psychology: Human Perception and Performance, 11*, 529-553.

Coles, M. G. H., Gratton, G., & Donchin, E. (1988). Detecting early communication: Using measures of movement-related potentials to illuminate human information processing. *Biological Psychology, 26*, 69-89.

Coles, M. G. H., Smid, H. G. O. M., Scheffers, M. K., & Otten, L. J. (1995). Mental chronometry and the study of human information processing. In M. D. Rugg & M. G. H Coles (Eds.), *Electrophysiology of mind: Event-related brain potentials and cognition* (pp. 86-131). New York: Oxford University Press.

Collins, A. M., & Loftus, E. F. (1975). A spreading activation theory of semantic processing. *Psychological Review, 82*, 407-428.

Conrey, F. R., Sherman, J. W., Gawronski, B., Hugenberg, K., & Groom, C. (2005). Separating multiple processes in implicit social cognition: The Quad-Model of implicit task performance. *Journal of Personality and Social Psychology, 89*, 469-487.

Crites, S. L., Jr., Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1995). Bioelectrical echoes from evaluative categorization: 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.

Curtin, J. J. & Fairchild, B. A. (2003). Alcohol and cognitive control: Implications for regulation of behavior during response conflict. *Journal of Abnormal Psychology, 112*, 424-436.

De Houwer, J., & Hermans, D. (1994). Differences in the affective processing of words and pictures. *Cognition and Emotion, 8*, 1-20.

De Houwer, J., Hermans, D., Rothermund, K., & Wentura, D. (2002). Affective priming of semantic categorization responses. *Cognition and Emotion, 16, 643-666.*

De Jong, R., Wierda, M., Mulder, G., & Mulder, L. J. M. (1988). Use of partial information in responding. *Journal of Experimental Psychology: Human Perception and Performance, 14*, 682-692.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56*, 5-18.

Dickter, C. L., & Bartholow, B. D. (2007). Event-related brain potential evidence of ingroup and outgroup attention biases. *Social, Cognitive, and Affective Neuroscience, 2,* 189-198.

Dickter, C. L., & Bartholow, B. D. (2010). Ingroup categorization and response conflict: Interactive effects of target race, flanker compatibility and infrequency on N2 amplitude. *Psychophysiology, 47,* 596-601.

Donchin, E., & Coles, M. G. H. (1988). Is the P300 component a manifestation of context updating? *Behavioral and Brain Sciences, 11*, 357-427.

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.

Dovidio, J. F., Kawakami, K., Johnson, C., Johnson, B., & Howard, A. (1997). On the nature of prejudice: Automatic and controlled processes. *Journal of Experimental Social Psychology, 33*, 510-540.

Duncan-Johnson, C. C., & Kopell, B. S. (1981). The Stroop effect: Brain potentials localize the source of interference. *Science, 214*, 938-940.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of target letter in a non-search task. *Perception and Psychophysics, 16,* 143–149.

Eriksen, C. W., & Schultz, D. W. (1979). Information processing in visual search: A continuous flow conception and experimental results. *Perception and Psychophysics, 25,* 249–263.

Fabiani, M., Gratton, G., & Federmeier, K. D. (2007). Event-related brain potentials: Methods, theory, and applications. In J. T. Cacioppo, L. G. Tassinary, & G. Berntson (Eds.), *Handbook of psychophysiology* (3rd ed., pp. 85-119). New York: Cambridge University Press.

Falkenstein, M., Hohnsbein, J., Hoormann, J., & Blanke, L. (1990). Effects of errors in choice reaction tasks on the ERP under focused and divided attention. In C. H. M. Brunia, A. W. K. Gaillard, & A. Kok (Eds.), *Psychophysiological brain research* (pp. 192–195). Tilburg, The Netherlands: Tilburg University Press.

Fazio, R. H. (1990). A practical guide to the use of response latency in social psychological research. In C. Hendrick & M.

S. Clark (Eds.), *Research methods in personality and social psychology* (pp. 74-97). Newbury Park, CA: Sage.

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.

Fillmore, M. T., & Vogel-Sprott, M. (1999). An alcohol model of impaired inhibitory control and its treatment in humans. *Experimental and Clinical Psychopharmacology, 7*, 49-55.

Fiske, S. T., & Taylor, S. E. (1991). *Social cognition* (2nd ed.). New York: McGraw-Hill.

Gawronski, B., Deutsch, R., & Seidel, O. (2005). Contextual influences on implicit evaluation: A test of additive versus contrastive effects of evaluative context stimuli in affective priming. *Personality and Social Psychology Bulletin, 31*, 1226-1236.

Gehring, W.J., Goss, B., Coles, M.G.H., Meyer, D.E., & Donchin, E. (1993). A neural system for error detection and compensation. *Psychological Science, 4*, 385-390.

Gratton, G., & Fabiani, M. (2001). Shedding light on brain function: The event-related optical signal. *Trends in Cognitive Sciences*, *5*, 357-363.

Gratton, G., Coles, M. G. H., & Donchin, E. (1992). Optimizing the use of information: Strategic control of activation of responses. *Journal of Experimental Psychology: General, 121*, 480-506.

Greeley, J., & Oei, T. (1999). Alcohol and tension reduction. In K. E. Leonard & H. T. Blane (Eds.), *Psychological theories of drinking and alcoholism* (2nd ed., pp. 14-53). New York: Guilford.

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review, 109,* 3–25.

Harmon-Jones, E., & Beer, J. S. (Eds.) (2009). *Methods in social neuroscience*. Guilford Publications: New York.

Harmon-Jones, E., & Winkielman, P. (Eds.) (2007). *Social neuroscience: Integrating biological and psychological explanations of social behavior*. Guilford Publications: New York.

Hermans, D., De Houwer, J., & Eelen, P. (1994). The affective priming effect: Automatic activation of evaluative information in memory. *Cognition and Emotion, 8*, 515–533.

Hillyard, S. A., & Anllo-Vento, L. (1998). Event-related brain potentials in the study of visual selective attention. *Proceedings of the National Academy of Sciences of the USA, 95*, 781-787.

Holroyd, C. B., & Coles, M. G. H. (2002). The neural basis of human error processing: Reinforcement learning, dopamine, and the error-related negativity. *Psychological Review, 109*, 679-709.

Hopfinger, J. B., & Mangun, G. R. (2001). Tracking the influence of reflexive attention on sensory and cognitive processing. *Cognitive, Affective, & Behavioral Neuroscience, 1,* 56-65.

Hopfinger, J. B., & Ries, A. J. (2005). Automatic versus contingent mechanisms of sensory-driven neural biasing and reflexive attention. *Journal of Cognitive Neuroscience, 17,* 1341-1352.

Ito, T. A., Larsen, J. T., Smith, N. K., & Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: The negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology, 75,* 887–900.

Ito, T. A., & Urland, G. R. (2003). Race and gender on the brain: Electrocortical measures of attention to the race and gender of multiply categorizable individuals. *Journal of Personality and Social Psychology, 85,* 616-626.

Ito, T. A., & Urland, G. R. (2005). The influence of processing objectives on the perception of faces: An ERP study of race and gender perception. *Cognitive, Affective, and Behavioral Neuroscience, 5*, 21-36.

Kerns, J. G., Cohen, J. D., MacDonald, A. W., III, Cho, R. Y., Stenger, V. A., & Carter, C. S. (2004). Anterior cingulate conflict monitoring predicts adjustments in control. *Science, 303,* 1023-1026.

Klauer, K. C., & Musch, J. (2002). Goal-dependent and goal-independent effects of irrelevant evaluations. *Personality and Social Psychology Bulletin, 28*, 802–814.

Klauer, K. C., & Musch, J. (2003). Affective priming: Findings and theories. In C. Klauer and J. Musch (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 7–49). Philadelphia, PA: Lawrence Erlbaum.

Klauer, K. C., Musch, J., & Eder, A. B. (2005). Priming of semantic classifications: Late and response-related, or earlier and more central? *Psychonomic Bulletin & Review*, *12*, 897–903.

Klauer, K.C., Rossnagel, C., & Musch, J. (1997). List-context effects in evaluative priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 246–255.

Klinger, M. R., Burton, P., & Pitts, S. (2000). Mechanisms of unconscious priming: I: Response competition, not spreading activation. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *26*, 441-455.

Kopp, B., Rist, F., & Mattler, U. (1996). N200 in the flanker task as a neurobehavioral tool for investigating executive control. *Psychophysiology, 33*, 282–294.

Kubota, J. T., & Ito, T. A. (2007). Multiple cues in social perception: The time course of processing race and facial expression. *Journal of Experimental Social Psychology, 43*, 738-752.

Kutas, M., McCarthy, G., & Donchin, E. (1977). Augmenting mental chronometry: The P300 as a measure of stimulus evaluation time. *Science, 197*, 792-795.

Kutas, M., McCarthy, G., & Donchin, E. (1977). Augmenting mental chronometry: The P300 as a measure of stimulus evaluation time. *Science, 197*, 792-795.

Lepore, L., & Brown, R. (1997). Category and stereotype activation: Is prejudice inevitable? *Journal of Personality and Social Psychology, 72*, 275-287.

Liotti, M., Woldorff, M. G., Perez, III, R., Mayberg, H. S. (2000). An ERP study of the temporal course of the Stroop color-word interference effect. *Neuropsychologia*, *38*, 701-711.

Livingston, R. W., & Brewer, M. B. (2002). What are we really priming? Cue-based versus category-based processing of facial stimuli. *Journal of Personality and Social Psychology, 82*, 5-18.

Luck, S. J. (2005). *An introduction to the event-related potential technique*. Cambridge, MA: MIT Press.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109*, 163-203.

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*, 93-120.

Macrae, C. N., Stangor, C., & Milne, A. B. (1994). Activating social stereotypes: A functional analysis. *Journal of Experimental Social Psychology, 30*, 370-389.

Magliero, A., Bashore, T. R., Coles, M. G. H., & Donchin, E. (1984). On the dependence of P300 latency on stimulus evaluation processes. *Psychophysiology, 21*, 171-186.

Makeig, S., Westerfield, M., Jung, T.-P., Covington, J., Townsend, J., Sejnowski, T.J., & Courchesne E. (1999). Functionally independent components of the late positive event-related potential during visual spatial attention. *Journal of Neuroscience, 19*, 2665-80.

Mandler, G. (1990). A constructivist theory of emotion. In N. S. Stein, B. L. Leventhal, & T. Trabasso (Eds.), *Psychological and biological approaches to emotion* (pp. 21-43). Hillsdale, NJ: Erlbaum.

Mangun, G. R., & Hillyard, S. A. (1995). Attention: Mechanisms and models. In M. D. Rugg & M. G. H. Coles (Eds.), *Electrophysiology of mind: Event-related potentials and cognition* (pp. 40–85). New York: Oxford University Press.

McCarthy, G., & Donchin, E. (1981). A metric of thought: A comparison of P300 latency and reaction time. *Science*, *21*, 171–186.

Meyer, J. O., Osman, A. M., Irwin, D. E., & Yantis, S. (1988). Modern mental chronometry. *Biological Psychology, 26*, 3-67.

Miller, J. O. (1983). Can response preparation begin before stimulus recognition finishes? *Journal of Experimental Psychology: Human Perception & Performance, 9*, 161-182.

Miller, J. O. (1988). Discrete and continuous models of human information processing: Theoretical distinctions and empirical results. *Acta Psychologica, 67*, 191-257.

Miller, J. O., & Hackley, S. A. (1992). Electrophysiological evidence for temporal overlap among contingent mental processes. *Journal of Experimental Psychology: General, 121,* 195-209.

Miller, J. O. & Schroter, H. (2002). Online response preparation in a rapid serial visual search task. *Journal of Experimental Psychology: Human Perception and Performance, 28,* 1364-1390.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibition-less spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General, 106*, 226-254.

Nieuwenhuis, S., Aston-Jones, G., & Cohen, J.D. (2005). Decision making, the P3, and the locus coeruleus-norepinephrine system. *Psychological Bulletin, 131,* 510-532.

Ochsner, K. N., & Lieberman, M. D. (2001). The emergence of social cognitive neuroscience. *American Psychologist, 56*, 717-734.

Olson, J. M., Roese, N. J., & Zanna, M. P. (1996). Expectancies. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 211-238). New York: Guilford Press.

Ostrom, T. M. (1984). The sovereignty of social cognition. In R. S. Wyer, Jr., & T. K. Srull (Eds.), *Handbook of social cognition* (Vol. 1, pp. 1-38). Hillsdale, NJ: Erlbaum.

Payne, B. K. (2001). Prejudice and perception: The role of automatic and controlled processes in misperceiving a weapon. *Journal of Personality and Social Psychology, 81*, 181-192.

Payne, B. K. (2005). Conceptualizing control in social cognition: How executive functioning modulates the expression of automatic stereotyping. *Journal of Personality and Social Psychology, 89*, 488-503.

Payne, B. K., Shimizu, Y., & Jacoby, L. L. (2005). Mental control and visual illusions: Toward

explaining race-biased weapon misidentifications. *Journal of Experimental Social Psychology, 41*, 36-47.

Porier, G. W., & Lott, A. J. (1967). Galvanic skin responses and prejudice. *Journal of Personality and Social Psychology, 5*, 253–259.

Posner, M. I. (1978). *Chronometric explorations of mind*. Hillsdale, NJ: Erlbaum.

Rankin, R. E., & Campbell, D. T. (1955). Galvanic skin response to Negro and white experimenters. *Journal of Abnormal and Social Psychology, 51*, 30–33.

Ratcliff, R. A. (1978a). A theory of memory retrieval. *Psychological Review, 85*, 59-108.

Ratcliff, R. A. (1985). Theoretical interpretations of the speed and accuracy of positive and negative responses. *Psychological Review, 92*, 212-225.

Requin, J. (1985). Looking forward to moving soon: Ante factum selective processes in motor control. In M. I. Posner & O. S. M. Marin (Eds.), *Attention and performance XI* (pp. 147–167). Hillsdale, NJ: Erlbaum.

Richeson, J. A., & Trawalter, S. (2005). On the categorization of admired and disliked exemplars of admired and disliked racial groups. *Journal of Personality and Social Psychology, 89*, 517-530.

Ridderinkhof, K. R., de Vlugt, Y., Bramlage, A., Spaan, M., Elton, M., Snel, J., et al. (2002). Alcohol consumption impairs the detection of performance errors by mediofrontal cortex. *Science, 298*, 2209-2211.

Ross, L., & Nisbett, R. E. (1991). *The person and the situation: Perspectives of social psychology*. New York: McGraw-Hill.

Rugg, M. D., & Coles, M. G. H. (1995). The ERP and cognitive psychology: Conceptual issues. In M. D. Rugg & M. G. H Coles (Eds.), *Electrophysiology of mind: Event-related brain potentials and cognition* (pp. 27-39). New York: Oxford University Press.

Sanders, A. F. (1990). Issues and trends in the debate on discrete versus continuous processing of information. *Acta Psychologica, 74*, 123-167.

Schupp, H. T., Cuthbert, B. N., Bradley, M. M., Cacioppo, J. T., Ito, T. A., & Lang, P. J. (2000). Affective picture processing: The late positive potential is modulated by motivational relevance. *Psychophysiology, 37,* 257–261.

Sherman, J. W., Gawronski, B., Gonsalkorale, K., Hugenberg, K., Allen, T. J., & Groom, C. J. (2008). The self-regulation of automatic associations and behavioral impulses. *Psychological Review, 115*, 314-335.

Smid, H. G. O. M., Lamain, W., Hogeboom, M. M., Mulder, G., & Mulder, L. J. M. (1991). Psychophysiological evidence for continuous information transmission between visual search and response processes. *Journal of Experimental Psychology: Human Perception and Performance, 17*, 696-714.

Spruyt, A., De Houwer, J., Hermans, D., & Eelen, P. (2007). Affective priming of non-affective semantic categorization responses. *Experimental Psychology, 54*, 44–53.

Sternberg, S. (1969). The discovery of processing stages: extensions of Donders' method. In W. G. Koster (Ed.), *Attention and performance II* (pp. 276-315). Amsterdam: North-Holland.

Van der Cruyssen, L., Van Duynslaeger, M., Cortoos, A., & Van Overwalle, F. (2009). ERP time course and brain areas of spontaneous and intentional goal inferences. *Social Neuroscience, 4*, 165-184.

Van Duynslaeger, M., Van Overwalle, F., & Verstraeten, E. (2007). Electrophysiological time course and brain areas of spontaneous and intentional trait inferences. *Social Cognitive and Affective Neuroscience, 2*, 174-188.

van Veen, V., & Carter, C. S. (2002a). The anterior cingulate as a conflict monitor: fMRI and ERP studies. *Physiology & Behavior, 77*, 477–482.

van Veen, V., & Carter, C. S. (2002b). The timing of action-monitoring processes in the anterior cingulate cortex. *Journal of Cognitive Neuroscience, 14*, 593-602.

van Veen, V., Cohen, J. D., Botvinick, M. M., Stenger, V. A., & Carter, C. S. (2001). Anterior cingulate cortex, conflict monitoring, and levels of processing. *Neuroimage, 14*, 1302–1308.

Vidal, F., Hasbroucq, T., Grapperon, J., & Bonnet, M. (2000). Is the 'error negativity' specific to errors? *Biological Psychology, 51*, 109–128.

Vidulich, R.N., & Krevanick, F.W. (1966). Racial attitudes and emotional response to visual representations of the Negro. *Journal of Social Psychology, 68*, 85–93.

Wagner, H., & Manstead, A. (Eds.) (1989). *Handbook of social psychophysiology*. New York: Wiley.

Wendt, M., Heldmann, M., Munte, T. F., & Kluwe, R. H. (2007). Disentangling sequential effects of stimulus- and response-related conflict and stimulus–response repetition using brain potentials. *Journal of Cognitive Neuroscience, 19*, 1104–1112.

Wentura, D. (1999). Activation and inhibition of affective information: Evidence for negative priming in the evaluation task. *Cognition and Emotion, 13, 65-91.*

Wentura, D., & Rothermund, K. (2003). The "meddling-in" of affective information: A general model of automatic evaluation effects. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 51–86). Mahwah, NJ: Erlbaum.

West, R., & Alain, C. (1999). Event-related neural activity associated with the Stroop task. *Cognitive Brain Research, 8*, 157-164.

Wheeler, S. C., & Petty, R. E. (2001). The effects of stereotype activation on behavior: A review of possible mechanisms. *Psychological Bulletin, 127*, 797-826.

Willadsen-Jensen, E.C., & Ito, T.A. (2008). A foot in both worlds: Asian Americans' perceptions of Asian, White, and racially ambiguous faces. *Group Processes and Interpersonal Relations, 11*, 182-200.

Yeung, N., Botvinick, M. M., & Cohen, J. D. (2004). The neural basis of error detection: Conflict monitoring and the error-related negativity. *Psychological Review, 111*, 931-959.