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Social Cognitive Neuroscience of Person Perception:

A Selective Review Focused on the Event-Related Brain Potential

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In E. Harmon-Jones and P. Winkeilman (Eds.), *Social neuroscience: Integrating biological*

*and psychological explanations of social behavior (*pp. 376-400). New York: Guilford Press.**

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Although social psychologists have long been interested in understanding the cognitive processes underlying social phenomena (e.g., Markus & Zajonc, 1985), their methods for studying them traditionally have been rather limited. Early research in person perception, like most other areas of social psychological inquiry, relied primarily on verbal reports. Researchers using this approach have devised clever experimental designs to ensure the validity of their conclusions concerning social behavior (see Reis & Judd, 2000). The cognitive revolution of the 1970s and 1980s provided a new conceptual model derived in part from a computer metaphor of human thought, involving input (perception), information processing (cognition), and output (behavior), as well as new methods for examining the mental operations underlying social behavior that did not depend on participants' self-reports (e.g., response latency; see Fazio, 1990).

Recently, another conceptual shift has occurred, based on the notion that complex human behaviors cannot be fully explicated by either a strictly biological or a strictly social psychological approach (e.g., Cacioppo, Berntson, Sheridan, & McClintock, 2000). That is, although human beings (and therefore human behaviors) are inherently social, a purely social level of analysis may ignore or misrepresent important biological events that mediate human action. At the same time, reducing behavior to its biological underpinnings generally does not satisfactorily account for situational differences in behavioral expression. In contrast, a social neuroscience (or social cognitive neuroscience) approach is based on the premise that the most comprehensive understanding of a host of psychological processes is achieved only by examining them at social, cognitive, and neural levels of analysis (Ochsner, 2004; Ochsner & Lieberman, 2001). The aim of this chapter is to review recent developments in social cognitive neuroscience associated with one admittedly narrow topic in the field of social psychology, that of person perception, and specifically to review work that examinines this topic through one primary technique – the event-related brain potential (ERP). We begin with a

brief overview of ERP theory and measurement (for more comprehensive reviews of the theory and methods of ERP research, see Fabiani, Gratton, & Coles, 2000) and conclude by reviewing recent research in which ERPs have been used as a tool for addressing theoretical questions in person perception.

<div align="center">*ERPs and Human Information Processing*</div>

Background and Theory

Hans Berger (1929) first demonstrated that it is possible to record the electrical activity of the human brain (the electroencephalogram; EEG) by placing a pair of electrodes on the surface of the scalp connected to a differential amplifier. When stimuli are presented during EEG recording, epochs of the EEG that are time-locked to stimulus onset can be defined. With repeated samplings of data from epochs time-locked to the same stimulus (or stimulus class), EEG activity that is not time-locked to stimulus onset will vary randomly across epochs and thus tend to average to zero; the remaining average waveform reflects activity associated directly with processing of the stimulus in question (i.e., the ERP). Physiologically, ERPs are assumed to reflect the post-synaptic activity of groups of neurons that are active synchronously and that share an electrical field orientation that permits their effects at the scalp to cumulate. Psychologically, ERP components – positive and negative voltage deflections in the waveform – reflect various sensory, cognitive, and motor processes based on their responsiveness to experimental manipulations (see Fabiani et al., 2000; Friedman & Johnson, 2000; Rugg & Coles, 1995; Stern, Ray, & Quigley, 2001).

Deriving the ERP

ERPs are recorded with an array of electrodes placed on the scalp (usually fixed in a nylon-lycra cap) according to standard location conventions (e.g., the 10-20 international electrode placement system; Jasper, 1958). The electrodes are connected to amplifiers, and the outputs of the amplifiers are converted to numbers using an analog-to-digital converter. Electrical potentials are generally sampled at a frequency ranging from 100 to 10,000 Hz (samples per second); sampling

rates of 250-1,000 Hz are common. Potentials may be recorded continuously during an experimental session (in which case epochs are defined later) or during pre-defined epochs around stimulus or response events. Deriving the ERP from the raw EEG begins with attenuating (filtering) portions of the EEG that are not of interest. A typical filter setting for recording ERPs will attenuate frequencies above 30-40 Hz (low-pass filter) and those below approximately 0.5 Hz (high-pass filter). Large artifacts in the data, typically defined as voltage deflections larger than some criterion (e.g., $100\,\mu V$), also must be removed or attenuated; this is typically accomplished with automated, regression-based procedures (e.g., Semlitsch, Anderer, Schuster, & Presslich, 1986).

ERP Components and their Interpretation

Components are typically described according to their polarity (positive or negative) and the latency (in ms) at which they typically peak. Component amplitude reflects the extent of neural activation associated with a particular cognitive operation, while component latency reflects the time required to carry out that operation (e.g., Gehring, Gratton, Coles, & Donchin, 1992; Rugg & Coles, 1995). Although a group of very short latency *exogenous* components is elicited in the ERP, most social neuroscientists focus on the longer latency *endogenous* components (see Figure 1), which are associated with higher cognitive processes such as those typically of interest to social psychologists (e.g., attention, memory, evaluation, categorization).

Notable endogenous components include the N100, P200, N200, and P300. Both the N100 and P200 (also sometimes called the P1 because it is the first notable positive peak) have been linked to attentional processes (see Fabiani et al., 2000; Rugg & Coles, 1995), with increasing amplitude of the components reflecting increased direction of implicit attention to a stimulus (e.g., Hopfinger & Mangun, 2001; Mangun, Hillyard, & Luck, 1993). In social neuroscience work, the N100 and P200 have been associated with automatic direction of attention to negative relative to positive information (Bartholow, Pearson, Gratton, & Fabiani, 2003; Smith, Cacioppo, Larsen, & Chartrand, 2003), and increased attention to outgroup relative to ingroup members (Ito, Thompson, & Cacioppo, in press;

Ito & Urland, 2003). The N200 has been associated both with stimulus infrequency (e.g.

(Nieuwenhuis, Yeung, Van Den Wildenberg, & Ridderinkhof, 2003; Squires, Squires, & Hillyard,

1975) and with conflict between the response demands associated with concurrent tasks (i.e.,

response conflict; see Botvinick, Braver, Barch, Carter, & Cohen, 2001).

One of the most widely studied endogenous components of the ERP is the P300, a large

positive component that usually peaks between 300-800 ms. The P300 has been associated with the

brain's response to novelty (Friedman, Cycowicz, & Gaeta, 2001), in that P300 amplitude increases

as the subjective probability of an eliciting event decreases (e.g., Donchin & Coles, 1988; Duncan-

Johnson & Donchin, 1977; Squires et al., 1975). The P300 has been described as a manifestation of

context updating in working memory, based on numerous studies indicating better subsequent

memory for stimuli that elicit larger P300 amplitude (e.g., Donchin, 1981; Donchin & Coles, 1988;

Friedman & Johnson, 2000). The latency at which the P300 peaks serves as a neural indicator of

stimulus evaluation or categorization time, with longer latencies indicating more effortful

categorization (see Coles, 1989). It is not uncommon for the P300 to peak substantially later than 300

ms; in tasks involving complex social or emotional stimuli, peaks often occur between 550-800 ms.

Thus, some researchers refer to this component more generically as the "late positive potential" or

LPP to refer to its general timecourse and polarity without reference to a specific temporal anchor

(e.g., see Cacioppo, Crites, Gardner, & Berntson, 1994; Crites, Cacioppo, Gardner, & Berntson,

1995; Ito, Larsen, Smith, & Cacioppo, 1998).

Why use ERPs to Study Person Perception?

Person perception research has a deep and important history in social psychology, involving

such seminal topics as stereotyping, causal attribution, impression formation, and expectancy effects,

to name just a few (see Jones, 1990 for a review). It goes without saying that the behavioral methods

typically used in person perception research, including recall (i.e., person memory), response latency,

and self-reported evaluations (among others; see Olson et al., 1996), have provided a strong

foundation for advancing our understanding of how people come to know what others are "really like" (Jones, 1990). However, the nature of the cognitive and affective processes thought to be important in driving person perception makes certain theoretical questions difficult to address when using such methods alone. For example, when participants are better able to recall information about people in one condition versus another, we infer that the information in the former condition received more extensive processing than the information in the latter condition. In this sense, recall represents one *outcome* of some cognitive activity associated with memory, but a number of processes likely intervene between stimulus encoding and recall that are not well represented in a memory measure. ERPs can provide a direct index of such intervening processes.

A related issue concerns the temporal specificity of cognitive measures. A number of theoretical models (e.g., Brewer, 1988; Fiske & Neuberg, 1990) posit multiple steps or stages of person perception, each of which may represent a distinct cognitive process or set of processes. Given that most social-cognitive processes are assumed to unfold very quickly (e.g., Bargh, 1997; Higgins, 1996), behavioral and self-report measures are not especially well suited to represent them as they happen. In contrast, the temporal specificity of the ERP makes it an ideal measure for examining hypothesized sequential components of information processing involved in person perception (e.g., see Ito, Thompson, & Cacioppo, in press), allowing identification of various stages of processing that mediate the link between perception and overt behavior (e.g., see Rugg & Coles, 1995). Even the act of responding to stimuli (as with a response latency measure) can introduce noise into the data associated with response preparation and execution, effectively confounding relevant cognitive processes with irrelevant motor-related processes. In this regard, P300 latency provides an advantage over more traditional measures of processing time (e.g., response latency) in that it is independent of behavioral responses (though it often correlates with response latency; see McCarthy & Donchin, 1981). Thus, this measure serves as an indicator of stimulus categorization time that is not confounded with the duration of response-related motor processes or task-relevant response

selection requirements (Ito & Cacioppo, 2000; Kutas, McCarthy, & Donchin, 1975; McCarthy & Donchin, 1981; Smid, Mulder, Mulder, & Brands, 1992). This issue is particularly relevant for researchers interested in separating relatively automatic from more controlled processes. Another advantage is that the brain activity represented by ERPs generally is less controllable than self-reports, thereby reducing concerns with self-presentational biases and permitting examination of the effects of a stimulus that individuals are either unable or unwilling to report.

P300 amplitude is particularly relevant for research in person perception for several reasons. First, the P300 can index the effects of probabilistic beliefs such as stereotypes and expectancies on perceivers' implicit reactions to others (see Ito & Cacioppo, in press). Second, given the link between the P300 and working memory processes (see Friedman & Johnson, 2000), P300 amplitude can serve as an online, neural marker for person memory effects (see Bartholow, Fabiani, Gratton, & Bettencourt, 2001). Third, the P300 is known to index evaluative categorization (e.g., Ito & Cacioppo, 1999), a fundamental aspect of differentiating friend from foe. Finally, research suggests that the P300 can reveal task irrelevant categorization processes (Ito & Cacioppo, 2000), and therefore may indicate implicit cognitive processes of which the participant is unaware.

In addition to these cognitive processes, affective processes also play a central role in many models of person perception. As one example, some models of expectancy processes (e.g., Burgoon, 1993; Mandler, 1990) predict that perceivers experience affective arousal when others behave in unexpected ways. However, the precise nature of these affective reactions has been debated. Some models (e.g., Mandler, 1990; Olson et al., 1996) predict that expectancy violations will always result in negative affect for the perceiver (at least initially) because unpredictability and uncertainty are generally unpleasant. Other models (e.g., Bettencourt, Dill, Greathouse, Charlton, & Mulholland, 1997; Kernahan, Bartholow, & Bettencourt, 2000), however, predict that the affective reaction to an expectancy violation depends upon the valence of the violating information. As will be reviewed

later, the temporal specificity of electrophysiological measures can allow direct tests of these

theoretical assertions that have been difficult to obtain with self-report measures.

ERP Studies of Person Perception

Cacioppo and colleagues (e.g., Cacioppo, Crites, Berntson, & Coles, 1993) were among the

first to study social perception using ERPs. These researchers reasoned that since the P300 serves as

an index of subjective probability in categorization processes (e.g., Donchin & Coles, 1988;

Friedman et al., 2001) it also should mark the implicit categorization of evaluatively consistent and

inconsistent attitude objects. Early research by this group (e.g., Cacioppo et al., 1993) supported this

hypothesis, showing that P300 amplitude was enhanced when participants implicitly categorized

attitude words that differed in valence from a preceding context established by other attitude words.

Similar research showed that the P300 to evaluative categorization (e.g., good, bad) differs from that

to nonevaluative categorization (e.g., vegetable, nonvegetable; Crites & Cacioppo, 1996). Extending

this paradigm to person perception, Cacioppo, Crites, Gardner, and Berntson (1994) showed that the

P300 also indexes evaluative categorization of positive and negative personality traits, and that this

effect is associated with categorization per se rather than response processes (Crites, Cacioppo,

Gardner, & Berntson, 1995), suggesting that the P300 might assess implicit interpersonal attitudes.

Expectancies and expectancy violation. Based in part on the findings of Cacioppo and

colleagues, Bartholow et al. (2001) reasoned that cognitive activity associated with interpersonal

expectancy violations also should be manifest in P300 amplitude. A large literature in social and

developmental psychology indicates that expectancy-violating information about people tends to be

recalled better than expectancy-confirming information (e.g., Stangor & McMillan, 1992).

Theoretical models (e.g., Srull & Wyer, 1989) posit that this recall advantage reflects updating of

working memory that occurs as people attempt to reconcile the discrepancy between new information

and existing "person concepts," a process generally known as *inconsistency resolution*. The

longstanding notion that the P300 is an electrocortical index of working memory updating (e.g.,

Donchin, 1981; Donchin & Coles, 1988; Friedman & Johnson, 2000) suggests that the amplitude of this component should reflect the neural processes associated with inconsistency resolution.

To test these assertions, Bartholow and colleagues (2001) asked participants to read paragraph descriptions of several fictitious individuals in order to form impressions of them, and then to read sentences (presented one word at a time on a computer monitor) depicting behaviors that were either consistent or inconsistent with those impressions. The valence of trait information was varied so that physiological responses to both positive and negative expectancy violations could be compared (Bettencourt et al., 1997; Olson et al., 1996). To examine affective reactions to expectancy violations, Bartholow et al. recorded the electrical activity of the *corrugator supercilii* muscle (under the brow) using electromyography (EMG). Previous research had established activity of the *corrugator* as an index of negative affective reactions that are too small or too fleeting to be noticed with the "naked eye" (e.g., Cacioppo, Petty, Losch, & Kim, 1986; see also (e.g., Dimberg & Petterson, 2000; Hess, Blairy, & Kleck, 2000; Vanman, Paul, Ito, & Miller, 1997).

As expected, Bartholow et al. (2001) found that expectancy-violating behaviors elicited larger P300 amplitude than did expectancy-consistent behaviors (see Figure 2). Similarly, expectancy-violating behaviors subsequently were recalled better than expectancy-consistent behaviors, supporting the idea that the P300 reflects working memory updating during person perception. Moreover, although earlier research suggested that the P300 to evaluatively inconsistent words was similar in amplitude regardless of word valence (Cacioppo et al., 1993), Bartholow et al. (2001) found that P300 effects were larger to inconsistent negative behaviors than to inconsistent positive behaviors (see Figure 2, bottom panel), consistent with the literature on positive-negative asymmetry in person perception (e.g., Peeters & Czapinski, 1990; Reeder & Coovert, 1986; Ybarra, Schaberg, & Keiper, 1999) and with other ERP evidence supportive of an implicit negativity bias (Ito, Larsen, Smith, & Cacioppo, 1998). Finally, facial EMG data indicated that the *corrugator* was activated by negative but not by positive expectancy-violating behaviors, supporting the notion that

valence is an important determinant of affective reactions to expectancy violation (e.g., Bettencourt et al., 1997).

Bartholow et al.'s (2001) findings indicated that the recall advantage long known to accompany expectancy violations (e.g., Stangor & McMillan, 1992) results from evaluative categorization processes occurring very rapidly following perception, and strongly implicate a role for working memory – one of a host of so-called executive cognitive functions, thought mediated by activity in the prefrontal cortex – in the process of inconsistency resolution (see also Macrae, Bodenhausen, Schloersheidt, & Milne, 1999). To further explore the role of executive working memory in the inconsistency resolution processes reflected in the P300, Bartholow, Pearson, Gratton, and Fabiani (2003) conducted an experiment in which participants consumed either a moderate (0.40 g/kg ethanol) or high (0.80 g/kg ethanol) dose of alcohol or a placebo beverage just prior to engaging in the person perception task used by Bartholow et al. (2001). Theory (e.g., Steele & Josephs, 1990) and research (e.g., Herzog, 1999) on the effects of alcohol has suggested that controlled processes are impaired following consumption, but that automatic processes are relatively unaffected. Inconsistency resolution arguably involves both automatic (e.g., early direction of attention to novel or salient information) and controlled components (e.g., comparison of new information with pre-existing person concepts). Moreover, alcohol's effects on interpersonal behaviors are commonly attributed to impairment of executive cognitive functions thought mediated by the prefrontal cortex (e.g., Hoaken, Giancola, & Pihl, 1998; Peterson, Rothfleisch, Zelazo, Pihl, 1990; Steele & Josephs, 1990). Given these factors, and the evidence suggesting an important role for executive function in person perception (e.g., Macrae et al., 1999), Bartholow et al. (2003) reasoned that inconsistency resolution might be impaired during intoxication, and used ERPs to specify which processes would be affected.

The main findings from this experiment are presented in Figure 3. For participants in the placebo condition, the ERP results largely replicated those of the earlier report (Bartholow et al.,

2001), in that (negative) expectancy-violating behaviors presented in a positive context elicited enhanced P300 amplitude compared to expectancy-consistent behaviors, whereas (positive) expectancy-violating behaviors presented in a negative context did not. This finding is consistent with other data indicating that negative expectancy violations elicit more processing than do positive expectancy violations (e.g., Sherman & Frost, 2000; Trafimow & Finlay, 2001; Ybarra et al., 1999; see also Ybarra, 2002). For participants in the alcohol conditions, however, the opposite pattern emerged, with generally larger expectancy violation effects associated with positive behaviors presented in a negative context. This reversal likely reflects the effects of alcohol-induced activation of the cerebral reward system on working memory operations associated with processing reward-congruent stimuli (see London, Ernst, Grant, Bonson, & Weinstein, 2000). These differential patterns of processing as a function of valence were corroborated by recall data. Whereas participants in the placebo condition recalled more negative expectancy-violating behaviors, those in the alcohol conditions recalled more positive expectancy-violating behaviors. Importantly, though, alcohol did not appear to disrupt the direction of attention to negative information in early processing stages. The N100 component was larger to negative than to positive behaviors among all participants, regardless of alcohol dose. This finding is consistent with prior research suggesting that alcohol does not disrupt relatively automatic aspects of person perception (Herzog, 1999) and that instead its effects are limited to somewhat later, more effortful processing stages associated with working memory updating. Distinguishing alcohol's effects on these two stages of processing would not have been possible in this paradigm using a recall measure alone. This study also illustrates the use of alcohol as a tool in social neuroscience research. Given that many social-cognitive phenomena are presumed to be mediated by prefrontal cortical activity, examining social cognitive processes in healthy individuals temporarily impaired by alcohol provides a method for bridging gaps between research in neuropsychology, social cognition, and cognitive neuroscience, literatures that traditionally have been largely segregated (see also Macrae et al., 1999).

Social categorization: Processes and consequences. A major focus of person perception research over the past 50 years has been to understand the influence of perceiving others as members of social categories. However, this research is made difficult by participants' unwillingness or inability to divulge their true reactions to others, particularly on issues pertaining to outgroup prejudice. In this regard, ERPs can provide relevant information concerning how differential categorization covertly influences information processing and ultimately behavioral responses.

A study by Osterhout and colleagues (1997) provided an early example of the use of ERPs to study the covert effects of social categorization. Participants were presented with sentences that violated definitional (e.g., "The fireman took a shower after *she* got home) or stereotypical (e.g., "Our aerobics instructor gave *himself* a break") noun-pronoun agreement (or violated neither) while ERPs were recorded. The results showed that both definitionally and stereotypically incongruent sentences elicited enhanced P300 amplitude. Moreover, these ERP effects were independent of participants' judgments of grammatical and syntactical acceptability, highlighting the effectiveness of ERPs in revealing implicit judgment processes.

In a more recent series of experiments, Ito and her colleagues (Ito & Cacioppo, 2000; Ito, Thompson, & Cacioppo, in press; Ito & Urland, 2003) have used ERPs to examine implicit and explicit aspects of categorization (for a more comprehensive review of physiological measures of implicit cognition, see Ito & Cacioppo, in press). In one such study, Ito and Cacioppo (2000) found enhanced P300 amplitude to negative images and to images of people (compared to objects), regardless of whether participants were explicitly categorizing the images. Also, consistent with many of the studies reviewed here (see also Bartholow et al., 2001, 2003; Ito et al., 1998), Ito and Cacioppo found larger effects of evaluative inconsistency with negative as compared to positive targets. In two follow-up experiments, Ito and Urland (2003) showed that several ERP components are sensitive to implicit racial and gender categorization processes. Early components, such as the N100 and P200, appeared sensitive to processing of race and gender information, with larger

amplitudes indicating more cognitive resources devoted to processing images of Blacks and men, respectively. Later working memory-related processes as indexed by the P300 were activated by individuals whose racial or gender category differed from that of the social context established by the preceding images. Another recent study by this group (Ito et al., in press) showed that the evaluative categorization effects reflected in the P300 correlated with perceivers' level of explicit prejudice toward outgroup members, establishing P300 amplitude as an implicit measure of outgroup bias that, unlike other implicit measures (e.g., Implicit Association Test; see Greenwald, McGhee, & Schwartz, 1998), requires no behavioral response.

When combined with behavioral measures, ERPs can also reveal the cognitive processes associated with the behavioral expression of racial bias. Because racial stereotypes are so pervasive in American culture, the behavior of White Americans – even those who believe themselves to be egalitarian – is often unintentionally biased against Blacks. In other words, low-prejudice Whites often face situations in which their egalitarian goals are in conflict with behavioral tendencies engendered by the automatic activation of stereotypes (e.g., Plant & Devine, 1998). Such situations exemplify *response conflict* – when prepotent, well-learned responses are in conflict with less automatic, goal-driven behaviors (see Botvinick et al., 2001). Two neural systems are posited to produce intended behaviors when conflict arises: a *conflict-detection* system that monitors ongoing responses for occasions of conflict, and a *regulatory control* system designed to implement intended responses once conflict has been detected.

Amodio and his colleagues (2004) used ERPs to examine whether race biased responses occur because the conflict detection system fails to recognize that a given behavior is at odds with an individual's nonprejudiced beliefs. These researchers presented participants with trials in which a Black or White face prime was followed by an image of either a gun or a tool. The participants' task was to categorize the second image (gun or tool) by pressing one of two buttons. Previous research using this paradigm (e.g., Payne, 2001) had established that participants are more likely to

miscategorize tools as guns following Black primes than following White primes, revealing racial

bias associated with the stereotype that Blacks are violent. As a neural index of conflict detection

associated with this bias, Amodio et al. measured the amplitude of the error-related negativity (ERN)

on miscategorization trials. The ERN is a response-locked ERP component that peaks within 100ms

after a response and is thought to reflect activation of the conflict detection system (see Botvinick et

al., 2001; but also see Bartholow et al., 2005). As predicted, the conflict detection system was more

strongly engaged on trials in which a tool was mistaken for a gun following Black primes (Black-tool

error) than following White primes (White-tool error). Nevertheless, participants were much more

likely to mistake a tool for a gun on Black prime trials (see Amodio et al.'s Figure 2), indicating that

racially biased responses occur despite the brain's detection of the conflict inherent in those

responses and suggesting that bias might result from failure of the regulatory control system to

overcome well-learned (though unintentional) response tendencies. (See chapter 16 in this volume

for a fuller account of this and related studies.)

In a recent test of this latter possibility, Bartholow, Dickter, and Sestir (2006, Experiment 2)

examined the influence of stereotype activation on biased responding using a task designed to assess

the role of the regulatory control system in withholding prejudiced responses. An important aspect of

self-regulation of behavior is the ability to inhibit well-learned but potentially maladaptive responses

in favor of other responses that are more appropriate in a given context (e.g., MacDonald, Cohen,

Stenger, & Carter, 2000). Experimental tests of inhibitory control often involve the use of "go-stop"

paradigms that engage participants in responding to go signals while stop signals occasionally inform

them to withhold their response (see Logan & Cowan, 1984). In such paradigms, responding in the

presence of a stop signal represents a failure of the regulatory control system to implement top-down

inhibitory control.

Bartholow et al. (2006) used a go-stop racial priming paradigm in which participants

responded to trait adjectives associated with stereotypes for Blacks (e.g., *violent*, *athletic*) and Whites

(e.g., *educated*, *uptight*) or to control words (descriptors of houses) following pictures of Black or White faces or pictures of houses. Their task was to indicate (via a key press) whether or not each word could ever be true of the person (or house) that preceded it (see Dovidio, Evans, & Tyler, 1986). On one-fourth of the trials, a stop signal appeared shortly after the trait adjective, indicating that no response should be made. To the extent that face primes activate racial stereotypes, stereotype-consistent responses should be facilitated and more inhibitory control should be required to withhold responses on stereotype-consistent stop trials (e.g., a Black face followed by *violent*) than on stereotype-violation stop trials (e.g., a Black face followed by *educated*). Bartholow et al. measured the frequency of inhibition errors (i.e., failures to inhibit) in participants' responses as well as the amplitude of the negative slow wave (NSW), a stimulus-locked ERP component that develops late in trial epochs (see Figure 1) and indexes activity in the regulatory control system (see West & Alain, 1999).

As an additional manipulation of cognitive control of inhibition, Bartholow et al. (2006) assigned participants to one of three alcohol dose conditions, as in previous research (Bartholow et al., 2003). A substantial number of studies have indicated that moderate doses of alcohol significantly impair behavioral inhibition but have no effect on the activation and implementation of responses (e.g., Easdon & Vogel-Sprott, 2000; Fillmore & Vogel-Sprott, 2000; Mulvihill, Skilling, & Vogel-Sprott, 1997), and that these effects stem specifically from alcohol's impairment of the regulatory cognitive control system (Abroms, Fillmore, & Marczinski, 2003; Easdon & Vogel-Sprott, 2000). Recent ERP evidence (Curtin & Fairchild, 2003) has shown that these effects are evident in an alcohol-induced reduction of NSW amplitude that correlates with behavioral undercontrol. Therefore, alcohol provides an excellent tool for testing hypotheses associated with the role of regulatory control in expression of racial bias. Bartholow et al. (2006) reasoned that alcohol's effects on regulatory control should result in a dose-dependent increase in the frequency of inhibition errors, but only (or primarily) on stereotype-consistent trials, which should be most difficult to inhibit. This

pattern of impairment also was predicted for NSW amplitude, with smaller amplitude of the

component reflecting less effective implementation of regulatory cognitive control.

The primary findings from Bartholow et al.'s (2006, Experiment 2) study are presented in

Figure 4. As predicted, the inhibition error data (Figure 4a) indicated a linear increase in failures to

inhibit on stereotype-consistent trials as a function of alcohol dose, but no significant effect of

alcohol on stereotype-violation trials. The ERP waveforms (Figure 4b) nicely mirrored the behavioral

data. First, the amplitude of the NSW was significantly reduced by alcohol, consistent with the idea

that alcohol impairs cognitive control (Curtin & Fairchild, 2003). More importantly, stereotype-

consistent trials elicited larger NSW amplitude than did stereotype-violation trials, but only among

those in the placebo group. Although the data presented in Figure 4A are restricted to the midline

fronto-central electrode location, this effect was fairly broadly distributed over frontal, central, and

anterior parietal scalp regions. This finding supports the idea that withholding dominant, prejudiced

responses engages more regulative cognitive control resources, and that this process is impaired

following alcohol consumption. These data indicate that intact regulatory control is a critical

component of inhibiting unintentional, race-biased behaviors. These data also suggest that motivation

to control prejudice (e.g., Plant & Devine, 1998; Monteith, Ashburn-Nardo, Voils, & Czopp, 2002) is

only part of what determines whether or not bias will be expressed; a high level of motivation to

exert control might not be enough to ensure unbiased responding when regulatory control is

impaired. These findings, along with those of Amodio et al. (2004), provide important evidence of

the neural underpinnings of racial bias and its control.

Racial priming effects: ERP evidence of response conflict. In a number of the studies just

described, various priming techniques were used to demonstrate the effects of automatic stereotype

activation on behavior. It has long been argued that racial primes facilitate stereotype-consistent

responses because of *spreading activation*, the process through which activation of particular

constructs (e.g., racial category labels) increases the accessibility of related constructs (e.g.,

stereotypically associated traits) in semantic memory and decreases the accessibility of unrelated constructs (e.g., counter-stereotypic traits) (see Higgins, 1996; Schank & Abelson, 1977). This hypothesized memory structure provides a concise expalanation for the faster response latencies typically associated with stereotype-consistent prime-word pairs, which are assumed to reside near one another in semantic space and thus require less time to "spread" activation from the category to the trait, compared to stereotype-violating prime-word pairs, which are assumed to occupy more distant semantic spaces (e.g., Dovidio et al., 1986; Fazio, Jackson, Dunton, & Williams, 1995; Gaertner & McLaughlin, 1983).

Recent evidence from cognitive neuroscience studies of response conflict suggests an alternative explanation for response facilitation in priming paradigms. As discussed previously, response conflict occurs when a well-learned or prepotent response must be overridden by an alternative response in order to respond correctly in a given context. A classic paradigm used to induce response conflict is the Eriksen flanker task (Eriksen & Eriksen, 1974), in which a target stimulus (e.g., a letter) is flanked by so-called "noise" stimuli. The participant's task is to categorize the target by pressing one of two keys. A very robust response facilitation is produced in this task on low-conflict, compatible trials (when the target and flankers are identical; e.g., HHHHH) compared to high-conflict, incompatible trials (when the target and flankers represent opposing categories; e.g., SSHSS). Research shows that the lateralized readiness potential (LRP) – a response-locked component of the ERP that reflects motor cortex activity associated with instigating behavioral responses – reveals initial activation of incorrect response channels preceding activation of the correct response on high-conflict trials in this task (for a review see Coles, Smid, Scheffers, & Otten, 1995). This initial activation of the incorrect response requires some degree of effort (and time) to reverse, leading to longer response latencies on high-conflict trials (see Gratton, Coles, Sirevaag, Eriksen, & Donchin, 1988). To the extent that responding to stereotype-incongruent prime-word pairs induces response conflict, incorrect response activation occurring on such trials could provide

an alternative account for the longer response latencies in racial priming experiments. This response activation should be evident in the LRP.

To test this assertion, Bartholow and Dickter (2006) recently conducted a series of experiments using a modified Eriksen flanker task in which the targets were facial photos of Blacks and Whites and the flankers were words associated with cultural stereotypes for Blacks and Whites. In this case, compatible trials were defined as those in which the race of the target was congruent with the stereotypicality of the flanker words (e.g., a Black face flanked by *violent*), and incompatible trials were those in which the target's race was incongruent with the stereotypicality of the flanker words (e.g., a White face flanked by *violent*). The participants' task was simply to categorize the target person as White or Black by pressing one of two keys, while attempting to ignore the flanker words.

In their first experiment, Bartholow and Dickter (2006) simply measured response latencies on compatible and incompatible trials. The data showed that participants were faster to categorize targets by race when they were flanked by stereotype-congruent as compared to stereotype-incongruent words, suggesting that response conflict occurs in this version of the paradigm even though the flankers were not associated with either response and shared only an implicit semantic relationship with the targets. However, these data do not directly address whether the slowed categorization of incongruent flankers results from initial activation of the incorrect response channel.

To address this question, Bartholow and Dickter (2006) added LRP measures in Experiment 2. These waveforms are presented in Figure 5. According to the logic of the LRP (see Coles et al., 1995), cortical activity associated with incorrect response activation results in a positive-going waveform, whereas correct response activation is associated with negative voltage (see also DeJong et al., 1994; Gratton et al., 1988). As shown in Figure 5, correctly categorized incompatible trials tended to elicit a small (but significant) degree of incorrect response activation (seen as the initial

positive-going "dip" in the waveform around 50 ms) prior to the activation of the correct response. In contrast, compatible trials were associated only with correct response activation. LRP activity also can be used to infer when behavioral responses will be emitted (see Gratton et al., 1988). The horizontal dotted lines in Figure 5 represent hypothetical response thresholds for commission of correct (upper line) and incorrect (lower line) responses. Examination of when the LRP waveform crosses this threshold in each condition provides a visual representation of the delay in response latency caused by initial incorrect response activation in the incompatible condition. Thus, these data suggest that stereotype-incongruent trials result in slower behavioral responses because they initially engender activation of the incorrect response, delaying activation of the correct response. This interpretation is at odds with notions from spreading activation theory that stereotype-incongruent constructs are activated slowly because of their distance from racial categories in semantic memory. Instead, these data support a response-conflict account whereby responses are activated quickly at the neural level, but the initial activation is incorrect. It is this "confused" activation of both response channels that slows response latency. This finding has a number of implications. For our purposes here, one important implication is that ERPs provide a more complete understanding of the apparent interference caused by stereotype-related contextual information during racial categorization than could be gained with reaction time measures alone. In this way, this study stands as a clear example of the promise of the social-cognitive neuroscience approach, which holds that processes of interest can be best understood when examined at the social, cognitive, and neural levels of analysis (see Ochsner & Lieberman, 2001).

Conclusions

The aim of this chapter was to outline ways in which electrocortical measures can be used to answer important theoretical questions in person perception. As the research reviewed here demonstrates, ERPs provide an additional tool for the experimental social psychologist's arsenal of methods. We contend, however, that ERPs are most fruitfully employed in conjunction with more

traditional behavioral methods. Most importantly, ERPs are only as effective in solving theoretical

dilemmas as the experimental designs in which they are applied (e.g., Cacioppo et al., 2003;

Willingham & Dunn, 2003). It is our hope that this chapter, along with the other chapters in this

volume, will inform researchers as to the potential value of including the ERP and other

physiological measures in their research programs.

In closing, it is important to briefly address when researchers should choose ERPs as opposed

to other measures of brain function. A host of other psychophysiological measures not included in

this review, including (but not limited to) brain imaging techniques designed to specify which brain

structures and systems underlie social cognitive processes (e.g., functional magnetic resonance

imaging; fMRI), also are now important tools for social neuroscientists interested in person

perception (e.g., see Phelps et al., 2000; Richeson et al., 2003). Deciding which kind of neural

measure(s) to use is driven by theoretical as well as practical considerations. On the practical side,

electrophysiological measures (such as ERPs) can be employed at far less cost than fMRI, and can be

incorporated into a social cognition lab with relatively modest physical renovations and technical

expertise. Acquiring fMRI technology requires a substantial, often institution-wide commitment of

financial and personnel resources to purchase and operate a magnet and construct a space in which to

house it. More importantly, ERPs and fMRI are simply suited to addressing different theoretical

questions. In general, ERPs are among the best tools available for specifying the temporal sequence

of cognitive processes associated with social perception, but their usefulness for determining the

neural sources of these processes is limited (but see Koles, 1998). In contrast, fMRI provides

exceptional spatial resolution but, at least at present, poor temporal resolution (on the order of 4-6

seconds post-stimulus). An ideal scenario for many researchers would involve the combined use of

ERPs and fMRI in order to specify both spatial and temporal parameters of the neural events

underlying person perception. Some relatively new technologies combining these properties already

have been applied in cognitive neuroscience (e.g., see Gratton & Fabiani, 1998). Use of such

techniques has promise for fostering further links between social and biological approaches and for

advancing our understanding of the neural machinery driving social psychological phenomena.

References

Abroms, B. D., Fillmore, M. T., & Marczinski, C. A.. (2003). Alcohol-induced impairment of behavioral control: Effects on the alteration and suppression of prepotent responses. *Journal of Studies on Alcohol, 64,* 687-695.

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.

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.

Bartholow, B. D., & Dickter, C. L. (2006). *Control of attention in racial categorization: Stereotype activation and response conflict*. Manuscript in preparation.

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., 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., Pearson, M. A., Gratton, G. & Fabiani, M. (2003). Effects of alcohol on person perception: A social cognitive neuroscience approach. *Journal of Personality and Social Psychology, 85*, 627-638.

Berger, H. (1929). Uber das Elektrenkephalogramm das Menchen. *Archiv für Psychiatrie, 87*, 527-570.

Bettencourt, B. A., Dill, K. E., Greathouse, S. A., Charlton, K, & Mulholland, A. (1997). Evaluations of ingroup and outgroup members: The role of category-based expectancy violation. *Journal of Experimental Social Psychology, 33*, 244-275.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108,* 624-652.

Brewer, M. (1988). A dual process model of impression formation. In T. Srull & R. Wyer, Jr. (Eds.), *Advances in social cognition* (Vol. 1, pp. 1-36). Hillsdale, NJ: Lawrence Erlbaum.

Burgoon, J. K. (1993). Interpersonal expectations, expectancy violations, and emotional communication. *Journal of Language and Social Psychology, 12,* 30-48.

Cacioppo, J. T., Berntson, G. G., Lorig, T. S, Norris, C. J., Rickett, E., & Nusbaum, H. (2003). Just because you're imaging the brain doesn't mean you can stop using your head: A primer and set of first principles. *Journal of Personality and Social Psychology, 85*, 650-651.

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

Cacioppo, J. T., Crites, S. L., Jr., 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(2),* 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.

Cacioppo, J. T., Petty, R. E., Losch, M. E., & Kim, H. S. (1986). Electromyographic activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of Personality and Social Psychology, 50,* 260-268.

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.

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

Crites, S. L., & Cacioppo, J. T. (1996). Electrocortical differentiation of evaluative and nonevaluative categorizations. *Psychological Science, 7*, 318-321.

Crites, S. L., 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 Jong, R., Liang, C. C., & Lauber, E. (1994). Conditional and unconditional automaticity: A dual process model of effects of spatial stimulus-response correspondence. *Journal of Experimental Psychology: Human Perception and Performance, 20*, 721-750.

Dimberg, U., & Petterson, M. (2000). Facial reactions to happy and angry facial expressions: Evidence for right hemisphere dominance. *Psychophysiology, 37,* 693-696.

Donchin, E. (1981). Surprise!…Surprise? *Psychophysiology, 18,* 493-513.

Donchin, E., & Coles, M. G. (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.

Duncan-Johnson, C. C., & Donchin, E. (1977). On quantifying surprise: The variation of event-related potentials with subjective probability. *Psychophysiology, 14,* 456-467.

Easdon, C. M., & Vogel-Sprott, M. (2000). Alcohol and behavioral control: Impaired response inhibition and flexibility in social drinkers. *Experimental and Clinical Psychopharmacology, 8*, 387-394.

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

Fabiani, M., Gratton, G., & Coles, M. G. H. (2000). Event-related brain potentials. In L. G. Tassinary & J. T. Cacioppo (Eds.), *Handbook of psychophysiology* (2nd ed., pp. 53-84). New York, NY, US: Cambridge University Press.

Fazio, R. H. (1990). A practical guide to the use of response latency in social psychological research. In M. S. Clark & C. Hendrick (Eds.), *Review of Personality and Social Psychology, Volume 11.* Thousand Oaks, CA, US: Sage Publications, Inc.

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.

Fillmore, M. T., & Vogel-Sprott, M. (2000). Response inhibition under alcohol: Effects of cognitive and motivational conflict. *Journal of Studies on Alcohol, 61,* 239-246.

Fiske, S. T., & Neuberg, S. L. (1990). A continuum of impression formation, from category-based to individuated processes: Influences of information and motivation on attention and interpretation. In M.P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 23, pp. 1-74). New York: Academic Press.

Friedman, D., & Johnson, R. Jr. (2000). Event-related potential (ERP) studies of memory encoding and retrieval: A selective review. *Microscopy Research and Technique, 51*, 6-28.

Friedman, D., Cycowicz, Y. M., & Gaeta, H. (2001). The novelty P3: An event-related brain potential (ERP) sign of the brain's evaluation of novelty. *Neurosceince and Biobehavioral Reviews, 25,* 355-373.

Gaertner, S. L., & McLaughlin, J. P. (1983). Racial stereotypes: Associations and ascriptions of positive and negative characteristics. *Social Psychology Quarterly, 46,* 23-30.

Gehring, W. J., Gratton, G., Coles, M. G., & Donchin, E. (1992). Probability effects on stimulus evaluation and response processes. *Journal of Experimental Psychology: Human Perception and Performance,* 18, 198-216.

Gratton, G., & Fabiani, M. (1998). Dynamic brain imaging: Event-related optical signal (EROS) measures of the time course and localization of cognitive-related activity. *Psychonomic Bulletin & Review, 5,* 535-563.

Gratton, G., Coles, M. G., Sirevaag, E. J., Eriksen, C. W., & Donchin, E. (1988). Pre- and poststimulus activation of response channels: A psychophysiological analysis. *Journal of Experimental Psychology: Human Perception and Performance, 14,* 331-334.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74,* 1464-1480.

Herzog, T. A. (1999). Effects of alcohol intoxication on social inferences. *Experimental and Clinical Psychopharmacology, 7,* 448-453.

Hess, U., Blairy, S., & Kleck, R. E. (2000). The influence of facial emotion displays, gender, and ethnicity on judgments of dominance and affiliation. *Journal of Nonverbal Behavior, 24,* 265-283.

Higgins, E. T. (1996). Knowledge activation: Accessibility, applicability, and salience. In E. T. Higgins & J. A. Bargh, (Eds.), *Social psychology: Handbook of basic principles* (pp. 133-168). New York: Guilford Press.

Hoaken, P. N. S., Giancola, P. R., & Pihl, R. O. (1998). Executive cognitive functions as mediators of alcohol-related aggression. *Alcohol and Alcoholism, 33,* 47-54.

Hopfinger, J. B. & Mangun, G. R. (2001). Electrophysiological studies of reflexive attention. In C. Folk & B. Gibson (Eds.), *Attraction, distraction, and action: Multiple perspectives on attentional capture* (pp. 3-26). Amsterdam: Elsevier Science.

Ito, T. A., & Cacioppo, J. T. (in press). Physiological measures of implicit attitudes. In B. Wittenbrink & N. Schwartz (Eds.), *Implicit measures of attitudes*. New York: Guilford Press.

Ito, T. A., & Cacioppo, J. T. (1999). The psychophysiology of utility appraisals. In D. Kahneman, E. Diener, & N. Schwartz (Eds.), Well-being: The foundations of hedonic psychology (pp. 470-488). New York: Russell Sage Foundation.

Ito, T. A., & Cacioppo, J. T. (2000). Electrophysiological evidence of implicit and explicit categorization processes. *Journal of Experimental Social Psychology, 36*, 660-676.

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., Thompson, E., & Cacioppo, J. T. (2004). Tracking the time course of social perception: The effects of racial cues on event-related potentials. *Personality and Social Psychology Bulletin, 30*, 1267-1280.

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.

Jasper, H. H. (1958). The ten-twenty electrode system of the International Federation. *Electroencephalography and Clinical Neurophysiology, 10*, 371-375.

Jones, E. E. (1990). *Interpersonal perception*. New York: W.H. Freeman & Co.

Kernahan, C. A., Bartholow, B. D., & Bettencourt, B. A. (2000). Effects of category-based expectancy violation on affect-related evaluations: Toward a comprehensive model. *Basic and Applied Social Psychology, 22,* 85-100.

Koles, Z. J. (1998). Trends in EEG source localization. *Electroencephalography and Clinical Neurophysiology, 106*, 127-137.

Kutas, M., McCarthy, G. & Donchin, E. (1975). Differences between sinistrals' and dextrals' ability to infer a whole from its parts: A failure to replicate. *Neuropsychologia, 13(4),* 455-464.

Logan, D. G., & Cowan, W. B. (1984). On the ability to inhibit thought and action: A theory of an act of control. *Psychological Review, 91*, 295-327.

London, E. D., Ernst, M., Grant, S., Bonson, K., & Weinstein, A. (2000). Orbitofrontal cortex and human drug abuse: Functional imaging. *Cerebral Cortex, 10*, 334-342.

MacDonald, A. W., Cohen, J. D., Stenger, V. A., & Carter, C. S. (2000). Dissociating the role of the dorsolateral prefrontal and anterior cingulate cortex in cognitive control. Science, 288, 1835-1838.

Macrae, C. N., Bodenhausen, G. V., Schloersheidt, A. M., & Milne, A. B. (1999). Tales of the unexpected: Executive function and person perception. *Journal of Personality and Social Psychology, 76*, 200-213.

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

Mangun, G. R., Hillyard, S. A., & Luck, S. J. (1993). Electrocortical substrates of visual selective attention. In D. Meyer & S. Kornblum (Eds.), *Attention and Performance XIV* (pp. 219-243). Cambridge, MA: MIT Press.

Markus, H., & Zajonc, R. B. (1985). The cognitive perspective in social psychology. In G. Lindzey & E. Aronson (Eds.), *Handbook of social psychology* (3rd ed., pp. 137-229). New York: Random House.

McCarthy, G. & Donchin, E. (1981). A metric for thought: A comparison of P300 latency and reaction time. *Science, 211,* 77-80.

Monteith, M. J., Ashburn-Nardo, L., Voils, C. I., Czopp, A. M. (2002). Putting the brakes on prejudice: On the development and operation of cues for control. *Journal of Personality and Social Psychology, 83*, 1029-1050.

Mulvihill, L. E., Skilling, T. A., & Vogel-Sprott, M. (1997). Alcohol and the ability to inhibit behavior in men and women. *Journal of Studies on Alcohol, 58,* 600-605.

Nieuwenhuis, S., Yeung, N., Van Den Wildenberg, W., & Ridderinkhof, K. R. (2003). Electrophysiological correlates of anterior cingulate function in a go/no-go task: Effects of response conflict and trial type frequency. *Cognitive, Affective and Behavioral Neuroscience, 3,* 17-26.

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.

Osterhout, L., Bersick, M., & McLaughlin, J. (1997). Brain potentials reflect violations of gender stereotypes. *Memory & Cognition, 25*, 273-285.

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.

Peeters, G., & Czapinski, J. (1990). Positive-negative asymmetry in evaluations: The distinction between affective and informational negativity effects. *European Review of Social Psychology, 1*, 33-60.

Peterson, J. B., Rothfleisch, J., Zelazo, P. D., & Pihl, R. O. (1990). Acute alcohol intoxication and cognitive functioning. *Journal of Studies on Alcohol, 51,* 114-122.

Phelps, E. A., O'Connor, K. J., Cunningham, W. A., Funayama, E. S., Gatenby, J. C., Gore, J. C., et al. (2000). Performance on indirect measures of race evaluation predicts amygdala activation. *Journal of Cognitive Neuroscience, 12*, 729-738.

Plant, E. A., & Devine, P. G. (1998). Internal and external motivation to respond without prejudice. *Journal of Personality and Social Personality, 75,* 811-832.

Reeder, G. D., & Coovert, M. D. (1986). Revising an impression of morality. *Social Cognition, 4,* 1-7.

Reis, H.T. & Judd, C.M. (Eds.) (2000). *Handbook of research methods in social and personality psychology.* New York: Cambridge University Press.

Richeson, J. A., Baird, A. A., Gordon, H. L., Heatherton, T. F., Wyland, C. L., Trawalter, S., & Shelton, J. N. (2003). An fMRI investigation of the impact of interracial contact on executive function. *Nature Neuroscience, 6*, 1323-1328.

Rugg, M. D., & Coles, M. G. H. (Eds.) (1995). *Electrophysiology of mind: Event-related brain potentials and cognition.* New York: Oxford University Press.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding: An inquiry into human knowledge structures.* Oxford, UK: Lawrence Erlbaum.

Semlitsch, H.V., Anderer, P., Schuster, P., & Presslich, O. (1986). A solution for reliable and valid reduction of ocular artifacts, applied to the P300 ERP. *Psychophysiology, 23*, 695-703.

Sherman, J. W., & Frost, L. A. (2000). On the encoding of stereotype-relevant information under cognitive load. *Personality and Social Psychology Bulletin, 26,* 26-34.

Smid, H. G., Mulder, G., Mulder, L. J., & Brands, G. J. (1992). A psychophysiological study of the use of partial information in stimulus-response translation. *Journal of Experimental Psychology: Human Perception and Performance, 18,* 1101-1119.

Smith, N. K., Cacioppo, J. T., Larsen, J. T., & Chartrand, T. L. (2003). May I have your attention, please: Electrocortical responses to positive and negative stimuli. *Neuropsychologia, 41*, 171-183.

Srull, T. K., & Wyer, R. S., Jr. (1989). Person memory and judgment. *Psychological Review, 96,* 58-83.

Stangor, C., & McMillan, D. (1992). Memory for expectancy-congruent and expectancy-incongruent information: A review of the social and social developmental literatures. *Psychological Bulletin, 111,* 42-61.

Steele, C. M., & Josephs, R. A. (1990). Alcohol myopia: Its prized and dangerous effects. *American Psychologist, 45,* 921-933.

Stern, R. M., Ray, W. J., & Quigley, K. S. (2001). *Psychophysiological recording* (2nd ed.)*.* New York: Oxford University Press.

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.

Trafimow, D., & Finlay, K. A. (2001). An investigation of three models of multitrait representations. *Personality and Social Psychology Bulletin, 27*, 226-241.

Vanman, E. J., Paul, B. Y., Ito, T. A., & Miller, N. (1997). The modern face of prejudice and structural features that moderate the effect of cooperation on affect. *Journal of Personality and Social Psychology, 73,* 941-959.

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

Willingham, D. T., & Dunn, E. W. (2003). What neuroimaging and brain localization can do, cannot do, and should not do for social psychology. *Journal of Personality and Social Psychology, 85,* 662-671.

Ybarra, O. (2002). Naïve causal understanding of valenced behaviors and its implications for social information processing. *Psychological Bulletin, 128,* 421-441.

Ybarra, O., Schaberg, L., & Keiper, S. (1999). Favorable and unfavorable target expectancies and social information processing. *Journal of Personality and Social Psychology, 77*, 698-709.

Figure Captions

Figure 1. A schematic representation of endogenous ERP components elicited by a novel visual stimulus. Very early components (approximately 0-100ms after stimulus onset; i.e., *exogenous* components) tend to be described with a different nomenclature and are not typically examined in social neuroscience research. The vertical arrow on the timeline represents stimulus onset (i.e., time zero); the 100ms preceding time zero represents a hypothetical pre-stimulus baseline period. Negative voltage is plotted up as a matter of convention, though ERPs are not always presented this way.

Figure 2. Difference waveforms representing effects of expectancy violation (top panel) and behavior valence (bottom panel) in the ERP recorded at the Pz (midline parietal) electrode site. Difference waveforms were created by subtracting amplitudes elicited by irrelevant behaviors from those elicited by expectancy-violating and expectancy-consistent behaviors (top panel), and from negative and positive behaviors (bottom panel). From Bartholow, Fabiani, Gratton, & Bettencourt, 2001. Copyright 2001 by the American Psychological Society. Reprinted by permission.

Figure 3. Event-related brain potential waveforms measured at the Pz (midline parietal) electrode as a function of alcohol dose, valenced expectancy context, and consistency of behaviors with expectancies. The vertical arrow on the timeline represents stimulus onset. From Bartholow, Pearson, Gratton, & Fabiani, 2003. Copyright 2003 by the American Psychological Association. Reprinted by permission.

Figure 4. Inhibition errors (panel A) and ERP waveforms elicited over the midline fronto-central cortex (panel B) on stop trials as a function of alcohol dose and trial type. Increased inhibition errors (panel A) on stereotype-consistent trials indicate difficulty inhibiting race-biased behaviors. The larger negative slow wave (NSW) amplitude associated with stereotype-consistent trials in the placebo group (panel B) indicates greater implementation of cognitive control resources to inhibiting responses on those trials. Time zero indicates onset of the stop signal. The decrease in NSW amplitude associated with the high alcohol dose indicates alcohol-induced impairment of cognitive control. Adapted from Bartholow, Dickter, and Sestir (2006). Copyright 2006 by the American Psychological Association. Reprinted by permission.

Figure 5. Lateralized readiness potential (LRP) waveforms elicited on stereotype-congruent trials (i.e., compatible trials; solid line) and stereotype-incongruent trials (incompatible trials; dashed line), measured over left and right motor cortex areas. The "error dip" evident in the incompatible trials waveform indicates initial activation of the incorrect response at the neural level prior to the correct response being activated and emitted.

N100

N200

Slow Wave

10μV

-

+

P200

P300

-100   200   400   600   800   1000

msec

Positive Context   Negative Context

Placebo

Moderate

High

Time (ms)   Time (ms)

Consistent - - - - Violation