Routledge
Taylor & Francis Group

Social Neuroscience

ISSN: 1747-0919 (Print) 1747-0927 (Online) Journal homepage: https://www.tandfonline.com/loi/psns20

Bioelectrical Echoes from a Career at the Cutting Edge: John Cacioppo's Legacy and the Use of ERPs in Social Psychology

Tiffany A. Ito & Jennifer T. Kubota

To cite this article: Tiffany A. Ito & Jennifer T. Kubota (2019): Bioelectrical Echoes from a Career at the Cutting Edge: John Cacioppo's Legacy and the Use of ERPs in Social Psychology, Social Neuroscience, DOI: 10.1080/17470919.2019.1647875

To link to this article: https://doi.org/10.1080/17470919.2019.1647875

Publisher: Taylor & Francis & Informa UK Limited, trading as Taylor & Francis Group

Journal: *Social Neuroscience*

DOI: 10.1080/17470919.2019.1647875

Bioelectrical Echoes from a Career at the Cutting Edge: John Cacioppo’s Legacy and the Use of ERPs in Social Psychology

Tiffany A. Ito[1] and Jennifer T. Kubota[2, 3]

Affiliations:

[1] Department of Psychology and Neuroscience, University of Colorado Boulder

[2] Department of Psychological and Brain Sciences, University of Delaware

[3] Department of Political Science and International Relations, University of Delaware

Corresponding author:

Tiffany Ito

Department of Psychology and Neuroscience

University of Colorado Boulder

345 UCB

Boulder, CO 80309-0345

Email: Tiffany.Ito@colorado.edu

Abstract

In his many writings, John Cacioppo stressed how neural and physiological events could reveal psychological phenomena. Far from merely “physiologizing” psychology, John advocated social neuroscience in service of theory development and causal inference. These themes can be seen in his ERP work, which he began in the early 1990s to answer basic questions about attitudes. Fortuitously, his foray into ERP research overlapped with the dominance of the social cognition perspective in social psychology, which argues that complex thoughts and behaviors can be understood by breaking them into their underlying elements. ERPs are a natural methodological complement to this perspective, assuming that complex thoughts and behaviors are composed to separable information processing stages that manifest on the scalp as ERPs. Social cognitive theories, with their roots in mental chronometry, are thus fertile ground for researchers possessing a way to quantify underlying mental operations. This review illustrates John's influence by tracing its impact on our own research.

Keywords: social cognition , social categorization , stereotyping , prejudice

Bioelectrical Echoes from a Career at the Cutting Edge: John Cacioppo's Legacy and the Use of ERPs in Social Psychology

If I have seen further it is by standing on the shoulders of giants. -Isaac Newton

It is challenging to distill the character of a pioneering scholar into a single description. Scholars are, after all, the multifaceted and complex integration of their character and achievements which can ripple across a field and revolutionize not only the science but also colleagues and students. However, if we were to try to succinctly describe John Cacioppo, "deeply curious" would be a fair characterization. This indelible inquisitiveness and driving desire to know can be traced throughout his career. Fueled by this curiosity, John launched methodological movements and derived critical theoretical advances that echoed across social psychology, ultimately leading to the creation of a new field of research now commonly referred to as social neuroscience.

What is now codified as a distinct discipline was not always so obvious. Social and biological perspectives were viewed by many as independent at best, and contradictory at worst. John, however, viewed social psychology and neuroscience as natural complements, with social psychology providing critical context for understanding how the social world impacts an individual brain (Cacioppo & Berntson, 1992). John thus viewed social neuroscience as a hub science, uniquely bridging the social and biological disciplines by discovering how our social world influences our biology and how our biology influences our interactions with the social world (Cacioppo, 2002). After decades of using other biological methods, starting with heart rate and skin potential responses in the 1970s (Cacioppo & Sandman, 1978), John pushed into new frontiers of methodological complexity in 1993 and 1994 when he and his colleagues published research using event-related brain potentials (ERP), a measure allowing researchers to sample electrical brain activity over time (Cacioppo, Crites, Berntson, & Coles, 1993; Cacioppo, Crites, Gardner, & Berntson, 1994). Prior to these publications, ERPs had been used in auditory science and cognitive and clinical psychology but from John's papers emerged two important theoretical advances for social psychology. The first was quite simple and perhaps now seems almost obvious. Evaluatively inconsistent information impacts unfolding information processing and it can be measured in real-time. Second, it is possible to measure an individual's evaluations without asking them. Up to that point, social psychologists had primarily relied on survey measures that required subjects to self-report their responses, usually only giving researchers access to a single summary output (the final overt response), but not the component processes that produced the response. ERPs allowed researchers a more direct measure of unfolding psychological processes with less interference from an individual's concerns about how they should respond or what is socially appropriate, providing a means to assess processes that may be difficult to self-reflectively access. John's initial ERP publications ushered in a tradition of ERP research into social questions that thrives today.

John was a visionary, always having his mind on what was just over the horizon in scientific pursuits in social psychology. Even so, he was firmly grounded in the sanctity of the scientific method. Because of this combination of vision and precision, over the course of John's ERP research four major themes arose: it was programmatic, methodologically rigorous, contributed deep theoretical knowledge, and synergized with the dominant social cognition perspective of the time. The programmatic, theoretical nature of John's ERP work derives from its focus on attitudes, where he was a giant theoretically long before using ERPs to study them. As early as 1977, John was documenting attitudes' resistance to persuasion (e.g., Petty & Cacioppo, 1977). Over the course of nine years of programmatic research, John and his long-term collaborator Rich Petty incrementally investigated aspects of attitudes and attitude change, culminating in the Elaboration Likelihood Model (ELM) (Cialdini, Petty, & Cacioppo, 1981; Petty & Cacioppo, 1986). This comprehensive model of persuasion argued for two routes of attitude change. The central route to persuasion involves careful, thoughtful consideration of an attitude object whereas the peripheral route is heuristic-based, relying on simple associations with the attitude object. The ELM is a powerful theoretical perspective accounting for what was hitherto difficult-to-explain variability in the degree of attitude change and persistence. It was also incredibly generative and contributed to the recognition of the degree to which many psychological processes are governed by dual processes (e.g., Kahneman, 2003; Sloman, 1996; Strack & Deutsch, 2004). Moreover, the ELM highlighted how implicit processes can influence our thoughts, feelings, and actions, advancing automaticity as an important component of social cognition (e.g., Bargh, 1994). In subsequent work, John focused on characterizing the basic positive and negative evaluative substrates that form the basis of attitudes, as reflected in his Evaluative Space Model (ESM) (Cacioppo & Berntson, 1994; Cacioppo, Gardner, & Berntson, 1997). The ESM argues that while attitudes are typically conceptualized as a bipolar, net level of positivity and negativity, they are derived from separable positive and negative evaluative systems. Recognizing that evaluations underlying attitudes can differ in organization from how they are expressed highlights the importance of quantifying attitude registration separately from attitude report. It was this observation that lead John to explore ERPs as a way to interrogate attitude registration, making John's ERP work a programmatic extension of decades of research on attitudes.

Not only was John programmatic in his scientific approach, he was methodologically omnivorous, innovative, and meticulous. As scholars began raising concerns that the popularity of an attitude or the idiosyncrasies of attitude scales could undercut the reliability of self-report measures (e.g., Nisbett & Wilson, 1977; Wilson, Hull, & Johnson, 1981), John began pursuing a range of physiological methods such as heart rate, skin conductance, and electromyography to assess critical questions in evaluation and attitudes (e.g., Cacioppo, Martzke, Petty, & Tassinary, 1988; Cacioppo, Petty, & Tassinary, 1989; Cacioppo, Tassinary, Stonebraker, & Petty, 1987; Cacioppo et al., 1992; Cacioppo & Petty, 1979; Cacioppo & Tassinary, 1990;

Tassinary, Cacioppo, & Geen, 1989). For example, in 1986 John and his colleagues demonstrated that facial electromyography (EMG) could distinguish between the valence and arousal intensity of attitudes. As he would later do with ERPs, John did not just slap electrodes on and let a box spit out numbers for analysis. He carefully studied the underlying physiology, thoughtfully crafted paradigms, and thoroughly tested his underlying assumptions.

John's turn to ERPs was driven by mixed results assessing attitudes with these other physiological measures. He specifically noted that individuals can distort or mask certain action-dependent psychophysiological responses such as EMG and that physiological data are at times inconsistent with self-report, even for noncontroversial topics (Cacioppo, Marshall-Goodell, Tassinary, & Petty, 1992; Cacioppo, Priester, & Berntson, 1993). John viewed ERPs as a way to more consistently assess attitudinal processes by removing dependency on response selection and execution. He specifically recognized the potential of a well-characterized ERP paradigm known as the oddball paradigm to assess attitudes. In a traditional oddball paradigm, stimuli from two categories are presented with different probabilities, with ERPs quantified to both low-probability target or oddball stimuli as well as high-probability context stimuli. A robust finding with auditory stimuli is that late positive potential amplitudes (the LPP, sometimes also labeled the P300) over parietal scalp regions are larger to rare oddball than frequent context tones (e.g., Squires, Squires, & Hillyard, 1975). Importantly, subjects do not need to explicitly attend to the probabilities or categorize the stimuli in order to produce these LPP differences (Farwell & Donchin, 1991; Renault, Signoret, Debruille, Breton, & Bolgert, 1989).

John as methodological innovator reasoned that he and his colleagues could utilize the oddball task to assess attitude registration (Cacioppo, et al., 1993). Their first paper therefore replaced the auditory tones of a classic oddball paradigm with attitude items, observing that attitudinal oddballs, such as an evaluatively positive stimulus embedded in a sequence of negative items, evoked larger LPPs than an attitude item evaluatively congruent with the preceding context. Illustrating his methodological meticulousness, subsequent studies showed the LPP was sensitive to the evaluative consistency of context and target oddballs, but not to variation along nonevaluative dimensions (Cacioppo, Crites, & Gardner, 1996; Crites & Cacioppo, 1996). He then worked through other critical questions, first showing that LPP amplitudes increased as a function of the degree of the evaluative discrepancy between a target oddball and its surrounding context (Cacioppo et al., 1994), showing that LPP amplitude could index attitude extremity. John and colleagues next tested the critical issue of whether the LPP was sensitive to the underlying evaluative categorization or its explicit report. They did this by asking subjects to either accurately report or misreport their attitudes towards people by, for example, reporting a positive attitude if they felt negative or neutral. Although individuals were able to misreport their attitudes in their explicit attitude reports, the LPP was dissociated from the explicit report and instead tracked the underlying initial evaluation (Crites, Cacioppo, Gardner, & Berntson, 1995). This observation has been critical to subsequent ERP research, as we illustrate shortly.

John's initial ERP research had a relatively more methodological emphasis -- critical given the implicit proof-of-concept hurdle he needed to clear to show others the relevance of ERPs to the study of attitudes – but John strongly advocated that social neuroscience investigations must go beyond merely "physiologizing" psychology. Consequently, after demonstrating the sensitivity of the LPP to attitude registration, John leveraged ERPs to deepen our theoretical understanding of attitudes and evaluations, with one line of research focusing on the implications of evaluative lateralization. John's initial oddball ERP investigations focused on how attitudes impact the cognitive operations indexed by the LPP along midline scalp locations. During that same time period, clinical and cognitive psychologists were observing that cognitive process such as language were left-lateralized whereas emotion processing was right-lateralized (Bear, 1983; Gazzaniga et al., 1996; Johnson, Hashtroudi, & Lindsay, 1993; Kolb & Taylor, 1981; Kosslyn, Holtzman, Farah, & Gazzaniga, 1985; Levy & Trevarthen, 1977;

Ruchkin, Canoune, Johnson, & Ritter, 1995; Tompkins & Mateer, 1985), supporting a distinction between the two types of operations. This separation was reinforced by John's observations that evaluative categorizations indexed by LPPs were differentiated from nonevaluative categorizations (Crites & Cacioppo, 1996). However, to further asses the separability of affective and cognitive processes, John and colleagues wondered whether attitudinal processing was right-lateralized, which they confirmed in a subsequent series of analyses (Cacioppo et al., 1996; Cacioppo & Gardner, 1999; Crites & Cacioppo, 1996), contributing to the growing theoretical debate of the role of laterality in emotion processing (Ahern & Schwartz, 1979; Borod et al., 1998; Davidson, 1992; Maxwell & Davidson, 2007).

John and his colleagues also began testing specific predictions from his Evaluative Space Model using ERPs. One implication that follows from the model's assertion that positivity and negativity are governed by separable systems is that the systems may have different operating characteristics. Research across many domains suggested a heightened sensitivity to negative as compared to positive information (e.g., Anderson & Jacobson, 1965; Fiske, 1980; Kahneman & Tversky, 1982; Kanouse & Hansen, 1971; Peeters & Czapinski, 1990; Skowronski & Carlston, 1989), which the ESM calls a *negativity bias*. Questions remained, however, over whether the negativity bias was introduced during evaluative categorization or response output, so John and colleagues turned to ERPs to compare the evaluative categorization stage for positive and negative stimuli. Consistent with predictions that the evaluation system responds more intensively to negative than comparably extreme positive information, they found larger LPPs to negative than positive stimuli, even though both were equally probable, evaluatively extreme, and arousing (Ito, Larsen, Smith, & Cacioppo, 1998).

A final notable feature of John's ERP work was its synergy with the social cognition perspective ascendant at the same time John was beginning his ERP research. Social cognition argues that complex thoughts and behaviors can be understood by breaking them into their underlying elements (Fiske & Taylor, 1991). The ability to interrogate these underlying component processes is therefore of critical importance in social cognition. ERP researchers assume that complex thoughts and behaviors are composed of separable information processing stages that manifest on the scalp as ERPs (Amodio, Bartholow, & Ito, 2013; Bartholow & Dickter, 2007; Ito & Bartholow, 2009; Kubota & Ito, 2009), making them a natural methodological complement to social cognition. John's initial papers illustrated to a wide audience that ERPs could be used to gain traction on theoretical social cognitive processes, showing both social psychologists and neuroscientists that complex, consequential social behaviors could be studied with electrodes on the scalp.

A Personal Reflection on John's Influence

John's paradigmatic example of how to do theoretically and methodologically rigorous social neuroscience research opened up many theoretical questions in our own work focused on how quickly and under what circumstances perceivers divide the world into us and them. Like other forms of categorization (Rosch, 1999; Rosch & Lloyd, 1978), identifying an individual as possessing membership in a social group is thought to appeal to the cognitive miser inside us all, maximizing information quantity while minimizing effort (Allport, 1954, 1979; Fiske & Taylor, 1984; Gilbert & Hixon, 1991; Tajfel, 1969). Models of impression formation articulate how and under what circumstances different types of information including social categorization are used to form judgments about individuals (e.g., Brewer, 1988; Fiske & Neuberg, 1990). However, these models emphasize the downstream processes of social categorization, such as the affect, beliefs, and behavior activated by the social category, rather than on the categorization itself. As a consequence, how we perceive social category information received relatively little attention, save for statements that categorization occurs automatically[i] and that cues associated with visually salient categories such as race, gender, and age are identified for all individuals we encounter without explicit intention.

However, if we accept that social categorization can activate category-based affect, cognitions, and behavior, then understanding person perception broadly, and prejudice, stereotyping, and discrimination specifically, requires us to be able to more directly interrogate social categorization. Enter John's work showing that ERP's are sensitive to attitude registration independent of attitude report, which raised the intriguing possibility that ERPs would be similarly sensitive to social identity registration independent of the explicit report of social identity membership. Such a measure could then be leveraged to assess the automaticity of social categorization without having to rely on explicit self-report. We thus began with a study to assess whether the LPP is sensitive not only to evaluative categorizations, as John had demonstrated, but also to social categorizations. We did so by closely adapting the oddball paradigm John had used with attitudinal stimuli, showing subjects sequences of individuals from one social category (e.g., Black males), followed by a less frequent social category "oddball" from a different social group (e.g., White males). To provide a clear assessment of social categorization, subjects in the initial studies were explicitly asked to categorize faces in terms of race or gender, focusing on the specific groups of Black and White males and females. Just as the LPP in John's initial attitude research was sensitive to differences in evaluate categories, the LPP in our studies was sensitive to differences in social categories (Ito & Urland, 2003). This was shown in social category oddball effects, with larger LPPs when the social category of a given individual differed from those on the preceding trials. For example, when subjects were seeing a series of Black individuals, LPPs were larger to a category "oddball" White individual as compared to a category-consistent Black individual.

After demonstrating the LPP's sensitivity to social category distinctions, our next step was to directly assess the hypothesis that social categorization occurs without intention or effort. We did so by following the example of Crites et al. (1995), testing whether ERPs were sensitive to social category encoding independent of explicit social categorization reports across a number of studies. In the first, we directed subjects' attention to another salient social group. In this case, we showed subjects pictures of individuals from two different races and two different genders, asking them to explicitly attend to either race or gender. Not only was the LPP sensitive to the social category information to which subjects were explicitly attending, but it also varied as a function of the non-task-relevant dimension. That is, for subjects instructed to categorize the faces they were seeing in terms of race, LPPs were sensitive not only to target race differences, but also to target gender differences. Likewise, for subjects instructed to categorize the faces they were seeing in terms of gender, LPPs were sensitive not only to target gender differences, but also to target race differences (Ito & Urland, 2003).

Since it might be argued that explicitly directing subjects' attention to one social category distinction could sensitize them to attend to other salient social category distinctions, which would make social categorization appear automatic when it in fact requires some intention, numerous other studies examined neural activity while attention was directed away from social category membership altogether. In Kubota and Ito (2007), subjects were instructed to determine whether target individuals were happy, angry, or emotionally neutral, finding that ERPs differentiated among targets of difference races even when attention was explicit directed at evaluative information fundamental to how we communicate with conspecifics. In other studies, subjects' attention was directed away from the social nature of the stimuli altogether by placing a small white dot on some pictures of faces and asking subjects to indicate when a dot was seen (Ito & Tomelleri, 2017; Ito & Urland, 2005). In all cases, LPPs still differentiated between targets of different races and/or genders, indicating that ERP responses were sensitive to social category differentiation in the absence of explicit social category registration.

These initial studies demonstrated that people process social category information even when asked to ignore it or focus on some other dimension. However, it remained unclear whether social category differentiation might result only under circumstances when people do not have knowledge about an individual or lack a goal to process the individuals more deeply. To address this question, we examined LPPs to faces that varied in race and/or gender as subjects were explicitly instructed to consider their individual attributes, which encourage organization of social information around the individual versus the social category (Brewer, 1988; Fiske & Neuberg, 1990). In our ERP studies, subjects were specifically asked to make judgments about targets' personal preferences and personality (Ito & Urland, 2005). Even with attention explicitly directed at forming a more individuated impression, LPPs differentiated between individuals from different racial and gender categories, further suggesting the differentiation of social category registration independent of social category report.

While the studies just reviewed question the potential for change in categorization to solely decrease subsequent bias, we have used ERPs to test other, more promising mechanisms of bias reduction. Personalization, whereby individuals are encoded with respect to their similarity to the self, is argued to be one of the most effective ways to decrease bias (Brewer & Miller, 1984; Miller, 2002). Kubota (2010) assessed whether such personalization affects the decrease of social category encoding. Personalization was manipulated by having White subjects write about the day in the life of a racial outgroup Black male and ingroup White male adopting either a first-person perspective to explicitly invoke the self (i.e., using "I") or third-person perspective (i.e., using "he") (Kubota, 2010). ERPs were then recorded as the subjects made novel judgments about the targets (e.g. "Cares a lot about Pop Culture" "Eats fast food a few times a week"). In the third-person condition, previous race ERP effects were replicated, but racial differences were eventually eliminated during processing among subjects who had first thought about the outgroup Black individual using a first-person perspective. This striking finding suggests that personalization diminishes the very quick differentiation based on race seen in most circumstances.

John's example of theoretical and methodological rigor also led us to ask whether the LPP modulations we observed reflect a social or non-social process. After all, John's ERP studies were based on a large body of research showing that the LPP is sensitive to non-social physical features such as tone pitch (e.g., Donchin & Coles, 1988; Donchin, 1981). We wondered whether LPP modulations as a function of target race and gender reflected initial registration of physical differences devoid of the social meaning the perceiver associates with those social categories or a social process. Said differently, we wondered whether the brain responses reflected a distinction like "this picture is relatively less luminant than others" versus "this person is Black," with the latter operation freighted with whatever meaning the perceiver ascribes to the social category of Black. We believe that when Allport (1954/1979) talked about social categories saturating all their members with the "same ideational and emotional flavor" (p. 21), he was talking about the latter (although detecting physical differences no doubt contributes to identifying someone as belonging to some social categories). Findings from numerous studies suggest that while the LPP can be sensitive to non-social physical differences in other paradigms, LPPs elicited by faces of members of different racial and gender groups reflect perceptions of individual as members of social categories. One piece of relevant evidence comes from a study showing that when physical differences between social groups are decreased but the racial and gender group membership of all individuals is still easily identifiable, LPPs are still sensitive to the differences in social category membership. This was demonstrated by showing face images in grayscale, with luminance and contrast equated across the social categories. With these stimuli, LPPs were still larger to categorially inconsistent individuals (e.g., a picture of a White male preceded by a context of multiple pictures of Black males) (Ito & Urland, 2003). Conversely, when we retain physical differences between the social categories but obscure their social meaning, LPP effects disappear. This was shown by inverting and blurring the face images, rendering them unrecognizable as faces but preserving low level physical differences between the social categories. When removing the social meaning, the entire morphology of the ERP waveform elicited by these stimuli changed and there were no significant differences in responses to stimuli derived from Black versus White or to female versus male faces (see also Kubota & Ito, 2007).

Perhaps the strongest evidence that ERPs are sensitive to the social meaning associated with category membership comes from a study in which we changed the explicit social categorization of faces and observed concomitant changes in ERP responses. This was done using pictures of individuals possessing features associated with two racial groups, then priming one of the social categories on a trial-by-trail basis. ERP responses followed the social categorization rather than the physical properties. That is, LPPs to racially ambiguous faces possessing features of both Blacks and Whites who were primed as Black were identical to LPPs elicited by clearly Black individuals but different from those elicited by clearly White individuals. Likewise, LPPs to the same racially ambiguous Black-White faces now primed as White were identical to those of clearly White individuals but different from those elicited by clearly Black individuals (Willadsen-Jensen & Ito, 2014). Said differently, when subjects were induced to subjectively perceive the exact same person in different ways, LPPs tracked the subjective perception rather than the physical properties. Similarly, ERPs are sensitive to social distinctions that are not readily apparent visually and must instead be learned, in this case information about morality and financial status (Gyurovski, Kubota, Cardenas-Iniguez, & Cloutier, 2018). Moreover, LPP differences as a function of both learned categories like status as well as visually-apparent categories such as race and gender are also elicited when stimuli are presented randomly, without the oddball stimulus structure (Correll, Urland, & Ito, 2006; Ito & Tomelleri, 2017; Willadsen-Jensen & Ito, 2014). Instantiating a strong contrast between categories via manipulation of category frequency is thus not necessary to drive encoding of category membership and the associated ERP effects.

Using Our Head When Imaging the Brain

We take to heart John's vision of social neuroscience as a tool for understanding the mind. Consequently, while we can trace John's influence on our ERP research in many concrete ways – the use of similar paradigms, expansion of related concepts -- our biggest inspiration was to view ERPs as but one item in our toolbox for understanding complex psychological processes. (Of course, if we wanted to be true to John, we would consider ERPs a part of our scientific armamentarium rather than our toolbox (c.f., Cacioppo et al., 2003).) We thus close our reflection of John's legacy by highlighting a few theoretical implications of the research he inspired by adding social neuroscience and ERPs to our own armamentaria. Critically, we do not view our observations are merely telling us that complex social behaviors have a neural instantiation. Instead, they tell us about the very nature of prejudice, stereotyping, discrimination, and person perception. They tell us, for instance, how quickly social categorization occurs. John's ERP work focused largely on the LPP and we have so far highlighted social category modulations in the LPP. However, in the chronometry of ERPs, the LPP is a relatively slow response, peaking some 400-500 ms after stimulus onset. While our initial work focused on this component, we along the way found that social category information modulates three ERP components occurring before the LPP, namely the N100, P200, and N200. The faster timecourse of these components, peaking at roughly 120 ms, 170 ms, and 250 ms after stimulus onset, respectively, shows that if we want to minimize the effects of social category distinctions, we must reckon with just how fast, automatic, and ubiquitous social category encoding is. Some manipulations fail to direct attention away from social category information (those that focus on other attributes of the person) (Ito & Tomelleri, 2017; Ito & Urland, 2005; Kubota & Ito, 2007) whereas others succeed (taking a first person perspective) (Kubota, 2010), telling us about the types of information processing operations affected by specific interventions.

Our results also implicate interactions between bottom-up, perceptual inputs and top-down, expectancy-based processes, congruent with models emphasizing the dynamic interplay of these factors (Correll, Hudson, Guillermo, & Earls, 2016; Freeman & Ambady, 2011; see also Cunningham, Zelazo, Packer, & Van Bavel, 2007). Consider a study of perceptions of digitally morphed faces containing features of either both Blacks and Whites, or Asians and Whites (Willadsen-Jensen & Ito, 2006). Responses differed across the P200, N200, and LPP components, suggesting rapidly shifting sensitivities as processing unfolded. Replicating other results, the non-morphed, clearly Black and Asian faces were always differentiated from ingroup White faces across the P200, N200, and LPP. However, the responses to the racially ambiguous faces differed across those components, with racially ambiguous Black-White and Asian-White faces eliciting P200 and N200 responses ERPs indistinguishable from ingroup White faces. This result is surprising from an ingroup overexclusion perspective, which argues that the desire for positive ingroup distinctiveness results in a high threshold for identifying someone as an ingroup member (Blascovich, Wyer, Swart, & Kibler, 1997; Leyens & Yzerbyt, 1992). Ingroup overexclusion would thus suggest that when presented with a face possessing features associated with both the ingroup and an outgroup, racially ambiguous faces would be distinguished from the ingroup. However, more recent models accounting for dynamically unfolding processing predict just the pattern we obtained. The Perceptual Enrichment, Expectancy, and Reciprocity (PEER) Model in particular assumes that experience with ingroup members tunes our perceptual systems to the visual patterns that best differentiate among ingroup faces, essentially creating an implicit expectation of what typical faces look like (Correll et al., 2016). An inherently time-varying process is assumed in the PEER, with initial preference to cues indicative of the ingroup. After this, processing diverges depending on the degree to which the percept matches the ingroup exemplar, with more attention to individuating information for faces possessing ingroup features and category-based processing for those not matching the ingroup exemplar (see also Hugenberg, Young, Bernstein, & Sacco, 2010; Levin, 2000/1996; Sporer, 2001). The similar P200 and N200 responses to ingroup and digitally morphed faces that contain some features of ingroup faces are consistent with a perceptual system tuned to ingroup features. Just a few hundred milliseconds later, in the LPP, the racially ambiguous faces were differentiated from clearly ingroup and outgroup faces. We take this to reflect continued processing of the visual percept identifying that the face does in fact differ from the features typically associated with ingroup Whites (as well as outgroup Blacks and Asians).

<u>Conclusion</u>

What was quite rare when John did it in the 1990s is now commonplace, with ERPs used to understand a range of social processes, including the self (e.g., Kitayama & Park, 2014), empathy (e.g., Han, Luo, & Han, 2016), and behavior regulation (e.g., Amodio, Kubota, Harmon-Jones, & Devine, 2006). These investigations can be found in traditional social psychological journals alongside any other theory-based inquiry. The explosive growth of social neuroscience also led to the creation of multiple more specialized journals, this one included. Critically, though, John’s focus was not merely on showing when or where in the brain something “occurred,” but in the *how* and *why* of behavior. He underscored the importance of Baconian inductive reasoning, arguing that the ultimate goal of social neuroscience should be to inform our understanding of psychological mechanisms by rejecting alternative hypothesis (Sarter, Berntson, & Cacioppo, 1996). The benefit of an integrative multi-level analysis approach to psychological inquiry was using observations of a phenomenon at one level of analysis (in this case, the neural level) to “inform, refine, or constrain” thinking at another level (in this case, psychological theory) (Cacioppo & Berntson, 1992, p. 1021). Thus, one of John’s lasting legacies is to keep us focused on the phenomena that intrigue us, rather than the contents of our armamentaria.

References

Ahern, G. L., & Schwartz, G. E. (1979). Differential lateralization for positive versus negative emotion. *Neuropsychologia*, *17*(6), 693–698.

Allport, G.W. (1954/1979). The Nature of Prejudice. Reading, MA:Perseus Books.

Amodio, D. M., Bartholow, B. D., & Ito, T. A. (2013). Tracking the dynamics of the social brain: ERP approaches for social cognitive and affective neuroscience. *Social Cognitive and Affective Neuroscience*, *9*(3), 385–393.

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*(1), 26–36.

Anderson, N. H., & Jacobson, A. (1965). Effect of stimulus inconsistency and discounting instructions in personality impression formation. *Journal of Personality and Social Psychology*, *2*(4), 531–539.

Bargh, J. A. (1994). The Four Horsemen of automaticity: Awareness, efficiency, intention, and control in social cognition. In J. R. S. Wyer & T. K. Srull (Ed.), *Handbook of Social Cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Bartholow, B. D., & Dickter, C. L. (2007). Social cognitive neuroscience of person perception: A selective review focused on the event-related brain potential. In *Social neuroscience: Integrating biological and psychological explanations of social behavior.* (pp. 376–400). New York, NY, US: The Guilford Press.

Bear, D. M. (1983). Hemispheric specialization and the neurology of emotion. *Archives of Neurology*, *40*(4), 195–202.

Blascovich, J., Wyer, N. A., Swart, L. A., & Kibler, J. L. (1997). Racism and racial categorization.

Journal of Personality and Social Psychology, *72*(6), 1364–1372.

Borod, J. C., Cicero, B. A., Obler, L. K., Welkowitz, J., Erhan, H. M., Santschi, C., … Whalen, J. R. (1998). Right hemisphere emotional perception: Evidence across multiple channels. *Neuropsychology*, *2(3),* 446- 458.

Brewer, M. B. (1988). A dual process model of impression formation. In T. Srull & R. Wyer (Eds.), *Advances in Social Cognition* (1st ed., Vol. 1, pp. 1–36). Hillsdale, NJ: Lawrence Erlbaum Associates.

Brewer, M. B., & Miller, N. (1984). Beyond the contact hypothesis: Theoretical perspectives on desegregation. In N. Miller & M. B. Brewer (Eds.), *Groups in contact: The psychology of desegregation* (pp. 281–302). Orlando, FL: Academic Press.

Cacioppo, J. T. (2002). Social neuroscience: Understanding the pieces fosters understanding the whole and vice versa. *American Psychologist*, *57(11)*, 819- 831.

Cacioppo, J. T., & Berntson, G. G. (1992). Social psychological contributions to the decade of the brain: Doctrine of multilevel analysis. *American Psychologist*, *47*, 1019-1028.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin*, *115*(3), 401–423.

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 & Social Psychology*, *85*(4), 650–661.

Cacioppo, J. T., Crites, S. L., Berntson, G. G., & Coles, M. G. H. (1993). If attitudes affect how stimuli are processed, should they not affect the event-related brain potential? *Psychological Science*, *4*(2), 108–112.

Cacioppo, J. T., Crites, S. L., & Gardner, W. L. (1996). Attitudes to the right: Evaluative processing is associated with lateralized late positive event-related brain potentials. *Personality and Social Psychology Bulletin*, *22*(12), 1205–1219.

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*(1), 115–

Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. *Annual Review of Psychology*, *50*(1), 191–214.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1997). Beyond bipolar conceptualizations and measures: The case of attitudes and evaluative space. *Personalality Social Psychological Review*, *1*(1), 3–25.

Cacioppo, J. T., Marshall-Goodell, B. S., Tassinary, L. G., & Petty, R. E. (1992). Rudimentary determinants of attitudes: Classical conditioning is more effective when prior knowledge about the attitude stimulus is low than high. *Journal of Experimental Social Psychology*, *28*(3), 207–233.

Cacioppo, J. T., Martzke, J. S., Petty, R. E., & Tassinary, L. G. (1988). Specific forms of facial EMG response index emotions during an interview: From Darwin to continuous flow hypothesis of affect-laden information processing. *Journal of Personality & Social Psychology*, *54*(4), 592–604.

Cacioppo, J. T., & Petty, R. E. (1979). Effects of message repetition and position on cognitive response, recall, and persuasion. *Journal of Personality and Social Psychology*, *37*(1), 97–109.

Cacioppo, J. T., Petty, R. E., & Tassinary, L. G. (1989). Social Psychophysiology: A New Look. In L. Berkowitz (Ed.), Advances in experimental social psychology, (Vol. 22, pp. 39–91).

San Diego, CA, US: Academic Press.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes. II: Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology*, *65*(1), 5–17.

Cacioppo, J. T., & Sandman, C. A. (1978). Physiological differentiation of sensory and cognitive tasks as a function of warning, processing demands, and reported unpleasantness. *Biological Psychology*, *6*(3), 181–192.

Cacioppo, J. T., & Tassinary, L. G. (1990). Inferring psychological significance from physiological signals. *American Psychologist*, 45(1), 16-28.

Cacioppo, J. T., Tassinary, L. G., Stonebraker, T. B., & Petty, R. E. (1987). Self-report and cardiovascular measures of arousal: Fractionation during residual arousal. *Biological Psychology*, *25*(2), 135–151.

Cacioppo, J. T., Uchino, B. N., Crites, S. L., Snydersmith, M. A., Smith, G., Berntson, G. G., & Lang, P. J. (1992). Relationship between facial expressiveness and sympathetic activation in emotion: A critical review, with emphasis on modeling underlying mechanisms and individual differences. *Journal of Personality and Social Psychology*, *62(1)*, 110-128.

Cialdini, R. B., Petty, R. E., & Cacioppo, J. T. (1981). Attitude and attitude change. *Annual Review of Psychology*, *32*(1), 357–404.

Correll, J., Hudson, S. M., Guillermo, S., & Earls, H. A. (2016). Of kith and kin: Perceptual enrichment, expectancy, and reciprocity in face perception. *Personality and Social Psychology Review*, *21*(4), 336–360.

Correll, J., Urland, G. R., & Ito, T. A. (2006). Event-related potentials and the decision to shoot: The role of threat perception and cognitive control. *Journal of Experimental Social Psychology*, *42*(1), 120–128.

Crites, S. L., & Cacioppo, J. T. (1996). Electrocortical differentiation of evaluative and nonevaluative categorizations. *Psychological Science*, *7*(5), 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*(6), 997-1013.

Cunningham, W. A., Zelazo, P. D., Packer, D. J., & Van Bavel, J. J. (2007). The iterative reprocessing model: A multilevel framework for attitudes and evaluation. *Social Cognition*, *25*(5), 736–760.

Davidson, R. J. (1992). Anterior cerebral asymmetry and the nature of emotion. *Brain and Cognition*, *20*(1), 125–151.

Donchin, E. (1981). Surprise!… surprise? *Psychophysiology*, *18*(5), 493–513.

Donchin, E., & Coles, M. G. H. (1988). Is the P300 component a manifestation of context updating? *Behavioral and Brain Sciences*, *11*(3), 357–374.

Farwell, L. A., & Donchin, E. (1991). The truth will out: Interrogative polygraphy ("lie detection") with event-related brain potentials. *Psychophysiology*, *28*(5), 531–547.

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

Fiske, S. T. (1980). Attention and weight in person perception: The impact of negative and extreme behavior. *Journal of Personality and Social Psychology*, *38*(6), 889–906.

Fiske, S. T., & Taylor, S. E. (1984). Social Cognition. *Social Cognition*, 1–43.

Fiske, S. T., & Taylor, S. E. (1991). *Social cognition, 2nd ed. Social Cognition, 2nd ed.* New

York, NY, England: Mcgraw-Hill Book Company.

Freeman, J. B., & Ambady, N. (2011). A dynamic interactive theory of person construal. *Psychological Review*, *118*(2), 247–279.

Gazzaniga, M. S., Eliassen, J. C., Nisenson, L., Wessinger, C. M., Fendrich, R., & Baynes, K. (1996). Collaboration between the hemispheres of a callosotomy patient: Emerging right hemisphere speech and the left hemisphere interpreter. *Brain*, *119*(4), 1255–1262.

Gilbert, D. T., & Hixon, J. G. (1991). The trouble of thinking: Activation and application of stereotypic beliefs. *Journal of Personality and Social Psychology*, *60*(4), 509–517.

Gyurovski, I., Kubota, J., Cardenas-Iniguez, C., & Cloutier, J. (2018). Social status level and dimension interactively influence person evaluations indexed by P300s. *Social Neuroscience*, *13*(3), 333–345.

Han, X., Luo, S., & Han, S. (2016). Embodied neural responses to others' suffering. *Cognitive Neuroscience*, *7*(1–4), 114–127.

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization-individuation model: An integrative account of the other-race recognition deficit. *Psychological Review*, *117*(4), 1168–1187.

Ito, T. A., & Bartholow, B. D. (2009). The neural correlates of race. *Trends in Cognitive Sciences*, *13*(12), 524–531.

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*(4), 887–900.

Ito, T. A., & Tomelleri, S. (2017). Seeing is not stereotyping: the functional independence of categorization and stereotype activation. *Social Cognitive and Affective Neuroscience*, *12*(5), 758–764.

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*(4), 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 & Behavioral Neuroscience*, *5*(1), 21–36.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, *114*(1), 3–28.

Kahneman, D. (2003). Maps of bounded rationality: Psychology for behavioral economics. *American Economic Review*, *93*(5), 1449–1475.

Kahneman, D., & Tversky, A. (1982). The psychology of preferences. *Scientific American*, *246*(1), 160–173.

Kanouse, D. E., & Hansen, L. R. (1971). Negativity in evaluations. In E. E. Jones, D. E. Kanouse, H. H. Kelley, R. E. Nisbett, S. Valin, & B. Weiner (Eds.), *Attribution: Perceiving the causes of behavior* (pp. 47–62). Morristown, NJ: General Learning Press.

Kitayama, S., & Park, J. (2014). Error-related brain activity reveals self-centric motivation: Culture matters. *Journal of Experimental Psychology: General, 143(1),* 62-70.

Kolb, B., & Taylor, L. (1981). Affective behavior in patients with localized cortical excisions: Role of lesion site and side. *Science*, *214*(4516), 89-91.

Kosslyn, S. M., Holtzman, J. D., Farah, M. J., & Gazzaniga, M. S. (1985). A computational analysis of mental image generation: Evidence from functional dissociations in split-brain patients. *Journal of Experimental Psychology: General, 114(3),* 311-341.

Kubota, J. T. (2010). *The neural correlates of categorical and individuated impressions*. University of Colorado at Boulder.

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*(5), 738–752.

Kubota, J. T., & Ito, T. A. (2009). You were always on my mind: How event-related potentials inform impression formation research. In T. D. Nelson (Ed.), *Handbook of prejudice, stereotyping and discrimination*. New York, NY: Psychology Press.

Levin, D. T. (1996). Classifying faces by race: The structure of face categories, *22*(6), 1364–1382.

Levin, D. T. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition. *Journal of Experimental Psychology-General*, *129*(4), 559–574.

Levy, J., & Trevarthen, C. (1977). Perceptual, semantic and phonetic aspects of elementary language processes in split-brain patients. *Brain: A Journal of Neurology*, *100(1)*, 105–118.

Leyens, J.-P., & Yzerbyt, V. Y. (1992). The ingroup overexclusion effect: Impact of valence and confirmation on stereotypical information search. *European Journal of Social Psychology*, *22*(6), 549–569.

Maxwell, J. S., & Davidson, R. J. (2007). Emotion as motion: Asymmetries in approach and avoidant actions. *Psychological Science*, *18*(12), 1113–1119.

Miller, N. (2002). Personalization and the promise of contact theory. *Journal of Social Issues*, *58*(2), 387–410.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, *84*(3), 231–259.

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

Psychology, *1*(1), 33–60.

Petty, R. E., & Cacioppo, J. T. (1977). Forewarning, cognitive responding, and resistance to persuasion. *Journal of Personality and Social Psychology*, *35*(9), 645-655.

Petty, R. E., & Cacioppo, J. T. (1986). The Elaboration Likelihood Model of persuasion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 19, pp. 123–205). New York: Academic Press.

Renault, B., Signoret, J.-L., Debruille, B., Breton, F., & Bolgert, F. (1989). Brain potentials reveal covert facial recognition in prosopagnosia. *Neuropsychologia*, *27*(7), 905–912.

Rosch, E. (1999). Principles of categorization. In E. Margolis & S. Laurence (Eds.), *Concepts: Core Readings* (pp. 189–206). Cambridge, MA, US: MIT Press.

Rosch, E., & Lloyd, B. B. (1978). *Cognition and categorization.* (E. Rosch & B. B. Lloyd, Eds.), *Cognition and categorization.* Oxford, England: Lawrence Erlbaum.

Ruchkin, D. S., Canoune, H. L., Johnson Jr, R., & Ritter, W. (1995). Working memory and preparation elicit different patterns of slow wave event-related brain potentials. *Psychophysiology*, *32*(4), 399–410.

Sarter, M., Berntson, G. G., & Cacioppo, J. T. (1996). Brain imaging and cognitive neuroscience: Toward strong inference in attributing function to structure. *American Psychologist*, *51(1)*, 13-21.

Skowronski, J. J., & Carlston, D. E. (1989). Negativity and extremity biases in impression formation: A review of explanations. *Psychological Bulletin*, *105*(1), 131–142.

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin*, *119*(1), 3-22.

Sporer, S. L. (2001). Recognizing faces of other ethnic groups: An integration of theories. *Psychology, Public Policy, and Law*, *7*(1), 36–97.

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*(4), 387–401.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, *8*, 220–247.

Tajfel, H. (1969). Cognitive aspects of prejudice. *Journal of Biosocial Science*, *1*(S1), 173–191.

Tassinary, L. G., Cacioppo, J. T., & Geen, T. R. (1989). A psychometric study of surface electrode placements for facial electromyographic recording: I. The brow and cheek muscle regions. *Psychophysiology*, *26*(1), 1–16.

Tompkins, C. A., & Mateer, C. A. (1985). Right hemisphere appreciation of prosodic and linguistic indications of implicit attitude. *Brain and Language*, *24*(2), 185–203.

Willadsen-Jensen, E. C., & Ito, T. A. (2006). Ambiguity and the timecourse of racial perception. *Social Cognition*, *24*(5), 580–606.

Willadsen-Jensen, E. C., & Ito, T. A. (2014). The effect of context on responses to racially-ambiguous faces: Changes in perception and evaluation. *Social Cognitive and Affective Neuroscience, 10(7),* 885-892.

Wilson, T. D., Hull, J. G., & Johnson, J. (1981). Awareness and self-perception: Verbal reports on internal states. *Journal of Personality and Social Psychology*, *40*(1), 53–71.

Endnotes

[i] More recent treatments recognize the multi-faceted nature of automaticity, including awareness, intentionality, efficiency, and controllability (Bargh, 1984). Earlier impression formation models did not distinguish among these different qualities of automaticity, but to our read, the descriptions imply a process occurring efficiently and without intention, possibly without awareness and controllability.