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Multi-level analysis of cultural phenomena: The role of ERPs approach to prejudice

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INTRODUCTION

Prejudice is one of the most pervasive cultural conditions of our current social life, where intergroup relationships constitute the rule rather than the exception. Prejudice is understood as the human individuals' psychological tendency to make unfavorable evaluations about members of other social groups. It is certainly a phenomenon in which different processes and description levels intervene. On one the hand, prejudice involves diverse psychological processes (Hamilton & Trolier, 1986) such as levels of impulsiveness and control (Bartholow, Dickter & Sestir, 2006), personal and social identity interests (Tajfel & Turner, 1979), and attitudinal processes containing cognitive, affective, and behavioral components (Dovidio, Brigham, Johnson, & Gaertner, 1996). On the other hand, prejudice also depends on social processes, such as social learning (Lieberman, Hariri, Jarcho, Eisenberg & Bookheimer, 2005), the intersubjective construction of attitudes and stereotypes, their transformation through communication, and intergroup relationships (Fiske, 1998). The history of social interaction that sustains these relationships is characterized by power differences and interdependence patterns as revealed, for example, in the existence of racial minorities (Hart, Whalen, Shin, McInerney, Fischer & Rauch, 2000; Phels, O'Connor, Cunningham, Funayama, Gatenby, Gore & Banaji, 2000; Cunningham, Johnson, Raye, Gatenby, Gore & Banaji, 2004; Fiske, 1998), which play a relevant role in the manifestation of prejudice. In addition, prejudice involves specific biological processes (Caccioppo, Berntson, Sheridan & McClintock, 2000; Todorov, Harris & Fiske, 2006) such as emotional activation, the analysis and integration of inner and outer information in neural networks, and the regulation of behavior on the basis of multiple concurrent sub-processes.

This paper addresses some neurophysiologic phenomena presumably involved in prejudice in order to show the benefits of a multi-level integration of the psychological, social and biological aspects of such a complex cultural phenomenon. The main ideas guiding the argumentation will be the following. Idea 1: the social, psychological, and biological approaches to prejudice are complementary and may benefit from an interdisciplinary account of prejudice. Idea 2: Prejudice is a complex kind of behavior that involves multiple aspects at different description levels, including historical, political, communicational, cognitive, motivational, emotional, and neural phases of one and the same dynamic process. Idea 3: Neurophysiologic observations, particularly those referred to the time course of bodily micro-changes during prejudicial behavior, may contribute to a dynamic comprehension of prejudice.

Toward a Multi-Level Approach to Prejudice

In social psychology the concept of prejudice derives from the concept of attitude, which refers to a global orientation of the organism when facing an object, an orientation that is basically characterized by an inclination within the continuum between approach and distance, between pleasure and pain, or simply between positive and negative affection. Therefore, it can be understood, on the one hand, that prejudice has a biological root, because it reflects a basic integral manner in which complex organisms react to their environment. However, on the other hand, prejudice is an attitude that appears, makes sense, and eventually has consequences only in the context of relationships between social groups. Thus, it is understood that prejudice has, in addition, a cultural root, since it reflects the adoption of a collective social perspective and involves a relationship with another community, including socially transmitted beliefs about these communities (i.e., consensual stereotypes). Therefore, the simple consideration of the concept of prejudice is enough to show that the elucidation of its psychological bases implies conjugating social and biological aspects of behavior. In spite of this, there are very few attempts to include this last dimension in the explanation of prejudice, as well as to synthesize the contributions of social and biological sciences in a comprehensive vision (Plotkin, 2003).

Nevertheless, in theoretical psychology and neuroscience, there is an increasing tendency toward a multi-leveled approach of mental processes. Interest in integrating theories and methods of social psychology, cognitive psychology and neurosciences has increased recently, which promises a more complex understanding of interesting phenomena such as social prejudice, social attitudes and control of emotions. Within the scope of cognition, some meta-theoretical approaches, known as explanatory pluralism (Bem, 2001; de Jong, 2001; Flanagan, 1992; Mc Cauley, 1986, 1996; Mc Cauley & Bechtel, 2001; Meyering, 2001; Radder, 2001, among others), encourage inter-level construction of psychological phenomena. Specifically, this movement proposes the co-construction of theories, rather than ontological reduction between levels of explanation; the possibility of a uniform vision is rejected; inter-theoretical development is promoted; and plural ontology is assumed, also focusing on a pluralistic scientific practice.

In this line, the social-neuroscience approach, which addresses social psychological phenomena from the neurosciences, is one of the more promising emergent developments within psychology and cognitive neuroscience (Adolphs, 2003; Cacioppo, Bernstson, Sheridan & McClintock, 2000; Lieberman, 2005; Oschner & Lieberman, 2001; Miller, 2006; Todorov, Harris & Fikes, 2006). Behavioral sciences have demonstrated clear shortcomings when approaching complex cultural behavior, because of the challenges involved in the development of theories that are not reductionist. As implied by Idea 1 of the present paper (see above), we follow explanatory pluralism in trying to show the necessity of a collaboration between the description of neurophisiological, cognitive, emotional, and social aspects of prejudicial behavior. This involves avoiding language games that are exclusively materialistic or exclusively mentalist in order to develop multi-leveled approaches to cultural behavior. Specifically in neuroscience, it has become evident that full comprehension of the brain cannot only be restricted to neural mechanisms (Cacioppo et al., 2000). Advances in social psychology have confirmed that the level of description of conscious social behavior is also insufficient, as discussed in the next section.

Explicit and Implicit Levels of the Description of Prejudice

These new perspectives allow us to redefine some social psychological problems, as well as to recreate the questions and the tools to respond to these questions. This is of crucial importance in the present consideration of contemporary prejudice. For almost 100 years, psychologists have studied attitudes and preferences by asking people to report on the good and bad attributes of people, things, and events (Eagly & Chaiken, 1993). However, recent evidence shows that people also spontaneously evaluate social objects within a good–bad dimension, without necessarily being aware that they are doing so (Bargh, Chaiken, Govender & Pratto, 1992; Fazio, Sanbonmatsu, Powell & Kardes, 1986). While contemporary prejudice has become more complex, less conscious, and more ambivalent, its study by social psychology is becoming increasingly complex. With the development of modern prejudice, subtle or benevolent, new methodological approaches have arisen, which tend to measure intergroup attitudes indirectly or unconsciously, not filtered by conscious control and social desirability (implicit). Thus, the study of prejudice has benefited from studies of cognitive processes at a descriptive level other than consciously recognized attitudes (explicit; Dovidio, Kawakami, Johnson, Johnson & Howard, 1997; Fazio, Jackson, Dunton & Williams, 1995; Greenwald, McGhee & Schwartz, 1998; Wittenbrink, Judd & Park, 1997).

Nevertheless, the study of contextual dynamics between explicit and implicit manifestations of prejudice is controversial. Several studies report little or no relation between measurements of explicit and implicit attitudes, suggesting that each one addresses different knowledge structures (e.g., Dovidio et al., 1997, Studies 1 and 3; Fazio et al., 1995, Study 1; Greenwald et al., 1998, Study 3). Nevertheless, other investigations have provided evidence of a positive relation between the two (Dovidio et al., 1997, Study 2; Greenwald et al., 1998, Study 2; Wittenbrink et al., 1997). Moreover, there is no consensus about the intrinsic meaning of implicit measures. Do they reflect unconscious attitudes? Can these attitudes be inhibited or controlled; or do they constitute a phenomenon of automatic social learning, totally separated from conscious judgment? Scientific research to date does not provide a unique and coherent explanation for the psychological bases of prejudice. This is partly due to the fact that joint investigation with explicit and implicit measurements of prejudice is relatively recent and, as a consequence, there is still much to clarify in terms of the relationship between the automatic processes triggered by social stimuli and the attitude consciously reported about them.

Such controversy is a good challenge for multi-leveled approaches. As long as this type of approach opens new forms of argumentation and explanation and creates new facts, an important option in the study of social phenomena will be formed. The requirement of co-construction from several description levels of prejudice, and the consequential necessity of an interdisciplinary approach, will only be imposed on the classic one-dimensional approach once the multi-level approaches offers better explanations and solutions to concrete questions concerning cultural behavior (Ideas 1 and 2). Within this framework, the specific aim of this paper consists in discussing the contribution of the social neurosciences to the understanding contemporary prejudice. In particular, the technique of extracting event related potentials (ERP, hereafter) will be discussed as a tool for measuring brain activity during the presentation of stimuli that relates to prejudice (Idea 3). The emphasis will be on understanding the dynamics that arise in the relationship between explicit and implicit manifestations of prejudice, given the relevance of this topic in social psychological studies of prejudice.

ERP STUDIES OF SOCIAL CUES, BIAS, AND PREJUDICE

Unlike neuroimaging techniques, the ERP approach has emerged recently and it seems to have some essential advantages for a dynamic comprehension of prejudice, as it will be argued in this paper. Neuroimaging techniques have been used to aboard diverse aspects of social behavior such as, moral reasoning (Moll, Zahn, Oliveria-Souza, Krueger & Grafman, 2005), social cooperation (Rilling, Guttman, Zeh, Pagnomi, Berns & Kilts, 2002), violent tendencies (Davidson, Putman & Larson, 2000), racial responses (Phelps, O'Connor, Cunningham, Funayama, Gatenby, Gore, & Banaji, 2000), as well as love and affection (Bartelz & Zeki, 2000). Nevertheless, the study of ERPs has notably enriched the literature in the area of the social psychology of stereotype dynamics, bias, prejudice, and other forms of group perception (Todorov et al., 2006). The possibility of assessing the fine time-dynamics of cultural behavior makes ERP a privileged tool for research (Idea 3). After a brief presentation of the ERP technique, a set of prototypical studies is presented.

Event Related Potentials

ERPs can be consistently measured using electroencephalography (EEG), a procedure that measures electrical fields of the brain through the skull and scalp. ERPs are the ongoing electrophysiological activity resulting from the synchronous activation of several neural subpopulations that occur in response to sensory, motor or cognitive events (Hillyard & Picton, 1987). ERPs reflect the summed activity of excitatory postsynaptic potential (EPSP) and inhibiting postsynaptic potential (IPSP) activated in response to each new stimulus. This technique has an excellent temporal resolution of milliseconds (ms); nevertheless, the ERPs are less precise for the anatomical localization of the neural generators than the neuroimage techniques (Kutas & Federmeier, 2000). The ERP's spatial distribution on the scalp is not indicative of its brain source generators (although some mathematical tools for source algorithm localization can enhance the spatial precision).

Electrodes need to be attached to various points on the scalp relative to bony landmarks. The head is measured using a standardized EEG measurement technique to determine the correct spots. The electrodes affixed to the scalp are then connected to the electric amplifiers. Typically, the participants are placed in front of a computer screen and auditory headsets displaying a pattern of stimuli. One computer records and amplifies the electrical peaks elicited by each stimulus onset (or participant response). Normally, this procedure implies recording EEG activity time locked to several presentations of the same or similar events, and then averaging these tracing together. The average decreases the influence of noisy activity (i.e., EEG not related to experimental events or background noise) while maintaining the event-related activity. The ERP waveforms are the summation, and cancellation, of neural activity registrations from a large number of neural generators from different brain areas.

ERPs are constituted by positive or negative changes of voltage that appear at specific latencies after the stimulus presentation. Most ERP components are referred to by a preceding letter (e.g., "N") indicating polarity followed by the typical peak latency in milliseconds (e.g., the "N400" ERP component is described as a negative voltage deflection occurring approximately 400ms after stimulus onset; Ibañez et al., 2006). The timing of these responses is thought to provide a measure of the timing of the brain processing. Voltage waveform features are described basically according to: latency (this is, how long after the event they appear); direction (positive or negative); amplitude (the strength of the voltage change); and topological

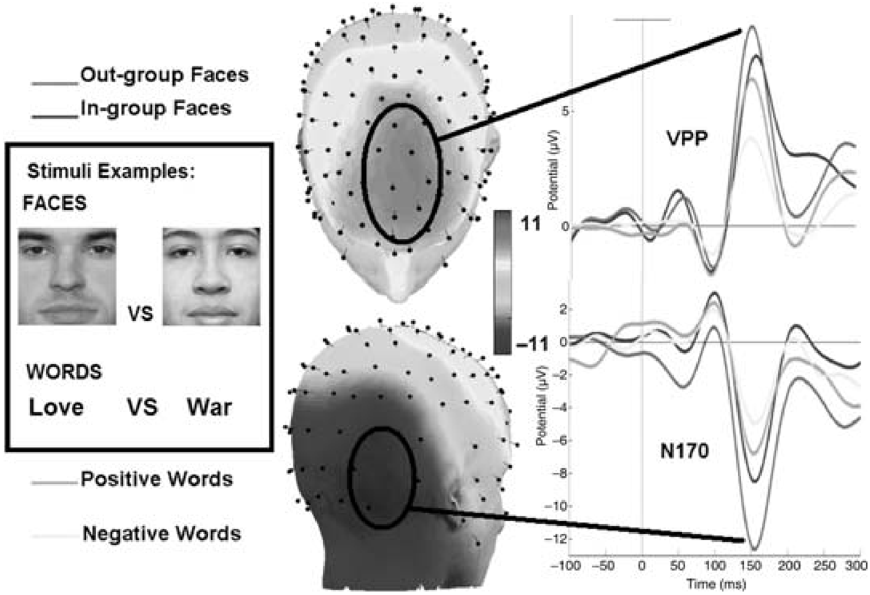

Figure 1. N170/VPP topography and waveform. LEFT: Examples of Stimuli presented (in-group and out-group faces; positive vs. negative words). CENTER: Topography maps of VPP component (above, a central vertex-to-frontal positivity) and N170 component (below, a right temporal-occipital negativity) elicited by out-group faces. RIGHT: VPP and N170 Waveforms modulated by structural features of stimuli (faces vs. words); race of the facial stimuli (in-group vs. out-group) and word valence (positive vs. negative). These results suggest that the race of the facial stimuli (indigenous, non-indigenous) and its associated valence (positive-negative) are processed quickly and early in the brain, in the same temporal window of the structural-perceptual discrimination (face vs. word). Modified from Gonzalez et al., 2008 and Ibáñez et al., 2008b.

distribution of the component on the surface of the head (frontal, parietal, occipital, etc.). Figure 1 illustrates these concepts. There are several ways to shows the ERP activity. The standard procedure consists in an amplitude (measured in microvolt) and latency (measured in milliseconds) waveform associated to a specific stimulus or response (as in Figure 1). By means of this procedure, different stimuli or conditions can be contrasted in terms of amplitude or latency (Ibañez et al., 2008). It is commonly said that a given ERP "is moduled by", "is sensitive to", or "discriminates" a given condition change when statistical differences are found in its latency, amplitude, or morphology, as a function of such condition change. Usually based on spatial interpolation from punctual electrical measurements at each electrode, a continuous reconstruction of electrical activity on the scalp is obtained in the form of what is called a topological map. As shown in the Figure 1, with the Vertex Positive Potential (VPP) and the N170 as examples, each component usually has a specific topographic distribution.

The so-called long latency components, cognitive components or endogenous components occur after 100 ms, and they are sensitive to changes in cognitive processing, as the meaning of the stimulus, or resources of processing required in the task performed (Hillyard, 2000). Here, we introduce a brief description of each component presented later in the social neuroscience studies: P100, N100; P200; N200; N170; P300; LPP, CNV, and ERN.

P100 & N1. Eason et al. (1969) found that visual stimuli located in visual fields where the attention if focused, elicits components with larger amplitude (P1 and N1, around 100 ms after stimulus onset), when compared with stimuli ignored or not attended. This amplitude enhancement presents its maximum in the temporal-occipital region, contralateral to the localization of the stimuli, and sensitive also to the specific localization of the stimuli in the visual field (Mangun et al., 1993). Similar results were obtained in the auditory modality, using a dichotic listening paradigm (Hillyard et al., 1973). This auditory early attention effect reflects a response increase of the auditory primary cortex (Woldorff et al., 1993). The P1 and N1 components, as presented later, are modulated in attention tasks by racial and emotional stimuli.

P200. P200 is a positive deflection occurring about 200 ms after the onset of the stimulus. The P200 has been interpreted as reflecting selective attention (Hackley, Woldorff, & Hillyard, 1990) and visual feature detection processes (Luck & Hillyard, 1994). In addition, P200 has been shown sensitive to orthographic/phonological tasks, semantic categorization tasks, and lexical decision tasks.

N200. Typically evoked 180 to 325 ms following the presentation of a specific visual or auditory stimulus, the N200 (or N2) is a negativity resulting from a deviation in form or context of a prevailing stimulus. Although the N2 is currently consider a family of different components, its classic manifestation can be elicited through an experimental oddball paradigm, and is sensitive to perceptual features (Bentin et al., 1999). Conflict detection during the regulation of successful behavior is associated to N200 (Nieuwenhuis, Yeung, Van Den Wildenberg & Ridderinkhof, 2003). Consistently, the source of N200 modulation compromises the Anterior Cingulate Cortex (ACC hereafter, a brain area sensitive to social monitoring of conflict) and other areas of prefrontal cortex (Nieuwenhuis et al., 2003).

N170/Vertex Positive Potential. The N170/VPP complex correspond to a negative peak around 170 ms in the temporal-occipital regions, and simultaneously one central-frontal positivity (VPP), functionally equivalent (Joycea & Rossion, 2005). Its neural source generators have been estimated in the Inferior Temporal Gyrus and Fusiform Gyrus (two areas associated to specific face processing). Its amplitude is bigger for human faces compared with objects (Bentin, Allison, Puce, Perez, & McCarthy, 1996; Jeffreys, 1989). The N170 component have shown amplitude/latency modulation based on race (Ito & Ulrand, 2005; Gonzales et al., 2008), and emotional variables (Ashley, Vuilleunier & Swick, 2004; see Figure 1).

P300. This component has been described to engage higher-order cognitive operations related to selective attention and resource allocation (Donchin & Coles, 1988). P300 amplitude may serve as a covert measure of attention that arises independently of behavioral responding (Gray et al., 2004). P300 has also been related to a post-decisional "cognitive closure" mechanism (Desmedt, 1980; Verleger, 1998); and to the access of information to consciousness (Picton, 1992). The amplitude of the P300 will generally vary as a function of the temporal distance between a target and a preceding outgoing stimulus (Cornejo et al., 2007).

Late Positive Potential (LPP). Although Sutton (1965) described initially the LPP as a unique frontal bilateral positivity, today is considered a family of components. LPP is a late component (300–700 ms) sensitive to stimuli valence, and to the previous emotional context (Cacioppo et al., 1994, Schupp et al., 2000). Several studies have shown a LPP amplitude increase in response to motivationally relevant stimuli (i.e., pleasant or unpleasant images; Cuthbert et al., 2000; Schupp et al., 2000; Schupp, Junghofer, Weike, & Hamm, 2004). The amplitude, latency ant topography of LPP is modulated by semantic emotional valence of stimuli (Cunningham et al., 2007) and contextual information (Cornejo et al., In press).

Contingent Negative Variation. CNV is a wide and prolonged negative potential recorded during simple warned reaction time paradigms from central and parietal scalp sites. Its scalp distribution is fairly wide, always begins bilaterally, symmetrically at the midline of the precentral-parietal regions, about 1.000–1.500 ms before response movement. CNV is a correlate of anticipation of the latter presentation of a stimulus target (Picton & Hillyard, 1988; Walter, Cooper, Aldridge, McCallum, & Winter, 1964).

Error Related Negativity. ERN is a component observed 50–100 ms after a response characterized as being of high conflict, in which a dominant response is inconsistent with respect to a correct response (Hohnsbein, Falkenstein & Hoormann, 1995 and others). The ERN component reflects conflict in ACC (Yeung, Botvinick, & Cohen, 2004). Consequently, the average ERN response of a subject serves as an index for the general sensitivity of the conflict monitoring system, which can be used to predict successful patterns of control.

It is important to note that we do not consider the ERPs as the generators of thoughts or feelings elicited in one social process. On the contrary, ERPs are obtained in response to one stimulus or response elicitation, and are modulated by different psychological process. Therefore, ERPs are considered as partial neural correlates of a global process being simultaneously neurological, psychological and social (Idea 2). The ERPs in this view are a powerful tool for improve the interlevel and co-construction approach between neurosciences, psychology and social sciences (Idea 1).

Early Processing and Automatic Bias

Psychological investigations have shown that in general we recognize faces of our own race more quickly and with greater confidence than other races (Brigham & Barkowitz, 1978). This is called same-race advantage. How does neuroscience contribute to understanding racial knowledge processing and, especially, face recognition of some races versus others, using electrophysiological techniques?

Mouchetant-Rostaing and Giard (2000), introduced participants (N = 19, aged 19–34, 9 male) to photograph blocks that contained either faces or body parts (hands and torsos of women, men or both). They found that the cerebral activity was sensitive to gender categorization from faces but not from the hands, beginning its potential at around 145 ms in central frontal areas. ERPs discriminated between tests in which gender distinction was possible and those in which it was not. Ito and Urland (2003) introduced participants (White, Asian and Hispanic females and males) to photos of women and men of White and Black race with the purpose of evaluating race and gender. They specifically quantified the amplitude of the components N100, P200, and N200 (see ERP section), which have shown variation as a function of task relevance or stimuli salience. Different processing for Black and White, men and women, was observed. Race modulated its first responses in the N100 component. The peak was observed with an average latency of around 120 ms after the starting point of the face presentation. The N100 peak was greater for Black targets than White. This continued within the next component, the P200 (peak average was observed around 180 ms), with greater amplitude for Black than White targets. P200 was greater for male targets than female. No earlier gender modulation was observed. The third component (N200) peaked around 260 ms. The modulation of both effects, race and gender, was inverted with respect to P200: N200 was greater for White and female than Black and male, respectively.

In brief, race and gender modulate ERP responses around 145 ms or earlier. Given the association of these early components with attentional selection, these results initially suggest a large allocation of automatic attentional resources to the out-group, based on race and gender. In addition, this effect occurs when the participant categorized specific faces in terms of race or gender, indicating that early attention does not require a conscious focus on the social dimension (Ito, Willadsen-Jensen & Correl, 2007). Since P100 and N100 are very early components, it could be suggested that social aspects (gender, race) have a very early effect in perceptual processing. This early social bias can be understood as an automatic initial phase of a larger process which, in its unfolding, may integrate other phases and sub-processes (Idea 2), both strongly automatic and highly controlled. Thus, this automatic bias, as observed at the level of electrophysiological measures, does not mean the inevitability of prejudice, since multiple other aspects of behavior have their part at different stages and scales in order to complete a prejudicial behavior. In other words, to think of automaticity is different from thinking of mechanistic determination of behavior. On the other hand, this automatic bias also helps us realize that prejudicial behavior might be deeply constrained by a fine-grained and dynamic integration of sub-processes, like the extremely early integration of social categorization into simple perceptual reactions. In line with Ideas 1 and 2, this is one important point that social psychology may learn form social neuroscience.

Type of Task and Stimulus Complexity

Nevertheless, other studies have not replicated this early effect of race. For example, Ito & Urland (2005) presented faces of men/women and White/Black, in which the participants (*N* = 50, 25 females, all Whites except two Asian American) had to focus their attention more deeply. Although the results with respect to the P200 component were replicated, the discrimination of race and gender happened after P200, and the differences in N100 were attenuated. N100s were greater for Black faces when participants explicitly focused on race or gender, but race did not affect N100 when the participants responded to other stimuli that were not related to faces. This suggests a delay of the race effect of N100 to P200 by the complexity of the visual stimulus.

Another study carried on by Willadsen-Jensen & Ito (2006) was based on close racial groups. The stimuli used were a mixture of racially ambiguous faces, in equal proportions, of Whites and Blacks, and Asians and Whites. The participants (*N* = 40, Whites, 21 male) had to make dichotomizing judgments on races and had to select between Blacks and Whites in a first study, and Asians and Whites in a second study. P200s were greater for Blacks and Asians than for Whites, and N200s were greater for Whites than for Blacks and Asians. Interestingly, P200 and N200 for racially ambiguous faces were indistinguishable from the responses for Whites in both studies. Again, in a task of greater complexity, previous differences were not observed at 200 ms.

Caldara, Rossion, Bovet & Hauert (2004) investigated through ERP the cerebral dynamics of face classification according to the race of participants (*N* = 12, 6 females, all Caucasian university students aged 18–30) while developing a task of face classification by race. The results of this study show that Asian faces were classified faster (M = 539 ms) than the Caucasians (M = 571 ms), however, differences between N170 (a negative occipito-temporal component related to face processing, see ERP section), evoked by other-race (OR) and same-race (SR) faces were not found. Also, there was no significant interaction with the race of the face. The effect of OR faces (an intense occipital medial activity for OR faces) found in previous studies was not replicated (Caldara, Thut, Servoir, Michel, Bovet & Renault, 2003). This suggests that the previous activity associated to OR faces was relative to the task and reinforces the interpretation of attentional modulations. These studies have shown that other-race face advantage can occur later than previous studies suggest, showing that the N170 component would not be influenced by the familiarity of the face and race features. This component would be distinguished from the activity in medial-occipital electrodes, which is greater for OR faces than SR faces, reflecting attentional processes associated with the relative non-familiarity of the OR.

Another relevant aspect in this topic is whether the type of stimuli has emotional implications. A face perception study (Ashley, Vuilleunier & Swick, 2004) realized in 10 male and 10 female participants, aged 22–31, found that ERP signals differ among emotional and non-emotional faces as early as at 120 to 160 ms after the stimulus. This study suggested that the processing of an emotional expression, a signal that can denote confidence or danger, may occur before and parallel to the process of facial structural codification. In other words, emotional significance can be processed before a stimulus is completely identified. Moreover, these early emotional processes are not only automatic, but they may also occur in the absence of conscious awareness.

As a whole, these results suggest that, in absence of high perceptual loads, automatic attentional allocations cannot be inhibited. From this perspective, the automatic codification of information on social categories could be attenuated when the perceptual demands are high, suggesting that the complexity of the task or stimulus delays the processing. Additionally, emotional implications seem to be discriminated before racial codes, suggesting possible early interactions between emotional priming and social codes. This can be seen, in accordance with Ideas 2 and 3, as evidence of the fine-grained integration of sub-processes in a temporal dynamic. Given that Ito & Urland (2005) demonstrated that N170 was modulated by race but not by gender, it can be argued that such electrophysiological change is sensitive to certain types of social categorizations only, even if stimuli are physically similar. Talking properly, N170 does not "discriminate" by race in itself, but is involved, as other ERP components, in a more complex process of racial categorization. In sum, these studies are consistent with our idea that physiological changes are not in them selves the much larger multifaceted behavior, but show partial aspects of a given global activity. For instance, at the level of cognitive processing one can distinguish several sub-processes and operations of different sorts, such as stimuli recognition, emotional response, etc., dynamically connected in a way that makes it impossible to reduce prejudice to one of its ingredients.

Stereotype Activation and More Complex Processing

The P300 is another component, sensitive to the processing of attention (Ito & Urland, 2003; see ERP section). The first studies of social stereotypes using ERP

(Cacioppo et al., 1993) have demonstrated that the P300 component is associated to an implicit categorization of attitudinal objects that are consistently and inconsistently evaluated. Osterhout, Bersick, & McLaughlin (1997; *N* = 28, 14 females, aged 19–35) used statements that contained stereotype violations ("the feminist made himself heard at the meeting") eliciting a large positive wave that began around 500 ms, similar to the responses evoked by phrases that contained definitional violations between a pronoun and its antecedent ("the wealthy Queen built himself a castle"). These results were independent of the participants' judgments and of the grammatical acceptability, emphasizing ERP sensitivity regarding implicit judgment processes.

Ito, Thompson, & Cacioppo (2004) presented White participants (*N* = 42, 33 males) a set of White and Black faces within contexts with positive and negative situations (i.e., cute puppies or appetizing foods, and dead animals or rotting food). When faces were seen in a positive context, a bigger P300 was observed for Black faces than for White faces. When the faces were seen in negative contexts, P300 was greater for White faces than Black. In a follow-up experiment, explicit measures of prejudice were included in order to test their relationship with ERPs responses at different time points. Participants completed the Modern Racism Scale (MRS; McConahay, Hardee, & Batts, 1981) and gave information on previous contacts with Blacks. N170 turned out to be sensitive to the processing of faces, without being modulated by the valence or race of the stimuli. Although race did not modulate the N170, the effects of race show that a deeper processing of in-group stimuli was made slightly evident later in N200. At this stage the difference in responses to Whites compared to Blacks did not vary as a function of MRS or previous contact, but even later ERP responses were associated to the explicit measures, approximately at 500 ms.

Chiu, Ambady & Delvin (2004) examined the emotional responses of White participants (aged 18–29) toward racial targets. Participants were set in groups of a great majority of Caucasian and only one Asian-American individual in each group. Participants were previously classified as high or low levels of explicit and implicit prejudice, as measured by means of the MRS and the Implicit Association Test (IAT; Greenwald, et al, 1998), respectively. A warning stimulus, for example "+ b" (+ = positive; – = negative; b = Black; w = White), was introduced before the exhibition of the target stimulus, which was a face (angry-Black, happy-White). Then participants had to make an evaluative judgment of the face (unpleasant, pleasant). Researchers registered behavioral responses and the contingent negative variation (CNV, see ERP section). In the experiment participants with high and low levels of prejudice exhibited differences in CNV responses to emotional in- and out-group stimuli. The analysis revealed that early CNV is enhanced by individuals with low levels of prejudice before angry Black faces, compared to White happy or Black happy faces. Similar comparisons among individuals with high levels of prejudice showed greater amplitude of the early CNV in anticipation of happy White faces compared to angry Black faces. These effects were not found in delayed CNV.

These results imply that prejudice and its associated behavior can depend on the in- or out-group position of the participant in relation to the target stimulus, as well as on the valence of the target. The early CNV component seems to reflect the anticipation effort, which makes it sensitive to prejudice. The data also indicates that emotional facial expressions affect behavioral and physiological responses to faces with overt racial characteristics. The large CNV component present in subjects with low prejudice in anticipation to making evaluative responses of angry Black faces is consistent with prejudice theories that propose that these individuals monitor automatic reactions to negative stereotypes, elicited by stimuli corresponding to out-groups (Bodenhausen & Macrae, 1998; Plant & Devine, 1998; Monteith, 1993; Devine, 1989). In this sense, data speaks against theories suggesting that individuals with low levels of prejudice would not activate stereotypes (Lepore & Brown, 1997).

On the basis of these studies we cannot assert a simple correspondence between these components such as the early CNV and prejudice. Evidence suggests, on the contrary, that at early stages of prejudice behavior, the physiological change is a not predictor of prejudice in itself but, as depicted by our Idea 2, a physiological aspect of a wider and more complex process that involves the integration of information of different kinds (emotional, group membership, etc.). The description of such sub-processes implies analyses at different levels (Idea 1), specifically the interaction between perceptual and emotional processes, on the one hand, and group membership or social position, on the other. This speaks toward the complementary approaches and eventual co-construction of social neurosciences and social sciences in understanding prejudice.

Cognitive Control in the Inhibition of Automatic Stereotypes

Several models have been proposed in social psychology on the regulation of automatic tendencies of racial bias. These, postulate descriptions about mechanisms of stereotype inhibition and response control, but assuming that regulation processes become active only after the conscious perception of a self bias (Blair & Banaji, 1996; Bodenhausen & Macrae, 1998; Dunton & Fazio, 1997; Lepore & Brown, 2002; Petty & Briñol, 2006; Plant & Devine, 1998; Wegener & Petty, 1995; 1997; Wegener, Petty & Dunn, 1998; Wegner & Bargh, 1998). Botvinick, Braver, Barch, Carter & Cohen (2001) propose a cognitive control model that postulates the existence of two neuro-cognitive systems that work together to regulate responses. The first one is a conflict-monitoring system, which monitors ongoing responses for conflicts between alternative tendencies of response. This system is constantly activated, requires few cognitive resources and operates below conscious awareness. It has been associated with the neuronal activity in the anterior cingulate cortex (ACC, hereafter) in research with fMRI and ERP (Carter, Braver, Barch, Noll, & Cohen, 1998). When a conflict is detected, a second system is activated, that is, a resource-dependent regulatory system which activates new processing in response to the prevailing intentioned action on the conflicting tendency. In research with fMRI this has been associated with neuronal activity in the prefrontal cortex (Carter et al., 1998).

These studies have demonstrated that ACC increases when dominant responses are opposed to the conscious response intention, as observed in Stroop tasks. Previous research using ERP related to both systems associated to behavior regulation indicate that conflict detection during the regulation of successful behavior is associated to N200 (Nieuwenhuis, Yeung, Van Den Wildenberg & Ridderinkhof, 2003). Consistently, the source of N200 modulation compromises the ACC and other areas of prefrontal cortex (Nieuwenhuis et al., 2003).

In a reaction times study, Bartholow, Pearson, Gratton & Fabiani (2003) requested participants (21 female and 18 male, aged 21–30) to consume moderate doses of alcohol, besides giving them a placebo just before they gave their perceptions on people. This study showed that alcohol disinhibited social bias evaluations, since alcohol reduces the control of the executive function (Macrae, Bodenhausen & Schloerscheidt, 1999).

Bartholow et al. (2006) designed another study in which the participants (48 Whites, 24 male, aged 21–30) had to consume placebo or alcohol, and then had to respond in a Go-Stop paradigm to words with different implications as soon as White faces and Black were displayed. It was found that alcohol does not influence the activation of stereotype, but it does influence the capability to regulate responses related to preponderant stereotypes by means of cognitive control deterioration. Differences in N2 and negative slow wave (NSW) where observed between go and stop trials, suggesting that ERPs can provide a sensitive and implicit measurement of stereotype activation independent from the processes of preparation and execution. The results of the P300 amplitude as well as their latency provide a measurement of the activation of stereotype. The inhibition of consistent responses with stereotype is reflected in the NSW amplitude. These results are consistent with previous studies that suggest that alcohol does not interrupt the relatively automatic aspects of the person's perception process and that their effects are limited to working memory.

In another double study, (Study 1: 24 female and 16 male, one of the male participants was Latino; Study 2: 33 female and 11 male, one of the male participants was Latino and one female was Asian) Correll, Park, Judd & Wittenbrink (2002) created a simulation in which participants observed photos of White and Black men, which they had to shoot or not, depending on whether they were armed or held innocuous objects (folders, cellular telephones). The results consistently demonstrated a bias to shoot Black men with guns quicker than White men. Similar results have been found in other studies (Greenwald, Oakes & Hoffman, 2003). For example, Correll, Urland & Ito (2006) directed a study in forty right-handed students (24 males) from the University of Colorado participated for class credit. Thirty one identified their race as White (19 males), 5 as Asian (1 male), 2 as Hispanic (2 males), and one each as Black (male) and Arabic (male), and developed a videogame related to shooting (Correll et al., 2002) using photos of Whites and Blacks. Results were similar to the previous study with respect to shooting bias and speed. N200 was associated with monitoring conflict during the successful regulation of behavior and was greater for Whites than for Blacks. At the same time, more errors were made in shooting unarmed Blacks than Whites.

These errors were measured through error-related negativity (ERN, see ERP section), a component sensitive to conflict monitoring following erroneous behavioral selections (when a participant shot at unarmed people or did not shoot at armed subjects). The ERN component reflects conflict in ACC (Yeung, Botvinick, & Cohen, 2004). According to this, in a Correll et al. (2002) study, race also moderated the effect on this component. Specifically when participants committed errors by "not shooting" armed subjects, ERNs were greater for armed Blacks than for Whites. In contrast, ERNs were equally high following erroneous shootings of Whites as for unarmed Blacks.

Amodio, Harmon-Jones, Devine, Curtin, Hartley & Corvet, (2004) examined the hypothesis that non-deliberate racial bias can happen in spite of the activation of neuronal systems that detect the need for control. For this purpose they used the Weapon Identification Task (WIT hereafter; Payne, 2001), a sequential priming task designed to obtain assess conflict among stereotype-related responses. In each trial a White or Black face, followed by an image of a hand tool or a handgun are exhibited during 200 ms and then masked. The participants ($N = 48$, all White females) had to quickly categorize each target as a weapon or tool. This task was designed to provide independent measures of automatic processing (i.e. responses based on stereotypes) versus controlled processing (i.e. responses based on accuracy; Payne, 2001). A limited response time was added to the task (under 500 ms) for the participants, making the implicit association of Black faces to weapons happen more frequently. In addition, it was pointed out to participants that the erroneous election of a weapon, associated to a Black face, indicated a racial prejudice, since it represented an unsuitable application of Black race stereotypes. This means that in order to correctly categorize the tool in the context of a Black face, control on the automatic tendency of implicit association is required. The results demonstrated an automatic association between Black faces and weapons. The associations between Black faces and tools showed greater latencies, suggesting that participants adopted an answer-control strategy so as to avoid errors leading to racial prejudice. Greater ERN in errors was observed, suggesting conflict detection when the tendency to respond entailed a racial bias. The responses indicating racial bias occur, although control mechanisms detecting such bias are activated. Racial bias happens in fast response tasks and in presence of insufficient availability of processing resources.

Research by Amodio et al. (2004) suggests that individual differences in the ability to control behavior can be explained by differences in conflict monitoring. ERN had greater amplitude in Black face-tool trials, where the automatic stereotypes generated high conflict responses, corroborating the hypothesis that the necessity to control stereotypes triggers activity in the neuronal system for conflict monitoring. The correlations between ERN amplitude and response control were examined. ERN of greater amplitude was also associated to high levels of control as well to post-error response latency and accuracy (Amodio, Devine & Harmon-Jones, 2007).

At the beginning of this section we indicated different social cognition models, developed within social psychology, that assume that regulation processes (control, inhibition) activate after the conscious awareness of one's bias, mostly following Devine (1989) & Fazio (1990), as in Wegener & Petty (1995) correction model. The results here discussed suggest that inhibition or control may activate from before and eve independently of conscious effort. The neuroscience approach may be useful in studying he the role played by early neuropsychological changes in control processes.

DISCUSSION

Three ideas have guided our selective review. First, the idea of the interdisciplinary: Social, psychological, and biological approaches to prejudice may benefit from an multi-level account. Second, the notion of complexity: Prejudice is a complex kind of behavior, involving sub-processes at different description levels of one and the same process. Thirdly, the idea of the dynamic: ERP research may contribute to understanding the early phases of the temporal course of prejudice behavior. This last idea has been the main focus. We have argued that multiple basic processes related to prejudice involve early brain activity. At the same time, we have emphasized that processing type and speed are context-dependent: The electrical signal will be modulated by stimuli valence, task and presentation format. More complex stimuli that are evaluated in relation to prejudice will involve slower processing. The activation of stereotypes and other evaluative knowledge structures presents a large amount of electrophysiological correlates, which allow us to distinguish between different processing levels (explicit, implicit), and to account for stimuli and individual differences. Research reviewed show that there is a dynamic temporal relationship between explicit and implicit manifestations, and evidence exists of interaction between them through multiple studies of control and conscious inhibition of automatic reactions.

Although the development of electrophysiological research on prejudice is extremely recent and emergent, the intention of this literature revision is to evaluate the potential of a multi-level approach for a better conceptualization of prejudice. The conclusion seems to be highly positive, although there are limitations because this approach is still in its infancy. Two argumentative lines endorse this optimism. On the one hand, there is the development of a multi-leveled language and co-construction of theories. The reviewed studies show the development of a lexicon that refers to cerebral processes as well as to cultural phenomena with the purpose of clarifying the nature of prejudice. In particular, behavioral science cannot currently give a good answer as to why some social automaticities are highly accurate while others are systematically inaccurate. Social cognitive neuroscience may be better positioned to investigate this (Lieberman, 2000; 2005). A successful social cognitive neuroscience should thoroughly integrate the methods of social cognition and cognitive neuroscience, and also rely in equal parts on the conceptual lexica of these two parent disciplines as well. Additionally, the co-construction of theories becomes evident in the use of classic social psychology methods in the context of experimental electrophysiology. Also, theories and explanatory models of one area are re-interpreted in another area, producing the co-development of interlevel explanations.

On the other hand, the expansion of unsettled questions and specific contributions developed from a multi-level approach. The study of ERPs in the area of social psychology seems to provide new insights, particularly, a more dynamic vision of prejudice; the reconsideration of the relationship between automatic activation and inhibition and control processes; and an emphasis on temporal processing. In the following we focus on these aspects in order to discuss the contribution of social neuroscience to the development of a multi-level, dynamic, and context-sensitive approach to prejudice. Finally, we argue that a dynamic framework for theorizing the psychological occurrence of intergroup attitudes in line with these insights is possible. In particular, and to illustrate this point, we now discuss how the analysis of process timing can help us go beyond the simple implicit/explicit dichotomy.

One of the main advantages of ERP approaches consists in the possibility of making very accurate time measurements for phenomena that take part in the psychological occurrence of prejudice, with much more precision than reaction times which are more indirect and therefore subject to greater variance. A clear benefit consists in being able to evaluate the time course for different processes that are imposed on a task, considering the qualitative differences in processing timings. A simple heuristic is that implicit aspects are processed earlier and later the explicit ones. Nevertheless, the possibility of observing the *temporal overlap* of electrophysiological correlates of the implicit and explicit manifestations gives a more dynamic and enriched image of attitude occurrence. With respect to processes timing, it is important to point out that it does not only depend on whether the manifestation of prejudice is explicit or implicit, but also on the type of stimuli that is used. Stimuli with emotional implications are processed quicker than racial features. In cases in which complex stimuli with emotional valence and racial information take part, it is possible to study the interaction between both, observing possible reinforcement or mutual inhibition. Therefore an important insight is that the timing of implicit or explicit indicators does not only depend on the intrinsic process (automatic or attitudinal) but also on the type of stimuli processing, connected in a dynamic interplay of serial and parallel processing.

Another factor that influences the dynamics of implicit and explicit prejudice, in spite of being a partially different conceptualization, is the interplay between the processes that are automatically activated and their latter control or inhibition. Not only different particular factors (stimulus type, situation, etc.) influence the manifestation of prejudice, but also the form in which these are activated and controlled. Multiple ERP studies have found that different bias manifestations with similar stimuli can occur due to a particular interaction between mechanisms of automatic activation and control. This certainly entails a contextual consideration on the stimulus type and its timing, *in conjunction* with social situations, moral norms and the degree of required cognitive control in each situation. Based on the preponderance degree of automatic processes and their early and delayed control, different prejudice manifestations should be observed.

In this sense, although a heuristic distinction is useful in certain paradigms, it is likely that a combination of automatic and controlled processes coexists within each attitude occurence. This encourages the development of a dynamic and contextual perspective of different manifestations of prejudice. Additionally, attitudes are an emergent phenomenon of multiple contextual sub-processes, affected by familiarity, emotion type, external control processes, etc. These more basic sub-processes have not been classically understood as prejudice, but they could play an important role at the time of its psychological manifestation.

Current social cognitive theories on attitudes propose, in the main, that two groups of processes/systems underlie the evaluation (see Strack & Deutsch, 2004). One system operates relatively automatically and without effort and the other needs more cognitive attention. This last system, which requires more effort, would play a corrective role in attitudinal processing when updating or modifying an initial response or an unsuitable or non-optimal syndicated judgment, given the concurrent motivational and situational restrictions. Following this line of thought, the dominant attitude models have suggested that attitudes reflect dissociated representations of the memory (Gawronski & Bodenhausen, 2006; Wilson, Lindsey & Schooler, 2000; Smith & DeCoster, 2000). That is to say, automatic processes activate implicit attitudes, and controlled processes activate explicit attitudes. The analysis presented in this text suggests that to think that attitudes have implicit and explicit components, is useful as a heuristic, but attitudes probably cannot be separated in a simple implicit–explicit dichotomy (Cunningham & Johnson, 2007). These have shown themselves to be not totally dichotomic and seem not to operate in an all or nothing mode. Explicit (or implicit) evaluations can call upon different processes and cerebral systems. Furthermore, these processes begin to interact or become integrated through the processing stream. For example, as the time between the beginning of the evaluation process and the measured answer increases, it is possible that additional component processes become involved, giving way to a much richer and elaborated attitude (Cunningham & Johnson, 2007), resulting in not totally separated, but relatively independent systems according to the context. When saying that the processes are automatic or controlled, we do not speak of absolute categories, but of relative terms that serve as shortcuts to point out differences in nature, quantity or complexity of the cognitive operations involved in the activity (Johnson & Reeder, 1997).

Toward a Dynamic Framework Concerning Intergroup Attitudes

As the result of multiple affective and cognitive processes recruited and/or adjusted in order to answer to situational and motivational restrictions, attitudes should not be considered as representations directly recovered from memory (Fazio, 1995; 2001). Schwarz's (2007) notion that attitudes are dynamically constructed within specific contexts (i.e., situational, cognitive, and motivational) is much more consistent with the insights gained from ERP studies.

In our view, this more dynamic and context-dependent approach does not mean that we should abandon the psychological level of description and replace it by the language game of neuroscience. On the contrary, it means that a more dynamic and context-dependent process model of the psychological level of description of prejudice must be developed actively taking into account the explanatory potentials from both neural and social levels of description of prejudice. Despite the specific claims about social neuroscience that we make here, the proposal of a more dynamic and context-dependent framework is in line with an approach that has conquered popularity among social psychologists. Namely, the notion that attitudes are temporary constructions (Tesser, 1978; Wilson & Hodges, 1992; Schwarz, 2007). For instance, Wilson and Hodges (1992) argue that attitude construction is the inference of one's own evaluation of a given object on the basis of a large database. This database includes one's behavior, mood, and multiple beliefs about the attitude object. However, people usually draw on a restricted subset or sample of this database. These researchers add that the social context has an influence on the selection of data people use. This last proposition helps explain why attitudes vary with the context of their expression.

A related approach to attitude and judgment states that mood and emotions have an informative function (Schwarz & Clore, 1983; 1988; 1996; Clore, Gasper, & Garin, 2001). Affective states can influence evaluative judgments by serving as a source of information in judgment. Clore, Gasper, & Garin propose that the core of the affect-as-information approach can be summarized in terms of the following principle: "When one is object focused, affective reactions may be experienced as liking or disliking, leading to higher or lower evaluation of that object of judgment" (2001, p. 129). Research in this line is particularly relevant to the notion that, in the context of collective memory, to take a position toward a given piece of knowledge is, as suggested here, a truth-judgment based on affective information. However, the affect-as-information view emphasizes only one of the ways in which affective information can influence judgment, namely, by means of attributing the positive or negative affect to the very object under judgment (Schwarz, 1990). When participants are primed with a given affective state so as to avoid their awareness of the source of such state, they are assumed to misattribute their feelings to target stimuli, thus producing an affective priming effect. Winkielman, Zajonc & Schwarz (1997) have shown that the affective priming effect is produced even if participants are told about the subliminal primes, thus suggesting that the influence of affective information may be independent of the attributional process. Such a direct influence has been described, for instance, by Zajonc (1968), who has shown that—other things being equal—the more familiar an object, the more positive the attitude toward it.

Indeed, the information that is integrated into an attitudinal response can also be derived from the very social stimuli under evaluation. For instance, according to the expectancy-value model of attitude formation (see Feather, 1982; Fishbein, 1963; Fishbein & Ajzen, 1975), the evaluative meaning of a given object arises spontaneously from beliefs about the object (see Ajzen & Fishbein, 2000). According to this framework, an individual's overall attitude toward an object is determined by the subjective values of the object's attributes associated with the object, in interaction with the strength of these associations. The overall evaluation of an object draws on other social information as well. In particular, information coming from the construction of a mental model of the intergroup context is necessary for attitude construction. For instance, information about the appropriate social norm may be important in the construction of an attitude.

In this line, we propose a general framework for intergroup attitudes that comprises the following set of *psychological* processes as may occur in time while people construe an attitude judgement: (1) initial information about a social category is automatically generated from conventional knowledge about relevant social groups, as a function of frequency and recency of use; (2) evaluative implications of this initial information may serve as the main guide in producing an attitude judgment if there is no time and/or effort left; otherwise (3) initial stereotypical information is examined more deeply and/or (4) personal and social norms regarding the social category are generated as a function of ego- and group-defense motives, in either a relatively automatic or controlled way, informing the judge about his own interests and about social demands; (5) stereotypical information is then compared, in either a relatively automatic or controlled way, with personal and social norms that happen to have high personal importance in the given situation; (6) if stereotypical information is consistent with such norms, or if generated norms happen to have low personal importance in the given situation, then an attitude judgement is constructed in line with the stereotypical information that functions as an anchor of judgement; but if it is consciously or unconsciously detected as inconsistent with highly important norms, then an attitude judgment is produced in contrast to such an anchor. Thus, assimilation toward the anchoring stereotypical information is the predicted pattern to be observed using indirect measures of attitude. We propose that direct measures allow judges to engage in motivated correction processes, in either a relatively automatic or controlled way, in order to fulfill relevant ego- and group-justification motives.

Some Epistemological Implications

The contribution of electrophysiological and multi-leveled studies, allows us to advance toward a dynamic conception of prejudice, in which many basic dynamically formed processes, according to different situations, take part. The study of those basic processes, not in isolation, but rather in interaction from different contextual situations, simultaneously constitutes a challenge and a promise for a more ecological and suitable conceptualization of prejudice with all the wealth of its manifestations. The same may be said for intervention strategies. A block or unitary strategy must not be proposed. On the contrary, before any application of a theoretical model on prejudice, the most elementary factors of each situation must be studied in detail (i.e., culture automatic influences, degrees of explicit and implicit dissociation in the particular situation under study and other contextual factors not directly understood as prejudice that can affect it). In synthesis, prejudice begins to be understood as a dynamic, multi-factorial, contextual phenomenon, with different processing levels within a multidimensional space (automatically-controlled, unconsciously-conscious, positive-negative affection, etc.). As such, it would not be a unitary phenomenon that happens identically in each case, and therefore it does not make any sense either to try a unique or general explanation of the manifestation of prejudice.

We have introduced the contributions resulting from the interaction between social psychology and ERPs studies in response to the complex phenomenon of prejudice, particularly its dynamic manifestation by means of explicit and implicit measures. A pluralist orientation, based on social neuroscience and multi-level analysis, should not seek to become a universal language, but rather a possibility, offering better solutions to those presented by one-dimensional approaches (de Jong, 2001). It would imply, on the one hand, the development of more and better theorization in neuroscience about cultural phenomena and, on the other, an opening to the influence of molecular phenomena in the manifestation of molar psychological phenomena (Cosmelli & Ibañez, 2008; Ibañez & Cosmelli, 2008).

Brain and culture do not seem to be divided in the same way that our departments of psychology and neuroscience are, with intra-disciplinary forces that separate the different processes. The social neuroscience perspective intrinsically implies cognition, emotion, social interaction, motivation, and involves the constraint for a multi-disciplinary approach to complex cultural phenomena (Todorov et al., 2006). Thus, the combination of psychological, social and neuroscience techniques and perspectives constitutes an ideal form of approach to prejudice. In this paper we have explored how this is possible within contemporary social psychological research.

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