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Psychophysiological Assessment of Prejudice: Past Research, Current Status, and Future Directions

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Many early studies of prejudice adopted psychophysiological measures as a way to circumvent the limitations of self-report instruments. Despite serious methodological weaknesses, that literature consistently points to the value of physiological probes as nonreactive indexes of affective responses to target stimuli. Possible reasons for the virtual abandonment of psychophysiological approaches in the study of prejudice over the last 15 years are outlined, and their reintroduction is advocated on methodological and conceptual grounds. Theoretical perspectives and empirical research in a closely related area, the psychophysiology of emotion, are reviewed and the implications of this literature for the study of prejudice are discussed. Several psychophysiological approaches have been found valuable for assessing the valence and intensity of emotional responses. The availability of these tools, together with the shifting theoretical zeitgeist, make prejudice research ready for a return to psychophysiological methodologies. A multimethod prejudice assessment model is proposed and its theoretical and heuristic advantages are discussed.

Stimulated by Thurstone's (1928) seminal work, the scientific study of attitudes has occupied social psychologists and other social scientists for the last 70 years. In his 1928 paper, Thurstone articulated a methodology for the scaling of attitudes, but also addressed important definitional and measurement issues that are still debated today. He described an *attitude* as "a subjective and personal affair" that includes feelings, thoughts, and actions. In the same landmark paper, Thurstone acknowledged that, although *opinions* (defined as verbal expressions of attitudes) are convenient indexes that can be used in the construction of attitude scales, the validity of these self-report measures may be threatened by deception or by social desirability concerns.

Notwithstanding some recent authoritative dissenting statements (Cacioppo, Petty, & Geen, 1989; Zanna & Rempel, 1988), the tripartite conceptualization of attitudes remains generally accepted in social psychology. Throughout the history of attitude research, the relative importance attached to one or the other of the three components has fluctuated with the prevailing theoretical zeitgeist. Attitude theories of the 1950s and 1960s accorded a preeminent, if not exclusive, role to the affective dimension. Still in 1970, in his review of physiological measures of attitude, Mueller unambiguously asserted that "affect is the major (if not the only) dimension of all attitudes" (p. 547). During the 20 years that followed, the pendulum swung in the cognitive direction, and social cognition research dominated the study of intergroup processes (Hamilton & Mackie, 1993). The recent past, however, has witnessed renewed interest in the investigation of emotion as a key ingredient of social attitudes.

Regardless of which particular attitude component is emphasized, there is general agreement that self-report measures, despite their widespread use, are vulnerable to selective distortion by self-presentational biases and other response sets, especially when it would be socially embarrassing or morally reprehensible to endorse unsavory thoughts, feelings, and actions about a particular attitude object. The need to develop indirect attitude measures that would escape the individual's censoring efforts was recognized long ago, and research on these unobtrusive measures has been periodically reviewed (e.g., Cacioppo, Petty, Losch, & Crites, 1994; Campbell, 1950; Cook & Selltiz, 1964; Crosby, Bromley, & Saxe, 1980; Himmelfarb, 1993; Kidder & Campbell, 1970; Livneh & Antonak, 1994; Mueller, 1970, 1986; Ostrom, Bond, Krosnick, & Sedikides, 1994; Petty &

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Cacioppo, 1981, 1983). Examples of indirect attitude measures include projective tests (e.g., the Thematic Apperception Test [TAT]), the information error test, the bogus pipeline method, behavioral indicators (e.g., the lost letter technique, the wrong number technique, paralinguistic cues, bodily cues), psychophysiological indexes and, most recently, priming procedures and implicit association tests.

Prejudice is clearly a type of attitude that is especially susceptible to the measurement biases associated with direct self-report procedures. Although there is still some debate about the relative importance of evaluation, affect, cognition, and action in defining the fundamental structure of attitudes (Olson & Zanna, 1993), prejudice is essentially defined in terms of the evaluative-affective dimension (Hilton & von Hippel, 1996; Mackie & Smith, 1998). Unfavorable judgments about a group and negative emotional reactions to it (*prejudice*) are supported by a particular belief structure (*stereotype*) and could result in adverse social action (*discrimination*). Social desirability concerns, however, may lead people to censor their prejudiced attitudes. As a result, between the mid-1950s and the late 1970s, a number of prejudice studies turned to psychophysiological indexes of emotion as an alternative to direct self-report measures. The guiding assumption was that by gaining access into people's emotional responses, which are presumably more resistant to voluntary suppression or distortion, we would have a more valid indicator of their prejudiced attitudes.

To this author's knowledge, that literature has not been comprehensively evaluated and the reasons for the striking loss of interest, during the years that followed, in psychophysiological investigations of prejudice remain somewhat elusive. Following a review of specific empirical contributions to the psychophysiology of prejudice literature and an assessment of its current status, I will discuss the methodological and theoretical value of psychophysiological methods in the study of prejudice. I will then broaden the focus and examine current theoretical perspectives and significant developments in the related literature on the psychophysiology of emotion. I will conclude this article with an analysis of the implications of emotion research for the psychophysiological study of prejudice, together with recommendations for future investigations.

Review of Psychophysiological Studies of Prejudice

Search Strategy and Overview of the Literature

Comprehensive searches of PsycLIT (American Psychological Association, 1974–1998) and MEDLINE (National Library of Medicine, 1965–1998), using a large number of keywords, including authors' names, produced a very poor yield, as most of the literature on this topic was published before the time span covered by those databases. The majority of the studies to be reviewed was located through an exhaustive search of *Psychological Abstracts* (American Psychological Association, 1927–1974) and especially through diligent inspection of the references section of already available papers. This search unearthed 30[1] published prejudice studies in which physiological measures were used to assess the intensity of emotional reactions to outgroup members.[2]

In the typical study, the physiological responses of undergraduate participants to prejudice targets (Black or disabled confederates, pictures of or statements about outgroup members) were assessed against control conditions. Some studies used an extreme groups design, whereby participants were selected on the basis of their very high or very low scores on some self-report prejudice measure administered before the experimental data were collected; the physiological responses of high- and low-prejudice groups to the attitude object were then compared. Preexperimental attitude assessment was frequently used, even in the absence of the extreme groups design, so that scores on the paper-and-pencil measure could be correlated with physiological indexes. To give the reader a flavor for this area of research, the earliest and the latest studies will be reviewed in some detail.

Rankin and Campbell (1955) measured the galvanic skin response (GSR) in a sample of 40 White male undergraduates who were told that they were participating in a word association study and that reaction time was the variable of interest. During the session, a Black male confederate and a White male confederate, twice each and in counterbalanced order, came into the room allegedly to make manual adjustments to the electrodes. During these adjustments, which actually provided an opportunity for the confederates to make physical contact with the participants, the confederates fiddled with dummy electrodes attached to the left hand of the participants, while the live GSR signal was recorded from the right hand. The hypothesis under investigation was that physical contact by the Black confederate would elicit a larger GSR than physical contact by the White confed-

[1] Multiple experiments within the same published report were counted as separate studies. Three reports on the same sample were excluded as they failed to meet minimum standards of scientific acceptability.

[2] The original plan to conduct a meta-analysis was frustrated by the realization that this literature does not appear to be a good candidate for a quantitative review. Psychophysiological studies of prejudice are extremely heterogeneous with respect to methods, measures, experimental manipulations, and overall quality. Furthermore, essential information needed to estimate effect sizes is too often missing and is irretrievable because of the age of this literature.

erate. Indeed, a highly significant race effect was found in the expected direction. A significant main effect was also found for contact, indicating that adaptation of the GSR had occurred over the four contact periods. Finally, significant correlations were found between GSR scores and two racial attitude measures.

More than 40 years later, Vanman, Paul, Ito, and Miller (1997) conducted a series of three experiments in which psychophysiological indexes (i.e., facial electromyography [EMG] and heart rate), as well as self-report affective measures (e.g., friendliness ratings) were used to assess White participants' responses to racial stimuli. In the first two experiments, participants underwent multiple trials during each of which they were presented with a slide of a target (a photograph of a Black or White student) followed by a written scenario that depicted the participant in cooperative interaction with the target. After reading the scenario on a computer screen, participants were asked to imagine working cooperatively with the target as described in the scenario. In addition to partner's race, the type of reward earned (joint or individual) and partner's deficiency on the task were also manipulated in Experiment 1 and in Experiment 2, respectively. In the third experiment, participants were divided into a high-prejudice group and a low-prejudice group on the basis of their scores on the Modern Racism Scale (McConahay, Hardee, & Batts, 1981). Participants were then asked to view a set of 36 slides, half of which featured a Black student and the remaining half a White student. Immediately after viewing each photograph, participants were asked to rate the perceived friendliness of the target. Consistently across the three experiments, self-report measures indicated more positive evaluations of the Black targets than of the White targets. At the same time, facial EMG activity showed evidence of more negative affect toward the Black targets, especially (in Experiment 3) among the high-prejudice group.

Twenty-one of the 30 studies focused on racial prejudice (see Table 1), whereas the remaining 9 dealt with prejudice against disabled people (see Table 2); 2 of these 9 studies also assessed attitudes toward homosexuality. In 29 of the 30 studies, responses controlled by the autonomic nervous system (ANS) were recorded.[3] At least in part, this virtually exclusive interest in autonomic reactivity may be attributable to the lasting influence of William James's theory that defined emotion as the perception of visceral changes (James, 1894). Whether this is an accurate exegesis of James's writings is an interesting issue that is, however, beyond the scope of this article (see Ellsworth, 1994, and Reisenzein, Meyer, & Schützwohl, 1995, for two contrasting views). Certainly, a second reason for the focus on ANS physiology in prejudice research lies in the involuntary nature of those biological events. It has been assumed that, in the presence of appropriate eliciting stimuli, sympathetic nervous system arousal exposes one's affective reactions to such stimuli, even in cases when the individual is unwilling or unable to verbally report those emotional states. The additional assumption that the magnitude of the physiological response tracks the intensity of the emotional experience (Cook & Selltiz, 1964; McCurdy, 1950) would seem to make ANS reactivity a powerful tool in the study of prejudice.

Of the 30 studies, 17 measured electrodermal activity (skin resistance, impedance, or conductance) either exclusively or in addition to other physiological responses (i.e., heart rate, peripheral skin temperature, respiration, and finger pulse volume). One racial prejudice study recorded facial EMG activity as well as heart rate. Three studies of racial prejudice used the pupillary response as the physiological dependent measure. Three other racial prejudice studies adopted a clever Pavlovian experimental paradigm based on semantic conditioning and generalization of the conditioned skin conductance response. In 2 studies of racial prejudice and in 2 disability studies, all by the same investigator, voice stress scores were used as the dependent variable.

Tables 1 and 2 provide details about participants, designs, measures, and significant findings for each of the 30 studies reviewed. The next sections present a general analysis of this literature, with particular reference to methodological issues, patterns of results, and overall assessment of its status.

Methodological Problems

The literature reviewed is characterized by a number of significant pervasive shortcomings. The published reports often fail to include important information, such as details needed to evaluate the adequacy of the design and analyses, length of baseline periods, gender and race composition of the sample, steps taken (if any) to make participants unaware of the research hypothesis or to randomly assign them to conditions, and results of significance testing. It should be noted at the outset that it seems rather unfair to judge this literature, typically published in the 1950s and

[3] In four prejudice studies included in this review, the Psychological Stress Evaluator (PSE; Dektor Counterintelligence and Security, 1974) was used to analyze the effects of emotional arousal on the acoustic waveform produced by vocalization. Both autonomic and somatic mechanisms are believed to be involved in the production of emotion-induced vocal changes. The psychophysiological determinants of vocal indicators of emotional arousal and their use in the assessment of affective states were thoroughly reviewed by Scherer (1989) and by Pittam and Scherer (1993). Used primarily in law enforcement, the PSE has attracted little interest in psychology, probably because its reliability and validity are rather suspect (Brenner, Branscomb, & Schwartz, 1979; Fuller, 1984; Podlesny & Raskin, 1977).

Table 1. *Studies of Racial Prejudice*

Study	Participants	Dependent Measures	Design and Procedure	Results
Rankin & Campbell (1955)	40 White, M undergraduates	• Pre-experiment direct racial attitude scale • Pre-experiment indirect racial attitude measure (information test) • GSR	• Race of E and of A manipulated in a within-subject design • Twice each, A and E (always of different race) adjusted dummy electrodes	• Larger GSRs to Black E/A • Evidence for GSR adaptation over 4 contacts • Significant correlation between GSR and direct attitude measure
Cooper & Singer (1956)	20 undergraduates (gender and race not indicated)	• Pre-experiment ratings and rankings of 20 national–ethnic groups (extreme scorers chosen for GSR study) • GSR	4 statements read to each P: 1. Derogatory of most liked group 2. Complimentary of least liked group 3. Derogatory of intermediately ranked group 4. Complimentary of intermediately ranked group	• Larger GSRs to both Statements 1 and 2, compared to 3 and 4 • Statement 2 yielded the largest GSRs
Cooper & Siegel (1956)	23 undergraduates (gender and race not indicated)	Replication of Cooper & Singer (1956), except that selection of Ps was based only on extreme ratings and rankings of least liked group	Same as above, except that GSR elicited by complimentary statement of disliked group was compared to GSR elicited by complimentary and derogatory statements of intermediately ranked groups	Replicated above findings
Cooper & Pollock (1959)	53 undergraduates ("divided approximately evenly as to sex; race not indicated," p. 124)	• GSR • Post-experiment rankings of 9 national–ethnic groups	• Reversed the design of previous 2 studies in order to assess affective valence (not only intensity) • GSRs elicited by complimentary statements about 9 national–ethnic groups were used to predict subsequent rankings of those groups	• General support for the hypothesis • Ranked GSR magnitudes were highly correlated with group rankings
Westie & De Fleur (1959)	46 undergraduates (23 M, 23 F, race not indicated)	• Pre-experiment racial attitude scale; high- and low-prejudice groups formed on the basis of extreme scores (top and bottom 25%) • GSR, FPV, and HR • Post-experiment interview	• 8 slides of dyadic interactions featuring Whites, Blacks, Ms, and Fs (one slide for each possible combination) • 4 slides of individuals (Black M, Black F, White M, White F)	• Slides of dyads: race effects not found; overall, no support for hypothesis • Slides of individuals: FPV results inconsistent with hypothesis, GSR results partially supportive of it • Findings selectively reported
Bernstein (1965)	36 White M	• Basal skin impedance	One group (Group 1) was tested by a White experimenter, another (Group 2) was tested by a Black experimenter	Group 2 exhibited significantly greater physiological arousal compared to Group 1

(Continued)

Table 1. (*Continued*)

Study	Participants	Dependent Measures	Design and Procedure	Results
Vidulich & Krevanick (1966)	40 undergraduates (20 M, 20 F, race not indicated)	• Pre-experiment racial attitude scale; high- and low-prejudice groups (identical in gender composition) formed on the basis of extreme scores • P's preference rating for each stimulus • GSR	18 photographs: • 8 neutral (e.g., landscapes) • 5 critical (i.e., Black–Black or Black–White interactions) • 5 control (i.e., White–White interactions)	• For both high- and low-prejudice groups, critical stimuli elicited greater GSRs than neutral and control stimuli • High-prejudice group and M subsample had larger GSRs than low-prejudice and F subsample
Porier & Lott (1967)	60 White, M undergraduates	• Pre-experiment California E Scale • Pre-experiment Rokeach's Opinionation Scale • GSR	• Replication, with methodological improvements, of Rankin & Campbell (1955) • Word association task with stimuli from an emotional or from a neutral word list • 4 experimental contacts (see Rankin & Campbell, 1955)	• No effect of word list on GSR • No effect of race on GSR • GSR adaptation over 4 contacts • Significant correlation between GSR and Scale E scores
Collins, Ellsworth, & Helmreich (1967)	8 undergraduates (gender and race not indicated)	• Semantic differential ratings (36 adjectives) • PR	Each P viewed 36 verbal and pictorial stimuli covering 4 subject areas: • 11 about miscegenation • 10 about compulsory military service • 11 about dorm hours • 4 abstract art pictures	• For each subject area (but only for pictorial stimuli), PR was correlated with stimulus potency ratings • For any subject area, PR was not correlated with stimulus evaluation
Cooper (1969)	30 undergraduates (10 M, 20 F, race not indicated)	• Pre-experiment paired comparisons of 10 national/ethnic groups; an "affinity" group and an "antipathy" group were formed on the basis of extreme scores • GSR	Each group heard 3 statements: • affinity group: 1. complimentary of preferred group 2. complimentary of neutral group 3. derogatory of neutral group • antipathy group: 1. derogatory of disliked group 2. derogatory of neutral group 3. complimentary of neutral group	• Complimentary statements of preferred group elicited ANS arousal • Mixed and not easily interpretable results
Woodmansee (1970) Study A	22 White, F undergraduates	• Pre-experiment Multifactor Racial Attitude Inventory; sample divided into "prejudiced" and "equalitarian" groups • PR • Liking and interest ratings of test stimuli	• Test stimuli: 5 pictures (4 depicting Blacks in various situations, and 1 racially neutral aversive scene) • Control stimuli: 5 emotionally neutral pictures • Each control-test pair was presented 8 times	• Group differences in PR only on the 1st of 8 presentations • Group differences in liking ratings of test stimuli • No evidence for PR as a bidirectional index of emotion

(Continued)

Table 1. (*Continued*)

Study	Participants	Dependent Measures	Design and Procedure	Results
Woodmansee (1970) Study B	20 undergraduates (10 M, 10 F, race not indicated)	Same as Study A	Generally replicates Study A, except that the number of presentations increased from 8 to 15	• No group differences in PR to test stimuli • General conclusions: PR is elicited by both positive and negative stimuli; PR reflects general ANS arousal and is not a bidirectional index of attitude-related emotion
Tognacci & Cook (1975)	24 White undergraduates (12 M, 12 F)	• Pre-experiment racial attitude scale; high- and low-prejudice groups, formed on the basis of extreme scores, were each subdivided into experimental and control groups • Semantic generalization of conditioned GSR to test stimuli • HR, digital blood flow, and respiration	Classical conditioning procedure given to both experimental groups: (a) US = electric shock (b) CS = nonracial statements previously judged by the P as "bad" (c) test stimuli = pro- and anti-integration statements	• As predicted, the low-prejudice experimental group responded to anti-integration statements • However, the high-prejudice experimental group showed no CR generalization to pro-integration statements • GSR to test stimuli differentiated between the 2 experimental attitude groups • As expected, no differences were found between the 2 control groups; only GSR findings are reported
Tursky, Lodge, Foley, Reeder, & Foley (1976)	24 White undergraduates (12 M, 12 F)	• Semantic generalization of conditioned SCR to test stimuli • P's ratings of degree to which each CS and test stimulus are "Black related" • HR	Classical conditioning procedure: (a) US = loud noise (b) CS = 15 Black-related words (Group 1), or 15 White-related words (Group 2) (c) test stimuli = 10 nonracial social issues	• For both groups, the SCR (conditioned to either "Black-relatedness" or "White-relatedness") generalized to test stimuli perceived as semantically similar to CS • High correlation between rank ordered SCRs and ratings of "Black-relatedness" of test stimuli
Vander Kolk (1977a)	18 White undergraduates (gender not indicated)	PSE scored on the basis of tape-recorded answers	Ps answered "Yes" or "NO" to: • 3 irrelevant (baseline) questions • 8 relevant questions about whether P would be comfortable in situations describing increasing degrees of contact with a hypothetical Black person	• A series of *t* tests found stress to 4 relevant questions (compared to mean of irrelevant questions) • Correlations between level of stress and degree of intimacy not performed • The report is very incomplete
Vander Kolk (1978)	88 undergraduates; 28 Black (15 M, 13 F); 30 Puerto Rican (14 M, 16 F); 30 White (17 M, 13 F)	Same as above	• Same as above, but 9 questions (4 irrelevant, 5 relevant) describing contact with a Black, a Puerto Rican, or a White person • Ps answered relevant questions twice (once for each outgroup) • 4 Independent dyads of raters scored the PSE charts	• Multiple *t* tests indicated that all groups experienced significant stress in each interracial situation • Little correspondence between self-reported discomfort and PSE scores

(Continued)

Table 1. (*Continued*)

Study	Participants	Dependent Measures	Design and Procedure	Results
Tursky, Lodge, & Reeder (1979)	60 White undergraduates (30 M, 30 F, race not indicated)	SCR	Replication of Tursky et al. (1976), except that 10 Black- and 10 White-related words were used as CSs, and 12 social issues were used as test stimuli	Generally replicated findings of Tursky et al. (1976)
Einarsen, Stenmark, & Danielsen (1991)	34 men from a military education institution	• Pre-experiment scale of attitudes toward immigrants embedded in a battery of 7 other personality measures • Post-experiment Modified Osgood Semantic Differential • Behavioral measure: number of questions asked • HR • SCR and SCL	• Ps assigned to an experimental group (N = 23) who interacted with a Black C, or to a control group who interacted with a White C • Timed problem solving task required communication between P and C and included a provocative statement by C	• Compared to control group, the experimental group: — showed greater HR during task relative to baseline — showed similar (but not significant) trends for SCR and SCL — asked fewer questions • For experimental group, significant positive correlations between negative attitudes toward immigrants and self-reported discomfort, inefficiency, and inattentiveness
Vanman, Paul, Ito, & Miller (1997) Experiment 1	27 White undergraduates (14 M, 13 F)	• Ratings of: — liking of partner — happiness in situation — likelihood of success — difficulty imagining situation • Facial EMG from: — corrugator supercilii — zygomaticus major — orbicularis oris • HR	• Ps viewed slides of White or Black partners, then read scenarios describing cooperative work with partners • Reward based on individual or joint performance	• Self-report measures: more positive affect toward Black partner • EMG: more positive affect toward White partner • HR: no significant findings • Both self-report and EMG indicate preference for individual reward structure
Vanman et al. (1997) Experiment 2	37 White undergraduates (18 M, 19 F)	Same as in Experiment 1, except that HR was not recorded	• Partner's race manipulated as above • Scenarios described either self or partner as deficient on task-relevant skills • Scenarios described deficient person as either willing or unwilling to expend extra effort to compensate for deficiency	• Self-report measures: same as above • EMG: same as above • Both self-report and EMG indicate preference for self-deficiency and for willingness to expend effort
Vanman et al. (1997) Experiment 3	25 White undergraduates (10 M, 15 F)	• Pre-experiment Modern Racism Scale; high- and low-prejudice groups formed by median split • Friendliness ratings of targets shown in the slides • EMG: same electrode placement as above	All Ps viewed 36 slides (photographs of 18 Black and 18 White students)	• Self-report measure: Black targets rated as more friendly than White targets • EMG: compared to low-prejudice group, high-prejudice group showed more positive affect toward White targets and more negative affect toward Black targets

Note: M = male; F = female; E = experimenter; A = assistant; P = participant; GSR = Galvanic skin response; FPV = finger pulse volume; HR = heart rate; PR = pupillary response; ANS = autonomic nervous system; US = unconditioned stimulus; CS = conditioned stimulus; CR = conditioned response; SCR = skin conductance response; PSE = psychological stress evaluator; SCL = skin conductance level; C = confederate; EMG = electromyogram.

Table 2. *Studies of Prejudice Against the Disabled and Homosexuals*

Study	Participants	Dependent Measures	Design and Procedure	Results
Kleck, Ono, & Hastorf (1966)	46 M high school juniors	• Total number of questions selected by P • Number of "sensitive" questions selected • Behavioral measures (e.g., length of interview, positive distortion of C's answers) • GSR	2 experimental conditions: Ps interacted with either a DS or an AB confederate	• Participants in DS condition (compared to those in AB): — exhibited greater GSR when C entered the room — took longer to select questions to be asked — demonstrated greater positive distortion of C's answers
Zych & Bolton (1972)	22 M undergraduates	• Pre-experiment Form B of ATDP scale; high- and low-prejudice groups formed on the basis of extreme scores • GSR	All Ps viewed 10 slides: • 2 showing NT • 4 showing DS • 4 showing AB	• No GSR differences between high- and low-prejudice groups in response to AB slides • Greater GSR to DS slides by the high-prejudice group
Marinelli & Kelz (1973)	32 undergraduates (gender not indicated)	• Pre-experiment ATDP scale and DFS–C; extreme scorers on both scales selected for experiment • Taylor's MAS • HR	All Ps interacted with a facially disfigured C	• Ps with negative attitudes toward cosmetic disability (measured by DFS–C) had higher HR and MAS scores than non-prejudiced Ps • No HR or MAS differences between high and low ATDP scorers
Marinelli (1974)	28 undergraduates (gender not indicated)	• HR	Ps were randomly assigned to interact with a C who was: • facially disfigured, or • not disfigured	No group differences in HR, though there was a trend in predicted direction
Vander Kolk (1976a, 1976b)	20 undergraduates (10 M, 10 F)	• PSE scores were based on tape-recorded answers • Ranks of 11 "disabilities"	• Ps verbalized and rank-ordered, in terms of their willingness to acquire them, 11 "disabilities" (which included several physical and mental conditions, but also being Black and HS) • 2 raters scored PSE charts	• 11 *t* tests found increased stress to all "disabilities" • Little correspondence between ranked "disabilities" and levels of stress
Vander Kolk (1977b)	27 graduate students (10 Black or Puerto Rican, 17 Whites; 13 M, 14 F)	• PSE scores were based on taped-recorded answers • Ranks of 6 photographs	• All Ps viewed photographs of 6 different individuals (5 exhibiting disabilities, one minority) and read a descriptive paragraph for each of them • Ps then talked about how comfortable they would be having as a client each of those 6 people • Ps rank-ordered photographs in terms of their comfort level	• 6 *t* tests found increased stress to all test stimuli compared to baseline (stress was greatest for minority picture) • Despite *t* test results, both majority and minority students rated level of comfort highest with the minority client • No gender or racial differences in stress response to the 6 test stimuli

(Continued)

Table 2. (*Continued*)

Study	Participants	Dependent Measures	Design and Procedure	Results
Wesolowski & Deichmann (1980)	40 undergraduates (20 M, 20 F)	• Pre-experiment ATDP, Form O; extreme scorers selected for experiment • SCR • HR	All Ps viewed 12 short videotaped vignettes: • 4 showing NT • 4 showing DS • 4 showing AB people	• High-prejudice group (based on ATDP) had higher SCR and HR in all vignette conditions • Group differences were largest for DS condition • No gender differences
Heinemann, Pellander, Vogelbusch, & Wojtec (1981)	108 German M students	• Ratings of C on 27 traits • Ratings of willingness to have further contact and picture published with C • Behavioral measures of above willingness • Self-rating of emotion • Videotaped P–C interaction scored by naive raters • Nonverbal behaviors (e.g., eye contact, interpersonal distance) • SCR	3 experimental conditions: Ps interacted with a C who was DS, HS, or NM	• Trait ratings: more positive for DS than for HS; no HS–NM differences • Self-rated emotion: more positive for DS than for HS; significant correlation between negative emotion and SCR • Communicated emotion: more positive for NM than for DS or HS • SCR: larger responses to DS and HS than to NM • Mixed findings for the other dependent variables; generally supportive of hypotheses
Gargiulo & Yonker (1983)	48 teachers (3 M, 45 F) formed 4 groups of 12 each: 1. preservice special education 2. preservice regular 3. inservice special education 4. inservice regular	• HR • PST • Following each slide presentation, rating of stress P would experience if she or he were the teacher of person in the slide	12 slides depicting individuals with various disabilities; presentation of each slide was accompanied by a tape-recorded statement identifying the disability	• No group differences on self-report measure • Significant HR differences between preservice and inservice teachers, the more experienced teachers showing lower physiological arousal

Note: M = male; F = female; P = participant; C = confederate; GSR = Galvanic skin response; DS = disabled; AB = able bodied; ATDP = Attitudes Toward Disabled Persons Scale; NT = neutral scenes; DFS–C = disability factor score–cosmetic; MAS = Manifest Anxiety Scale (Taylor, 1953); HR = heart rate; HS = homosexual; PSE = psychological stress evaluator; SCR = skin conductance response; NM = "normal"; PST = peripheral skin temperature.

1960s, by today's standards. Nevertheless, to the extent that our ability to reach conclusions about the value of physiological indexes of prejudice is impacted by significant methodological and analytical problems, and to the extent that this work will be held as a model for future research, those shortcomings need to be pointed out, even in those cases when the authors themselves acknowledged them.

Failure to include appropriate control conditions. This failure makes it impossible to rule out alternative explanations of results. Marinelli and Kelz (1973), for example, found that while interacting with a facially disfigured confederate, participants who held negative attitudes toward cosmetic disability exhibited higher heart rates than their low-prejudice counterparts. Although it is possible that the high-prejudice group was, indeed, responding specifically to the confederate's cosmetic disability, it is equally possible that this group was hyperresponsive to any stimulus. In this study, the inclusion of a control condition (i.e., a nondisfigured confederate) would have made it possible to adjudicate between those rival interpretations.

Poor control of confounding variables. This is a very serious problem that is present even in the most recent racial prejudice study. Vanman et al. (1997) noted that, due to practical considerations, namely the amount of time required to run the sessions, they were unable to use only one experimenter for all the sessions. Instead, either a White male graduate student or a Black female graduate student served as experimenters. If the single experimenter option was not available, it would have been preferable, and certainly feasible, to at least hold the race (and, for that matter, the gender) of the experimenter constant. Failure to control for experimenter's race, in a study of racial prejudice, may hopelessly muddle the interpretation of findings.

Failure to indicate the participants' race or ability or disability status. With respect to race, for example, it would seem reasonable to assume that whether the participants and the targets are of the same or of different races would affect the participants' physiological responses to the targets. Yet, in 9 (43%) of the 21 racial prejudice studies participant race is not reported. Only 3 (30%) of the racial prejudice studies published before 1970 (Bernstein, 1965; Porier & Lott, 1967; Rankin & Campbell, 1955) provide this important information.

Failure to use a standard protocol for all participants. Illustrative of this problem is the pioneering study of Rankin and Campbell (1955) who openly acknowledged it as a serious methodological flaw. For reasons beyond the researchers' control, some of the participants completed the two racial attitude measures before the GSR experiment in an unrelated context, whereas others completed them after the experiment. This unintended manipulation of the experimental protocol was found to have a strong effect on the GSR; participants who filled out the attitude measures before the experiment exhibited significantly lower GSR levels than those accidentally assigned, as it were, to the other "condition" ($p < .001$).

Restriction of range. Several racial prejudice studies used the extreme groups design with undergraduate samples. It may be difficult to find very high levels of prejudice among college students. Vanman et al. (1997, Experiment 3), for example, found evidence for a restricted range of prejudiced attitudes in their undergraduates sample; even the high-prejudice group obtained relatively low scores on the Modern Racism Scale. Poor group separation, of course, would work against the hypothesis by attenuating group differences and could explain some of the mixed results reported in the literature (e.g., the absence of a race effect on GSR in the study by Porier and Lott, 1967).

Selective reporting of findings. In some cases, multiple physiological responses to target stimuli were recorded, but results are reported for only one dependent measure. This provides an incomplete, and possibly misleading, picture of the findings. Westie and De Fleur (1959), for example, recorded the GSR, heart rate, and finger pulse volume from high- and low-prejudice participants exposed to various experimental conditions in which race of the targets was manipulated. The heart rate findings are not reported and the pulse volume results are given for some experimental conditions but not for others. Similarly, in Tognacci and Cook's (1975) investigation of semantic generalization of the conditioned GSR to pro- and anti-integration statements, heart rate, digital blood flow, and respiration were recorded in addition to the GSR, but only the GSR results are described.

Failure to keep participants unaware of the research hypothesis. Although candor is certainly a virtue, full disclosure to research participants, especially when the research deals with racial prejudice, may maximize the undesirable influence of demand characteristics. Even when the physiological measure recorded is beyond the participants' voluntary control, expectancy effects and social desirability concerns are likely to influence the individual's psychological ap-

proach to the task which, in turn, will affect the physiological response. Woodmansee (1970, Study A), for example, fully informed research participants about all critical aspects of the study before the experimental session began. Clearly, postexperimental debriefing would have been a wiser choice, especially considering that, according to the author, many students who participated in this particular study felt strongly about racial issues.

Failure to randomize or counterbalance the order of stimulus presentation. Such failure, of course, makes it impossible to rule out adaptational effects and order effects. In Vander Kolk's (1976a) study, for example, participants rank-ordered their willingness to acquire 11 different "disabilities," and then read aloud the name of each disability. These utterances were tape recorded and later analyzed with the PSE. The list, which included 9 physical and mental disorders as well as "Black" and "homosexual," was given in the same order to all participants. Although all items on the list yielded significant PSE scores, not surprisingly an orderly and steady decline in PSE means was found, suggesting adaptation of the physiological response over time.

Data reduction and analysis problems. The quantification of the physiological event and the evaluation of physiological effects across different participants were clearly very problematic issues, especially in the early psychophysiological studies. According to the Law of Initial Values (Wilder, 1950), the size of an individual's physiological response to a stimulus is inversely related to the baseline (initial) value of that response. Because different individuals will exhibit different prestimulus levels of basal activity, it follows that the physiological effects of a stimulus cannot be compared across participants unless the influence of those initial values is removed. This can be accomplished either by subtracting the baseline value from the poststimulus response, thus obtaining a difference (change) score for each participant, or by entering the baseline level as a covariate in the analysis of covariance (Russell, 1990). Although most of the researchers were aware of this issue, the way they handled it was sometimes unsatisfactory. In three studies by Cooper and associates (Cooper & Pollock, 1959; Cooper & Siegel, 1956; Cooper & Singer, 1956), for example, only intrasubject analyses were performed so that "each subject's laboratory session was treated as an independent experiment" (Cooper, 1959, p. 315). In another study, Cooper (1969) resorted to binomial tests to determine the presence of differences across conditions. Yet in other studies, no information is provided about whether the scores were baseline-adjusted (Zych & Bolton, 1972), or about the procedure used to quantify the physiological responses (Cooper & Singer, 1956). Westie and De Fleur (1959) computed change scores but failed to indicate whether the direction of the change was taken into account in the analyses.

Questionable ecological validity of experimental manipulations. The literature reviewed differs considerably in the extent to which presentation of the target stimuli used to elicit physiological arousal approximates "real life" situations. At one end of the continuum there are several studies (i.e., Bernstein, 1965; Einarsen, Stenmark, & Danielsen, 1991; Heinemann, Pellander, Vogelbusch, & Wojtek, 1981; Kleck, Ono, & Hastorf, 1966; Marinelli, 1974; Marinelli & Kelz, 1973; Porier & Lott, 1959; Rankin & Campbell, 1955) in which participants interacted with a live target whose race or disability status was manipulated. In most of the other studies reviewed, participants responded to written statements and/or pictures in which the race or disability status of the target was manipulated. Finally, at the other extreme, Vanman et al. (1997, Experiments 1 and 2) asked their participants to imagine, for 5 sec, scripted scenarios in which they were interacting with a White or a Black partner. Artificiality of experimental conditions is likely to be particularly problematic in prejudice research as participants' affective responses may be dampened, or simply different, when the situation bears little resemblance to real life.

Another disadvantage of imaginal exposure inherent in the scenario methodology is that participants are, in a sense, left free to manipulate, in unknown ways, their own exposure to the target stimuli. The experimenter can only hope that participants will do what they are instructed to do and, assuming a diligent and cooperative attitude, that they will be able to do it. In vivo exposure, of course, would make all of these assumptions unnecessary, would return control over the independent variable to the experimenter, and would enhance the ecological validity of the manipulation.

General Findings

In view of the serious problems outlined in the previous section, it might be tempting to simply dismiss the aforementioned research on the grounds that it is fundamentally flawed. It should be noted, however, that those problems are not inherent in the use of psychophysiological procedures but simply reflect general inadequacy of research design. Moreover, when a number of different studies share the same findings but not the same methodological weaknesses,

the convergence of results cannot be easily disregarded even in the presence of significant problems. With few exceptions, the findings of this literature are remarkably consistent.

Except for a heart rate study by Marinelli (1974) that revealed only trends in the predicted direction, the other eight disability studies found psychophysiological reactivity to be a reliable indicator of emotional discomfort in the presence of disabled individuals introduced either in vivo or pictorially. The psychophysiological measures used in these studies included electrodermal activity (Heinemann et al., 1981; Kleck et al., 1966; Wesolowski & Deichmann, 1980; Zych & Bolton, 1972), heart rate (Gargiulo & Yonker, 1983; Marinelli & Kelz, 1973; Wesolowski & Deichmann, 1980), or the PSE (Vander Kolk, 1976a, 1976b,[4] 1977a).

With respect to racial prejudice, all three classical conditioning studies (Tognacci & Cook, 1975; Tursky, Lodge, Foley, Reeder, & Foley, 1976; Tursky, Lodge, & Reeder, 1979) found significant generalization of the conditioned skin conductance response to racially perceived test stimuli. Similarly, both racial prejudice studies that focused on voice stress analysis (Vander Kolk, 1977b, 1978) reported significant findings in the expected direction. In contrast, all three racial prejudice studies that used the pupillary reflex (Collins, Ellsworth, & Helmreich, 1967; Woodmansee, 1970, Studies A and B) found no differential pupillary response to racial stimuli compared to control stimuli. Of the remaining 13 racial prejudice studies, three electrodermal activity investigations (Cooper, 1969; Porier & Lott, 1967; Westie & De Fleur, 1959) obtained mixed results. The other 10 studies found that race manipulations significantly affected emotional arousal regardless of whether the physiological response was the GSR (Bernstein, 1965;[5] Cooper & Pollock, 1959; Cooper & Siegel, 1956; Cooper & Singer, 1956; Rankin & Campbell, 1955; Vidulich & Krevanick, 1966), facial EMG activity (Vanman et al., 1997, Experiments 1, 2, & 3), or heart rate (Einarsen et al., 1991).[6]

The pattern of results described previously is sufficiently robust to warrant two general conclusions. First, the pupillary response is an ineffective discriminator; it is not surprising that no pupillographic prejudice studies have been published since 1970. The three studies mentioned previously failed to support Hess's (1965) claim that the pupillary response is a useful bidirectional indicator of the evaluative dimension of attitudes. (For a thorough methodological critique of Hess's work, see Woodmansee, 1970.) Second, electrodermal activity, heart rate, and facial EMG activity are promising indicators of affective–evaluative responses in prejudice studies. As a matter of fact, facial EMG (Vanman et al., 1997) and heart rate (Gargiulo & Yonker, 1983) were found to discriminate attitudinal states even when self-report measures failed to do so.

The Abandonment of Psychophysiological Methods in the Study of Prejudice: Historical and Conceptual Antecedents

The literature summarized in Tables 1 and 2 consistently points to the heuristic value of psychophysiological probes in the assessment of prejudice, regardless of whether the attitude stimuli are presented verbally, pictorially, imaginally, or in vivo. The reliability of the effect is especially striking if one considers the heterogeneity of measures, procedures, methodological sophistication, and design quality that characterizes this area of research. Why, then, with the exception of a Norwegian investigation (Einarsen et al., 1991) and the recent work by Vanman et al. (1997), have no psychophysiological studies of prejudice been published in the last 15 years? There are several probable reasons for the failure to pursue those promising early leads.

The ascendancy of the cognitive perspective. As discussed earlier, in the last 2 decades cognitive approaches have markedly influenced social psychologi-

[4] This report is a briefer version of the 1976a paper. Both deal with the same data.

[5] This study was primarily designed to investigate the presence of basal skin conductance differences between Black and White participants (both normal and schizophrenic). Although racial prejudice and its physiological correlates were not within its focus, the study included an implicit race of examiner manipulation, as participants worked with either a Black or a White experimenter. Using the information contained in the published report, I was able to determine that the electrodermal response of the White normal group exposed to the Black experimenter indicated significantly greater physiological arousal than the response of a similar group who worked with a White experimenter, $t(33) = 5.26$, $p = .00001$. Interestingly, the same analyses for a sample of normal Black participants who worked with a White or a Black experimenter yielded no significant race of experimenter effect, $t(34) = 0.87$, $p = .39$.

[6] The recent racial prejudice study by Vanman et al. (1997) found that facial EMG activity reliably indexes affective valence in response to target stimuli, whereas heart rate does not. Two unpublished investigations (not included in Table 1), however, point to the value of heart rate as an index of emotional reactions to racial stimuli. In a study by Vrana and Rollock (1996, as cited in Jones, 1997), an increase in heart rate was observed when White men were touched by a Black confederate, whereas women's heart rates showed no differential response to the two racial targets. On the other hand, Simons (1996, as cited in Jones, 1997) found that heart rate increased in both Black and White participants when a Black confederate entered the room, but physical contact elicited no additional cardiac effects.

cal research and particularly the study of intergroup processes. The strong emphasis placed on stereotypes, stereotype measurement, and cognitive processes underlying stereotyping (e.g., Brigham, 1971; McCauley, Stitt, & Segal, 1980; Hamilton, 1981) clearly signaled a change in the dominant theoretical perspective. The shift from affective to cognitive conceptualizations is perhaps best illustrated by Tajfel's (1969) view of prejudice "as a phenomenon in the minds rather than in the guts of men" (p. 96). Considered in the cultural context of the time, Tajfel's position represented a refreshing alternative to unconscious motivation theories of intergroup processes and to a model of social relations that he characterized as "a blood-and-guts romanticism so fashionable at present" (p. 80). On the other hand, the exclusive focus on cognitive processes in the etiology of prejudice appears today just as reductionistic as the blood-and-guts model.

Inadequate physiological knowledge and training in social psychology. As late as 1990, Blascovich and Kelsey (1990) lamented the rare use of psychophysiological measurement in social psychological investigations. Their search of the leading social psychological journals over the previous 20 years revealed that fewer than 3% of published articles utilized psychophysiological measures and that the number was actually on a declining trajectory. The situation, they noted, is especially surprising if one considers the obvious potential advantages of physiological indicators compared to self-report measures. One factor that, according to Blascovich and Kelsey, is responsible for this state of affairs is the relative lack of knowledge and training in psychophysiological methods on the part of social psychologists, as well as the unavailability of psychophysiological equipment in their laboratories. Cacioppo and Tassinary (1989, 1990) have echoed these views and have pointed to poor technical knowledge as a major obstacle to the ability to extract psychological meaning from physiological signals.

Autonomic reactivity and the orienting reflex. Cacioppo and coworkers (Cacioppo & Sandman, 1981; Petty & Cacioppo, 1981, 1983), among others, have suggested that stimulus-induced ANS arousal need not reflect affective–evaluative responses to the stimulus but could instead be simply a component of the orienting reflex. Sokolov (1963a, 1963b) described the orienting reflex as a nonspecific response, consisting of autonomic and somatic components, elicited by change in the environment and particularly by stimuli that are perceived as novel and unexpected. Cacioppo and his associates reviewed some of the early psychophysiological studies of prejudice and suggested that physiological responses to racial stimuli might be more indicative of attentional and orienting processes than of prejudice. In reference to Rankin and Campbell's (1955) study, for example, Cacioppo and Sandman (1981) noted that "a Black experimenter may have been more novel to a prejudiced person than to a person not prejudiced" (p. 86). Assuming that such is the case, these differential novelty effects could occur for either of two reasons, or both. Compared to their unprejudiced counterparts, prejudiced individuals might be more surprised by a Black experimenter because of perceived incongruence between the race of the experimenter and the desirable intellectual and social status associated with that role. Alternatively, prejudiced individuals might find a Black experimenter more novel because they do not associate as much with Black people and therefore race-based categorization is more salient to them. In either case, I would suggest, the physiological measure is doing its job; the very fact that the stimulus is perceived as more novel may provide information about the underlying attitude toward it. It could be argued, then, that stimulus novelty, rather than confounding the meaning of the physiological response, holds valuable information about stimulus evaluation.

Autonomic reactivity and undifferentiated arousal. In their review of attitude measurement approaches, Cook and Selltiz (1964) concluded that ANS arousal gives information about the intensity of the attitude-related emotion, but does not discriminate the affective valence (direction) of the emotional state. Both strongly positive and strongly negative emotions, in other words, would be associated with physiological arousal. This verdict was certainly consistent with the work of Schachter and Singer (1962), who had presented impressive evidence suggesting that emotion is a function of undifferentiated ANS arousal combined with cognitive appraisal of the contextual cues in which physiological arousal occurs. According to this view, the intensity of the emotional experience is coded by the level of ANS arousal, whereas the specific nature of the emotion (how we label it) is appraisal-dependent. William James's emotion-specific patterns of physiological activation gave way to the idea that ANS arousal is nonspecific and undifferentiated.

The dominance of Schachter and Singer's (1962) two-factor (arousal-cognition) theory, probably more than any other factor, contributed to the dampening of interest in the search for autonomic differentiation of emotion in social psychology in general and in the study of prejudice in particular. It stands to reason that, to be useful, a physiological measure must provide, at a minimum, bidirectional information about

the attitude-related evaluative response: Is the person responding favorably–positively or unfavorably–negatively to the attitude object? A bidirectional index, however, may not be required in prejudice research. Cook and Selltiz (1964) noted that the emotional reactions explored in prejudice studies do not encompass the full affective continuum (i.e., from strongly positive to strongly negative), but probably cover a truncated range going from neutral (or mildly positive) to strongly negative responses. If this were indeed the case, and if the magnitude of the physiological response reflects the intensity of the emotional experience (as research has consistently indicated), simple logic would lead to the conclusion that, in prejudice research, large physiological responses are directionally meaningful as they reflect high levels of prejudice.

Furthermore, the classical conditioning paradigm adopted by some of the prejudice studies is immune to the directionality criticism. The phenomenon of *semantic conditioning,* first described by Razran (1939), refers to the establishment of an association between the meaning of a verbal stimulus (the conditioned stimulus [CS]) and a physiological response (the conditioned response [CR]). Following conditioning, there will be a transfer of the CR to stimuli similar in meaning to the CS, with the gradient of generalization being determined by the degree of similarity between the test stimuli and the CS. To use Razran's (1939) example, if the word *cent* is conditioned to elicit salivation, greater generalization of the CR will occur to words similar in meaning to the CS (e.g., the word *penny*) than to words similar to the CS phonetically but not semantically (e.g., the word *scent*). Razran (1961) reviewed a large body of Soviet classical conditioning literature, including the work of Volkova (1953, as cited in Razran, 1961) who used semantic conditioning and generalization to assess a 13-year-old boy's political attitudes. A closer examination of Tognacci and Cook's (1975) study will help illustrate how this approach can provide information about both strength and direction of attitude-related affective responses. In that study, electric shock was used as the unconditioned stimulus to classically condition the GSR (CR) to nonracial stimuli (CS) previously evaluated by the participant as "bad." Generalization of the CR to test stimuli consisting of pro- and anti-integration statements was then determined. A sample of undergraduates, chosen on the basis of extreme scores on a racial attitude scale administered 1 to 6 months prior to the experiment, was divided into a high-prejudice group and a low-prejudice group. As predicted, the conditioned electrodermal response to the anti-integration sentences was significantly greater for the low-prejudice group than for the high-prejudice group; the CR to the concept bad had generalized to statements evaluated as bad by the participant.The complementary test of the hypothesis, however, indicated that the high-prejudice group did not respond more than the low-prejudice group to pro-integration statements. As noted earlier, very high racial prejudice scores may be unlikely among college students and inadequate group separation could explain the pattern of findings.

Regardless of the specific results, and Feather's (1965) methodological critique of the general procedure notwithstanding, this research, as well as the other two classical conditioning studies summarized in Table 1, clearly suggest that semantic conditioning and generalization can be used not only to determine the intensity of prejudiced attitudes, but also to differentiate attitude valence. The Soviet origin of the extensive work on this experimental paradigm may have contributed to its undeserved neglect among prejudice investigators. The chill of the cold war, however, has finally dissipated and this promising methodology merits renewed interest.

The foregoing discussion suggests that the virtual abandonment of psychophysiological methods by prejudice investigators over the last 2 decades is not based on sound theoretical or empirical grounds, but probably reflects outdated notions about the psychophysiology of emotion coupled with lack of knowledge about the use of physiological measurement procedures. The absence of a theoretical and empirical justification for this position becomes apparent when one reviews the factors that originally produced it. The relatively new area of social psychophysiology has emerged within social psychology; unfortunately prejudice research has remained rather impermeable to its influence. Moreover, as mentioned earlier, the zeitgeist has shifted again and the focus on affect is back in style.

Methodological and Theoretical Bases for the Psychophysiological Study of Affect

The renewed interest in the study of emotional responses to attitude objects, especially outgroup targets, can benefit substantially from the adoption of psychophysiological procedures as they effectively address two difficult issues in prejudice assessment. The first issue is methodological in nature and deals with the validity of prejudice measures vis-à-vis the known limitations of self-report procedures. The second issue is conceptual in nature and concerns the key role of affect in current conceptualizations of prejudice.

Are Self-Report Measures Valid?

Many have convincingly argued that prejudiced attitudes, once readily acknowledged and often acted

upon, have not been eradicated but continue to exist in a cloaked form that frequently escapes the very owner's recognition. With respect to racial prejudice, old-fashioned racism has been replaced by less blatant, but no less pernicious, mutations that have been variously referred to as "modern racism" (McConahay, 1986), "aversive racism" (Gaertner & Dovidio, 1986), "symbolic racism" (Sears, 1988), "ambivalent racism" (Hass, Katz, Rizzo, Bailey, & Eisenstadt, 1991), and "subtle prejudice" (Pettigrew & Meertens, 1995). Gaertner and Dovidio (1986), for example, suggest that these newer forms of racism may be harbored even by well-meaning egalitarian individuals who are actually unaware of their prejudice and who overtly reject blatantly racist and discriminatory positions. Similarly, Devine (1989) suggested that although the expression of racist attitudes can be censored and inhibited, racial stereotypes are so ingrained that their activation may sometimes become automatic. Very similar analyses have been applied to the changing face of prejudice in other social domains. Several measures have been recently developed, for example, to identify new and more subtle variations on the old gender stereotype theme, such as the Modern Sexism Scale (Swim, Aikin, Hall, & Hunter, 1995), the Neo-Sexism Scale (Tougas, Brown, Beaton, & Joly, 1995), and the Ambivalent Sexism Inventory (Glick & Fiske, 1996).

If the concepts of modern racism and modern sexism, with all of their variations, hold any legitimacy, as suggested by abundant research, the futility of self-report measures in the assessment of prejudice becomes readily apparent. To the extent that people are unaware of their own prejudice or are able to disown it when directly asked, even the recent development of subtle self-report instruments cannot adequately address the basic validity problem. In fact, our collective sensitivity to prejudice (especially racial prejudice) has been so heightened in recent years as to make it rather doubtful that any direct assessment procedure can be subtle enough to disguise its intent and still be a valid measure of the construct. Even a cursory inspection of the items comprising the Modern Racism Scale, the most widely used subtle self-report measure of racial prejudice, would indicate that what may have been subtle 10 years ago would probably carry the stench of racial prejudice even to a socially anosmic individual. Not surprisingly, there is now empirical evidence that its validity is severely compromised by its reactivity (Fazio, Jackson, Dunton, & Williams, 1995). Additional criticisms of this scale have centered around other validity concerns; in particular, it has been argued that the Modern Racism Scale may be a better predictor of political conservatism than of racial prejudice (see Fazio et al., 1995, for a lucid summary of this issue).

Another Look at the Validity Issue: Automatic Versus Controlled Processes

Widespread concerns about the validity of self-reported attitudes have stimulated, in the last few years, the development of implicit measures based on stereotype priming procedures and on associative tasks. This approach has proved useful for exposing automatic or unacknowledged stereotypes as well as their effects on social judgments in the study of racial attitudes (e.g., Devine, 1989; Fazio et al., 1995; Lepore & Brown, 1997; Wittenbrink, Judd, & Park, 1997), age biases (Perdue & Gurtman, 1990), and gender biases (Banaji & Greenwald, 1995). The development of these new procedures has prompted a reexamination of the validity issue. It has been persuasively argued that implicit and explicit measures may both be valid when they are used to assess the appropriate construct. This perspective has been articulated most recently by Dovidio, Kawakami, Johnson, Johnson, and Howard (1997). According to their multidimensional view, self-reported attitudes and automatic responses to attitude stimuli may encompass two separate systems. People may display automatic reactions indicative of prejudice (as indexed, for example, by response latencies in suitable priming studies), and yet reject prejudiced beliefs when asked directly. Dissociation between implicit and explicit attitude measures has been found repeatedly (Banaji & Greenwald, 1995; Devine, 1989; Fazio et al., 1995; Greenwald, McGhee, & Schwartz, 1998; von Hippel, Sekaquaptewa, & Vargas, 1997), suggesting that the two systems may coexist on two probably interacting but nonoverlapping planes (some may even say on separate levels of consciousness). If so, according to Dovidio et al. (1997), measures of automatic, implicit, noncontrolled responses and measures of deliberative, explicit, and controlled reactions would both be valid in their own right, each providing unique information about a person's attitudinal structure, and each predicting different behavioral expressions.

In support of this formulation, Dovidio et al. (1997) found: (a) dissociation (weak correlation) between implicit racial attitudes (measured with a priming technique) and explicit prejudice (assessed with the Modern Racism Scale) and (b) differential predictive power of those two measures. The implicit measure predicted reactions to the attitude object that are spontaneous and difficult to control, such as indirect evaluations of White and Black faces in a word-completion task and, at the interpersonal level, videotaped nonverbal responses (e.g., blinks, visual contact) to White and Black interviewers. Participants' scores on the explicit measure, on the other hand, predicted effortful and deliberative judgments about the guilt or innocence of a

Black man described in a script and, at the interpersonal level, direct evaluations of the likableness and sincerity of White and Black interviewers. Thus, implicit measures tell us something about people's uncensored and spontaneous reactions to a target, whereas explicit measures give us information about how people express their attitudes when social desirability pressures are operating and impression management strategies are in effect.

Fazio and Dunton (1997) further elaborated this multidimensional perspective by demonstrating that the relationship between implicit and explicit measures of prejudice is moderated by one's motivational state. Participants who obtained high scores on their Motivation to Control Prejudiced Reactions Scale behaved indeed in accordance with that motivation and endeavored to counteract or mask their readiness to make race-based judgments (controlled responses) when their racial attitudes were automatically activated.

The important conclusion to be drawn at this point is that both implicit and explicit measures must be used in the study of intergroup attitudes, as they appear to tap separate dimensions. This has significant implications for the role of psychophysiological measures in prejudice research. As I will argue later, psychophysiological indexes may fill an important methodological gap by providing a way to assess implicit, noncontrolled affective processes in intergroup attitudes. I will turn to that issue following a discussion of the importance of affect in current conceptualizations of prejudice.

The Centrality of Affect

Recent reviews (e.g., Dovidio, Brigham, Johnson, & Gaertner, 1996; Hilton & von Hippel, 1996; Mackie & Smith, 1998) have pointed out that a key element shared by all contemporary conceptualizations of prejudice is the view that negative affect is a defining characteristic of prejudice. Moreover, a number of theorists have posited a specific role for affect in intergroup relations. Stephan and Stephan (1985), for example, suggested that intergroup anxiety has a particularly disruptive effect on intergroup encounters. Similarly, Dijker (1987) found that people expect to experience negative emotions when interacting with members of certain ethnic groups, and Fiske and Ruscher (1993) argued that all intergroup encounters have the strong potential to produce negative affect.

Others have suggested that affect plays a critical role in stereotyping. Mackie, Hamilton, Susskind, and Rosselli (1996), for example, argued that affective mechanisms are involved in the formation of stereotypes. Vanman and Miller (1993) reviewed evidence suggesting that, under certain circumstances, stereotypes could be conceptualized as rationalizations of one's emotional responses (e.g., fear of Blacks causes one to believe that they are especially aggressive). Affect-priming research (Forgas, 1992) has consistently documented the biasing effects of mood on social categorization and social judgment, and positive incidental affect has been found to impact intergroup evaluations (Dovidio, Gaertner, Isen, Rust, & Guerra, 1998).

Finally, the superiority of affect over cognition in predicting attitudes and behavior has been demonstrated in several studies. Stangor, Sullivan, and Ford (1991), for example, found that emotional reactions to nine different outgroups were much more predictive of people's attitudes and of social distance responses than group stereotypes assessed in a variety of ways. Similar findings were reported by Esses, Haddock, and Zanna (1993). Jackson et al. (1996) demonstrated that affect, not cognition, was the strongest predictor of attitudes toward the three racial groups they studied. The predictive power of affect has been demonstrated not only in traditional intergroup attitude studies, but also in cases when one would expect cognitive processes and deliberative reasoning to inform people's actions, such as voting behavior. Lavine, Thomsen, Zanna, and Borgida (1998) found strong support for their "ambivalence-moderated primacy of affect hypothesis" (p. 403). When participants experienced conflict between thoughts and feelings about presidential candidates, affect consistently outperformed cognition in predicting their attitudes and voting behavior. Ambivalence is a key element in most contemporary conceptualizations of prejudice. Thus, when these research findings are applied to the case of intergroup relations their theoretical importance becomes readily evident.

Perhaps the most unequivocal statement about the wisdom of targeting affect in the study of intergroup attitudes has been issued by Fiske (1998). She reviewed literature indicating that affective, emotional, and "gut-level" reactions perform much better than cognitive measures, beliefs, and stereotypes in predicting a variety of outcomes (i.e., discrimination, social distance, explicit evaluations, judgmental bias, and political behavior). She concluded by noting that "stereotypes clearly underperform in predicting evaluations of and behavior toward outgroup members; more gut-level types of prejudice may be stronger predictors. Two words, to the wise researcher, should be sufficient: Study prejudice" (p. 373).

Affect and Cognition: A Relationship in Need of Clarification

So far, however, this growing appreciation for the role of affect has failed to make a substantial impact on empirical investigations. As Mackie and Smith (1998)

noted, much of the research on intergroup relations conducted over the last quarter of a century has accorded special importance to the role played by cognitive processes (stereotypes) and has accepted a general assumption regarding the causal pathways among cognition, affect, and behavior: Stereotypes about a target lead to negative affective responses to it and ultimately result in discriminatory practices against it. The validity of this view, however, has been challenged by Jussim, Nelson, Manis, and Soffin (1995), who tested four different models of the role of affect and cognition in explaining how group labels bias judgments of group members. They found no support for the cognitive primacy assumption that, as mentioned earlier, has dominated the research on intergroup relations. In four different experiments, judgmental bias was eliminated after controlling for perceivers' affective responses, but not after controlling for their beliefs. The findings of this investigation strongly support an affective model according to which category-based cognitions and affect are both activated by group labels but affect behaves as the only mediator of the biasing effects of those labels. To my knowledge, this is the only comprehensive attempt to test experimentally different theoretical formulations. The fact that, since its publication, this study has been cited only a handful of times by prejudice and stereotype researchers is a reflection of the continuing dominance of the cognitive perspective.

Although the empirical work on intergroup attitudes continues to be heavily influenced by the cognitive revolution, theoretical formulations have taken a more interactive perspective. The long-running controversy about the primacy of affect over cognition (Zajonc, 1980, 1984, 1998) or its converse (Lazarus, 1982, 1984) have been replaced by contemporary models of intergroup processes in which cognition and affect are viewed as interactive parallel networks that can exert reciprocal agonist or antagonist influences (e.g., Stephan, Ageyev, Coates-Shrider, Stephan, & Abalakina, 1994; Stephan & Stephan, 1993). Interest in understanding how the two systems interact has inspired prominent contributions to an entire volume on the issue of the "developing interface" (Mackie & Hamilton, 1993).

At the same time, growing evidence of dissociation among measures of intergroup stereotype, prejudice, and discriminatory behavior has led to the suggestion that those components might actually operate somewhat independently (see Mackie & Smith, 1998 for a very recent review of this issue). These conclusions are certainly consistent with the importance accorded by contemporary prejudice theories to the distinction between cognitive and affective components. Modern racism theory (McConahay, 1986), for example, uses the concept of anti-Black affect to explain the mismatch between the seemingly tolerant attitudes Whites express toward Blacks on opinion polls and Whites' strong opposition to policies designed to achieve interracial equality. Presumably, although Whites' negative beliefs about Blacks have declined dramatically over the last few decades, negative feelings toward Blacks, acquired "nonverbally" early in life, are much more resistant to change. Similarly, aversive racists are said to experience conflict between egalitarian beliefs and lingering unacknowledged negative feelings toward Blacks (Gaertner & Dovidio, 1986). It is becoming increasingly apparent that affective and cognitive elements are at times independent and may contribute uniquely to intergroup attitudes and behaviors (Dovidio et al., 1996; Dovidio & Gaertner, 1993; Esses et al., 1993; Mackie & Smith, 1998). Independence of constructs requires independence of the procedures used to assess the constructs. Affective and cognitive measures are not interchangeable; to the extent that thoughts and feelings make separate contributions to intergroup attitudes, it cannot be assumed that assessment of one component necessarily carries information about the other.

The two important points established so far can be summarized as follows: (a) methodologically speaking, both implicit and explicit measures are necessary in the study of prejudice, and (b) from a theoretical perspective, both affective and cognitive processes need to be investigated as they seem to contribute independently to intergroup attitudes. Is current prejudice research following this multipronged assessment strategy? Both affective and cognitive self-report measures are available and useful suggestions for methodological improvements of these explicit assessment techniques have been offered by Crites, Fabrigar, and Petty (1994). Implicit procedures, however, have been developed specifically to study the cognitive dimension. The urgent need for implicit measures of affect provides the conceptual justification for the role of psychophysiological methods.

Why Should Affect Be Studied With Psychophysiological Methods?

The literature reviewed earlier in this article suggests that psychophysiological tools could be profitably added to the armamentarium of the prejudice investigator as they circumvent the known limitations of self-report measures. The evidence also indicates that psychophysiological methods allow access into people's implicit (automatic) affective responses to target stimuli (how they feel), whereas self-report instruments, no matter how subtle, can only tell us about people's explicit (controlled) affective reactions (how they say that they feel). Previously noted methodologi-

cal reservations notwithstanding, Vanman et al. (1997) provided the most recent and compelling evidence for this conclusion. Across three experiments, they consistently found a dissociation between self-reported affective responses to racial targets and facial EMG responses to those targets, a finding that parallels the divergence repeatedly demonstrated between implicit and explicit cognitive measures. Given a choice between Black and White targets, White undergraduates evaluated Black targets as more friendly, expressed greater liking for them, and reported greater happiness and probability of success when they imagined working with Black partners. Yet, in all three experiments facial EMG activity betrayed more negative affect toward Black targets. Other prejudice studies revealed the same type of dissociation between self-report and psychophysiological measures (Gargiulo & Yonker, 1983; Vander Kolk, 1977a).

Although the literature reviewed points to their value, psychophysiological methods come with a cost; they are expensive in time and dollars and a full exploitation of their utility requires some degree of technical sophistication. The prejudice researcher, then, might look for simpler and equally effective alternatives. A growing literature strongly suggests that implicit attitude measures can be used to identify automatic processes in stereotyping, just as traditional self-report measures are useful for assessing the role of controlled processes. At this point, the prejudice researcher might think that this two-pronged research approach is so promising as to make, perhaps, the cumbersome addition of psychophysiological methods unnecessary. Not so. The obvious strength of the automatic stereotype activation line of research is its ability to elucidate the implicit cognitive processes involved in stereotyping, but can such measures adequately tap the affective dimension of intergroup attitudes?

In the last few years it has been argued that priming procedures can index not only cognitive influences on social judgments but also an evaluative component, and thus can be used to assess indirectly the affective dimension (e.g., Fazio et al., 1995; Wittenbrink et al., 1997). Group category labels, presented as primes, automatically activate both stereotypic and evaluative components. Wittenbrink et al. (1997) used a semantic priming procedure to disentangle the independent contributions of cognitive and of evaluative facilitation effects. Furthermore, Greenwald et al. (1998) found their implicit association test useful for assessing automatic evaluative associations. These are interesting methodological developments, but they rest on two questionable premises. First, they assume a sort of cognitive primacy whereby the mere categorization process drives these automatic evaluative responses. The central role of cognition has been challenged and the possibility that the relative position of affect and cognition in the causal chain might actually be reversed has not only been raised (Mackie & Smith, 1998), but also empirically supported (Jussim et al., 1995). Second, the assumption that evaluation and affect are essentially interchangeable is also disputable. Although the relationship between automatic evaluations and affective states needs to be empirically elucidated, at this point it seems unwise to accept indirect evaluative indexes as implicit measures of affect in the study of prejudice. Stephan et al.'s (1994) parallel network model of stereotype and prejudice distinguishes between *affect,* defined as "feeling states," and *evaluations,* defined as "cognitive representations of affect" (p. 282). Mere evaluations of group traits are a far cry from the raw, gut-level, unprocessed, visceral, hot affect that so often accompanies prejudiced attitudes. How many times have we heard, during class discussions of homosexuality, comments such as "they just disgust me, I don't even know why"? Obtaining evaluative indexes (by means of either implicit or explicit measures) of whether homosexuals are perceived as "good" or "bad" fails to capture the quality and intensity of the affective response, even in cases when the individual's reaction is more subtle (e.g., uneasiness rather than disgust).

Recent reviews (Dovidio et al., 1996; Mackie & Smith, 1998) have bemoaned the relatively poor understanding of the relationships among stereotypes, prejudice, and discrimination, as well as the need for greater theoretical and methodological sophistication in the study of intergroup attitudes. With respect to the issue of measurement, Dovidio et al. (1996) pointed out the need for greater precision and suggested that methodological diversification, inspired by appropriate theoretical frameworks, will fuel progress in this area. The position taken here is consistent with their call. Implicit and explicit measures have shed light on the role of cognitive processes, and their value was discussed in an earlier section. The newly recognized importance of affect, however, stands in sharp contrast with the inadequacy of the measures used to study it. The assessment of affect has typically relied on self-report and, most recently, on indirect evaluative indexes, both problematic. What is needed is a methodology for the assessment of implicit affective responses. The literature reviewed in this article indicates that psychophysiological procedures would fill this need. I will argue later that the reintroduction of these measures in the study of prejudice would have several additional advantages: It would promote the development of more comprehensive theoretical models of intergroup attitudes, make empirical tests of those models possible, and permit an assessment of the independent and interactive contributions of affective and cognitive factors to intergroup attitudes and discriminatory behavior.

This section has highlighted the importance of targeting affect in the study of prejudice, the need to use nonreactive measures in addition to explicit ones, and the wisdom of including psychophysiological methods as a way to achieve both of those objectives. Having laid those foundations, several important questions need to be considered next: Should the prejudice researcher, who is persuaded about the value of psychophysiological procedures, simply pick up where work stopped 2 decades ago? Are there alternatives to the autonomic measures that dominated the psychophysiological study of prejudice in the 1950s, 1960s, and 1970s? What is the state of the evidence concerning the ability of psychophysiological probes to provide information about affective responses to target stimuli? Is there support for emotion-specific physiological changes? To answer these questions it is necessary to expand the focus of this review to the physiology of emotion literature. Over the last 15 to 20 years, significant developments have occurred in this area of research but have not been acknowledged and exploited in prejudice studies. These developments hold great promise for the scientific study of prejudice and will be discussed next.

The Psychophysiology of Emotion

Research on the psychobiology of emotion has produced a voluminous and rapidly growing literature to which prominent interdisciplinary journals have recently dedicated special issues or special sections: For example, *Cognition and Emotion* (Stein & Oatley, 1992); *Monographs of the Society for Research in Child Development* (Fox, 1994a); *Personality and Social Psychology Bulletin* (Arkin, 1990); *Psychological Review* ("Centennial Issue," 1994); and *Psychological Science* (Davidson & Cacioppo, 1992). A comprehensive survey of this work is clearly beyond the scope of any review. The main issue under examination in this section is whether there are emotion-specific biological changes that can be assessed by psychophysiological methods that, ultimately, could be usefully applied to the study of prejudice.

Two forms of the specificity question will be examined. The first is often referred to as the *categorical* issue and centers on whether there are physiological response patterns that uniquely mark discrete emotional categories (e.g., fear, anger, happiness, etc.). The second part of the specificity question deals with the *dimensional* issue, or the extent to which physiological events provide information about basic dimensions of the emotional experience. One of these dimensions is affective valence, which characterizes the hedonic value of an emotion (bipolar valence characterizations found in the literature include: positive–negative, pleasant–unpleasant, appetitive–defensive, approach–withdrawal). The other dimension is arousal, which marks the intensity of the emotional experience, whatever its valence, and ranges from calm and relaxed to activated and excited. Factor analytic studies of affective judgments assessed with the semantic differential approach have consistently indicated that these two basic dimensions account for most of the variance in emotional responses (Osgood, Suci, & Tannenbaum, 1957). Whether physiological events provide categorical or dimensional information, or both, is of obvious interest to the prejudice investigator.

Theoretical models of emotion have guided the search for emotion-specific physiological patterns in three general directions: ANS changes, facial muscle activity, and brain function. Some of the theories of emotion to be discussed next are known as *feedback* hypotheses. They posit that the emotional experience is the result of afferent (sensory) feedback coming to the brain either from the ANS and the visceral organs it innervates or from contractions of facial skeletal muscle fibers innervated by the somatic nervous system. In either case, the theoretical heritage can be traced directly to William James's (1894) peripheral origin hypothesis.

Autonomic Feedback and Emotion

New impetus to the search for emotion-specific ANS patterns came from an influential article by Ekman, Levenson, and Friesen (1983), who presented evidence for autonomic specificity at both the categorical and the dimensional levels. In recent summaries of the work that he and his colleagues conducted in the years that followed, Levenson (1992, 1994) reported that heart rate and peripheral skin temperature discriminate among several negative emotions. In particular, he found greater heart rate acceleration in fear, anger, and sadness, compared to disgust, and larger skin temperature increases in anger than in fear. Furthermore, autonomic differentiation of affective valence was also found; anger and fear produced greater heart rate acceleration than happiness, whereas fear and disgust were associated with larger increases in skin conductance than happiness. In this research, emotional states were evoked either by means of the Relived Emotions Task, in which participants are asked to imaginally reenact discrete emotional states, or with the Directed Facial Action Task, in which participants are given muscle-by-muscle instructions about how to contract the facial musculature so as to achieve facial expressions characteristic of those emotional states. Levenson, Ekman, and Friesen (1990) reported that the aforementioned findings are robust and independent of participants' age, gender, culture, and profession, and

also of emotion elicitation mode. Moreover, Levenson (1992, 1994) argued that those ANS activation patterns are consistent with a functional analysis of the behavioral and metabolic requirements associated with each emotion, as well as with lay metaphorical descriptions of affective states (e.g., the association of heat with anger and chill with fear).

Although acknowledging the provocative and promising nature of these findings, others (Cacioppo, Klein, Berntson, & Hatfield, 1993; Davidson, 1993b, 1994; Gray, 1994; LeDoux, 1994, 1996) have pointed out that the lines of evidence from various investigations are not sufficiently convergent to conclude that emotional states have indeed unique autonomic signatures. According to Cacioppo, Klein, et al. (1993), who provided the most comprehensive review of the autonomic afference literature, reliability of results is questionable even for heart rate, generally found to be the most effective discriminator of emotion. Moreover, Davidson (1992a, 1993b, 1994) has questioned the conceptual basis for this research approach. He argues, as have others (Cacioppo, Klein, et al., 1993; Dijker, 1987; Frijda, 1986; Panksepp, 1994), that a key function of the ANS is to meet the metabolic demands associated with impending action. By failing to evoke emotion-specific action tendencies, both elicitation procedures used by Levenson and coworkers (e.g., Ekman et al., 1983; Levenson, 1992) introduce a degree of physiological consistency that is essentially artificial. Because the same emotion can trigger different action tendencies in different situations and in different individuals, variability rather than specificity in autonomic activity should be expected.

The picture that emerges from the autonomic specificity literature is not a tidy one. At this point, it seems prudent to suspend judgment and join Cacioppo, Klein, et al. (1993) who rendered a verdict of "inconclusive evidence." Some recent investigations provide support for the same verdict. One study (Boiten, 1996) found that heart rate changes were not emotion-related but effort-related; cardiac acceleration occurred when the facial expression that participants were asked to adopt was difficult to produce. Two other studies (Collet, Vernet-Maury, Delhomme, & Dittmar, 1997; Sinha & Parsons, 1996), on the other hand, found significant evidence for emotion-specific ANS activity.

The foregoing discussion has focused on the categorical aspect of the specificity issue. The comparatively scant literature that deals with dimensional assessment provides tentative support for the claim that ANS indexes discriminate affective valence and intensity. In a recent review, Bradley, Greenwald, and Hamm (1993) summarized the contribution of Lang's research team (e.g., Lang, Greenwald, Bradley, & Hamm, 1993) to this issue. In the typical study, the International Affective Picture System (IAPS), a large set of standardized color slides, is used to evoke emotional responses that vary in valence and intensity. Following each presentation, the participant renders dimensional judgments using the Self-Assessment Manikin (Lang, 1980), a pictorial system in which each emotional dimension is represented on a rating scale. Lang et al. (1993) found that correlations between participants' dimensional ratings and their ANS responses to IAPS stimuli reveal interesting and dimensionally informative relationships. In particular, heart rate acceleration is related to positive valence ratings (r = .76), whereas skin conductance appears to track the arousal dimension (r = .81), regardless of emotional valence. Note that these very high correlations need to be viewed with caution as mean physiological levels were correlated with mean dimensional ratings; the removal of individual variance artificially inflates the correlations. Also note that, although there is general agreement about the skin conductance findings, the heart rate acceleration and deceleration associated with positive and negative valence, respectively, reported by this research team, are at odds with the patterns of results found by Levenson and his associates (e.g., Levenson, 1992, 1994; Levenson et al., 1990). To the extent that heart rate indexes the arousal dimension, in addition to affective valence, unless the degree of arousal is held constant, heart rate responses to stimuli differing in valence may be contaminated by the arousal value of those stimuli. This might account for discrepant findings across laboratories. Although Lang et al. (1993) partialed out the effects of arousal on heart rate by entering arousal ratings as a covariate, the point remains that cross-laboratory differences may result, at least in part, from lack of standardized procedures whereby the physiological effects of one emotional dimension are considered after controlling for the other.

Although all the research on the autonomic differentiation of emotion has focused on the sympathetic division of the ANS (e.g., skin conductance, heart rate, blood pressure, peripheral blood flow), recently it has been suggested that parasympathetic activity, and particularly cardiac vagal tone, may modulate emotional expression and regulation (Porges, Doussard-Roosevelt, & Maiti, 1994). Future research will hopefully indicate whether afferent feedback from vagal activity bears a specific relationship to emotional experience.

Facial Expression and Emotion

Theories that confer to the face a key function in the expression and regulation of emotion find their historical antecedents in Charles Darwin's work (1872/1965). Ekman, who for over 30 years has in-

vestigated the social communication function and the universal meaning of facial expressions, recently summarized Darwin's influence on psychological theories of emotion (Ekman, 1992, 1993).

According to *facial feedback theories,* sensory feedback from the face's striate muscles and cutaneous receptors to the brain generates, or at least enhances, the emotional experience (Izard, 1971; Tomkins, 1962). Although the specific pathways leading from the facial musculature to the emotional state have yet to be elucidated, and critical appraisals of this hypothesis (e.g., Matsumoto, 1987) notwithstanding, Ekman's demonstration that facial expressions, achieved with muscle-by-muscle instructions, as well as the results of many other empirical contributions, have been generally interpreted as supportive of at least some form of the facial feedback hypothesis (informative reviews can be found in Camras, Holland, & Patterson, 1993; Ekman, 1992; Izard, 1990, 1993; Leventhal & Tomarken, 1986; Manstead, 1988; Plutchick, 1994).

More recently, a variation on the same theoretical theme has been proposed by Zajonc (Zajonc, 1985; Zajonc, Murphy, & Inglehart, 1989; Zajonc, Murphy, & McIntosh, 1993), who resuscitated and revised a theory first advanced by Waynbaum, a turn-of-the-century French physician. According to this hypothesis, the state of contraction or relaxation of the facial musculature regulates cerebral blood flow and, hence, cerebral temperature which, in turn, influences emotional state. Although, in my estimation, this vascular theory of facial efference does not rest on solid physiological or logical grounds, supportive evidence has recently been published (McIntosh, Zajonc, Vig, & Emerick, 1997).

A second group of theories that attach great importance to the face in the experience of emotion are known as *efference hypotheses.* They suggest that motor (efferent) flow from the brain to the facial skeletal muscles creates specific facial expressions that mirror, but do not generate, distinct emotional states. Regardless of whether the focus is on afferent or efferent mechanisms, both theoretical positions maintain that specific emotions are associated with unique facial expressions, and for both approaches the reliable measurement of these facial expressions has been an important research issue. In an effort to objectively quantify observable facial actions and overcome the problems connected with observers' judgments, a number of coding systems have been developed. Ekman and Friesen (1978) should be credited with the most elaborate and comprehensive of these quantification procedures, the Facial Action Coding System. Even with objective coding schemes, however, emotional states cannot be inferred from patterns of facial efference unless the emotion is accompanied by detectable muscle contractions. Direct electromyographic recording of muscle action potentials has made it possible to identify facial muscle contractions even when muscular activity is too subtle or too short-lived to be detected by an observer.[7]

A large body of EMG research (reviewed by Bradley, Greenwald, et al., 1993; Camras et al., 1993; Cacioppo, Klein, et al., 1993; Cacioppo, Martzke, Petty, & Tassinary, 1988; Cacioppo & Petty, 1981; Fridlund & Izard, 1983; Tassinary & Cacioppo, 1992; Zajonc & McIntosh, 1992) has yielded consistent findings, regardless of the emotion elicitation procedure used (i.e., pictorial stimuli, posed facial expressions, imagery, written passages). This research strongly supports the notion that facial EMG activity provides reliable dimensional information regarding both valence and intensity of evoked emotions. As Darwin (1872/1965) had described, the *corrugator supercilii* muscle, which lowers the brow, increases its activity in response to unpleasant emotional stimuli and decreases it following pleasant ones. Lang et al. (1993) reported a –.90 correlation between valence ratings and corrugator activity. Also consistent with Darwin's (1872/1965) account is the response of the *zygomaticus major* muscle, which "by the drawing backwards and upwards of the corners of the mouth" (p. 202) molds the face into an expression that we often recognize as a smile. According to Lang et al. (1993), zygomatic activity exhibits a J-shaped relationship with valence ratings: It is highest for positive stimuli, lowest for neutral stimuli, and intermediate for negative stimuli (e.g., mutilation slides). These investigators found a .90 quadratic correlation between rated stimulus valence and zygomatic activity. Note, again, that the correlations reported by Lang et al. (1993) are based on means, and note also that the J-shaped relationship was not found in other studies (e.g., Cacioppo, Petty, Losch, & Kim, 1986; Jäncke, 1994). The heuristic potential of facial EMG probes has been pointed out by Cacioppo and his colleagues (Cacioppo et al., 1988, 1986), who found that accurate EMG-based valence discrimination occurs when movement of the facial muscles is visually undetectable and the emotional state is too weak to elicit measurable ANS responses. Furthermore, Vanman et al. (1997) recently provided evidence that facial EMG activity can consistently identify racial bias even when self-report measures do not.

Facial EMG activity also appears to index the intensity dimension. The evidence indicates that, for both corrugator and zygomaticus muscles, EMG levels increase with the intensity of the associated negative or positive emotion, respectively. From a categorical per-

[7]The issue of whether emotion can occur without facial expression (and vice versa) is of obvious theoretical importance (see Ekman, 1993, for a thorough analysis), but cannot be discussed here.

spective, on the other hand, there is little support for the notion that patterns of facial efference, as measured by the EMG, discriminate among different emotions (but see Sinha & Parsons, 1996, for evidence of electromyographic differentiation between anger and fear).

Before concluding this section, it is important to mention a different research paradigm utilized by Lang and coworkers (Bradley, Cuthbert, & Lang, 1990; Lang, 1995; Lang, Bradley, & Cuthbert, 1990, 1992; Vrana, Spence, & Lang, 1988). Reflexive closure of the eyelids is a stable component of the startle response pattern and is produced by contraction of the *orbicularis oculi* muscle, whose activity (peak amplitude and latency) can be recorded electromyographically. Lang and his associates have repeatedly found that the amplitude and latency of a defensive startle probe (the eyeblink reflex) indexes the positive or negative evaluation of a foreground stimulus (e.g., IAPS slides). In several experiments, they consistently reported that the eyeblink reflex is attenuated if triggered while participants view or imagine pleasant stimuli (reflex–affect mismatch condition), and is potentiated by exposure to unpleasant stimuli (reflex–affect match condition). Moreover, Bradley et al. (1990) demonstrated that these findings are independent of startle probe modality; for both acoustic and visual probes, startle modulation was primarily a function of affective valence.

Emotion and the Brain

During the early decades of this century, neuroscientists engaged in systematic attempts to locate the neural substrates of emotion within the brain. Bard's (1928) demonstration of "sham rage" in decorticated animals, for example, pointed to the importance of the hypothalamus in emotional expression. Papez (1937), on the other hand, suggested that, although expression of emotion may be regulated at the subcortical level, the experience of emotion requires an intact cortex. He proposed a specific regulatory circuit that included the hypothalamus, thalamus, hippocampus, the cerebral cortex, and the evolutionarily older cingulate cortex. MacLean (1949) expanded Papez' circuit into the "visceral brain," which implicated other limbic structures, and placed particular importance on the hippocampus and amygdaloid complex. Interest in the limbic system as a key player in emotion has continued to this date. LeDoux (1993) suggested that the longevity of the limbic hypothesis may be due, at least in part, to one of its components, the amygdala. LeDoux (1993, 1994, 1995, 1996) has made a strong case for the central role played by the amygdala, especially in evaluating the emotional significance of environmental stimuli.

Excellent reviews of the functional neuroanatomy of brain circuitry involved in emotion have been provided by LeDoux (1995) and by Derryberry and Tucker (1992), to which the reader is referred for additional information. Research on the neuroanatomical correlates of emotion has relied on a variety of methodologies, including ablation and stimulation experiments on animal preparations, neuropsychological studies of patients with focal brain lesions, as well as psychophysiological approaches, to which our attention now turns. Psychophysiological investigations of emotion-specific brain circuitry can be divided into electrophysiological and neuroimaging studies. Generally, all of this research has focused on the dimensional question (i.e., valence and intensity) and has provided little information about the relationship between brain mechanisms and specific emotion categories.

Electrophysiological Research

The effects of emotional stimuli on the electrical activity of the brain, measured from specific scalp locations with the EEG, have been investigated by two methodologically and conceptually distinct approaches: hemispheric asymmetry studies and event-related potential (ERP) studies.

EEG studies: Hemispheric lateralization of affective valence. A great deal of research, conducted mostly by Davidson and his associates (see reviews of this work by Davidson, 1992a, 1992b, 1993a, 1993b, 1994) has consistently found that asymmetrical hemispheric activity may differentiate between positive and negative emotions. In particular, the EEG has indicated increased activity in the left frontal area in the presence of positive emotional stimuli and increased activation of the right frontal region during exposure to negative emotional stimuli. Restated in terms of a motivationally meaningful approach–withdrawal continuum, which Davidson prefers to the positive–negative dichotomy, it appears that the anterior region of the right hemisphere is specialized for withdrawal processes whereas the corresponding area in the left hemisphere supports an approach system.

Differential activation of the right and left frontal regions as a function of approach and withdrawal evaluative tendencies has been found also in infants (Davidson & Fox, 1982; Fox, 1991, 1994b), leading to the suggestion that this motivationally-based hemispheric asymmetry is present at birth (Davidson,

1992a). Furthermore, Davidson and others (Davidson, 1992a, 1993a, 1993b; Fox, 1991, 1994b; Fox & Calkins, 1993) have proposed that individual differences in frontal asymmetry may be related to temperament, affective style, and affective psychopathology. In a recent review of her research with infants, Dawson (1994) argued that distinct patterns of frontal EEG activity provide information not only about affective valence, but also about emotional intensity. Consistent with the research described previously, she found that measures of frontal EEG asymmetry differentiate between positive and negative emotions. In addition, she reported that differences in intensity of emotional expression can be reliably predicted on the basis of generalized (bilateral) activation of the frontal areas; the intensity of the infant's distress following separation from mother was strongly correlated with EEG activity in both left and right anterior regions.

Interestingly, evidence of functional asymmetry has also been found at peripheral sites. Facial asymmetries in emotional expression and lateral biases in the perception of human faces are well-established (Sackeim & Gur, 1980) and have been confirmed by EMG studies. Schwartz, Ahern, and Brown (1979), for example, found lateralized zygomatic responses to emotional stimuli, with positive emotions eliciting significantly greater EMG activity from the right side compared to the left, whereas the opposite was true for negative emotions. Finally, asymmetrical control and lateralization of function, consistent with the evidence reviewed so far, have been described at the ANS level (Leventhal & Tomarken, 1986; Porges et al., 1994).

ERP studies. The effects of particular events on brain activity can be measured by averaging samples of EEG waves that are time locked to the occurrence of the evoking stimuli (Coles, Gratton, & Fabiani, 1990). The resulting waveform is known as the *event-related potential* (ERP). The ERP waveform consists of a series of peaks and troughs that can be characterized on the basis of their polarity (positive or negative), amplitude (measured in microvolts), latency (time in milliseconds from stimulus onset to peak amplitude), and topography (scalp location). The various peaks and valleys are referred to as ERP components. The P300 is a late component consisting of a positive potential that occurs approximately 300 ms after stimulus onset. The latency of the P300 is thought to be determined by stimulus processing time, or the time required for identification and categorization of a stimulus. P300 amplitude, on the other hand, has been found to be influenced by several factors, such as the probability of an event, the relevance or meaning of the event in the context of a task, and the specific cognitive operations involved in processing and categorizing the event (Coles et al., 1990; Hoffman, 1990). Although the precise meaning of the P300 component continues to elude us, a considerable body of research has found that the P300 is maximally elicited by task-relevant events that are infrequent, unexpected, or categorically inconsistent with contextual stimuli.

From this research base, Cacioppo and coworkers (Cacioppo, Crites, Berntson, & Coles, 1993) reasoned that when participants are asked to categorize stimuli along an evaluative dimension, evaluatively inconsistent items ought to evoke larger P300 responses than evaluatively consistent ones. In a series of experiments (Cacioppo, Crites, et al., 1993; Cacioppo, Crites, & Gardner, 1996; Cacioppo, Crites, Gardner, & Berntson, 1994; Crites, Cacioppo, Gardner, & Berntson, 1995), they indeed showed that the amplitude of the late positive potential (LPP)[8] varied as a function of evaluative incongruence and concluded that this electrophysiological index may be a useful tool in the assessment of attitudes. Evaluative inconsistency was typically manipulated by presenting target stimuli that were (from an evaluative dimension) very consistent, mildly inconsistent, moderately inconsistent, and very inconsistent with a set of preceding (contextual) stimuli. The logic of their experimental paradigm could be easily applied to prejudice research. For example, if the target word *Italian* were embedded in a sequence of positively evaluated contextual stimuli, a large LPP response following the target stimulus would indicate inconsistency between the evaluative categorization of the target word and the positively evaluated context stimuli. From this electrophysiological evidence of evaluative inconsistency, then, it would be possible to infer the presence of a negative attitude toward Italians; in fact, the more negative the attitude, the larger the amplitude of the LPP to the target stimulus.

Cacioppo and his associates (Cacioppo, Crites, et al., 1993, 1994) also persuasively demonstrated that the LPP amplitude does not directly index the positive or negative valence of a given stimulus, because a large

[8] Following Crites et al. (1995), I refer to the ERP component elicited in these studies as LPP rather than P300. Although the ERP they recorded bears striking similarities to the P300, Crites et al. (1995) indicated that differences in the lateral scalp distribution between their LPP and the P300 may actually reflect differential brain processing of evaluative and nonevaluative information. As a matter of fact, in subsequent studies (Cacioppo et al., 1996; Crites & Cacioppo, 1996) they compared the scalp distribution of the ERP elicited by evaluative and nonevaluative categorization tasks. The LPP elicited by evaluative judgments was larger over the right scalp region. This asymmetrical topographic activation is, of course, consistent with the established importance of the right hemisphere in processing the hedonic value of stimuli (cf. Leventhal & Tomarken, 1986; Tucker, 1981; Tucker & Frederick, 1989).

LPP can be elicited equally by positive and negative target stimuli. The necessary requirement is that the target stimulus be evaluatively inconsistent with the preceding items; thus attitude polarity is gleaned indirectly from knowledge of the context in which the target stimulus is embedded. Furthermore, this research team provided compelling evidence that the LPP component of the ERP can be used to assess attitudes that people are unwilling to report. Crites et al. (1995) found that when participants were instructed to intentionally misreport their attitudes toward target stimuli, the LPP amplitude still correctly identified their implicit evaluative judgments. Not surprisingly, recent research (reviewed by Bashore & Rapp, 1993) has indicated that ERP components can be used successfully in the detection of deception, even when peripheral measures, used in traditional polygraphic approaches, prove ineffective.

Neuroimaging Research

Most recently, a number of studies have employed neuroimaging techniques to investigate the relationship between regional brain activity and emotion. In the majority of these studies, regional cerebral blood flow (rCBF) was measured by positron emission tomography (PET), and various emotion induction procedures were used either alone or in combination (e.g., Baker, Frith, & Dolan, 1997; Drevets et al., 1992; George et al., 1995; Kosslyn et al., 1996; Lane, Reiman, Ahern, Schwartz, & Davidson, 1997; Morris et al., 1996; Paradiso et al., 1997; Pardo, Pardo, & Raichle, 1993; Reiman et al., 1997). In the typical study, the rCBF associated with happiness is compared to the rCBF produced by one or two negative emotions (i.e., sadness, fear, or disgust), and by emotionally neutral stimuli.

Although this research generally finds regional differentiation of emotion, the most striking picture emerging from the neuroimaging literature is one of great inconsistency across studies in the particular neuroanatomical structures that are activated by individual emotions. This lack of converging evidence is apparent not only when one considers the question of whether distinct neural substrates underlie each emotion category, but also with respect to the simpler issue of whether affective valence can be discriminated on the basis of differential brain activation patterns. Several reasons have been suggested for these replication difficulties, including differences across studies in the procedures used to elicit emotions (Lane et al., 1997; Reiman et al., 1997; Robinson, 1995); the possibility that changes in rCBF may not be mediated by specific emotions but may instead be the byproduct of other brain operations, such as attention and memory functions, and cognitive categorization of ongoing stimuli (Robinson, 1995); as well as technical limitations of PET imaging procedures (Lane et al., 1997).

One especially puzzling aspect of the neuroimaging literature is its failure to corroborate the affective valence lateralization hypothesis, which frontal asymmetry EEG studies, described earlier, have reliably supported. Contrary to the EEG findings, several PET studies have reported that: (a) negative emotions either activate left hemisphere frontal regions, or fail to increase rCBF in frontal areas on the right side (Drevets et al., 1992; George et al., 1995; Kosslyn et al., 1996; Paradiso et al., 1997; Pardo et al., 1993); (b) positive emotions either activate frontal areas on the right side, or fail to elicit greater rCBF in left hemisphere anterior regions (Baker et al., 1997; George et al., 1995; Paradiso et al., 1997); and (c) both positive and negative emotions activate frontal regions bilaterally (George et al., 1995; Lane et al., 1997; Pardo et al., 1993). Furthermore, asymmetry analyses for individual emotions, when performed, have found no emotion-specific asymmetrical activation pattern (Lane et al., 1997).

Prejudice Assessment: Lessons From Emotion Research

Table 3 presents a summary, based on this review, of the various psychophysiological methods that have been used in the study of emotion, together with an assessment of their ability to differentiate emotional categories (i.e., each specific type of emotion, such as fear, happiness, anger, etc.) and emotional dimensions (i.e., valence and intensity). It is evident that none of those experimental paradigms reliably discriminates among specific emotion categories. It is also clear, however, that all of the procedures summarized in Table 3, except for neuroimaging methods, can provide information about the affective valence of emotional stimuli. The same can be said about affective intensity (arousal), although the overall evidence for accurate intensity estimation is not as abundant or as robust as it is for valence differentiation. At this point, ANS measures appear to be better indicators of emotional intensity than of affective direction. An important point to keep in mind in evaluating this literature is that much of the evidence available is laboratory-specific. Although integrative views have been offered (e.g., Cacioppo, Klein, et al., 1993; LeDoux, 1993, 1996), and examples of multimodal research can be cited (e.g., Bradley, Cuthbert, & Lang, 1996; Hubert & de Jong-Meyer, 1991; Lang et al., 1993; Witvliet & Vrana, 1995), most of the work that supports the value of the startle probe, of frontal asymmetry measures, of the LPP

Table 3. *Summary of Psychophysiological Approaches*

Methodological Approach	Categorical Differentiation	Dimensional Differentiation	
		Affective Valence	Affective Intensity
ANS measures	Inconclusive evidence	Some evidence that HR, and perhaps SCR, discriminate between pleasant and unpleasant stimuli, but findings are generally inconsistent	SCR and HR positively correlated with emotional intensity
Semantic conditioning and generalization of the CR (autonomic)	Not designed to test the categorical hypothesis	Affective direction based on generalization of CR to stimuli similar in valence to CS	Amplitude of generalized CR presumably indicates affective intensity
Facial EMG	No reliable differentiation of emotional categories	• Corrugator supercilii activity: ↑ to unpleasant stimuli ↓ to pleasant stimuli • Zygomaticus major activity: ↑ to pleasant stimuli ↓ to unpleasant stimuli	For both muscles, EMG activity increases as the intensity of the associated emotion increases
Startle probe (e.g., eyeblink reflex)	Not designed to test the categorical hypothesis	Inhibition of reflex by positive emotional stimuli, potentiation of reflex by negative emotional stimuli	Some evidence that startle modulation (in either direction) may occur only for high-arousal stimuli
EEG: frontal asymmetry	Not designed to test the categorical hypothesis	• Positive (approach-related) stimuli: ↑ activation of left frontal region • Negative (withdrawal-related) stimuli: ↑ activation of right frontal region	Preliminary evidence that bilateral activation of frontal areas is positively correlated with emotional intensity
Event-related potentials: LPP	Not designed to test the categorical hypothesis	LPP amplitude is a marker of evaluative inconsistency; valence information is extracted from contextual stimuli	LPP amplitude varies with the degree of evaluative incongruence
Neuroimaging of rCBF: PET	No reliable evidence for neuroanatomical correlates of specific emotions	No reliable evidence for regional valence differentiation; findings are inconsistent with EEG evidence for hemispheric lateralization of affective valence	No reliable evidence relating rCBF patterns to emotional intensity

Note: ANS = autonomic nervous system; HR = heart rate; SCR = skin conductance response; CR = conditioned response; CS = conditioned stimulus; EMG = electromyography; LPP = late positive potential; rCBF = regional cerebral blood flow; PET = positron emission tomography.

and, to a lesser degree, of semantic conditioning, has been conducted, in each case, by one research team. Cross-laboratory replications are clearly needed before definitive statements can be issued on the effectiveness of these procedures. In fact, a side benefit of renewed interest in the psychophysiological study of prejudice would be cross-fertilization of the emotion literature, which would benefit a great deal from independent replications by different laboratories.

The research findings summarized in Table 3 bear importantly on conceptual models of emotion and on controversial theoretical issues, such as the role of attentional and cognitive mechanisms in processing emotional stimuli. Here, however, I take a more pragmatic approach and focus on the implications of that research for the study of prejudice.

As suggested earlier in this article, the striking neglect of psychophysiological measures by prejudice investigators over the last 15 to 20 years may be partly attributable to the view that patterns of physiological activity do not differentiate specific emotion categories. On the basis of this review, that conclusion is irrefutable. It would certainly be of interest to know whether the emotion experienced in response to an attitude stimulus is fear, anger, or disgust, and this knowledge could clearly assist in the development of prevention and intervention programs aimed at stamping out the scourge of prejudice in society. Differentiation among negative emotions, however, is not required when the question at hand is whether an individual's response to an attitude stimulus is positive or negative, and, especially in the latter case, how strong the attitude is. In fact, as indicated earlier, arousal information may be all that is necessary in prejudice studies. With a single exception (Vanman et al., 1997), the psychophysiology of prejudice literature, reviewed in the first part of this article, relied exclusively on ANS measures of affective reactions to target stimuli. On the other hand, the psychophysiology of emotion literature indicates that ANS measures are better indexes of the arousal dimension than of affective valence. One may wonder, then, why those early studies were generally successful in identifying prejudiced responses on the basis of ANS indicators. A plausible reason may be that prejudiced attitudes are essentially univalent and do not encompass the full affective range (from strongly positive to strongly negative). Arousal, in the context of stimuli toward which people's reactions range from neutral (or mildly positive) to strongly negative, necessarily carries also valence information, making independent estimates of affective direction unnecessary. That said, there is no doubt that, whenever feasible, psychophysiological approaches that index both emotional dimensions are to be preferred as they provide finer discrimination and a more complete assessment of the construct.

Most of the psychophysiological procedures summarized in Table 3 provide reliable information about both the valence and intensity dimensions of emotion. Furthermore, these procedures appear to have the requisite sensitivity to detect relatively small degrees of the construct. Cacioppo and his associates have pointed out that psychophysiological measures can be useful indicators of evaluative and affective responses even when the person is unable or unwilling to report them. Accurate valence discrimination on the basis of facial EMG, for example, is still possible when muscle contractions are so imperceptible that observers, who are unaware of the research hypothesis, cannot detect them (Cacioppo et al., 1986, 1988). Similarly, Crites et al. (1995) showed that the LPP tracks the valence of evaluative judgments even when participants are explicitly instructed to misrepresent them.

The semantic conditioning procedure and the LPP probe appear to index cognitively-based evaluative processes more than raw affective responses. On the other hand, they should be of interest to the prejudice researcher because they were expressly developed to assess attitudes. The classical conditioning approach, in particular, has been used successfully to study racial attitudes (Tognacci & Cook, 1975). The logistic and technical demands associated with both the conditioning and the ERP paradigms, however, might discourage many potential users. The same can probably be said about the EEG asymmetry approach. Facial EMG recording would be relatively simpler from a technical perspective, and the utility of this approach in the study of prejudice has been clearly demonstrated by Vanman et al. (1997). On the other hand, the fact that facial muscles are under voluntary control and are activated also in response to nonemotional stimuli raises important conceptual issues (Cacioppo et al., 1986, 1988). Facial expressions indicative of particular emotional states could be inhibited or enhanced in an effort to deceive the observer, especially when the motivation to do so is driven by strong social desirability concerns, as one could reasonably expect in prejudice investigations. Thus, future EMG studies of prejudice will need to adopt appropriate procedures so as to reduce participants' awareness of the research hypothesis. Vanman et al. (1997), for example, attached dummy electrodes to the neck, although the signals of interest were recorded from the face. At debriefing, none of their participants reported knowledge of the hypothesis under investigation.

ANS measures, which have been found useful by most of the prejudice studies summarized in Tables 1 and 2, could yield valuable information about the intensity of raw affective responses to attitude stimuli although, as noted earlier, their ability to discriminate affective valence has not been firmly established.

Setting aside neuroimaging approaches, which are both technically cumbersome and generally ineffective, we are left with the startle probe paradigm. This procedure appears to have the advantage of simplicity and a considerable body of evidence attests to its effectiveness in reliably differentiating affective valence and intensity. To this author's knowledge, however, no prejudice study has used the startle probe. It would be interesting to determine whether potentiation or inhibition of magnitude and latency of the eyeblink reflex, elicited by an acoustic probe and recorded electromyographically, differentially mark the affective valence of racially charged stimuli. It could be objected that the repeated presentation of startle probes may lead to habituation (i.e., the weakening and eventual disappearance of the eyeblink response as a function of repetitive presentations of the acoustic eliciting stimuli). Lang et al. (1990), however, reported that the eyeblink reflex is relatively resistant to habituation, dishabituates rapidly, and can be elicited as many as 40 to 50 times within a 30-min period. In an experiment expressly designed to assess habituation patterns of the acoustic startle response and of other peripheral somatic and autonomic measures, Bradley, Lang, and Cuthbert (1993) found that although the eyeblink habituates over trials, its differential modulation of affective valence does not; as a matter of fact, its valence discrimination power improved after some habituation had occurred. However, a recent study by Cuthbert, Bradley, and Lang (1996) might dampen somewhat premature enthusiasm about the possible utilization of the startle probe in prejudice research. These investigators have presented evidence that the potentiation and inhibition of the startle reflex to unpleasant and pleasant stimuli, respectively, are dependent on the arousal value of those stimuli. In particular, affective modulation of the eyeblink reflex was found for high-arousal slides but not for low arousal stimuli. If this were confirmed, and if the typical stimuli used in prejudice research indeed elicit a truncated range of affective intensity, the applicability of the startle probe to the study of prejudice may be compromised. Interestingly, in the same study, Cuthbert et al. also found that both skin conductance and heart rate differentiate affective valence as well as arousal value of the stimuli. Larger skin conductance responses and greater heart rate deceleration were elicited by unpleasant, compared to pleasant, stimuli, and by high-arousal, compared to low-arousal, slides. Moreover, skin conductance analyses revealed a highly significant interaction between stimulus valence and arousal such that valence discrimination, on the basis of skin conductance responses, became difficult at high arousal levels. In summary, the results of this research indicate that magnitude of the eyeblink reflex can discriminate stimulus valence only at high levels of arousal, whereas skin conductance loses its ability to differentiate valence when stimuli have high arousal values. This, obviously, suggests that each measure provides unique information and that the inclusion of both might yield a much more complete picture of affective responses to stimuli than either one alone.

The use of multiple physiological measures seems especially wise in view of accumulating evidence that different emotional dimensions are best indexed by different physiological probes. In a very recent study, Schupp, Cuthbert, Bradley, Birbaumer, and Lang (1997) measured eyeblink and P300 responses elicited by an acoustic startle probe during exposure to IAPS slides. Affective valence of the pictures modulated eyeblink response magnitude, but P300 amplitude varied primarily as a function of the arousal dimension. Similarly, Witvliet and Vrana (1995) examined a variety of startle responses evoked during affective imagery that varied in valence and arousal. They recorded the eyeblink reflex, facial EMG, and ANS measures (skin conductance and heart rate), and found that autonomic responses were modulated by affective arousal, whereas the magnitude of the eyeblink reflex and various patterns of facial muscle activity were modulated by both arousal and valence of the imagined situations.

The multimodal approach exemplified by the research just described holds a great deal of promise. As noted earlier in this article, mere evaluations of an attitude object and gut-level emotional responses probably reflect very different affective states. The ERP and semantic conditioning procedures are, in a sense, the psychophysiological equivalents of automatic associations and priming measures; they do not index raw affect but reflect instead cognitive operations from which evaluations of the stimulus can be indirectly inferred. It would be useful to determine, possibly in the same study, whether such electrophysiological and priming measures yield, in fact, convergent findings. Furthermore, it would be of interest to compare this information with that obtained from psychophysiological measures of raw affect. What seems clear, at this point, is that a multimodal approach is the best strategy for the study of prejudice. This point is fully articulated next.

Future Prejudice Research: A Proposal

Important methodological and theoretical issues regarding the relationship between affect and cognition in determining intergroup attitudes and behavior were discussed in an earlier section. Two general conclusions were reached on the basis of the available evidence. First, both implicit and explicit measures need

to be used as they appear to index two separate processes, often referred to as automatic and controlled. Second, affect and cognition are best conceptualized as parallel and probably interactive networks (cf. Stephan & Stephan, 1993) that contribute uniquely to intergroup attitudes and whose relative influence is likely to be context-dependent (Vrana & Rollock, 1996) and may vary for different attitudes (Edwards, 1990). In view of this methodological and conceptual complexity, the often-accepted assumption that understanding the cognitive processes involved in prejudice necessarily carries information about the affective and behavioral dimensions is no longer justified. Each of those components, instead, needs to be investigated with sufficient precision and with construct-congruent methods. Furthermore, in each case these methods must be able to assess the construct at both levels of processing (i.e., automatic and controlled responses).

What is proposed here is a tricomponent, bilevel, multimethod assessment model, according to which the three basic components of intergroup attitudes (cognitive, affective, and behavioral) are investigated at both the implicit and the explicit levels (see Table 4). Each cell in this 3 × 2 assessment scheme needs to be studied with appropriate methods that the literature has shown to have demonstrated utility. The cognitive bases of prejudice can be investigated, at the implicit level, by means of automatic stereotype activation procedures (e.g., priming paradigms) and, at the explicit level, with traditional self-report measures such as adjective checklists and diagnostic ratios. Noncontrolled affective responses to attitude objects can be studied with psychophysiological procedures, whereas controlled emotional reactions can be assessed with standard self-report measures such as feeling thermometers, intergroup anxiety scales, and emotion checklists. Finally, unobtrusive behavioral indexes will provide information about the implicit behavioral consequences of prejudice, whereas self-reported discriminatory behaviors and social distance preferences will assess the explicit behavioral correlates of prejudiced attitudes.

Admittedly, the dividing lines in this classification scheme are somewhat blurry and the precise location of individual assessment procedures is currently difficult to determine. Several measures straddle the implicit–explicit and the cognitive–affective distinction lines. The Modern Racism Scale, for example, was originally intended to provide evidence of subtle racism unacknowledged by the perceiver, but it is clearly a reactive measure that is vulnerable to control efforts. Moreover, the statements included in this scale assess participants' general beliefs about race issues, but are also affectively tinged. As noted earlier, priming strategies and the implicit association test are essentially cognitive procedures which, however, are believed to index also an evaluative dimension. Similarly, the LPP probe is a cognitive psychophysiological method that reflects primarily stimulus categorization processes but can also be used to extract evaluative responses to the stimulus. With respect to level of processing, there is debate about whether priming procedures are truly implicit. The unconditional automaticity of stereotype activation, for example, has been challenged (e.g., Gilbert & Hixon, 1991; Macrae, Bodenhausen, Milne, Thorn, & Castelli, 1997). The same can be said about at least one psychophysiological measure. As discussed earlier, electromyographic activity is under voluntary control, although protective measures can be implemented to prevent participants' awareness.

It is indeed the complexity of these multidirectional interactions among constructs and among measures that argues for the value of the assessment approach proposed here. Single-method strategies are poorly equipped to unravel those entangled relationships (cf. Guglielmi & Tatrow, 1998, for a discussion of the single-method trap in a different research domain). The cognitive approach has dominated empirical work in the intergroup attitude field for many years. The focus needs to be broadened to the affective dimension that cannot be fully assessed with self-report measures or with cognitively-based procedures; thus the importance of the psychophysiological strategy advocated in this article. The integrative model presented in Table 4

Table 4. *A Tricomponent, Bilevel, Multimethod Model for the Assessment of Stereotyping, Prejudice, and Discrimination*

	Level of Processing–Level of Measurement	
Intergroup Attitude Component	**Automatic–Implicit**	**Controlled–Explicit**
Cognitive	Implicit stereotypes and associations (e.g., priming procedures, implicit memory and implicit association tests)	Self-reported stereotypes and beliefs (e.g., adjective checklists, diagnostic ratios, Modern Racism Scale[a])
Affective	Psychophysiological methods (see Table 3)	Self-reported affective responses (e.g., intergroup anxiety scales, emotion checklists, feeling thermometers)
Behavioral	Unobtrusive behavioral indices (e.g., nonverbal cues, covert measures of prosocial and aggressive behavior)	Self-reported discriminatory behaviors (e.g., social distance preferences)

[a]McConahay, Hardee, and Batts, 1981.

would help clarify the intricate relationships among stereotyping, prejudice, and discriminatory behavior. When the role of moderator variables (e.g., Dunton & Fazio's, 1997, motivation to control prejudiced reactions) and the role of contextual factors are also considered, this approach will move the field toward the development of more complete theoretical models of intergroup attitudes in which the independent and interactive influences of the various components are fully articulated. In turn, these multivariate frameworks should prove heuristically fertile by organizing research findings, clarifying inconsistencies, and suggesting meaningful research questions.

An important issue that could be effectively addressed with the adoption of a multimodal approach concerns, for example, the particular role of affect in intergroup attitudes and the extent to which different affective states, marked by different degrees of physiological arousal, may contribute differently to attitudinal and behavioral outcomes. It stands to reason that cold, cerebral evaluations of an attitude object might relate to cognitive and motivational processes differently than hot, emotional reactions to the object in question. If there is a continuum of affective responses characterized by increasing intensity of physiological arousal, we need to know how this intensity dimension colors people's cognitive, affective, and behavioral responses at both the implicit and explicit levels. More specifically, nonverbal behaviors (e.g., prosocial tendencies, eye contact, avoidance) and extreme intergroup behaviors (e.g., hate crimes and other types of intergroup aggression) might be much more accurately predicted on the basis of high arousal affective responses than by self-reported social distance preferences or by evaluative indexes. Arousal is also likely to have a differential impact on cognitive and affective processes (see, for example, Stephan & Stephan, 1993). Focused predictions regarding the role of arousal could be empirically tested if the appropriate methodology is used.

There is a great deal of value in extending our analysis of prejudice from a rigid cognitive perspective to a multidimensional view that makes use of multimethod measurement strategies. The methodological and conceptual proposal outlined in this section is consistent with the recommendations issued in several recent and influential analyses of the state of prejudice research (e.g., Dovidio et al., 1996; Fiske, 1998; Mackie & Smith, 1998). All of them have urged greater conceptual integration, greater attention to the contribution of affect, and the adoption of measures that are better equipped to study the multifaceted nature of this social phenomenon. Thinking about intergroup attitudes in broad theoretical terms that include attention to affective processes would not only enhance our understanding of the structure of prejudice, it might also help us formulate more effective strategies for its reduction. Edwards (1990), for example, presented evidence that certain attitudes are more cognitively based and others are more affectively based. She pointed out the wisdom of distinguishing the two types as they respond to different modification strategies. In particular, affect-based attitudes responded more to affective means of persuasion than to cognitive persuasive appeals, whereas cognition-based attitudes responded equally to the two counterattitudinal strategies. To the extent that intergroup attitudes are affectively based, Edwards's findings would argue against the simplistic view that ignorance breeds prejudice and that all the prejudiced person needs is more information.

At the risk of oversimplifying a complex and weighty social phenomenon, an affective reconceptualization of prejudice might also reveal interesting parallels between prejudice and phobic syndromes. Negative affect, particularly anxiety, has been discussed as a central component of intergroup encounters (Britt, Boniecki, Vescio, Biernat, & Brown, 1996; Dijker, 1987; Stephan & Stephan, 1993; Vanman & Miller, 1993). Anxiety is also the key element of phobias, and it is tempting to think of xenophobia, ethnophobia, and homophobia as maladaptive social manifestations of the same processes that lead to the development of phobic disorders. Phobias cannot be understood from a purely cognitive perspective. In phobias, the emotional response is prepotent and it occurs in the face of an intact appraisal system. Patients readily recognize the irrationality of their fears and are aware of their tendency to overestimate danger. Such understanding, however, does not prevent the automatic emotional reactions. Asking phobic patients to evaluate whether the snake, the airplane, or the mouse are "pleasant" or "unpleasant," "good" or "bad," would fail to capture the gut-level nature of the response. For these reasons, phobias do not respond to purely cognitive intervention strategies; the treatment of choice consists of exposure and response prevention procedures.

A similar analysis can be applied to prejudice. Just as in phobias, avoidance and escape behaviors may maintain prejudiced attitudes by reducing the anxiety elicited by intergroup encounters which, in turn, negatively reinforces the avoidance behavior and perpetuates it. Viewed in this way, the exposure and response prevention approach can be considered the clinical counterpart of the contact hypothesis for reducing prejudice (Allport, 1954; Amir, 1969). For a number of years, social psychological research has explored and debated the particular conditions under which intergroup contact promotes stereotype disconfirmation and change in the way people are categorized (e.g., Brewer & Brown, 1998; Brewer & Miller, 1984; Gaertner, Dovidio, Anastasio, Bachman, & Rust, 1993; Hewstone & Brown, 1986). Various cognitive

processes have been invoked to explain cases when enhanced contact failed to reduce prejudice. From a clinical perspective, exposure to the feared stimulus will not prove efficacious unless it is accompanied by anxiety reduction. In fact, the key element of this therapeutic approach is that exposure cannot be terminated unless anxiety (often monitored physiologically) begins to abate. Applied to prejudice, this suggests that intergroup contact will be ineffective unless it is associated with a reduction in negative affect. By implication, social psychologists should pay special attention to the conditions under which intergroup contact may actually fuel anxiety (cf. Dijker, 1987; Islam & Hewstone, 1993). Finally, the clinical literature also suggests that generalization of the desired response is facilitated by exposing the patient to various forms of the feared stimulus. This approach might also be useful in intergroup situations in which generalization of attitude change has failed to occur.

Conclusions

The subtle nature of modern prejudice raises important measurement issues, especially in view of growing evidence that it may operate outside of the individual's awareness. Although impressive progress has been made in understanding and assessing the implicit cognitive processes involved in intergroup attitudes, the need for nonreactive and sensitive indexes of affect is greater today than ever before. Several psychophysiological procedures have demonstrated their value in the assessment of dimensional aspects of emotion and should be profitably added to the study of prejudice as they fill an evident methodological gap. Such a recommendation is certainly consistent with the prevailing theoretical winds in the study of intergroup processes. Prejudice research is ready for a return to psychophysiological strategies which, however, need to be considered in addition to, not in lieu of, other measurement approaches. Different methodologies provide unique information and all of them are needed to understand the multifaceted nature of prejudice. For these reasons, the most conceptually and heuristically productive strategy is the adoption of a multimethod assessment model.

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