Ethnic Differences in Thermal Pain Responses

ROBERT R. EDWARDS, BA, AND ROGER B. FILLINGIM, PHD

Objective: Although numerous studies have reported ethnic differences in the prevalence and severity of clinical pain, little is known about how these differences affect the perception of experimental pain. The present experiment examined the effects of ethnicity (African American vs. white) on thermal pain responses in a healthy undergraduate population. **Methods:** Thirty white subjects (16 women and 14 men) and 18 African Americans (10 women and 8 men) participated in the study. Thermal testing included evaluation of the following: warmth thresholds, thermal pain thresholds, thermal pain tolerances, and magnitude estimates of both the intensity and unpleasantness of thermal pain (at 46°, 47°, 48°, and 49°C). **Results:** Although no group differences emerged for warmth thresholds, thermal pain thresholds, or pain intensity ratings, African Americans demonstrated lower thermal pain tolerances than whites. In addition, African Americans had smaller slopes and larger intercepts than whites for ratings of pain unpleasantness. Additional analyses suggested that these findings were a consequence of group differences in thermal pain unpleasantness ratings at the lowest temperatures assessed (46° and 47°C); at these temperatures, African Americans rated the stimuli as more unpleasant than whites. Finally, group differences in thermal pain tolerance and thermal pain unpleasantness ratings seemed to partially account for greater self-reported daily pain symptoms among African Americans. **Conclusions:** Collectively, these findings seem to suggest ethnic differences in the perception of the affective-motivational dimension of thermal pain. **Key words:** ethnicity, race, thermal pain, pain sensitivity.

WTH = warmth threshold; TPTH = thermal pain threshold; TPTO = thermal pain tolerance; KRS = Kohn Reactivity Scale; BSRI = Bem Sex-Role Inventory; PILL = Pennebaker Inventory of Limbic Languidness.

INTRODUCTION

Reports of ethnic or cultural differences in the experience of pain are hardly a recent phenomenon. Zborowski's (1, 2) pioneering work in the 1950s and 1960s laid the groundwork for many of the more recent investigations of the relationship between ethnicity and the experience of pain. As summarized by Encandela (3), Zborowski's work has led to new developments in definitions of pain, ethical considerations in pain treatment, the role of learning factors in the expression of pain, and advancing comprehension of cultural and racial factors in chronic pain and illness. With respect to this latter development, numerous clinical studies, investigating a wide variety of painful conditions, have suggested ethnic differences in pain perception. Several investigators have recently noted differences between African Americans and whites in various forms of clinical pain. Specifically, African Americans report greater levels of pain than whites for such chronically painful conditions as glaucoma (4), AIDS (5), migraine headache (6), jaw pain (7), postoperative pain (8), and myofascial pain (9). Interpretations of such findings remain difficult, however, because of potential group differences in disease severity (6) and physician management (10). With respect to the latter factor, several studies have indicated that physicians tend to prescribe less analgesic medication for African Americans than for whites (11, 12), although contrary findings have also been reported (13).

Although the mechanisms underlying these differences remain unclear, one plausible explanation involves enhanced pain sensitivity on the part of African Americans. That is, if African Americans were more sensitive than whites to noxious stimuli, then they would be expected to report relatively greater clinical pain. However, in contrast to the fairly rich clinical literature, relatively few experimental studies have examined differences between whites and African Americans in responses to experimental pain. In a review of this literature, Zatzick and Dimsdale (14) noted that methodological considerations, such as the diversity of racial groups studied and methods of pain induction, have varied widely across studies. Indeed, of the 13 studies identified in this review, only three examined differences between whites and African Americans in responses to experimental noxious stimuli. Woodrow et al. (15) investigated racial differences in pain tolerance using mechanical pressure applied to the Achilles tendon; relative to African Americans, whites demonstrated higher pain tolerances. Similarly, Walsh et al. (16), using the cold pressor test as the method of pain induction, reported greater pain tolerance among whites than among African Americans. Finally, Chapman and Jones (17) indicated that whites possessed greater heat pain thresholds and tol-

From the Department of Psychology, University of Alabama at Birmingham, Birmingham, Alabama.

Address reprint requests to: Roger B. Fillingim, PhD, Department of Psychology, University of Alabama at Birmingham, 1300 University Blvd., Birmingham, AL 35294-1170. Email: Rfilling@uab.edu

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erances than did African Americans, although this study seems to suffer from several methodological flaws (14), including collapsing of multiple ethnic groups into one "non–Anglo-Saxon" group (16), failure to specify subjects' gender and experimenter ethnicity (17), and use of only unitary pain measures (ie, threshold and/or tolerance) (16, 17).

These three experimental studies, widely separated in time and utilizing diverse methodologies, collectively suggest differences between whites and African Americans in responses to experimental noxious stimuli. However, these studies relied on unitary measures of pain and did not directly assess both the sensory and affective dimensions of pain. Notably, several authors have suggested that clinical pain may be more highly related to the affective-motivational dimension of pain than the sensory-discriminative dimension (18, 19); thus, enhanced clinical pain in African Americans relative to whites indicates that differences in pain perception might be most prominent for measures of pain unpleasantness. Accordingly, the present study sought to support and extend previous research by investigating race-related differences in both sensory and affective responses to thermal pain. In addition, the relationship between thermal pain responses and self-reported clinical pain complaints was examined to determine (1) the clinical relevance of laboratory measures involving administration of noxious thermal stimuli and (2) whether group differences in responses to these stimuli might account for group differences in reported daily pain symptoms. Furthermore, because numerous investigators have suggested that psychological factors exert a sizeable influence on affective-motivational aspects of pain (20, 21), the role of psychological factors in these group differences was investigated.

METHODS

Participants

Forty-eight students (18 African Americans and 30 whites) enrolled in a Psychology 101 course participated in this study for course credit. Subjects' ages ranged from 18 to 47 years. No participants reported histories of chronic pain, diabetes, cardiac disease, or other conditions known to influence pain perception. Before beginning the experiment, all participants gave written consent, in which they were informed of their right to withdraw from the study at any time. No subjects reported any prior experience with experimental pain procedures. All testing took place in a quiet room, with the subject seated on a comfortable armchair, resting the tested limb on a pillow. Testing took place in a single session lasting approximately 1.5 hours. A single experimenter conducted each test session; a total of three experimenters (two white men and one African American woman) conducted the test sessions. All procedures were approved by the human subjects committee of the University of Alabama at Birmingham.

Only subjects who identified themselves unequivocally as either African American or white were selected for this study. One participant was omitted from subsequent analyses because she did not select the "African American" option but rather wrote in "African" under the "Other" category. Three other participants were disqualified because they were neither African American nor white (two indicated that they were Asian, and one identified herself as Hispanic).

Psychological Measures

Before undergoing the psychophysical procedures described below, all subjects completed a questionnaire packet containing the following standardized measures: the KRS, the BSRI, and the PILL. The KRS (22) is a valid, reliable measure of reactivity, a construct that has been related to pain tolerance and ratings of pain intensity (23). The BSRI (24) measures the two orthogonal dimensions of masculinity and femininity, yielding three subscale scores: masculinity, femininity, and androgyny. The validity and reliability of the BSRI are well established (25, 26). In addition, BRSI masculinity and femininity scores have been related to experimental pain (27). The PILL (28) is a measure of recent symptom reporting; the construct underpinning this inventory is that of somatic focus or somatization. Scores on the PILL seem to be related to both clinical and experimental pain (29–31). In addition, subjects completed questionnaires assessing demographic information and health history. Finally, subjects' reports of pain in the previous month were assessed. Subjects indicated the number, severity (0–100 scale), and duration of the following symptoms during the previous month: headache, backache, muscle pain, joint pain, stomach pain, premenstrual or menstrual pain, dental or facial pain, and other pain. These data were condensed to yield three scores: the number of pain sites, total number of pain episodes, and average severity of pain episodes.

Psychophysical Procedures

Contact heat stimuli were delivered using a computer-controlled Medoc Thermal Sensory Analyzer (TSA-2001, Ramat Yishai, Israel), which is a peltier element-based stimulator. Temperature levels were monitored by a contactor-contained thermistor and were returned to a preset baseline temperature (32°C) by active cooling at a rate of 10°C/second. The 9-cm^2 contact probe was applied to the left volar forearm and affixed in place with Velcro straps.

Warmth thresholds, heat pain thresholds, and heat pain tolerances were assessed using an ascending method of limits. From a baseline of 32°C, contactor temperature increased at a rate of 0.5°C/second until the subject responded by pressing a button. The cutoff temperature (to avoid tissue damage) for all trials was 50°C. Interstimulus intervals of at least 30 seconds were maintained between successive stimuli to avoid either sensitization or habituation of cutaneous receptors.

Magnitude estimates of pain intensity and unpleasantness were measured using numerical scales (0–100) with the following anchors: for pain intensity, zero corresponded to "no pain at all," and 100 was equivalent to "the most intense pain imaginable"; for pain unpleasantness, zero was "not unpleasant at all," and 100 was "the most unpleasant pain imaginable." Thermal stimuli of 46°, 47°, 48°, and 49°C, in random order, were delivered for 5 seconds each. Contactor temperature increased at a rate of 4°C/second from a baseline of 32°C to the stimulus temperature, remained at that temperature for 5 seconds, and decreased to the baseline temperature at a rate of 4°C/second. Again, a minimum of 30 seconds separated each trial.

Thermal stimuli were delivered in the following order: four trials

of WTH, four trials of TPTH, and four trials of TPTO, followed by two blocks of magnitude estimation trials, each of which contained eight thermal stimuli (two trials each of 46°, 47°, 48°, and 49°C stimuli in random order). WTH, TPTH, and TPTO were always assessed first. Next, subjects were instructed in the conceptual distinction between pain unpleasantness and intensity using the instructions of Price et al. (32)

> There are two primary aspects of pain that we are interested in measuring; the intensity, how strong the pain feels, and the unpleasantness, how unpleasant or disturbing the pain is for you. The distinction between these two aspects of pain might be made clearer if you think of listening to music on a radio. As the volume of the music increases, I can ask you how loud it sounds or how unpleasant it is to hear. The intensity of pain is like loudness. The pleasantness or unpleasantness of the music depends on how much you like or dislike the music. The unpleasantness of pain depends on how much you dislike the feeling.

For one block of magnitude estimation trials, ratings of pain intensity were obtained, whereas for the other block, subjects gave ratings of pain unpleasantness. The order of the two blocks of magnitude estimation trials was randomized. The position of the thermode was altered slightly between blocks of trials (although it remained on the ventral forearm) to avoid sensitization or habituation.

Data Analysis

Data are presented as means and standard errors. Because of distributional nonnormality, as well as group differences in sample sizes and variability, the significance of simple group differences was determined using the Wilcoxon rank-sum test (33, 34). For measures of pain threshold and pain tolerance, the mean of the last three trials was determined and used in subsequent analyses.

Magnitude estimation data for pain intensity and pain unpleasantness were transformed to power functions according to the method of Harkins et al. (19) and Price and Harkins (35). Briefly, stimulus-response functions are plotted for thermal stimulus temperatures and pain ratings, with separate functions for estimates of intensity and unpleasantness. After log-transformation of stimulus temperatures and magnitude estimates, the latter variable is regressed on the former. Slopes and intercepts for the resultant regression lines (separate analyses are conducted for ratings of intensity and unpleasantness) of individual subjects are then amenable to group analysis.

Analysis of variance was used to test for interactions between race and rating scale (intensity vs. unpleasantness) for slopes and intercepts. Significance level was set at $p < .05$ for each analysis. All analyses were performed using Statistical Analysis System (SAS) software.

RESULTS

To ascertain the effect of different experimenters on subjects' responses, the results from the sessions conducted by the female African American experimenter (a total of 17) were compared with those conducted by either male white experimenter (a total of 31). No differences were observed for measures of WTH, TPTH, and TPTO or for magnitude estimates (all p values $>.2$). Additionally, no experimenter race × subject race interactions were observed for these variables (p values $>.1$), suggesting that experimenter race did not differentially affect African American and white subjects.

Whites and African Americans did not differ significantly (p values $>.6$) in age (whites: mean = 21.3, SE = 1.1, range = 18–46 years; African Americans: mean = 23.2, SE = 1.8, range = 18–47 years) or proportion of women relative to men (53% women and 47% men in the white group; 56% women and 44% men in the African American group). Furthermore, no group differences were observed in reports of family income ($p > .1$) or the proportion of individuals reporting a family history of chronic pain (50% with a positive family history in the white group; 38% with a positive family history in the African American group; $p > .3$). No group differences were observed on measures of WTH or TPTH (p values $>.2$); however, group differences did emerge on the measure of TPTO, with whites demonstrating significantly greater tolerances than African Americans ($Z(1,46) = 2.25$, $p < .05$). WTH, TPTH, and TPTO data are presented in Table 1.

Magnitude estimation data for pain intensity and pain unpleasantness were transformed to power functions as described above. Significant group × rating scale interactions were observed for function slopes ($F(1,46) = 7.0$, $p < .01$) and intercepts ($F(1,46) = 7.6$, $p < .01$). Further analysis indicated that even though no group differences were apparent for ratings of pain intensity (p values $>.8$), African Americans had greater intercepts and lower slopes than whites for ratings of pain unpleasantness (p values $<.01$). Slopes and intercepts for ratings of pain intensity and unpleasantness are presented in Table 2.

Magnitude estimates of pain intensity and unpleasantness were both positively accelerating functions of nociceptive skin temperature. Magnitude estimate data are presented in Figures 1 (pain intensity ratings) and 2 (pain unpleasantness ratings).

To elucidate observed differences in function slopes and intercepts, group differences in magnitude estimates of pain intensity and unpleasantness were examined at each stimulus temperature. Wilcoxon rank-sum tests revealed no significant differences between African Americans and whites on ratings of pain in-

TABLE 1. Group Comparison of Warmth Thresholds, Thermal Pain Thresholds, and Thermal Pain Tolerances

	African Americans	Whites
	Mean (SE)	Mean (SE)
Warmth threshold (°C)	34.8 (0.3)	34.6 (0.3)
Thermal pain threshold (°C)	44.8 (1.2)	46.2 (0.3)
Thermal pain tolerance (°C)	47.1 (1.3)	49.6 (0.2)[a]

[a] $p < .05$.

TABLE 2. Group Comparison of Slopes and Intercepts for Functions Describing the Intensity and Unpleasantness of Thermal Pain From 46 to 49°C

	Pain Intensity		Pain Unpleasantness	
	African Americans	Whites	African Americans	Whites
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Slope	4.9 (1.0)	5.1 (0.5)	3.5 (0.5)	7.3 (1.0)[a]
Intercept	−10.8 (2.8)	−11.2 (1.4)	−6.6 (1.4)	−17 (2.7)[a]

[a] $p < .01$.

tensity for any of the stimulus temperatures assessed (p values >.3). Group differences emerged for ratings of pain unpleasantness at stimulus temperatures of 46°C ($Z(1,46) = -2.6$, $p < .01$) and 47°C ($Z(1,46) = -1.9$, $p = .05$). At each of these temperatures, African Americans rated the thermal stimuli as more unpleasant than whites rated the stimuli. No significant group differences were observed for ratings of pain unpleasantness at 48° or 49°C (p values >.1).

Two questionnaire packets (both from white subjects) were incomplete and thus were not included in the following analyses. No group differences were observed for reactivity scores, scores on the PILL, or scores on the androgyny subscale of the BSRI (all p values >.3). whites and African Americans did differ on BSRI subscale scores of masculinity ($F(1,44) = 7.05$, $p < .01$) and femininity ($F(1,44) = 11.53$, $p < .01$). Interestingly, African Americans scored higher on both subscales than did whites. Data from psychological measures are presented in Table 3.

To determine whether group differences in BSRI scores accounted for differences in pain tolerances and pain unpleasantness ratings, masculinity and femininity subscale scores were entered as covariates, and the significant effects were reanalyzed. The previously identified group differences in thermal pain responses remained unchanged after statistically adjusting for differences in masculinity and femininity (all p values < .05).

Analysis of the clinical pain data (reported pain during the previous month) revealed no significant group difference in the total number of pain complaints in the past month ($p > .1$). Significant group differences were observed in mean pain severity rating ($F(1,46) = 4.14$, $p < .05$), with African Americans reporting greater average pain severity than whites. Finally, there was a marginally significant group difference in number of pain sites ($F(1,46) = 3.64$, $p < .1$), with African Americans tending to report a greater number of pain sites than whites. Data relating to pain during the previous month are presented in Table 4.

To determine the relationship between thermal pain responses and self-reported pain during the previous month, univariate correlations were computed between these variables. To limit the number of correlations computed, thermal pain intensity and unpleasantness ratings are presented as the mean rating for all four stimulus temperatures (46°, 47°, 48°, and 49°C). Although thermal pain tolerance was significantly negatively related to the number of pain symptoms ($r = -0.30$; $p < .05$) and pain sites ($r = -0.33$; $p < .05$), TPTHs were unrelated to any of the clinical pain variables (all p values >.4). In addition, ratings of both pain intensity and unpleasantness were positively re-

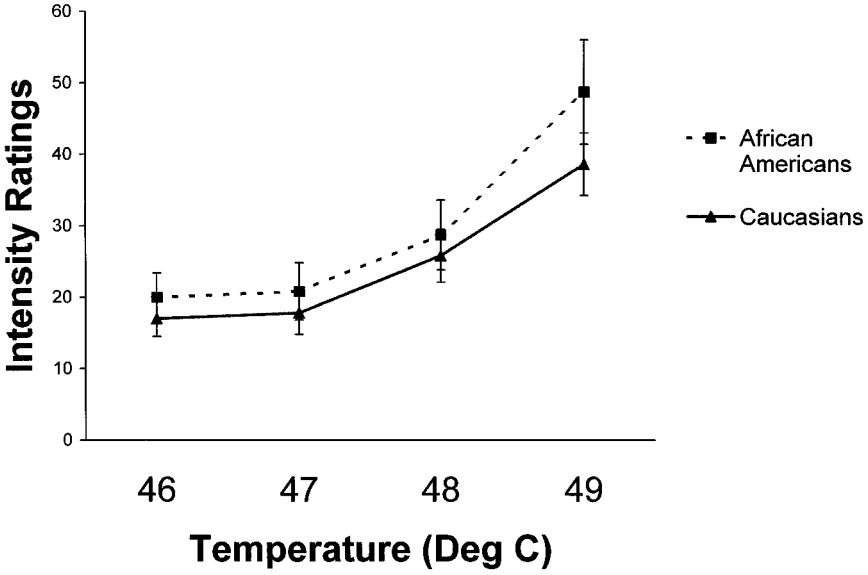

Fig. 1. Ratings of thermal pain intensity at temperatures of 46°, 47°, 48°, and 49°C for African Americans and whites.

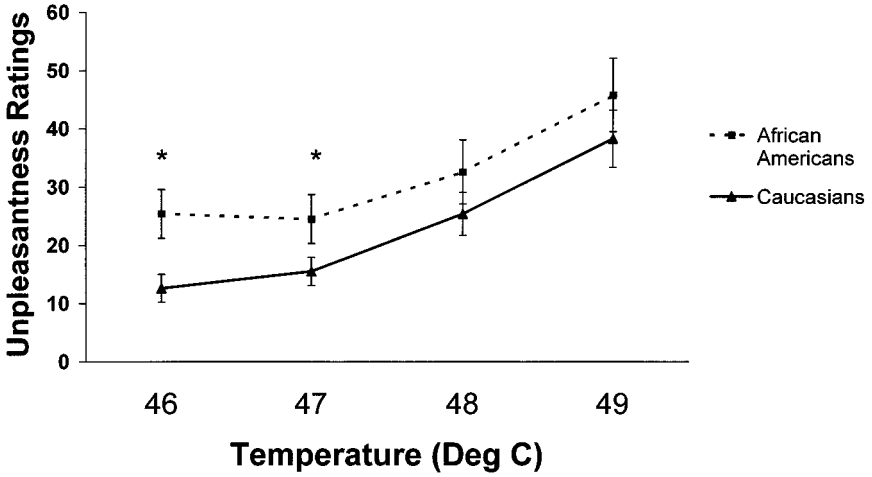

Fig. 2. Ratings of thermal pain unpleasantness at temperatures of 46°, 47°, 48°, and 49°C for African Americans and whites.

TABLE 3. Group Comparison of Psychological Questionnaire Data

	African Americans	Whites
	Mean (SE)	Mean (SE)
KRS (reactivity)	70.9 (1.8)	69.1 (0.9)
PILL (somatic)	97.8 (5.0)	98.8 (3.8)
BSRI		
Androgyny	−0.53 (0.4)	−0.96 (0.4)
Masculinity	5.5 (.2)	4.9 (.1)[a]
Femininity	5.2 (.1)	4.5 (.1)[a]

[a] $p < .01$.

TABLE 4. Group Comparison of Clinical Pain Complaints in the Previous Month

	African Americans	Whites
	Mean (SE)	Mean (SE)
Pain symptoms (*N*)	6.8 (1.8)	4.3 (1.2)
Pain sites (*N*)	2.0 (.3)	1.4 (.2)[a]
Mean pain severity (0–100)	39.3 (4.8)	26.5 (4.0)[b]

[a] $p < .1$.
[b] $p < .05$.

lated to the average severity of reported symptoms ($r = 0.34$ for pain intensity and 0.31 for pain unpleasantness; both p values $<.05$).

To investigate the possibility that group differences in the number of pain sites and severity of pain symptoms could be accounted for by differences in thermal pain responses, two sets of covariates were entered, and the significant effects were reanalyzed. The first set of covariates, conceptually representing the sensory-discriminative dimension of pain, included TPTH and the mean thermal pain intensity rating. The second set, intended to reflect the affective-motivational dimension, was comprised of TPTO and the mean thermal pain unpleasantness rating. When TPTH and pain intensity were entered as covariates, the group difference in clinical pain severity remained significant ($p < .05$). Similarly, the difference in the number of pain sites remained marginally significant ($p < .1$). However, when TPTO and pain unpleasantness were entered as covariates, group differences in clinical pain were nonsignificant (p values >0.2), suggesting that group differences in thermal pain tolerance and thermal pain unpleasantness can at least partially account for observed group differences in clinical pain report.

DISCUSSION

The results of this study suggest ethnic differences in responses to noxious thermal stimuli. Specifically, although African Americans did not differ from whites on measures of WTH, TPTH, or suprathreshold magnitude estimates of pain intensity, group differences emerged for measures of TPTO as well as magnitude estimates of pain unpleasantness at the lowest stimulus temperatures assessed. On these latter measures, African Americans had lower TPTOs and greater magnitude estimates of the unpleasantness of the 46° and 47°C stimuli. It remains unclear why similar group differences in unpleasantness ratings did not emerge at 48° and 49°C. Given the slightly lower pain thresholds among African Americans (although this difference was not significant), one possibility is that although the 46° and 47°C stimuli were frankly painful (in the sense of being above the pain threshold) for most of the African American subjects, these stimuli may have been merely uncomfortable for a substantial proportion of the whites, whereas the 48° and 49°C stimuli were likely painful for the majority of subjects in both

groups. No such differences emerged, however, for ratings of thermal pain intensity. It has been suggested that pain tolerance and suprathreshold ratings of pain unpleasantness reflect primarily the affective-motivational aspects of pain and that pain threshold and suprathreshold ratings of pain intensity load predominantly on the sensory-discriminative dimension (21). Thus, it seems that race-associated differences in responses to noxious thermal stimuli may be most evident for the affective-motivational dimension of pain.

The present study supports and extends previous findings of enhanced experimental pain sensitivity among African Americans. However, the explanation of these differences remains elusive. Observed group differences cannot be attributed to demographic factors (eg, sex, age, and income) or family history of chronic pain, because the two groups were comparable on these variables. Furthermore, group differences in responses to noxious stimuli were unchanged after statistical adjustment for the psychological factors assessed in this investigation. Zatzick and Dimsdale (14) discussed several difficulties of interpreting measures of pain threshold and pain tolerance, and the previously reported low (36) to moderate (37) correlations between pain threshold and pain tolerance suggest that these measures reflect different aspects of the pain experience (38). Specifically, pain threshold may be more representative of the sensory-discriminative dimension of pain, whereas tolerance may relate more strongly to the affective-motivational dimension. Unfortunately, a relatively restricted range of TPTO scores in the present sample precludes correlational analysis of these data. The results of the present study indicate that measurement of the both the sensory-discriminative and affective-motivational aspects of the pain experience may be illuminating in cross-cultural comparisons, because group differences emerged for pain unpleasantness but not pain intensity.

The clinical relevance of these laboratory measures of responses to noxious thermal stimuli is suggested by the significant correlations between these measures (with the exception of TPTHs) and measures of clinical pain complaints during the previous month. Furthermore, race-related differences in TPTO and ratings of thermal pain unpleasantness seem to partially account for the marginally greater number of pain sites and greater clinical pain severity observed among African Americans. That is, after statistically controlling for differences in pain tolerance and unpleasantness, group differences in reported pain during the previous month (pain sites and pain severity) were rendered nonsignificant. Conversely, statistical adjustment for TPTHs and ratings of pain intensity had no effect on the significance of these differences. Thus, it seems that ethnic variations in the perception of the affective-motivational dimension of pain may account for the observed differences in the severity and number of sites of clinical pain.

There are a number of potential explanations for the present findings of differential TPTOs and unpleasantness ratings among African Americans. First, peripheral processing of thermal stimuli may differ as a function of skin pigmentation. Reports of negative correlations between TPTH and degree of skin pigmentation do exist (39); such effects are generally attributed to more rapid or complete retention of heat by more highly pigmented skin. However, this explanation seems inadequate in explaining the present findings, in which no differences were observed between African Americans and whites on measures of WTHs, TPTHs, or ratings of heat pain intensity.

Race-related differences in endogenous pain-modulatory systems might also account for these findings. Specifically, subgroups of African Americans and whites (hypertensive individuals, in this case) have exhibited differences in circulating β-endorphins in response to stress (40). In the aforementioned study, although no ethnic-group differences in β-endorphin levels emerged while subjects were at rest, black hypertensive men had significantly lower β-endorphin levels during a stressor than did white hypertensive men. To the extent that these findings can be generalized to nonhypertensive individuals, group differences in release of endogenous opioids could explain the present findings. Exogenous opioids have been reported to attenuate the affective (unpleasantness) rather than the sensory (intensity) experience of pain (41, 42); thus, race-associated differences in endogenous opioid release during painful stimulation might exert relatively selective effects on pain responses that emerge predominantly when pain responses reflect the affective-motivational dimension of pain. However, this possibility remains speculative at present, in the absence of neurohumoral data.

Because of the paucity of evidence suggesting ethnic differences in neurophysiological systems that process nociceptive information (14, 43), race-associated differences in pain sensitivity are often attributed to "psychological factors." However, although many authors have suggested that pain tolerance is strongly influenced by psychological factors (14, 18), the psychological variables assessed in the present study failed to account for the observed effects. It is possible that race-associated differences in unmeasured psychological factors contributed to the present findings. For example, factors such as coping and efficacy beliefs have been associated with experimental pain responses (30, 44). In general, race-related differences in

coping styles and efficacy beliefs remains a neglected area of research. In addition to psychological variables, Zatzick and Dimsdale (14) indicated that experimenter race or gender might influence the results of laboratory studies. However, we found no evidence that these experimenter characteristics affected subjects' responses, although the variables of experimenter race and gender could not be factorially manipulated. Hence, our assessment of the effect of experimenter race and gender remains incomplete.

Finally, several studies have suggested that the strength and salience of group identification can influence responses to noxious stimuli (45, 46). In these studies, stronger and more salient group identification was associated with greater pain tolerances. To the extent that African Americans and whites possess different levels of group identification, this variable might account for the observed effects in the present study. Several aspects of these previous investigations, however, make it unlikely that group identification can account for the present results. First, the methodology of the previous studies differed substantially from the present work in that assessment of pain tolerance was framed in terms of a group challenge. That is, subjects were provided (false) information about their group's performance relative to other groups. The current study provided subjects with no information about the purpose of the research. Second, none of the previous studies used race or ethnicity as a group membership category. Finally, examination of previous results suggests that minority religious groups tended to demonstrate increases in pain tolerance in the face of a group challenge. In the current study, the minority group (African Americans) demonstrated decreased pain tolerance relative to a majority group (whites).

Additional studies are needed to determine the mechanisms by which selective differences between African Americans and whites in affective-motivational responses to noxious thermal stimuli are effected. In addition, specification of differing ethnic subgroups or cultures within the racial categories of white and African American might allow for subtle intraracial distinctions. Both Chapman and Jones (17) and Sternbach and Turskey (47) reported differences in laboratory pain responses among several ethnic groups within the single racial category of white.

The present study includes a number of limitations that may restrict the generalizability of the results. First, the pattern of results indicates group differences on some but not all experimental pain measures. Although this may be due to differences in affective-motivational vs. sensory-discriminative processing of pain, it is also possible that these results actually reflect marginal group differences that emerged by chance on only selected variables. Second, the findings center entirely around responses to acute experimental pain, whereas many other studies examining race-related differences have involved populations of individuals who have experienced chronic pain. Because the factors influencing chronic and acute pain may differ considerably (48), the generalizability of the present findings to chronic pain populations awaits independent empirical verification. Third, although the significant relationships between TPTOs, as well as magnitude estimates of thermal pain, and measures of self-reported pain during the previous month attest to the clinical relevance of laboratory measures of thermal pain responses, it is unclear whether these results would apply outside the relatively healthy population examined here. Fourth, the group differences observed in the present study may not be relevant outside the microculture of a university setting. It is unclear whether observed group differences in thermal pain responses or in clinical pain reports among young, healthy college students would be present in a sample of middle-aged, elderly, or chronically ill individuals. Fifth, the correlational methodology used to examine relationships between thermal pain responses and clinical pain cannot establish a causal link between these two sets of variables. For example, African Americans may experience greater daily pain than whites for a number of reasons unrelated to enhanced pain sensitivity (eg, more frequent and intense physical and psychological stressors). Several researchers have reported that pain may combine additively within individuals (49, 50, 51). Thus, the greater experience of daily pain among African Americans may have sensitized members of this group to the experience of pain, resulting in decrements in pain tolerance and enhanced ratings of pain unpleasantness relative to whites. The present methodology neither supports nor refutes this hypothesis.

In summary, although explanations underlying race-related differences in pain perception remain elusive, the results of the present study suggest that measures of pain tolerance, rather than pain threshold, and pain unpleasantness, rather than pain intensity, may be more sensitive indicators of differences between African Americans and whites in responses to noxious stimuli. Because these measures load predominantly on the affective-motivational, as opposed to the sensory-discriminative, dimension of the pain experience, one potential conclusion is that whites and African Americans differ primarily in affective rather than sensory processing of noxious stimuli. Of course, this tentative conclusion awaits replication of these findings. Future studies examining differences between

African Americans and whites in both experimental and clinical pain would likely benefit from explicit, independent measurement of affective-motivational and sensory-discriminative dimensions of pain. In addition, the present results highlight the potential role of laboratory investigation of responses to experimental noxious stimuli in the explication of group differences in clinical pain presentation. Collectively, the implications of the present findings for clinical populations presenting with pain remain unclear pending further investigation. However, although there is an emerging body of evidence regarding undertreatment of pain among African Americans (11, 12, 52), the results of the present study might suggest that African Americans may require quantitatively greater degrees of pain treatment than whites. In the absence of more direct evidence, though, such a hypothesis remains speculative.

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