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Original Research Article

Clinician–Patient Racial/Ethnic Concordance Influences Racial/Ethnic Minority Pain: Evidence from Simulated Clinical Interactions

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Abstract

Objective. Racial and ethnic minorities in the United States report higher levels of both clinical and experimental pain, yet frequently receive inadequate pain treatment. Although these disparities are well documented, their underlying causes remain largely unknown. Evidence from social psychological and health disparities research suggests that clinician–patient racial/ethnic concordance may improve minority patient health outcomes. Yet whether clinician–patient racial/ethnic concordance influences pain remains poorly understood. **Methods**. Medical trainees and community members/undergraduates played the role of "clinicians" and "patients," respectively, in simulated clinical interactions. All participants identified as non-Hispanic Black/African American, Hispanic white, or non-Hispanic white. Interactions were randomized to be either racially/ethnically concordant or discordant in a 3 (clinician race/ethnicity) × 2 (clinician–patient racial/ethnic concordance) factorial design. Clinicians took the medical history and vital signs of the patient and administered an analogue of a painful medical procedure. **Results**. As predicted, clinician–patient racial/ethnic concordance reduced self-reported and physiological indicators of pain for non-Hispanic Black/African American patients and did not influence pain for non-Hispanic white patients. Contrary to our prediction, concordance was associated with increased pain report in Hispanic white patients. Finally, the influence of concordance on pain-induced physiological arousal was largest for patients who reported prior experience with or current worry about racial/ethnic discrimination. **Conclusions**. Our findings inform our understanding of the sociocultural factors that influence pain within medical contexts and suggest that increasing minority, particularly non-Hispanic Black/African American, physician numbers may help reduce persistent racial/ethnic pain disparities.

Key Words: Health Disparities; Pain Report; Clinician–Patient; Racial/Ethnic Concordance

Introduction

Persistent racial/ethnic disparities in pain reporting and treatment are well documented. Non-Hispanic Black/African American (hereafter referred to as Black) and in some cases Hispanic white (hereafter referred to as Hispanic) individuals in the United States report more intense and disabling pain in clinical [1, 2] and experimental [3, 4] settings compared with non-Hispanic white (hereafter referred to as white) individuals. Despite reporting greater pain and pain-related disability, minority patients are more likely to receive inadequate pain treatment compared with white patients [5–8]. Although these pain disparities are well documented, their underlying causes are likely complex and not well understood [9]. Recently, several studies have identified potential contributing factors at the patient and provider levels, including provider false beliefs [10], stereotypes [11], ambiguity in clinical pain etiology [12], and perceptual biases [13].

However, one factor that has been underexamined in the pain disparities literature is the role of clinician–

patient racial/ethnic concordance, the focus of the present study. The US physician workforce remains predominantly white, with Black and Hispanic physicians each comprising roughly 5% of the workforce [14]. As a result, minority patients are less likely to have a racially/ethnically concordant provider than white patients. This is potentially a problem, as evidence from social psychological research indicates that sociocultural factors such as group concordance may improve the quality of interpersonal interactions via increased feelings of similarity and trust [15]. In the context of medical interactions, clinician–patient concordance in terms of race [16, 17], gender [18], and language [19, 20] has been associated with improved patient satisfaction. Clinician–patient concordance in terms of shared race/ethnicity has also been associated with more positive interactions, including improved minority patient trust [17, 21], positive affect [22], and continuity of care [23]. Importantly, there is evidence that clinician–patient racial/ethnic concordance may improve more direct health outcomes as well, particularly for Black patients, including receiving HIV treatment sooner [24] and improved medication adherence [25, 26]. Whether the effects of racial/ethnic concordance extend to pain or help explain existing racial/ethnic pain disparities remains poorly understood. An effect of concordance on pain seems likely, however, given the substantial known sociocultural [27, 28] and psychosocial [29, 30] modulators of pain report.

In a prior study [31], we examined the effects of clinician–patient sociocultural group concordance on pain report using lab-created groups and simulated clinical interactions. We found that artificial sociocultural group concordance increased patients' feelings of trust and personal similarity to their clinician, which in turn predicted lower pain. In the present study, we examined the effects of clinician–patient racial/ethnic concordance on pain using more realistic simulated clinical interactions. Based on the effects of concordance on racial/ethnic minority health outcomes reported in prior studies, we predicted that minority patients in concordant interactions would report lower pain and have lower pain-induced physiological arousal compared with minority patients in discordant interactions. We also predicted that life history factors, such as racial/ethnic discrimination, low socioeconomic status, or medical mistrust, would help explain the predicted benefit of racial/ethnic concordance for minority patients.

Methods

Participants

Participants playing the role of "patients" in the simulated clinical interactions were a total of 107 healthy adults (47 female, 37 Black, 34 Hispanic, 36 white) aged 18–30 years ($M = 20.23$, $SD = 2.44$) recruited from the University of Miami and surrounding community. Participants playing the role of "clinicians" in the simulated clinical interactions were a total of 13 healthy adults (six female, five Black, four Hispanic, four white) aged 19–22 years ($M = 20.85$, $SD = 0.90$) recruited from the University of Miami prehealth program and surrounding Miami-Dade County universities. Clinician and patient participants were recruited using the University of Miami Sona System undergraduate participant pool, advertisements on Craigslist and Facebook targeted to the surrounding community, and advertisements placed on campus and in the surrounding Miami-Dade County area. During the course of data collection, one clinician indicated that they did not find the study realistic and had low belief in the stated aim of the study. Additionally, this clinician indicated that they had moderate familiarity with two of their patients. As a result, we chose to replace this clinician (and their patients) within our factorial design before the completion of data collection. In addition, one patient participant was replaced because they indicated after study completion that they had taken pain medication on the day of their study session. These exclusions resulted in a final sample of 97 patient participants and 12 clinician participants. Demographic characteristics for the participants included in the final sample are available in Table 1.

Patient participants were eligible for inclusion in the study if they were between the ages of 18–55, capable of completing the experimental tasks, and had no current or recent medical issues. Clinician participants were eligible for inclusion if they were between the ages of 18–55, capable of completing the experimental tasks, had no current or recent medical issues, were currently a premedical trainee at the University of Miami or a surrounding Miami-Dade County university, and had some prior clinical experience. Additionally, both clinician and patient participants were eligible for the study if they self-identified as non-Hispanic Black/African American, non-Hispanic white, or Hispanic white, as these are the racial/ethnic groups in which the majority of pain disparities and concordance effects on health outcomes have been previously demonstrated [3], and which represent more than 95% of individuals in Miami-Dade County [32]. Clinician and patient participants were excluded from participation in the study if they reported the current presence of pain, chronic pain syndrome, or regular usage of pain medication (Supplementary Data).

The study was approved by the University of Miami Institutional Review Board (IRB), and all participants provided informed consent. All participants were told during informed consent that the purpose of the study was to "gain a better understanding of how people respond to pain during medical care." Patient participants were told during informed consent that they would be participating as a "patient" in a simulated clinical interaction with a medical or premedical trainee playing the role of "clinician" (and identifiable by a white medical coat). Patient participants were informed that two

Table 1. Demographic characteristics of participants included in final sample

	Clinician (N = 12)	Patient (N = 97)	Overall (N = 109)
Age			
Mean (SD)	20.8 (0.866)	20.1 (2.38)	20.2 (2.27)
Median [min, max]	21.0 [19.0, 22.0]	19.0 [18.0, 30.0]	20.0 [18.0, 30.0]
Race/ethnicity			
Black	4 (33.3%)	31 (32.0%)	35 (32.1%)
Hispanic	4 (33.3%)	32 (33.0%)	36 (33.0%)
White	4 (33.3%)	34 (35.1%)	38 (34.9%)
Gender			
Female	6 (50.0%)	47 (48.5%)	53 (48.6%)
Male	6 (50.0%)	50 (51.5%)	56 (51.4%)

experimenters, identified by name and dressed in surgical scrubs, would be running the study session. Patient participants were informed that, as part of their participation in the study, they would be asked to experience a series of painful (but tolerable) 10-second heat stimulations on their forearm that feel like touching a hot cup of coffee. Heat stimulations would be administered by the "clinician" in order to simulate a painful medical procedure, such as a shot. Clinician participants were provided the same information as patient participants regarding the purpose and procedures of the study. Because patient and clinician participants were initially provided with incomplete information about the purpose of the study in order to avoid biasing their subsequent behavior (i.e., we omitted a description of our focus on racial/ethnic concordance), all participants were fully debriefed about the aims and purpose of the study at the end of their participation, with the opportunity to ask the experimenters questions and provide feedback.

Clinical Experience Score

In order to increase the ecological validity of our experimental paradigm, and importantly to control clinicians' level of clinical experience across racial/ethnic groups, clinicians were required to be an undergraduate medical trainee at the University of Miami or a surrounding Miami-Dade County university with prior clinical experience. Given the heterogeneous clinical experiences present in undergraduate premedical trainees, we assigned points for clinical experiences and then computed a total Clinical Experience Score (CES) for each clinician participant using a scale developed for the current study. Valid clinical experiences included certification or licensure as an emergency medical technician (EMT), certified nurse assistant, certified physical therapist, or licensed vocational nurse. Due to the similarity in skillset with our simulated clinical interaction paradigm, we assigned slightly greater weight to certification as a paramedic/EMT compared with other types of certification or licensure. Points were also given for experience as a medical scribe, medical office assistant, assisted living assistant, hospice assistant, and for shadowing medical professionals. Finally, points were given for skills directly relevant to our simulated clinical interaction paradigm (e.g., taking pulse). We used the calculated CES during the selection of clinician participants to match clinical experience between clinicians in each racial/ethnic group ($F(2,5) = 0.35$, $P = 0.722$) and between male and female clinicians ($F(1,5) = 0.13$, $P = 0.738$). In addition, clinician experience did not differ due to clinician age ($F(1,5) = 1.65$, $P = 0.255$). See the Supplementary Data for additional details on the scoring system and points used for the CES, as well as clinician CES and age by race/ethnicity and gender.

Procedures

Procedures Overview

As part of their participation in the study, each patient participant completed one simulated clinical interaction with a clinician participant. In contrast, each clinician saw at least eight patients as part of their participation in the study. Clinicians completed informed consent as part of a separate training session for the clinician role that each clinician completed before seeing their first patient (see the Supplementary Data for additional details on clinician training). Approximately one to two weeks before arriving in the lab, patients completed trait-level questionnaires online (at home) via Qualtrics. On the day of the study session, the clinician arrived to the experiment room first to be reminded of the simulated clinical interaction procedures by the two experimenters, who were each dressed in surgical scrubs.

The experimenters then applied electrodes to the clinician's hand and chest to measure physiological arousal (heart rate, skin conductance) using two Biopac BioNomadix devices. BioNomadix devices wirelessly transmitted each participant's physiological data, thus not impeding movement, and were positioned when possible underneath clothing so as not to be intrusive. The experimenters also gave the clinician a stethoscope and a University of Miami Miller School of Medicine white coat to wear in order to increase the realism of the simulated clinical interaction. The clinician was then taken to a separate room to wait until cued by an experimenter to begin the simulated clinical interaction. While the clinician waited, the patient for the day's session arrived and

completed informed consent with one of the experimenters.

After informed consent, the patient was taken into the experiment room and had electrodes applied to measure physiological arousal. As part of the psychophysiological data collection procedures, the patient sat quietly for a baseline period while the clinician sat just outside of the experiment room to gather their own baseline. After the conclusion of the baseline period, the patient was told by an experimenter, "The doctor will be with you shortly." After a short wait, the clinician knocked on the experiment room door and entered while introducing themselves as "Doctor [Last Name]." Once the clinician was seated, an experimenter closed the divider wall in the experiment room, separating the clinician–patient dyad from the experimenters.

Each clinician–patient dyad then completed the simulated clinical interaction. Simulated clinical interactions took place in an experiment room specially designed and furnished to resemble a medical exam room (Figure 1A). Patients sat in a phlebotomy chair throughout the experiment. Clinicians conducted the simulated clinical interaction with the aid of a nearby computer, similar to electronic medical record note-taking conducted during real-life clinical interactions. Although the computer guided the interaction via the stimulus delivery software Presentation (Neurobehavioral Systems, Inc.), advancement through the interaction was controlled by the clinician. In addition, although the clinician was following a general on-screen script for each interaction, they were free to paraphrase to utilize their own clinical style and engage in other kinds of conversation with the patient in order to establish rapport.

All study data, including audio and video recording, painful heat stimulations, stimulus display program, and physiological data were monitored in real time by the two study experimenters from behind the closed divider wall outside of view of the study participants. The beginning of the experimental scenario in Presentation initiated the simultaneous triggering of associated data collection devices, ensuring appropriate time-locking of the multiple data streams. After the completion of the simulated clinical interaction, the clinician removed the patient's electrodes and left the experiment room. The patient was then debriefed by the experimenters. Clinicians were debriefed after seeing all patients.

Simulated Clinical Interaction

Each simulated clinical interaction consisted of 1) the clinician taking the patient's medical history (Figure 1B) and vital signs (Figure 1C), 2) the clinician training the patient on how to provide pain ratings during the painful medical procedure analogue, 3) participants completing prepain questionnaires rating aspects of their interaction partner, 4) the clinician administering the painful medical procedure analogue to the patient (Figure 1D), 5) participants completing postpain questionnaires rating aspects of their interaction partner, and 6) participants completing poststudy questionnaires assessing study belief, study realism, and familiarity with their interaction partner. In order to minimize experimenter effects and social desirability bias, which could have influenced our outcomes of interest, clinicians and patients completed ratings in separate locations and were informed that their responses would be kept confidential.

Painful Medical Procedure Analogue

As part of the simulated clinical interaction, the clinician administered a series of painful heat stimulations to the patient in order to simulate a painful medical procedure similar to what a patient might receive in a typical outpatient medical setting, such as a shot, biopsy, or mammogram. Painful heat stimulations were delivered using a Medoc Pathway Pain & Sensory Evaluation System (Medoc, Inc.). To ensure that all patients received the same heat stimulation procedure and to ensure the safety of the procedure, clinicians did not control the duration, order, or temperature of the heat stimulations delivered to the patient's forearm. Instead, clinicians were only instructed by the scenario on which of four skin sites on the patient's forearm to place the Medoc thermode before commencing each heat stimulation trial. Additional safety controls within the Medoc Pathway system ensured that all heat stimulations were below temperatures and durations that could damage the skin.

Based on thermal heat stimulation protocols published in previous studies [31, 33, 34], heat stimulations in the present study were delivered to four evenly spaced locations on the volar surface of the patient's left forearm using a 16×16-mm contact Peltier thermode (Figure 1E). Different skin sites on the forearm were chosen in order to control for individual differences in local skin pain sensitivity and to minimize the amount of heat stimulation delivered to any one area of the skin. During the painful medical procedure analogue, the clinician first administered the thermode to the patient's forearm to measure pain threshold and tolerance, as there is evidence that these two measures of pain sensitivity may be affected by sociodemographic factors such as race, ethnicity, and gender [35, 36]. For threshold and tolerance stimulations, the baseline temperature of the thermode was set at 38°C and the rate of temperature increased by 0.5°C/s. For patient safety, the maximum temperature was set at 51°C. For the heat stimulations assessing pain threshold, participants were instructed to indicate when they first detected pain. For the heat stimulations assessing pain tolerance, participants were instructed to indicate when the pain was no longer tolerable.

Next, in order to assess patient pain ratings in response to fixed levels of heat intensity, which have been used in prior studies demonstrating racial/ethnic differences in pain report [37], all patients received stimulations

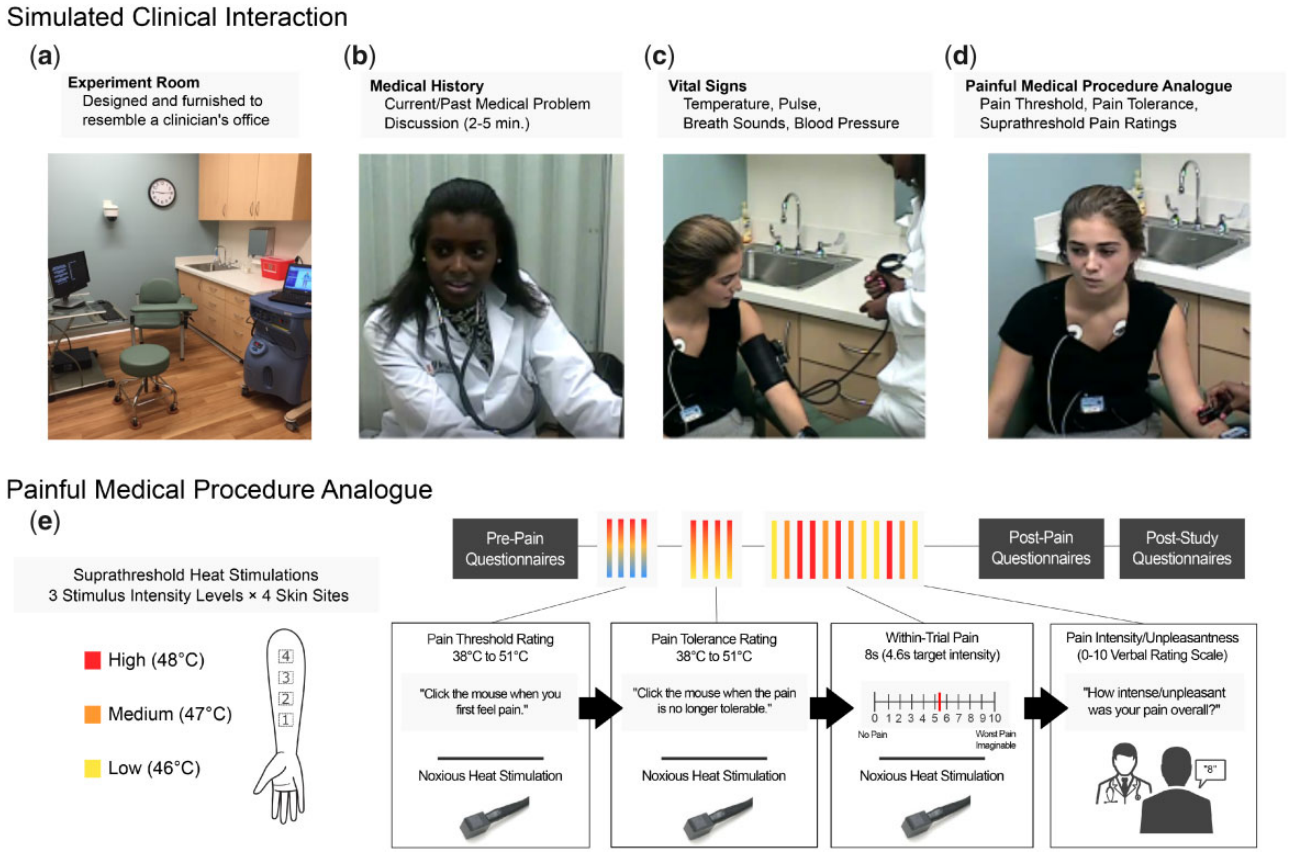

Figure 1. Simulated clinical interaction and painful medical procedure analogue design. A) Experiment room setup. B) Medical history section of the simulated clinical interaction. C) Vital signs section of the simulated clinical interaction. D) Painful medical procedure analogue using thermal heat stimulations. E) Painful medical procedure analogue design. Written and signed audio/video recording permission was obtained from depicted participants.

for a sustained period of time at one of three target stimulus intensity levels (46°C, 47°C, 48°C) to four evenly spaced locations on the inner forearm (Figure 1E, left). These stimulus intensity levels have been identified as above the pain threshold for most individuals [4]. Using heat stimulations at three fixed-intensity levels also allowed us to assess the dose–response relationship between painful stimulus intensity and pain rating. Each suprathreshold heat stimulation lasted approximately eight seconds in total, comprising 4.6 seconds at the target temperature, flanked by 1.85-second ramp periods to get to/from the target temperature to the 32°C baseline. Patients underwent a total of 20 heat stimulation trials during each interaction. Trial order for the suprathreshold trials was pseudo-randomized, such that no skin site received more than one heat stimulation in a row. The temperature of the suprathreshold stimulations was randomized.

Clinician–Patient Racial/Ethnic Concordance

We manipulated clinician–patient racial/ethnic concordance using a 3 (clinician race/ethnicity) × 2 (clinician–patient racial/ethnic concordance) factorial design. Based on participants' self-reported racial/ethnic identity, half of the recruited patients were randomly assigned to a clinician who shared their racial/ethnic identity (concordant), and half of the patients were assigned to a clinician who did not share their racial/ethnic identity (discordant), within the constraints of the clinician's schedule and availability. Each of the 12 clinicians in the study saw at least eight patients, with half of those concordant and half discordant. Among the discordant patients, half were from each of the clinician's two racial/ethnic out-groups. In order to avoid confounds between concordance and clinician practice effects, we ensured that half of the clinicians saw a concordant patient first, while the other half saw a discordant patient first. These procedures for determining clinician–patient pairings resulted in approximately half of the total simulated clinical interactions being racially/ethnically concordant. Additionally, all clinician–patient dyads were gender-matched, as previous studies have demonstrated an effect of subject–experimenter gender discordance on pain report, namely that males report less pain in the presence of female experimenters [38]. In order to control for the influence of clinician-patient age difference on participant perceptions of the simulated clinical interaction and perceived similarity, clinicianpatient dyads were selected

to be relatively close in age, with clinicians slightly older than patients (clinician–patient age difference: M = 2.14, SD = 1.79, range = 0–11 years).

Manipulation Checks

Ethnic and Appearance Similarity

As a manipulation check of clinician–patient racial/ethnic concordance, we measured patients' perceived ethnic and appearance similarity to their clinician using the Perceived Similarities Measure (PSM) [39] and Similarity Visual Analog Scale (SVAS) [31]. The PSM Ethnic Similarity Subscale asks patients to rate their perceptions of similarity to their clinician in terms of ethnicity on a scale ranging from 0 (strongly disagree) to 100 (strongly agree). Subscale scores are averages of subscale items, with higher scores corresponding to more perceived ethnic similarity. The PSM has been found to relate to clinician–patient racial/ethnic concordance and patient outcome measures [39]. In the SVAS Appearance Similarity Subscale, patients are asked to rate how similar they feel to their clinician in terms of appearance on a scale ranging from 0 (not at all similar) to 100 (extremely similar). The relationship between concordance and patients' perceptions of ethnic and appearance similarity with their clinician was tested in separate linear regression models, with an interaction effect specified between concordance and patient race/ethnicity, similar to our pain rating outcome models.

Study Belief and Realism

As manipulation checks of the simulated clinical interaction, clinician and patient participants each completed a series of questions assessing study belief and realism upon completion of the study. These questions asked how realistic (0 = not at all to 100 = completely) participants thought the simulated clinical interaction was and how much they believed in the stated aim of the study (which was "to gain a better understanding of how people respond to pain during medical care").

Familiarity

Clinician and patient participants were also asked whether they were familiar with their interaction partner (0 = no, 1 = yes). Participants who indicated "yes" were then asked how they knew the simulation partner and how well they knew them (0 = stranger to 100 = close friend). Approximately half of the patient participants (and all of the clinician participants) in the final sample indicated a response to the simulation partner familiarity questions due to their delayed inclusion in the study. Two patients indicated having prior familiarity with their clinician. Because these patients indicated that their clinician was considerably less familiar than a "close friend," we opted to retain the data for these two participants. As noted in the *Participants* section, one clinician indicated that they had moderate familiarity with two of their patients and was replaced in our factorial design before the completion of data collection.

Primary Outcome Measures

Pain Intensity

After each suprathreshold heat stimulation trial, patients provided a verbal rating of pain intensity to their clinician on a 0–10 verbal rating scale (VRS; 0 = no pain to 10 = most intense pain imaginable). This allowed us to assess summary judgments of recalled pain communicated directly to the clinician, as is commonly conducted in real-world medical settings.

Pain-Induced Physiological Arousal

Increases in autonomic nervous system (ANS) arousal during painful stimulation, measured via the skin conductance response (SCR), provided a measure of pain-induced physiological arousal. The SCR is reliably induced by noxious heat stimulation [40] and emotional stimuli, particularly anxiety-provoking stimuli [41–43]. SCR data were collected from patients in order to provide a measure of implicit, neurobiological responses to pain to complement the explicit pain report measures. SCR data were collected using two electrodes placed on the middle phalanx of the index and middle finger, which connected to a BioNomadix transmitter worn on each patient's left wrist. The transmitters then wirelessly connected to a Biopac MP150 receiver. The signal collected during each interaction was characterized by a low-frequency baseline component plus shorter spike events indicating SCRs. Our analysis of physiological arousal for the current study focused on the heat stimulation procedure, as we hypothesized that physiological arousal during this period would most directly reflect the influence of clinician–patient racial/ethnic concordance on pain. The results of other indices of physiological arousal collected during the study, including electrocardiogram (ECG) data, will be reported in a future manuscript.

Secondary Outcome Measures

Additional Pain Ratings

The temperature at which the heat stimulation was stopped when the patient clicked the mouse during threshold and tolerance trials was recorded by the Medoc Pathway system and used as the threshold or tolerance rating, respectively. For suprathreshold heat trials, we calculated the peak of within-trial pain rating on a 0–10 NRS (0 = no pain to 10 = worst pain imaginable; scale encompassed both pain intensity and unpleasantness). In addition to pain intensity ratings, after each suprathreshold trial patients provided ratings of their pain unpleasantness on a 0–10 VRS (0 = no unpleasant pain to 10 = most unpleasant pain imaginable).

Life History Factors

We predicted that racial/ethnic minority patients would benefit the most from racial/ethnic concordance with their clinician. As a result, we collected several measures of life history factors that previous literature suggests may help explain the predicted benefit of concordance for minority patients [11, 44–47]. These included the Experiences of Discrimination (EOD) scale [48–50], Williams Coping with Discrimination Scale [48, 51, 52], Medical Mistrust Survey (MMT) [53], Barratt Simplified Measure of Social Status (BSMSS), and Multigroup Ethnic Identity Measure (MEIM) [54]. See the Supplementary Data for additional details on each life history factor measure used in the present study.

Analysis

Statistical Analysis

We used linear mixed effects models (LMMs) to estimate the effect of our racial/ethnic concordance manipulation on patients' repeated measures of pain and pain-induced physiological arousal [55]. Our use of LMMs also allowed us to specify a random intercept for each patient, which accounted for individual differences in baseline pain sensitivity. LMMs were specified using the *lme4* package in R [56], with results reported using analysis of variance (ANOVA) tables. F-statistic *P* values for fixed effects were calculated using Satterthwaite approximation (*lmerTest* R package) of degrees of freedom [57]. Separate models were specified for each of our primary pain outcome measures (pain intensity rating, pain-induced physiological arousal) and for each of our secondary pain outcome measures (pain threshold rating, pain tolerance rating, the peak of within-trial pain ratings, pain unpleasantness rating). A concordance-by-patient race/ethnicity interaction was specified in each model because we predicted that there would be a greater benefit of concordance for minority patients. Planned pairwise mean differences were calculated for significant interaction effects using estimated marginal means [58, 59]. Several fixed effects were included in each model for statistical control, including the stimulus intensity level (temperature) and skin site of the suprathreshold heat stimulation (for suprathreshold pain outcome models only) and the stimulation trial number. Effect sizes were calculated using partial eta-squared (ηp^2) [60]. All statistical analyses were conducted using R (version 3.3.2) [61].

Outliers

The effects of potentially influential outliers were examined using the *Influence.ME* R package for estimating outliers in mixed effects models [62]. Examining estimates for each dependent variable at the subject level, potentially influential outlier subjects were identified using Cook's D [63]. The number of potentially influential outlier subjects in each model ranged from 0 (pain intensity model) to 6 (pain-induced physiological arousal model). After reviewing each identified subject's study session logfile to verify that the data were not affected by data collection or measurement error, we chose to conduct all subsequent analyses retaining the potentially influential subjects, consistent with recent views on statistical best practices for outlier analysis [64]. Finally, visual inspection of Q-Q plots and histograms of standardized residuals did not suggest violations of the assumptions of normality and homogeneity of variance.

Missing Data

For questionnaire scoring that involved summing individual item responses, an imputation algorithm was used in which participant responses to a given subscale were marked as NA if they answered less than 50% of questions in that subscale, and missing values were mean-imputed if the participant answered more than 50% of questions in the given subscale. A single rating of pain unpleasantness was marked NA because the clinician did not ask the patient to provide the verbal rating. Linear mixed effects models utilized listwise deletion for predictor or outcome variables that had missing data.

Physiological Data Analysis

A decomposition-based analysis of patient SCR data was conducted using the publicly available software Ledalab (www.ledalab.de) in Matlab, version 9.0 (MathWorks, Inc.). Per recommendations for analyzing SCR data [65], preprocessing included downsampling the data to 50 Hz and adaptive Gaussian data smoothing. Event markers were extracted from Presentation scenario logfiles and matched with each participant's SCR data. We extracted continuous phasic and tonic activity using Ledalab's Continuous Decomposition Analysis (CDA) function, which decomposed the phasic signals into individual SCRs associated with each stimulus. The response window for the heat stimulation procedure was set at 3.5–13.5 seconds from the Presentation trigger of the Medoc thermode, with a 3.5-second delay specified based on prior studies showing a delayed SCR to noxious heat [66], and to take into account a pretest time delay in thermode heating. We specified a minimum SCR amplitude threshold of 0.01 μS for the response window. The exported values used in subsequent analyses were each participant's mean SCR per suprathreshold heat stimulation trial.

To ensure the quality of the physiological data used in subsequent analyses, each participant's data were visually examined to detect signal dropout or a physiological nonresponder. Data from seven subjects were determined to be affected by widespread signal dropout or physiological nonresponding (defined by a flat or grossly fluctuating signal throughout the heat stimulation procedure). As a result, these subjects had their SCR values for each trial

of the suprathreshold heat stimulation procedure assigned as NA. Examining signal quality at the level of individual trials among subjects included in subsequent analyses of SCR data (N = 90), 1.02% (11/1,080) of the suprathreshold trials were determined to be affected by signal dropout and were assigned as NA.

Post Hoc Search for Life History Factors Explaining Concordance Effects

Finally, we tested whether any life history factors might help explain the effects of concordance that we observed in Black patients. We did so using a two-step process similar to that used in a prior study [67]. In the first step, we conducted an exploratory search for racial/ethnic group differences in the life history factor measures collected during the study. Specifically, in separate linear regression models, we tested for differences in life history factors between Black patients (contrast coded as 0.5) and white and Hispanic patients (together contrast-coded as −0.25), as this was the observed group difference in the effects of concordance we sought to explain. We corrected for the 13 statistical tests by adjusting P values using Bonferroni correction. In the second step, we tested whether any of the life history factor measures that significantly differed (at a corrected $P < 0.05$) between Black patients and the other patient groups moderated the effect of racial/ethnic concordance on pain. Each model was specified with a three-way interaction between racial/ethnic concordance, patient race/ethnicity, and the life history factors measure identified in the first step of the *post hoc* search.

Results

Manipulation Checks

Ethnic and Appearance Similarity

In order to test the efficacy of the concordance manipulation, we first tested whether patients' feelings of ethnic and appearance similarity to their clinician differed based on whether their clinician was racially/ethnically concordant or discordant with them. As expected, there was a main effect of concordance on ethnic similarity, such that patients with a concordant clinician felt more ethnically similar to their clinician than patients with a discordant clinician ($F(1,91) = 50.34$, $P < 0.001$, $\eta p^2 = 0.356$). There was also a significant concordance-by-patient race/ethnicity interaction ($F(2, 91) = 11.73$, $P < 0.001$, $\eta p^2 = 0.205$) (Figure 2A), such that the expected increase in patients' feelings of ethnic similarity toward concordant vs discordant clinicians was larger for Black compared with Hispanic patients ($t(91) = 57.60$, $P < 0.001$) and for white compared with Hispanic patients ($t(91) = 37.20$, $P = 0.002$), but only marginally larger for Black compared with white patients ($t(91) = 20.40$, $P = 0.09$).

Tests of the concordance effect in each racial/ethnic group separately revealed that Black patients with a concordant clinician reported more ethnic similarity with their clinician than Black patients with a discordant clinician ($t(91) = 60.87$, $P < 0.001$). Similarly, white patients with a concordant clinician reported more ethnic similarity with their clinician than white patients with a discordant clinician ($t(91) = 40.47$, $P < 0.001$). In contrast, Hispanic patients with a concordant clinician did not report more ethnic similarity with their clinician than Hispanic patients with a discordant clinician ($t(91) = 3.25$, $P = 0.702$). We found a similar pattern of results for patients' perceptions of appearance similarity with their clinician (Figure 2B; Supplementary Data). These results suggest that our racial/ethnic concordance manipulation worked as predicted for Black and white patients by increasing their feelings of ethnic and appearance similarity with their clinician. Counter to our prediction, these results suggest that our racial/ethnic concordance manipulation did not work as intended for Hispanic patients, as it did not increase their feelings of ethnic or appearance similarity with their clinician.

Study Belief and Realism

To gauge the effectiveness of the simulated clinical interaction, we examined clinician and patient ratings of the believability and realism of the interaction at the end of the study. Patients reported that the simulated clinical interaction felt realistic (M = 70.12, SD = 22.56; 0 = not at all to 100 = completely) and that they believed in the stated purpose of the study (M = 70.84, SD = 24.46; 0 = not at all to 100 = completely). Furthermore, in follow-up questions asking patients to rate the extent to which they thought the study was about different factors, we found that patients did not think the study was about any single factor, as means across the different factors were similar. For example, mean patient responses for the study being about race/ethnicity (M = 49.83, SD = 34.70), the clinician–patient relationship (M = 53.13, SD = 24.36), and pain sensitivity (M = 50.52, SD = 21.89) were all around the middle of the response scale. These results suggest that patients were not aware of the study's focus on racial/ethnic concordance, thus decreasing the chances that self-presentational biases influenced patients' behavior. We also checked to see if our racial/ethnic concordance manipulation influenced patients' perception of the believability and realism of the study. Patients' perception of the believability of the study aims did not differ based on whether they had a racial/ethnic-concordant or -discordant clinician ($t(93.04) = -1.06$, $P = 0.292$). Patients' perception of the realism of the simulated clinical interaction also did not differ by concordance ($t(92.50) = -0.44$, $P = 0.664$).

Clinicians reported that the simulated clinical interactions felt realistic (M = 61.67, SD = 23.59) and that they believed in the stated purpose of the study (M = 79.67, SD = 27.04). Given the nature of the study design, which had clinicians seeing multiple patients from different

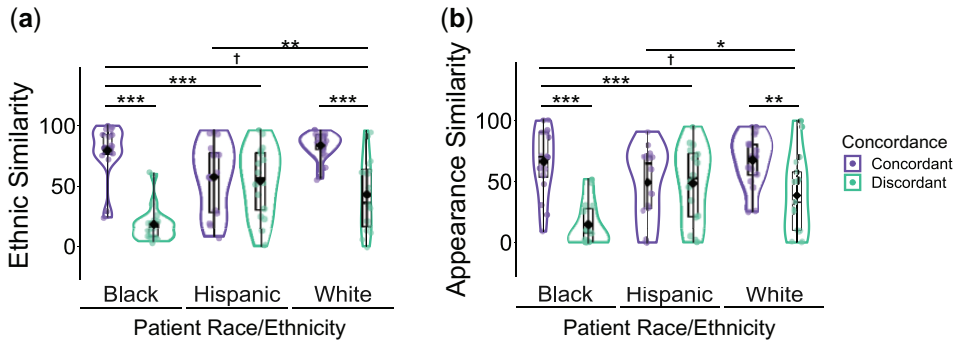

Figure 2. Racial/ethnic concordance effects on patients' perceptions of similarity with their clinician. A) Racial/ethnic concordance effect on patient-perceived ethnic similarity with their clinician by patient race/ethnicity. B) Racial/ethnic concordance effect on patient-perceived appearance similarity with their clinician by patient race/ethnicity. Dots and diamonds represent raw data points and means, lines represent medians, and asterisks represent the results of simple effects tests and interaction contrasts from linear regression models. Black = non-Hispanic Black/African American; Hispanic = Hispanic white; white = Non-Hispanic white. $^{***}P < 0.001$; $^{**}P < 0.01$; $^{*}P < 0.05$; $^{\dagger}P < 0.10$.

racial/ethnic groups, clinicians reported moderate belief that the study was about race/ethnicity (M = 80.35, SD = 21.94), the clinician–patient relationship (M = 65.13, SD = 25.57), and pain sensitivity (M = 53.46, SD = 21.25). This suggests that clinicians were more aware than patients of our focus on racial/ethnic concordance; however, they still had substantial belief that the study was about multiple factors. Thus, we believe there is a relatively low likelihood that self-presentational biases related to race/ethnicity substantially influenced clinicians' behavior in the study.

Primary Outcome Measures

Pain Intensity

Consistent with our hypothesis of concordance-related reductions in pain in minority patients, we did not find that patients' pain intensity differed based on racial/ethnic concordance with their clinician across all ethnic groups (i.e., there was no main effect of concordance; $F(1, 91) = 0.06$, $P = 0.803$, $\eta p^2 < 0.001$). Instead, we found a significant concordance-by-patient race/ethnicity interaction ($F(2, 91) = 3.97$, $P = 0.022$, $\eta p^2 = 0.007$) (Figure 3A, Table 2), such that the predicted reduction in pain intensity with a concordant compared with a discordant clinician was significantly larger for Black compared with Hispanic patients ($t(91) = 2.74$, $P = 0.006$), but not for white compared with Black patients ($t(91) = -1.50$, $P = 0.121$), or for white compared with Hispanic patients ($t(91) = 1.24$, $P = 0.196$). Tests of the concordance effect in each racial/ethnic group separately revealed that Black patients with a concordant clinician reported significantly lower pain intensity than Black patients with a discordant clinician ($t(91) = -1.51$, $P = 0.032$). In contrast, Hispanic patients with a concordant clinician reported marginally higher pain intensity than Hispanic patients with a discordant clinician ($t(91) = 1.23$, $P = 0.075$). White patients reported similar levels of pain intensity regardless of racial/ethnic concordance ($t(91) = -0.01$, $P = 0.988$). These findings are consistent with our prediction that having a racially/ethnically concordant clinician would reduce pain for minority patients, but this effect was only apparent for Black patients, not Hispanic patients. This difference in the effect of concordance on Black and Hispanic patients' pain may be due to the previous finding that concordance did not increase feelings of ethnic or appearance similarity for Hispanic patients.

Pain-Induced Physiological Arousal

Similar to our pain intensity primary outcome, we found a significant concordance-by-patient race/ethnicity interaction on pain-induced physiological arousal ($F(2, 84) = 3.44$, $P = 0.037$, $\eta p^2 = 0.007$) (Figure 3B, Table 3). The predicted reduction in pain-induced physiological arousal with a concordant compared with discordant clinician was significantly larger for Black compared with Hispanic patients ($t(84) = 0.008$, $P = 0.034$), and for Black compared with white patients ($t(84) = 0.008$, $P = 0.019$), but not for white compared with Hispanic patients ($t(84) = -0.0005$, $P = 0.883$). Tests of the concordance effect in each racial/ethnic group separately revealed that Black patients with a concordant clinician had significantly lower pain-induced physiological arousal than Black patients with a discordant clinician ($t(83.9) = -0.006$, $P = 0.034$). In contrast, concordance did not influence pain-induced physiological arousal for Hispanic patients ($t(84) = 0.002$, $P = 0.369$) or for white patients ($t(84) = 0.003$, $P = 0.235$). These findings demonstrate that having a racially/ethnically concordant clinician had the predicted effect of reducing pain-induced physiological arousal, but only for Black patients, similar to our pain intensity outcome. This finding suggests that the observed reductions in pain ratings for Black patients with concordant clinicians are unlikely to arise solely at the level of communicative decision-making.

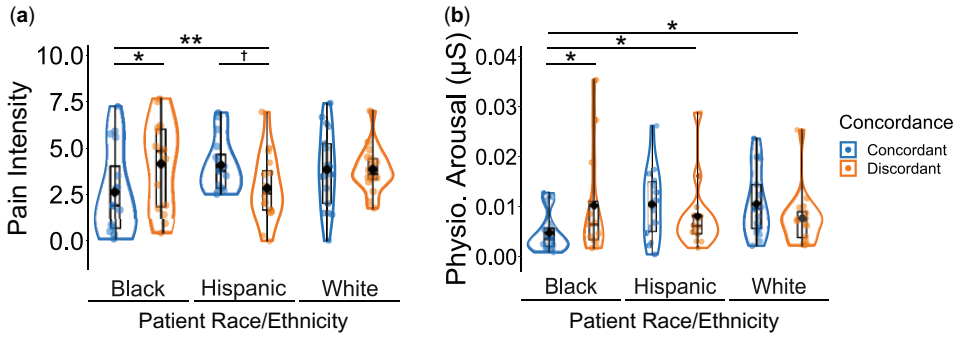

Figure 3. Racial/ethnic concordance effects on patient pain intensity and pain-induced physiological arousal. A) Racial/ethnic concordance effect on pain intensity by patient race/ethnicity. B) Racial/ethnic concordance effect on pain-induced physiological arousal during painful medical procedure analogue by patient race/ethnicity. Dots and diamonds represent raw data points and means, lines represent medians, and asterisks represent the results of simple effects tests and interaction contrasts from linear mixed effects models. Black = non-Hispanic Black/African American; Hispanic = Hispanic white; white = Non-Hispanic white; μS = microsiemens. $^{**}P < 0.01$; $^{*}P < 0.05$; $^{\dagger}P < 0.10$.

Table 2. Results of linear mixed effects model predicting pain intensity

	Sum of Squares	Mean Squares	Num DF	Den DF	F	*P*	ηp^2
Fixed Effects							
Patient race/ethnicity	1.64	0.82	2	91	0.54	0.587	0.001
Racial/ethnic concordance	0.10	0.10	1	91	0.06	0.803	<0.001
Concordance × patient race/ethnicity	12.19	6.10	2	91	3.97	**0.022**	0.007
Stimulus intensity level	1352.96	676.48	2	1051	441.01	**<0.001**	0.456
Trial	26.19	2.38	11	1051	1.55	0.108	0.016
Skin site	4.55	1.52	3	1051	0.988	0.398	0.003
Random effects							
σ^2	1.53						
τ00 PtID	3.60						
ICC	0.70						
N_{PtID}	97						
Observations	1164						
Marginal R^2/conditional R^2	0.233/0.771						

Results displayed as analysis of variance table with Satterthwaite approximation for degrees of freedom. Bolded *P* values indicate statistical significance at the $P < 0.05$ level.

DF = degrees of freedom; ICC = intraclass correlation coefficient.

Table 3. Results of linear mixed effects model predicting pain-induced physiological arousal

	Sum of Squares	Mean Squares	Num DF	Den DF	F	*P*	ηp^2
Fixed Effects							
Patient race/ethnicity	0.00003	0.00002	2	84	0.62	0.540	0.001
Racial/ethnic concordance	0.0000001	0.0000001	1	84	0.01	0.943	<0.001
Concordance × patient race/ethnicity	0.0002	0.0001	2	84	3.44	**0.037**	0.007
Stimulus intensity level	0.009	0.004	2	963.13	155.37	**<0.001**	0.243
Trial	0.007	0.0006	11	963.11	23.27	**<0.001**	0.209
Skin site	0.0001	0.00003	3	963.10	1.18	0.316	0.004
Random effects							
σ^2	0.00						
τ00 PtID	0.00						
ICC	0.62						
N_{PtID}	90						
Observations	1069						
Marginal R^2/conditional R^2	0.206/0.700						

Results displayed as analysis of variance table with Satterthwaite approximation for degrees of freedom. Bolded *P* values indicate statistical significance at the $P < 0.05$ level.

DF = degrees of freedom; ICC = intraclass correlation coefficient.

Secondary Outcome Measures

Additional Pain Ratings

We found a similar pattern of results for ratings of pain unpleasantness and the peak of within-trial pain ratings as we did for the primary outcome of pain intensity. Specifically, while these measures did not differ based on clinician–patient concordance across racial/ethnic groups, we found a significant concordance-by-patient race/ethnicity interaction for pain unpleasantness ($F(2, 90.97) = 3.94$, $P = 0.023$, $\eta p^2 = 0.007$). The predicted reduction in pain unpleasantness with a concordant compared with a discordant clinician was significantly larger for Black compared with Hispanic patients ($t(91) = 2.57$, $P = 0.006$), but not for white compared with Black patients ($t(91) = -1.17$, $P = 0.20$), or for white compared with Hispanic patients ($t(91) = 1.40$, $P = 0.12$) (Supplementary Data). Tests in each racial/ethnic group separately revealed that Black patients with a concordant clinician had significantly lower pain unpleasantness than Black patients with a discordant clinician ($t(91) = -1.36$, $P = 0.041$). In contrast, Hispanic patients had marginally higher pain unpleasantness with a concordant clinician ($t(91) = 1.21$, $P = 0.063$), and white patients had similar pain unpleasantness regardless of concordance ($t(91) = -0.19$, $P = 0.763$).

Similarly, we found a significant concordance-by-patient race/ethnicity interaction for the peak of within-trial rating of suprathreshold stimuli ($F(2, 91) = 4.33$, $P = 0.016$, $\eta p^2 = 0.008$). The predicted reduction in the peak of within-trial rating with a concordant compared with discordant clinician was significantly larger for Black compared with Hispanic patients ($t(91) = 3.15$, $P = 0.004$), but not for white compared with Black patients ($t(91) = -1.69$, $P = 0.114$), or for white compared with Hispanic patients ($t(91) = 1.47$, $P = 0.165$) (Supplementary Data). Tests in each racial/ethnic group separately revealed that Black patients with a concordant clinician had a significantly lower peak of their within-trial pain ratings than Black patients with a discordant clinician ($t(91) = -1.56$, $P = 0.045$). In contrast, Hispanic patients had a significantly higher peak of their within-trial pain ratings with a concordant clinician ($t(91) = 1.60$, $P = 0.03$), and white patients had a similar peak of their within-trial pain ratings regardless of concordance ($t(91) = 0.13$, $P = 0.858$). We did not find any significant effects of patient race/ethnicity or clinician–patient racial/ethnic concordance on pain threshold or tolerance ratings (Supplementary Data). Pain threshold and tolerance ratings by patient race/ethnicity are presented in the Supplementary Data.

In addition, we conducted analyses using the same models as above while controlling for clinicians' Clinical Experience Score (CES). Controlling for clinician experience did not meaningfully alter the significant concordance-by-patient race/ethnicity interactions predicting any of our pain report outcomes (see the Supplementary Data for pain intensity outcome model results). Two of our models with pain-induced physiological arousal as the outcome had their concordance-by-patient race/ethnicity interactions become marginally significant when controlling for clinician experience. However, because the overall pattern of results remained the same even when controlling for clinician experience and the main effect of clinician experience was not significant in any of our tested models, we chose not to control for clinical experience in our final models (see the Supplementary Data for additional details).

Perceived Similarity Predicting Pain

Given that we observed high variability in the perceived ethnic and appearance similarity measures in Hispanic patients but no significant difference due to our racial/ethnic concordance manipulation, we also examined whether patients' perceived similarity with their clinician influenced pain. We specified in linear mixed effects models a perceived similarity-by-patient race/ethnicity interaction in order to gain insight into whether perceived similarity influenced pain differently for Hispanic patients. There was a significant interaction between patient-perceived appearance similarity, but not ethnic similarity, with their clinician and patient race/ethnicity predicting pain tolerance ($F(2,90) = 4.54$, $P = 0.013$) (Supplementary Data). Specifically, Hispanic patients' pain tolerance increased the more similar in appearance they felt to their clinician. Patients' perception of appearance similarity did not interact with patient race/ethnicity to predict any of our other pain outcome measures, however. This finding suggests that Hispanic patients' perceived similarity in appearance, but not ethnicity, to their clinician mattered in terms of pain tolerance, possibly due to factors beyond perceived race/ethnicity such as skin tone, attractiveness, or perceived national origin.

Post Hoc Search for Life History Factors Explaining Concordance Effects

In a *post hoc* search for life history factors that might help explain the observed benefits of racial/ethnic concordance for Black patients, we found five measures that significantly (at a Bonferroni-corrected $P < 0.05$) differentiated the Black patients from the Hispanic and white patients (identified in bold in the Supplementary Data). Black patients reported significantly more frequent experience with racial/ethnic discrimination (EOD—Experience) than white and Hispanic patients ($B = 8.37$, SE = 1.54, $P < 0.001$). Black patients also reported significantly more worry about racial/ethnic discrimination (EOD—Worry) than white and Hispanic patients ($B = 4.55$, SE = 0.56, $P < 0.001$). Similarly, Black patients reported that they felt personally discriminated against due to race, ethnicity, or color (EOD—Global) significantly more often than white and Hispanic patients ($B = 1.42$, SE = 0.23, $P < 0.001$). In a yes/no question

assessing prior experience with racial/ethnic discrimination (WQ—Discrimination), Black patients were also significantly more likely to report having previously experienced any racial/ethnic discrimination compared with white and Hispanic patients ($B = 0.77$, SE $= 0.12$, $P < 0.001$). Finally, consistent with current data on racial and ethnic diversity in the physician workforce [14], Black patients who reported having a regular health care provider were significantly less likely than white and Hispanic patients to report that their provider was racially/ethnically concordant with them (MMT—Concordance with Provider; $B = -0.47$, SE $= 0.15$, $P = 0.028$).

In the second step of the *post hoc* search, we selected each of the measures tested in the first step that was significant at a corrected $P < 0.05$ and tested whether there was a three-way interaction between racial/ethnic concordance, the life history factors moderator, and patient race/ethnicity predicting pain. This three-way interaction tested whether the variability in the concordance effect on pain between racial/ethnic groups differed based on participants' previous life history factors. Because the three-way interaction was not significant for any of our life history factors measures, we next examined the two-way interaction between concordance and life history factors. We found that whether patients reported ever having experienced racial/ethnic discrimination (WQ—Discrimination) moderated the relationship between racial/ethnic concordance and pain-induced physiological arousal ($F(1, 85.99) = 6.54$, $P = 0.012$) (Figure 4A). The predicted reduction in pain-induced physiological arousal due to concordance was larger for patients who had experienced discrimination compared with those who had not experienced discrimination ($t(86) = 0.008$, $P = 0.012$). Looking within the group that reported experiencing discrimination, these patients had marginally lower pain-induced physiological arousal when paired with a concordant vs discordant clinician ($t(86) = -0.005$, $P = 0.05$). Looking within the group that did not report experiencing discrimination, these patients did not differ in pain-induced physiological arousal as a result of concordance ($t(86) = 0.003$, $P = 0.112$).

In a separate model, we found that current worry about racial/ethnic discrimination (EOD—Worry) also moderated the relationship between racial/ethnic concordance and pain-induced physiological arousal ($F(1, 85.93) = 5.08$, $P = 0.03$) (Figure 4B). Patients who worried frequently about racial/ethnic discrimination had lower pain-induced physiological arousal when paired with a concordant vs discordant clinician. In contrast to these findings, we did not find that the other life history factor measures identified in the first step of the *post hoc* moderator search (EOD—Experience, EOD—Global, MMT—Concordance with Provider) moderated the relationship between racial/ethnic concordance and pain-induced physiological arousal. We also did not find that any of the life history factor measures tested in step 2 of the *post hoc* search moderated the relationship between racial/ethnic concordance and pain report.

Discussion

Racial and ethnic group differences in pain reporting and treatment have been well documented in clinical and experimental settings, yet the causes of these disparities remain poorly understood [9]. In the present study, we examined whether clinician–patient racial/ethnic concordance influenced pain from an analogue of a painful medical procedure in simulated clinical interactions. We found that racial/ethnic concordance increased Black and white patients' perceptions of ethnic and appearance similarity with their clinician but did not have an effect on Hispanic patients. In terms of our primary outcome measures, we found that clinician–patient racial/ethnic concordance resulted in a significant reduction in pain and pain-induced physiological arousal for Black patients. In contrast, racial/ethnic concordance increased pain reported by Hispanic patients but did not affect pain reported by white patients or pain-induced physiological arousal for either Hispanic or white patients. We also found that both patients and clinicians reported finding the simulated clinical interaction realistic and were not aware of our focus on racial/ethnic concordance.

Consistent with our hypothesis, we found that Black patients benefitted from racial/ethnic concordance with their clinician in terms of reduced pain report. This finding is consistent with prior health disparities research indicating that clinician–patient racial/ethnic concordance may improve racial/ethnic minority patient health outcomes, such as reduced time to receiving antiretroviral treatment [24] and improved medication adherence [25], in addition to increasing treatment satisfaction [16, 17]. Our finding that Black patients specifically benefited from concordance is supported by the extant literature, which has typically focused on the role that concordance can play in improving health disparities disproportionately impacting Black patients [16, 24, 26, 68]. Given that the US physician workforce remains majority white [14], the typical experience for Black patients is still to be treated by a racially discordant clinician. As a result, our findings may provide support for the hypothesis that racial discordance contributes to the higher pain reported by Black patients in clinical settings.

Our finding that racial/ethnic concordance also reduced pain-induced physiological arousal among Black patients suggests that the mechanisms underlying these pain report disparities may go deeper than pain communicative decision-making [27]. Autonomic nervous system arousal is known to be induced by negative emotional stimuli, particularly anxiety-provoking stimuli [41–43]. As a result, this finding suggests that having a Black clinician may have reduced anxiety and its physiological correlates among Black patients during the

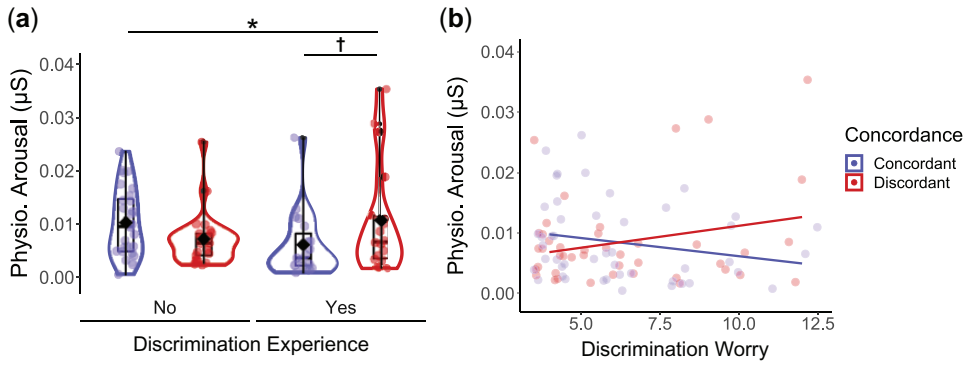

Figure 4. Effect of clinician–patient racial/ethnic concordance on pain-induced physiological arousal moderated by racial/ethnic discrimination. A) Patients who had previously experienced racial/ethnic discrimination had lower pain-induced physiological arousal when paired with a racial/ethnic-concordant clinician. B) Patients who reported currently worrying about racial/ethnic discrimination had lower pain-induced physiological arousal when paired with a racial/ethnic-concordant clinician. Dots and diamonds represent raw data points and means, lines represent medians, and asterisks represent the results of simple effects tests and interaction contrasts from linear mixed effects models. μS = microsiemens. $^{*}P < 0.05$; $^{\dagger}P < 0.10$.

painful medical procedure analogue. Thus, concordance may have influenced both the experience of pain and pain communication for these patients.

Our data also point to a potential sociocultural mechanism linking racial/ethnic concordance and reductions in pain-induced physiological arousal: reduced fear of discrimination. Patients who had previously experienced racial/ethnic discrimination or who currently worried about discrimination had lower pain-induced physiological arousal when paired with a concordant clinician. It is well documented that Black patients have worse experiences in health care than white patients. For example, Black patients are more likely to report that their health care provider did not believe them when they reported being in pain [69] and have been found to report lower trust in health care providers overall [21]. In addition, a number of studies have demonstrated connections between the experience of discrimination and pain. For example, there is evidence that discrimination may heighten the physiological and emotional responding states known to influence pain [70], including increased depression and anxiety [71, 72] and the upregulation of pro-inflammatory gene expression [73, 74]. Suggesting an even more direct link between discrimination and pain, we previously found a positive association between the frequency of discrimination experiences and pain-related brain activity, which was stronger for Black compared with nonblack individuals [67]. Racial/ethnic discrimination has also been linked to the likelihood of developing chronic pain [45]. Furthermore, Black patients' previous experiences of discrimination have been found to influence the ratio of talking time between the physician and patient in racially discordant medical interactions [75]. Given that the Black patients in our study reported significantly more experience with and worry about discrimination compared with Hispanic and white patients, our findings suggests that reduced concern about discrimination may underlie the observed benefit of concordance on pain in this group.

Counter to our hypothesis, we found that Hispanic patients reported marginally, and in some cases significantly, higher pain report when paired with a concordant clinician, and no difference in pain-induced physiological arousal due to concordance. The literature examining clinician–patient concordance effects for Hispanic patients is notably more limited and mixed than the literature for Black patients [76–78]. Hispanic patients in one study were more likely to report feeling disrespected when paired with an ethnically concordant clinician [77]. In another study, Hispanic patients with ethnically concordant clinicians were no more likely than those with discordant clinicians to rate their clinician as excellent, in contrast to Black patients [79]. Notably, the Hispanic patients in our study did not perceive concordant clinicians as more similar to them in terms of ethnicity or appearance. This suggests that our concordance manipulation did not work as intended for Hispanic patients, who may have been responding to alternative dimensions of similarity with their clinician. Speaking to this, we found that Hispanic patients' pain tolerance increased the more similar in appearance they felt with their clinician. This may suggest that, for Hispanic patients, factors beyond the perceived race/ethnicity of their clinician, such as skin tone, attractiveness, or perceived national origin, may have influenced pain tolerance. Indeed, there is evidence that clinician–patient concordance in terms of factors other than race/ethnicity, such as gender [78, 80] or language [25, 81], may be more salient for Hispanic patients. This is especially possible given the substantial heterogeneity among individuals identifying as Hispanic/Latino in terms of national origin, language, and acculturation, particularly in Miami-Dade County [32], where the present study took place. Future studies are required to understand the

dimensions of similarity that are salient to Hispanic patients, who nonetheless remain impacted by health disparities [82].

Finally, consistent with our hypothesis, we found that although racial/ethnic concordance influenced white patients' perceptions of ethnic and appearance similarity with their clinician, it did not influence their pain or pain-induced physiological arousal. These findings are consistent with our interpretation that a reduction in concern about racial/ethnic discrimination may be a mechanism by which concordance reduced pain-induced physiological arousal for Black patients, as the white patients in our study reported an overall low frequency of experience with discrimination.

Limitations

Our results should be considered in the context of several limitations. First, the relatively small number of patient participants (~15) in each cell of our factorial design limits our ability to make causal inferences about potential mechanisms underlying the benefit of racial/ethnic concordance that we observed in Black patients. Specifically, the interaction we observed between concordance and racial/ethnic discrimination may be primarily due to the fact that the Black patients in our study reported overall more experience with racial/ethnic discrimination. Future studies with larger samples of Black patients should be conducted in order to examine variability in discrimination experience and its relationship to clinician–patient concordance within this group.

Second, although we took steps to avoid pairing patients and clinicians who knew each other outside of the study, we did not measure clinicians' familiarity with each other. Thus, it is possible that clinicians were able to confer among themselves regarding the study's aims. However, clinician responses to the study belief questionnaire indicated that they did not think the study was solely about racial/ethnic concordance, increasing our confidence that even if clinicians communicated outside of the study, this did not substantially impact the study's outcomes.

Our use of premedical trainees as clinician participants and healthy undergraduates and community members as patient participants may limit the generalizability of our findings to real-world clinical settings. However, our choice of participant populations had the advantage of increasing the feasibility of our experimental approach to the topic of clinician–patient racial/ethnic concordance, and we further reduced the impact of this limitation by including as clinician participants only premedical trainees with prior clinical experience (although we did not require proof of clinician participant certification or licensure).

Additionally, other aspects of our simulated clinical interaction may have qualitatively differed from real-world medical experiences. For example, although the Medoc thermode we used for our painful medical procedure analogue is commonly used in medical settings for quantitative sensory testing, the procedure differed from real-world medical procedures in that it was not associated with any potential benefit for the patient, such as diagnosing a medical condition. As a result, our painful medical procedure analogue may have been viewed qualitatively differently by the clinician and patient participants in our study compared to real-world medical procedures in which the pain is in the context of a potential medical benefit.

However, we took extensive measures to increase the ecological validity of our medical simulations, including furnishing our experiment room to resemble a medical exam room and having clinician participants wear realistic clothing, including a stethoscope and medical coat with a University of Miami insignia. Importantly, as a social, rather than clinical, phenomenon, the effects of racial/ethnic concordance should be relatively invariant across clinical contexts, increasing our confidence that the concordance effects observed in our clinical simulations have some parity with real clinical settings.

To counterbalance the aforementioned limitations, our experimental approach to the topic of clinician–patient racial/ethnic concordance also provides some benefits and insights not typically achievable in clinical research. The experimental control of our study allowed random assignment to concordant or discordant dyads, as well as data streams not typically feasible in clinical settings, such as audio/video recording and continuous measurement of dyadic physiological arousal. Specifically, having balanced numbers of patients in each racial/ethnic group and randomization into concordant/discordant dyads may help explain mixed prior findings on the effects of racial/ethnic concordance on health outcomes [83]. For example, it is possible that a lack of demographic group balance among naturalistically recruited clinical samples may have confounded the effects of concordance in some prior studies. As a result, we believe that our findings provide an important contribution to a literature that has, to date, been primarily informed by retrospective chart reviews and observational/cross-sectional studies [84–86].

Clinical Significance

Our findings suggest that clinician–patient racial/ethnic concordance may reduce the pain associated with painful medical procedures in Black patients, while factors affecting perceptions of clinician–patient racial/ethnic concordance and its impact on pain in Hispanic patients may be more complex. Minority patients in the United States are still more likely to encounter a racially/ethnically discordant physician, as Black and Hispanic physicians each comprise roughly 5% of the physician workforce [14]. Furthermore, it is projected that the number of minority physicians will continue to lag further behind the number

of minority patients as the United States continues to become more racially and ethnically diverse [87]. Our findings suggest that a potential benefit of reversing this trend and increasing the number of minority, particularly Black, physicians in the US workforce may be a reduction in persistent racial/ethnic pain disparities.

Acknowledgments

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Code Availability Statement

All code used to analyze the data in the present study is available in an R Markdown available on Open Science Framework (OSF): https://osf.io/k9rsx/?view_only=3ef148803f5f4eb0b19f8e37d10102ea.

Supplementary Data

Supplementary data are available at *Pain Medicine* online.

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