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The impact of patient race, patient socioeconomic status, and cognitive load of physician residents and fellows on chronic pain care decisions

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Abstract

Social stereotypes are more likely to influence decision-making under conditions of high cognitive load (i.e., mental workload), such as in medical settings. We examined how patient race, patient socioeconomic status (SES), physician cognitive load, and physician implicit beliefs about race and SES differences in pain tolerance impacted physicians' pain treatment decisions. Physician residents and fellows (N=120) made treatment decisions for 12 computer-simulated patients with back pain that varied by race (Black/White) and SES (low/high). Half of the physicians were randomized to be interrupted during the decision task to make hypertension medication conversion calculations (high cognitive load group), while the other half completed the task without interruptions (low cognitive load group). Both groups were given equal time to make pain care decisions (2.5 minutes/patient). Results of multilevel ordinal logistic regression analyses indicated that physicians prescribed weaker analgesics to patients with high vs. low SES (OR=.68, 95% CI [0.48, 0.97], p=.03). There was also a patient SES-by-cognitive load interaction (OR=.56, 95% CI [0.31,1.01], p=.05) that is theoretically and potentially practically meaningful but was not statistically significant at p<.05. These findings shed light on physician cognitive load as a clinically relevant factor in the context of pain care quality and equity.

Perspective—These findings highlight the clinical relevance of physician cognitive load (e.g., mental workload) when providing pain care for diverse patients. This line of work can support

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the development of interventions to manage physician cognitive load and its impact on pain care, which may ultimately help reduce pain disparities.

Keywords

chronic pain; cognitive load; race; socioeconomic status; health equity; medical decision-making

INTRODUCTION

Black patients and patients with low socioeconomic status (SES) are at risk for not receiving evidence-based, multidisciplinary pain care.[1–4] Physician beliefs about treatment adherence and medication misuse[5–7] likely contribute to them recommending inadequate treatment.[8–10] Nonetheless, the literature is mixed, with some studies finding that Black patients and patients with low SES receive more pain treatments.[11–14] A complicating factor is that few studies on pain disparities have investigated race and SES together. Others have controlled for patient SES to highlight race effects, which may produce results showing a significant SES effect but not a significant race effect. Although common, this approach is misguided because the socioeconomic distributions are not equal; that is, Black people are twice as likely to be in lower SES categories.[15,16] Thus, knowledge gaps remain in understanding how patient race and SES uniquely and interactively impact physicians' pain treatment decisions.

An important factor in pain disparities is cognitive load—the mental burden that performing a task(s) imposes on the cognitive system.[17] According to the dual process model (DPM), decision-making can be influenced by two cognitive processes: a fast, unconscious system (system 1) and a slow, conscious, effortful system (system 2).[8,18] The DPM suggests that when making decisions under high cognitive load, a context that physicians frequently work under, people are more likely to use system 1 processes, which include social stereotypes.[8,19–21] We are aware of one study on cognitive load in the context of pain care. Burgess et al.[22] found that when under high cognitive load, male (but not female) physicians were more likely to prescribe opioids to White than Black patients. Interpreting this through the DPM, the high cognitive demands inhibited physicians' use of top-down bias-regulation strategies, allowing stereotypes about Black people (e.g., more likely to misuse medications[23]) to influence their decisions, leading to fewer opioid prescriptions to Black patients. Cognitive load appears to be relevant to chronic pain care, but unanswered questions remain, including how it impacts physicians' treatment decisions for a range of treatments.

Implicit biases—stereotype evaluations that occur automatically without full awareness[24]—are relevant to cognitive load. The literature is mixed on whether physician implicit biases about race impact their treatment decisions.[25,26] The studies on implicit biases about SES have not found significant effects.[27–31] Most of these studies examined general implicit preferences for one group over another. Implicit biases that are specific to pain may be more relevant to pain disparities. Prior work demonstrates that laypersons and medical trainees believe that Black people and people with low SES are more pain tolerant compared to their demographic counterparts.[32,33] Pulling this together, when under high cognitive load,

physicians with strong implicit beliefs that Black people and people with low SES are relatively pain tolerant may recommend suboptimal (i.e., fewer) pain treatments to these patients.

We used an experimental design with virtual human (VH) technology to examine how patient race, patient SES, physician cognitive load, and physician implicit beliefs about pain tolerance affected their pain treatment decisions. We hypothesized: (1) physicians would recommend fewer pain treatments and prescribe weaker medications to Black (vs. White) patients and patients with low (vs. high) SES, and recommend the fewest treatments and prescribe the weakest medications to patients who were both Black and had low SES; (2) physicians under high (vs. low) cognitive load would recommend fewer pain treatments and prescribe weaker medications to Black (vs. White) patients and patient with low (vs. high) SES; and (3) the largest disparities would be demonstrated by physicians under high cognitive load who had strong implicit beliefs that Black (vs. White) people and people with low (vs. high) SES are more pain tolerant.

METHODS

Participants

Participants (“physicians”) included physician residents and fellows from any specialty. Eligible physicians were 18 years or older, spoke English, had access to a computer with internet, and had not previously participated in research with VHs and pain care decision-making. Recruitment occurred by sending emails to residency and fellowship programs at 38 institutions across all geographic regions of the US inviting physicians to participate in the study. After completing the study, physicians were also encouraged to share the study announcement with potentially eligible peers. Given that this is the first empirical study to our knowledge that examines the effect of physician cognitive load on pain treatment decisions for racially and socioeconomically diverse patients, we casted a wide net regarding physician specialty. This decision also reflects that pain care occurs across clinical settings.[34,35] We selected residents and fellows because they provide frontline care for patients, and because it is important to understand how patient, physician, and contextual factors affect early-career physicians’ treatment decisions. All physicians received a $50 gift card after completing the study.

Study Design and Procedure

According to the lens model design, individuals attend to and differentially weigh informational “cues” in their environment to make decisions.[36] Lens model designs have been used to examine what cues physicians “use” (or are influenced by) when making clinical decisions in general and specifically for pain care.[37,38] In the current study, we examined how physicians used the “cues” of patient race and SES to make pain care decisions and to what extent their use of patient race and SES cues varied under low and high cognitive load conditions.[36] Lens model designs typically have participants view a series of patient profiles that contain different combinations of the cues of interest. Best practices recommend at least a 5:1 profile-to-cue ratio for reliable data and adequate power.[39] Four unique patient profiles were needed to represent all cue combinations (two

levels of race by two levels of SES). Each patient race and SES cue combination was presented thrice to each physician for a total of 12 patient profiles, yielding a 6:1 profile-to-cue ratio.

The study was delivered online from April to September 2021. The study website stated that the purpose of the study was to gain a better understanding of how physicians make pain assessment and treatment decisions. Informed consent was obtained from all subjects. All physicians completed the pain treatment decision-making task first, followed by self-reported measures of cognitive load (NASA Task Load Index [NASA TLX]). Physicians then completed two implicit association tests (IATs; 1 for race and 1 for SES; see below) and a questionnaire battery, which were counterbalanced across physicians. A diagram of the study flow can be found in the Supplementary Materials. The study was approved by the Institutional Review Board at a public university located in the Midwestern US.

Pain Treatment Decision Task and Stimuli

During the pain treatment decision task, physicians viewed randomized videos of VH patients presenting with low back pain in an outpatient exam room (Figure 1). Physicians were instructed that these patients were coming to establish primary care and that their pain had been managed by their previous primary care physician. In addition to race and SES, patients also varied by gender, with two males and one female representing each race/SES cue combinations. Although there are known gender disparities in pain,[40] we did not examine the effects of patient gender on pain care decisions; we made this decision for feasibility reasons including managing study burden on physicians (examining patient gender would require physicians to view additional patient profiles to be adequately powered for the lens model design) and to facilitate statistical analyses and interpretation of results. Patients conveyed pain through empirically-validated and standardized facial expressions and bodily movements (i.e., bracing lower back), maximizing the experimental control and ecological validity of the stimuli.[41] Patient race was represented visually by altering skin tone and facial phenotypes. Because occupation is a key indicator of SES,[15] patient SES was depicted by work-denoting clothing. Patients with low SES wore clothing associated with low-income jobs (e.g., dishwasher), and patients with high SES wore clothing associated with high-income jobs (e.g., lawyer); job categories were determined by the Nam-Powers-Boyd Occupational Status Scale.[42]

Below each patient video was a text vignette, formatted like a medical record, containing additional patient information. All patients were described as having chronic pain (average pain intensity ranging from 4–6/10 across patients) and as experiencing a current pain flare (acute pain intensity ranging from 7–9/10 across patients). They were also noted to have previously taken prescribed opioids that were “somewhat helpful”, were currently taking over-the-counter pain medication (e.g., ibuprofen) and using heat or ice, were not involved in structured pain management activities, and were open to all treatments. Additionally, all patients were described as having vital signs within normal limits, experiencing pain-related impairments in physical function (e.g., difficulty walking), experiencing sleep difficulty, denying neurological symptoms, and having unremarkable physical exam findings except for paralumbar tenderness and an antalgic gait. Specific wording and non-essential details

(e.g., patient name, within normal limit vital signs) varied across vignettes for clinical realism, but all information presented was essentially equivalent, except for patient SES, which varied to match the patients' clothing.

Cognitive Load Manipulation

Physicians were randomized to either the high or low cognitive load groups. Because prior work suggests that cognitive load impacts male and female physicians differently,[22] cognitive load group assignment was balanced across physician gender. Physicians in both conditions were informed that they would have two and a half minutes to view and make decisions for each patient. This time allotment was derived from pilot testing indicating that it produced a moderate amount of subjective cognitive load for the task as measured by NASA TLX scores and resulted in minimal missing data. A countdown timer was displayed on screen during the task.

For the high cognitive load group, physicians were instructed that they would be interrupted throughout the pain treatment decision task. The interruptions occurred as follows. For each patient with pain, after 30 seconds elapsed, the pain treatment decision task locked (i.e., physicians could not select pain treatments). A "pop up" box appeared on the screen, with the narrative frame of a nurse asking about switching the hypertension medication for another patient (Figure 2). Physicians were instructed to read a brief description of that patient and complete one conversion from an angiotensin-converting enzyme inhibitor (ACE inhibitor) to an angiotensin II receptor blocker (ARB) before they could return to the pain decision-making task. A table with specific ACE inhibitor and equivalent ARB doses was provided on screen. ACE inhibitor prescriptions (i.e., medication and dose) and requested ARB medications varied for each interruption, which were randomized across patients. Once physicians entered the correct value, the pain treatment decision task "unlocked" so that they could finish making treatment decisions for the patient with pain. If an incorrect conversion value was entered, physicians were informed that their response was incorrect and were instructed to try again. Physicians had three tries before the screen unlocked, allowing them to proceed with the pain treatment decision task regardless of the conversion accuracy.

This cognitive load task was selected for three reasons. First, it mirrors the types of cognitive demands that physicians face in real clinical settings. Interruptions by staff are common,[43] and adjusting hypertension medications is highly relevant to primary care where chronic pain is typically managed.[44] Further, the medication conversion has a correct answer, mirroring the clinical reality that responding accurately to interruptions is essential. Second, completing the ACE inhibitor to ARB conversions required physicians to shift their attention and transfer some of their available working memory from the pain treatment decision task to the conversion task.[45] Third, physicians were under increased time pressure, as they had to complete both tasks (pain treatment decisions and medication conversion) within the fixed timeframe. Physicians in the control group completed the pain decision-making task with the same fixed timeframe (two and a half minutes) but without interruptions.

Measures

Pain Treatment Decisions—Physicians were presented with five pain treatment modalities,[1,46,47] for which they selected "yes" or "no" to indicate whether they would recommend it to the patient. Specifically, physicians were asked: (1) "Would you prescribe this patient an *oral opioid analgesic* for their pain?" (2) "Would you prescribe this patient an *oral non-opioid analgesic* for their pain?" (3) "Would you recommend the patient use *complementary or alternative approaches* for their pain (e.g., yoga, acupuncture)?" (4) "Would you recommend the patient make *lifestyle changes* to manage their pain (e.g., diet, exercise, rest)?" and (5) "Would you refer this patient to *a specialty care clinic or provider* for their pain (e.g., multidisciplinary pain clinic, physical therapy)?"

Responses to the above treatment questions were converted into two primary outcome measures—amount of treatment (AoT) and medication strength (MS)—as follows. For AoT, each "yes" to a pain treatment modality was scored 1 point, and each "no" was scored 0 points; hence, all treatments were weighted equally. These points were summed for each patient. In the end, each physician had 12 AoT values (1 for each of the 12 patients) ranging from 0 points (no treatments) to 5 points (all treatments). A higher AoT score can be interpreted as recommending more and a wider array of treatments for a given patient. For MS, each patient was assigned to one of the following ordinal categories of increasing medication strength, according to physician decisions for that patient: 0 = "no" to opioids + "no" to non-opioids, 1 = "no" to opioids + "yes" to non-opioids, 2 = "yes" to opioids + "no" to non-opioids, and 3 = "yes" to opioids + "yes" to non-opioids. In the end, each physician had 12 MS values (1 for each of the 12 patients) ranging from 0 (weakest) to 3 (strongest). Although the term "strong" is used to describe prescribing opioids (higher ordinal categories include opioids), this does not imply that opioids are always "stronger" or more effective analgesics than nonopioids.[48,49] A higher MS score can be interpreted as prescribing more analgesics (i.e., a combination of opioids and nonopioids) and being more likely to prescribe opioids for a given patient.

Subjective Cognitive Load—Subjective cognitive load was measured immediately following the pain treatment decision task with the NASA TLX, which has been used in medical settings.[50–52] Physicians rated their experience of the pain treatment decision task on separate visual analog scales from very low (0) to very high (100) for 6 dimensions of cognitive load: mental demand, physical demand, temporal demand, effort required, performance, and frustration level.[53] Scores were averaged for an overall mental workload score for each physician, with higher scores indicating higher cognitive load.

Implicit Beliefs—Implicit beliefs about race and SES differences in pain tolerance were measured with separate Implicit Association Tests (IATs).[54] For the race-pain IAT, physicians categorized *facial images* as Black or White people and *pain-related descriptive words* as pain sensitive (e.g., "wimpy") or pain tolerant (e.g., "hardy"). Similarly, for the SES-pain IAT, physicians categorized *silhouette images* of people as having a low-income (low SES image) or high-income job (high SES image) as determined by the Nam-Powers-Boyd Occupational Status Scale[42] and the *pain-related descriptive words* corresponding to pain sensitive or tolerant. Example IAT images can be found in the Supplementary

Materials. To complete the race-pain IAT, physicians were instructed to press one key if the stimulus was a Black face (low SES image for the SES-pain IAT) or a pain sensitive word and a different key if the stimulus was a White face (high-income SES image) or a pain tolerant word. In reverse trials, physicians were instructed to press one key for Black faces (low SES images) or pain tolerant words and another key for White faces (high SES images) or pain sensitive words. Faster responses to the White faces (high SES images)/pain sensitive and Black faces (low SES images)/pain tolerant pairings than to the Black faces (low SES images)/pain sensitive and White faces (high SES images)/pain tolerant pairings indicated an implicit belief that White people (people with high SES) are relatively more pain sensitive and that Black people (people with low SES) are relatively more pain tolerant. The IAT produces a D score, ranging from −2 to +2, with positive values indicating an implicit belief that White people (people with high SES) are more pain sensitive, and negative values indicating an implicit belief that Black people (people with low SES) are more pain sensitive.[55] Cut points have been defined as: ±.15 = slight bias, ±.35 = moderate bias, ±.65 = strong bias.[56] The IAT has demonstrated good reliability and validity.[57]

Demographic Questionnaire—Physicians reported their age, biological sex, gender identity, race, ethnicity, and information about their medical training program and clinical practice setting.

Socially Desirable Responding—To assess whether the tendency to respond in a socially desirable manner impacted physicians' pain treatment decisions, we used the Marlowe Crown Social Desirability Scale (MCSDS).[58,59] Physicians responded to 13 true-false items regarding everyday behaviors, such as "I am always courteous, even to people who are disagreeable." Responses were summed, and higher scores indicated a greater tendency to respond in a socially desirable manner.

Analytic Plan

Descriptive statistics were computed to characterize the sample and study variables. The outcome variables (AoT and MS) were ordinal, and the data were clustered (patient profiles were nested under physicians). In other words, the data structure has two levels: between-physician level and within-physician level. Consequently, multilevel ordinal logistic regression models were used.[60] These models account for both the ordinal nature of the outcomes and the interdependence of within-physician decisions, leading to unbiased parameter and standard error estimates as well as properly controlled Type 1 error rates.[61] Six models were tested: 1) two separate models to determine the main and interaction effects of patient race and SES on physicians' pain care decisions (Hypothesis 1), one for each outcome variable (AoT and MS), 2) four models to examine how physician cognitive load and implicit beliefs impacted physicians' pain treatment decisions for Black vs. White patients or patients with low vs. high SES (Hypotheses 2 & 3). Two of the models included patient race, physician cognitive load, physician race-pain IAT scores, and all two-way and three-way interactions as predictors of AoT and MS. The other two models included patient SES, physician cognitive load, SES-pain IAT scores, and all two-way and three-way interactions as predictors of AoT and MS.

To facilitate interpretation, for all models, non-significant ($p > .05$) two-way and three-way interactions were removed one at a time until the final model was determined. The proportional odds assumption was made for all models; thus, effects (quantified by odds ratios) were assumed to be equivalent between each pair of ordinal categories (i.e., the predictor variables did not have a disproportionate effect on any specific level of the outcome variables). For example, if there was a significant main effect of patient race on AoT, with an odds ratio of 2.5, this would indicate that the odds of physicians recommending all 5 treatments vs. fewer treatments (0, 1, 2, 3, 4) to White patients were 2.5 times than the corresponding odds to Black patients.

If significant effects were found, exploratory analyses (multilevel binary logistic regressions) were performed to investigate which individual treatments (e.g., opioids, referrals) drove the differences. Lastly, given that physician gender has been found to moderate the relationship between patient race, physician cognitive load, and physician opioid decisions,[22] we conducted exploratory analyses assessing whether physician gender, as well as physician race and socially desirable responding, moderated the hypothesized associations. Because none of these moderators were significant, we did not include them in this report.

Power Analyses

To the best of our knowledge, there is only one published study on power analyses for multilevel ordinal logistic regression.[62] That study suggests that for a 5-category response model with maximum likelihood estimation, at least 50 clusters (i.e., physicians) and 5 units (i.e., patient profile per cluster) are needed to achieve >0.80 power (α=0.05) for first-order fixed effects. Our study outcome variables have 6- and 4-category response options (AoT and MS, respectively); thus, this power estimate was applicable. Thus, we aimed to recruit at least 100 physicians (i.e., clusters).

RESULTS

Sample Demographics and Characterization

The final sample consisted of 120 physicians (Table 1) who were affiliated with 25 different institutions representing all geographic regions of the US. A slight majority were male (52%), and the average age was 30.8 years (SD=4.5). Just over half (55%) identified as White, 27% as Asian, 4% as Black or African American, 3% as other race, and 11% did not report their race; 3% identified as Hispanic ethnicity. The majority worked in a hospital setting (70%), and the most represented clinical specialties were family or internal medicine/primary care (22%), anesthesiology (18%), and psychiatry (16%). IAT scores indicated that, on average, physicians had a slight implicit belief that White people are pain sensitive and Black people are pain tolerant (Mean race-pain IAT=.20, SD=.33), and had a moderate implicit belief that people with low SES are pain sensitive and people with high SES are pain tolerant (Mean SES-pain IAT=−.44, SD=.45).

Cognitive Load

The average subjective cognitive load score of the study sample (Mean NASA TLX=48.3 [SD=12.0]) is similar to that found in studies using this measure to assess physician

cognitive load in real clinical settings.[63] Scores were significantly higher for the high vs. low cognitive load group (Mean NASA TLX=51.0 [SD=10.3] vs. Mean NASA TLX=45.2 [SD=13.1]; t[116]=−2.68, p=.01, Cohen's d=.50), confirming that the cognitive load manipulation was successful.

Pain Treatment Decisions

Amount of Treatment—Across all patients and cognitive load conditions, physicians recommended a median of 4 pain treatments (range: 0–5) to patients. There were no main effects of patient race or SES nor a patient race-by-SES interaction for AoT (Table 2). There was a patient SES-by-physician cognitive load interaction (OR=.56, 95% CI [0.31, 1.01], p=.05) for AoT that was noteworthy but not statistically significant at p<.05. Under low cognitive load, physicians tended to recommend more pain treatments to patients with high vs. low SES (OR=1.35, 95% CI [0.91, 2.00], p=.13), but the opposite was found when physicians were under high cognitive load (OR=.76, 95% CI [0.48, 1.18], p=.22). Exploratory analyses examining the patient SES-by-cognitive load interactions for individual treatments (opioid, non-opioid, complementary or alternative approaches, lifestyle, and referral) can be found in the Supplementary Materials. No other main or interactive effects were found on AoT.

Medication Strength—Across all patients and cognitive load conditions, physicians prescribed a median of 1 on the MS scale (non-opioid analgesics only; range: 0–3). There was a significant main effect of patient SES (OR=.68, 95% CI [0.48, 0.97], p=.03), such that physicians prescribed weaker analgesics to high vs. low SES patients. There was no main effect of patient race or race-by-SES interaction for MS. Additionally, none of the two-way interactions between patient variables (race or SES) and physician cognitive load or the three-way interactions among patient variables (race or SES), physician cognitive load, and physician IAT scores were significant.

DISCUSSION

The purpose of this study was to examine the impact of two patient characteristics (race and SES), physician cognitive load, and physician implicit beliefs on chronic pain treatment decisions. One significant effect of patient SES and one noteworthy but not statistically significant patient SES-by-cognitive load interaction emerged. Our study is important for several reasons. First, given the increasingly demanding nature of healthcare, physician burden-related constructs, such as cognitive load, are essential areas in need of research. Physician burnout is at an all-time high of 63%,[64] and a recent study showed a positive relationship between physician cognitive load and burnout.[65] Second, chronic pain care is known to be particularly cognitively demanding given its clinical uncertainty, the lack of care guidelines, and pressures stemming from the opioid crisis. Third, despite high cognitive load being known to impact decision-making,[22,66–68] this is only the *second* empirical study to examine the impact of cognitive load on pain care decisions,[22] and the *first* to examine interactive effects with patient SES. Although the empirical findings in our study had important limitations, in the discussion that follows, we contextualize them in the broader

literature on pain disparities and aim to inspire future investigations in this critical and neglected area.

Physicians prescribed stronger medications to patients with low vs. high SES. When faced with distressed patients who have a great need for pain relief, physicians often prescribe opioids because they are uncertain about alternative options.[69,70] Such patients have more comorbidities and psychosocial stressors and are more likely to occupy lower socioeconomic positions.[71,72] Applying this to the current study, physicians may have assumed that patients with low SES were distressed and in need of immediate pain relief, and consequently, prescribed them stronger medications. Physicians may also have recommended stronger medications, given that they presented to a clinic despite the known barriers patients with low SES face when accessing medical care.[73] Nonetheless, these are speculative explanations in need of empirical scrutiny.

We found a non-significant but potentially meaningful interaction such that under high cognitive load, physicians recommended more pain treatments to patients with low vs. high SES ($p=.05$). As suggested by the DPM, this mentally demanding situation may have allowed the stereotype that patients with low SES are distressed to impact decision-making, leading to physicians indiscriminately recommending treatments in hopes that *any* of them would be palliative. Although speculative, this interpretation suggests that the stereotype about patients with low SES being distressed is more potent than the stereotype that these patients are pain tolerant.[74] When under low cognitive load, physicians recommended more pain treatments to patients with high SES. In this less mentally demanding context, physicians may have relied on knowledge about differential healthcare access across the SES spectrum and adjusted their treatment decisions accordingly.[8] Nevertheless, it is important to keep in mind that the interaction was not significant at $p<.05$; thus, raising doubts about its relevance to real-life pain care. Clinical decision-making is complex, and other physician (e.g., prior experience with patients across the socioeconomic spectrum) and contextual (e.g., treatment availability) factors likely also influence the relationship between patient SES and physician pain care decisions.

We did not find a significant interaction between patient race and cognitive load. To our knowledge, Burgess et al[22] is the only other study to examine the effects of cognitive load on pain treatment decisions for racially diverse patients. They found that under high cognitive load, male physicians were more likely to recommend opioids to White vs. Black patients, while under low cognitive load, the opposite effect was found. Female physicians were more likely to recommend opioids to Black patients in both cognitive conditions. This difference in findings may be due to different cognitive load tasks and statistical methods used. Burgess et al[22] used a dot memorization task,[75] which may have been more demanding, thus, leading to race differences that were not observed herein. This is speculative given that Burgess et al[22] did not assess physician perceptions of cognitive load, as we did. Although our interruption task may have been less demanding, it has the notable advantage of being more clinically relevant. Additionally, they used logistic regressions while we used multilevel ordinal logistic regression, which is likely more sample size demanding.

There were neither main effects of patient race or SES on amount of treatment, nor a main effect of patient race on medication strength. One potential explanation is that physicians were recently trained and, thus, exposed to more content about health disparities than in previous cohorts.[76,77] The majority also reported working with racially and socioeconomically diverse populations. Additionally, data collection began less than a year after the murder of George Floyd and during the COVID-19 pandemic when there was heightened attention to racial injustices,[78] including within healthcare contexts.[79,80] Further, our hypothesized patient race-by-SES interactions—that patients who are both Black and low SES would receive the fewest pain treatments and be prescribed the weakest medications—were not supported by the data. In a recent VH study, we found a significant patient race-by-SES interaction on physicians' recommendations for pain-related workplace accommodations but not for opioid prescriptions.[31] Much remains to be known about the intersections of patient race, SES, and social characteristics in this context.

Physicians demonstrated a slight implicit belief that Black vs. White people are more pain tolerant, which aligns with two prior studies.[81,82] However, this contrasts real-world data that Black people report more pain.[83–87] For SES, physicians demonstrated a moderate implicit belief that patients with low vs. high SES are less pain tolerant. We are not aware of any prior published studies that examined this implicit belief, but this finding aligns with real-world data that patients with low SES report more pain.[88,89] Nevertheless, these physician implicit beliefs were not significantly associated with treatment decisions in the current study nor in a prior study that used VH pediatric patients.[82] Consequently, there is not strong empirical support for interventions that target physician implicit beliefs about race and SES differences in pain to improve pain treatment equity.

Our findings inform several future research directions. Larger replication studies are needed, particularly for the interaction between patient SES and physician cognitive load. Given that several of our findings had small to medium effect sizes but were not statistically significant, we may have been underpowered, particularly in detecting interaction effects. Published studies on power analyses for multilevel ordinal logistic regression are limited. The work of Ali and collegues[62] informed our study, but they used effect sizes greater than those observed herein and did not included ordinal predictors as we did. We explored power calculations for our smaller SES-by-cognitive load interaction effect (i.e., logit = .58) using a similar analytic method—multilevel logistic regression.[90] We found that our sample size (120 physicians with 12 patients per physician) produced sufficient power (>80%) to detect first-order fixed effects but lower power (67%) to detect cross-level interaction effects.

Future studies can also test the differential impact of varying levels of cognitive load. The "high" group in our study rated their subjective cognitive load as moderate, indicating room to further increase their mental workload. Yet, this level of cognitive load is similar to that of physicians in real clinical settings,[63] and increasing it further may not be representative. It is also important to note that "more treatment" is not necessarily "better" care. Optimal pain care is patient-centered.[91] Thus, future studies might examine how physician cognitive load impacts the patient-centeredness of pain care. Moreover, many clinical decisions, such as the hypertension conversion in the current study, require accuracy, which may introduce another demand on physician cognitive bandwidth. It was beyond the scope of the study

to examine whether conversion accuracy was related to decision-making, but this is an area ripe for future research. Likewise, future studies could investigate the effects of other mental demands, such as multi-tasking (e.g., documentation) and task complexity (e.g., patient comorbidities). Incorporating self-report measures of cognitive load (e.g., NASA TXL) can help us further understand the mental demands that physicians encounter. Lastly, cognitive load fits under the broader umbrella of physician burden. Patients with chronic pain frequently present with complex medical and psychosocial comorbidities that pose challenges for physicians. This is not to say that patients are at fault but rather to recognize the frequent mismatch between patient need and physician capabilities in a system that is replete with constraints. These factors were not considered in the current study but are a notable area for future work.

The current study has several limitations. First, although study physicians rated their cognitive load similarly to that reported by physicians in real clinical encounters (Mean NASA TLX=47.6 [SD=18.4] vs. 48.3 [SD=12.0], respectively),[92] our VH methodology does not fully represent real-world environments. Other patient (e.g., insurance), physician (e.g., pain knowledge), and contextual (e.g., treatment costs) factors that were not assessed may impact and interact with physician cognitive load to affect their treatment decisions. Given that our patient SES-by-cognitive load interaction was non-significant, it is important to examine these other factors in future research on physician decision-making for pain. Second, physicians may have responded in socially desirable ways; however, scores on the social desirability measure (MCSDS) were not associated with treatment decisions. Third, participating physicians were from a variety of specialties, were predominately White or Asian, and worked in urban hospital settings. We only examined patients with chronic back pain who varied by race (Black/white) and socioeconomic status (low-income vs. high-income jobs). These physician and patient characteristics should be considered when generalizing the results and planning future research, such as using a gender ratio that reflects the clinical pain condition of interest. Limitations aside, our results highlight cognitive load as a clinically-relevant factor in pain care. This line of work can support the development of interventions that help physicians reduce the impact of cognitive load and stereotypical beliefs on their pain care decisions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Disclosures

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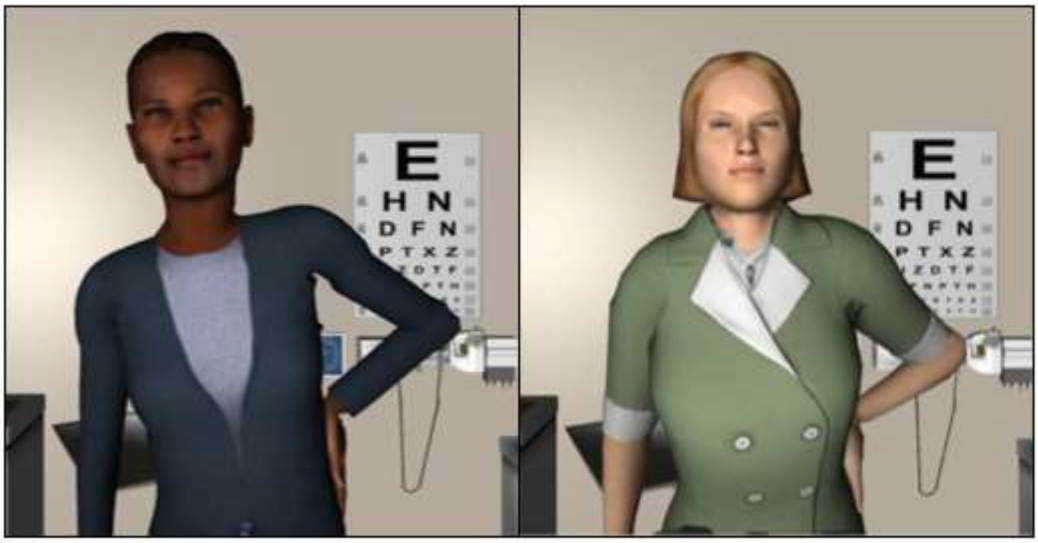
Highlights

- People are more likely to be influenced by stereotypes when making decisions under cognitive load.
- This study examined the effects of cognitive load on pain care decisions for diverse patients.
- Results suggest cognitive load is a clinically relevant factor in pain decision-making and equity.



Height	Weight	Temperature	Blood Pressure	Heart Rate	Respiratory Rate	Mental Status	Pain Report
5 ft. 4 in.	135 lbs.	98.2	117/79	71 bpm	17 rpm	A/O X 4	9/10
Ms. Brown presents to your office. She is 44 years old. She reports sharp and throbbing pain in her low back that began while carrying a stack of books to her home office. Ms. Brown is employed as a dentist (housekeeper at a nearby hotel). Even though the most recent pain flare started a few days ago, she has experienced chronic low back pain for a year. She reports that her previous provider prescribed her opioids and that they "kind of worked." Currently, she denies taking any prescription medications for her pain or participating in any formal pain management activities. She rates her average pain as 6 out of 10, and says her current pain (rated as 9 out of 10) interferes with walking and sitting. She does not present with any neurological symptoms (i.e., bowel or bladder dysfunction). On physical exam, she displays moderate paralumbar tenderness and an antalgic gait, but no other signs or symptoms of note. She reports not sleeping well and feeling exhausted lately. Regarding her recent pain flare, she reportedly still experiences pain even after trying naproxen that she purchased over-the-counter and a topical cream. Ms. Brown is asking for something stronger for her pain. She says that she is open to all treatments.							

Figure 1.

Still images taken from full-motion videos of virtual patients with chronic pain (Black/high SES patient [left pane], White/low socioeconomic status patient [right]) and an example text vignette for a high SES patient with parenthetical content representing a low SES patient.

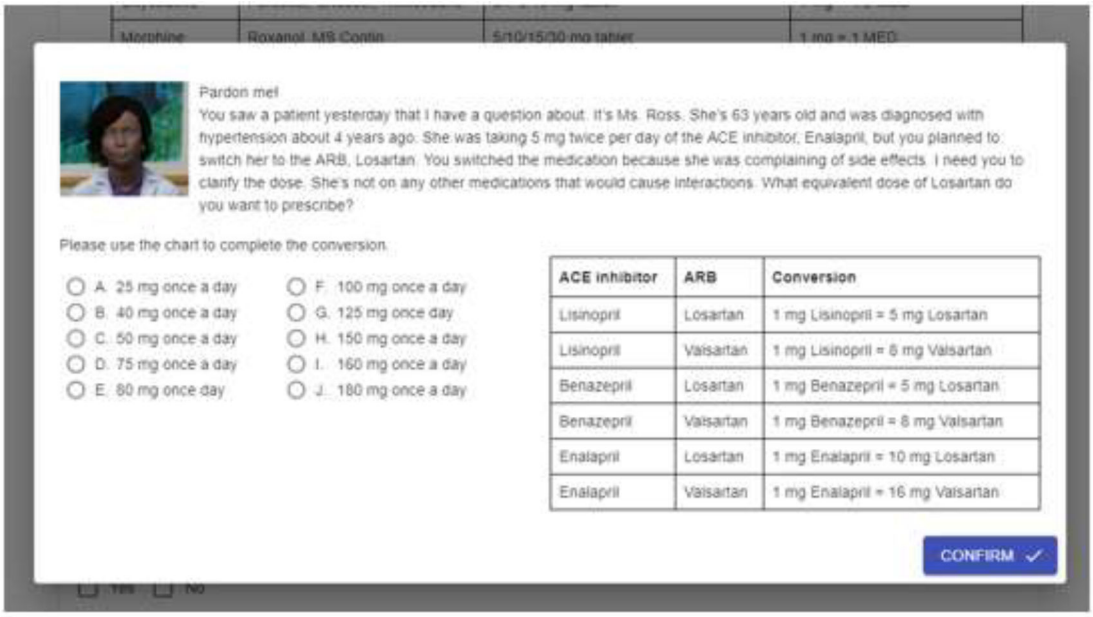


Figure 2.
Still image of cognitive load interruption

Table 1.

Physician Characteristics

N=120	n (%)/ Mean (SD)	
Age (years)	30.8 (4.5)	
Gender[a]		
	Male	62 (52%)
	Female	53 (44%)
	Not reported	5 (4%)
Race		
	White	66 (55%)
	Asian	32 (27%)
	Black or African American	5 (4%)
	American Indian/Alaska Native	2 (2%)
	Other[b]	3 (3%)
	Not reported	12 (10%)
Ethnicity		
	Not Hispanic or Latino	111 (93%)
	Hispanic or Latino	4 (3%)
	Not reported	5 (4%)
Geographic Region[c]		
	West	19 (16%)
	Midwest	55 (46%)
	Northeast	28 (23%)
	South	18 (15%)
Healthcare experience		
	<1 year	36 (30%)
	2–3 years	57 (48%)
	4–5 years	22 (18%)
	Not reported	5 (4%)
Adult or pediatric clinical focus		
	Adult	101 (84%)
	Pediatric	12 (10%)
	Not reported	7 (6%)
Clinical specialty		
	Family or internal medicine/primary care	27 (23%)
	Anesthesiology	22 (18%)
	Psychiatry	19 (16%)
	Neurology	10 (8%)
	Other specialties[d]	35 (29%)
	Not reported	7 (6%)
Practice setting		

N=120	n (%)/ Mean (SD)
	Hospital 85 (71%)
	Outpatient clinic 24 (20%)
	Other practice settings[e] 4 (3%)
	Not reported 7 (6%)
Urbanicity of practice setting[d]	
	Rural 6 (5%)
	Suburban 16 (13%)
	Urban 91 (76%)
	Not reported 7 (6%)
Racial demographic of practice setting[f]	
	0–25% BIPOC 9 (8%)
	25–50% BIPOC 64 (53%)
	50–75% BIPOC 33 (28%)
	75–100% BIPOC 7 (6%)
	Not reported 7 (6%)
Socioeconomic demographic of practice setting[f]	
	0–25% low income 10 (8%)
	25–50% low income 52 (43%)
	50–75% low income 45 (38%)
	75–100% low income 6 (5%)
	Not reported 7 (6%)

[a] Participants were asked to report their biological sex and gender identity. In all cases, self-reported sex and gender aligned. Thus, for ease of presentation, only gender identity is reported.

[b] Physicians who identified as other racial groups selected multi-racial (White and Asian; n=2) and Arab (n=1) categories.

[c] US geographic regions were determined in accordance with the US Census Bureau.[82]

[d] Other practice setting included hospice (n=1), emergency room/urgent care (n=2), and multiple practice settings (n=1).

[e] Other clinical specialties included: critical care, emergency medicine, endocrinology, gastroenterology, neonatal and perinatal medicine, obstetrics and gynecology, orthopedics, otolaryngology, nephrology, plastic surgery, radiology, rheumatology, sleep medicine, and surgery.

[f] Reported by participating physicians.

BIPOC: Black, Indigenous, people of color

Table 2.

Effects of Patient Race and SES, Physician Cognitive Load, and Implicit Beliefs on Physician Pain Treatment Decisions

Hypothesis	Outcome	Variable	Estimate	SE	OR	95% CI	*p*
1	AoT						
		Race	−0.02	0.14	0.98	0.74–1.29	.86
		SES	−0.10	0.13	0.90	0.70–1.17	.44
2 & 3 (Race)	AoT						
		Race	.03	.71	1.03	0.26–4.14	.84
		Cognitive Load	−.11	.15	1.16	0.67–1.20	.86
		Race-Pain IAT	−.23	.98	2.66	0.12–5.42	.81
2 & 3 (SES)	AoT						
		SES	0.30	0.20	1.35	0.91–2.00	.13
		Cognitive Load	0.29	0.62	1.34	0.40–4.51	.64
		SES-Pain IAT	0.82	0.58	2.26	0.72–7.07	.16
		SES X Cognitive Load	−0.58	0.30	0.56	0.31–1.01	.05
1	MS						
		Race	0.12	0.20	1.12	0.76–1.67	.57
		SES	−0.38	0.18	0.68	0.48–0.97	.03
2 & 3 (Race)	MS						
		Race	0.16	0.72	1.18	0.29–4.81	.46
		Cognitive Load	0.47	0.68	1.61	0.42–6.07	.48
		Race-Pain IAT	0.46	1.04	1.58	0.21–12.16	.66
2 & 3 (SES)	MS						
		SES	−0.19	0.19	0.83	0.57–1.20	.33
		Cognitive Load	0.53	0.68	1.70	0.45–6.44	.43
		SES-Pain IAT	1.25	0.67	3.49	0.94–13.00	.06

Abbreviations: AoT (amount of treatment), CI (confidence interval), IAT (implicit association test), MS (medication strength), SES (socioeconomic status)

Dummy coding: Patient race: 0=Black, 1=White; Patient SES: 0=Low SES, 1=High SES; Cognitive load: 0=Low cognitive load, 1=High cognitive load

Note. The table presents the result from the final models. As mentioned in the text, although we examined all possible two-way or three-way interaction effects, they were removed from the final models if they were not significant.