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Short Communication

Neuroticism and resting mean arterial pressure interact to predict pain tolerance in pain-free adults

Ian A. Boggero [a,*], Laura M. Smart [b,1], Tracey C. Kniffin [a], Rheeda L. Walker [b]

[a] Department of Psychology, University of Kentucky, Kastle Hall, Lexington, KY 40506-0044, USA
[b] Department of Psychology, University of Georgia, Psychology Building, Athens, GA 30602-3013, USA

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ABSTRACT

Personality traits and resting mean arterial pressure are known to play a role in how people experience and cope with chronic pain, but their relationships with acute pain responses in healthy adults remain unknown. The current study aims to examine the effects of personality variables, blood pressure variables, and their interactions on pain tolerance in a sample of healthy, pain-free adults. Data were collected from 41 pain-free participants. Results revealed a significant crossover interaction such that those with higher mean arterial pressure (MAP) were able to tolerate more pain only at low levels of neuroticism. At high levels of neuroticism, MAP was inversely related to pain tolerance. The current study is the first to our knowledge to suggest that stable personality traits interact with physiology to influence pain tolerance in healthy populations. These findings could be useful in advancing the theoretical understanding of the psychological correlates of pain.

1. Introduction

1.1. Personality and pain

Since Melzack and Wall (1965) first argued that psychological variables influence pain processing, researchers have studied how personality shapes the experience of pain. Comparisons of personality characteristics between pain patients and normal controls have found that anxiety, depression, and other "trait" negative affect variables are positively correlated with pain (e.g., Gatchel & Weisberg, 2000; Endler, Corace, Summerfeldt, Johnson, & Rothbart, 2003). In chronic pain patients, higher levels of neuroticism are associated with higher pain intensity, interference, and affective distress, while higher levels of extraversion and openness are associated with lower pain severity and distress (Schmidt, Hooten, & Carlson, 2011; Hood, Pulvers, Carrillo, Merchant, & Thomas, 2012). However, relatively little research has examined how neuroticism, extraversion, agreeableness, conscientiousness, and openness influence pain responses in healthy pain-free adults.

1.2. Blood pressure and pain

Personality variables are known to influence cardiovascular functioning, which is closely tied to pain responses (Räikkönen, Matthews, Flory, Owens, & Gump, 1999). Blood vessels contain free nerve endings called baroreceptors that monitor distension and initiate an endogenous opioid response synchronized to the heart beat (Elbert, Rockstroh, Lutzenberger, Kessler, Pietrowsky, & Birbaumer, 1988). Increases in blood pressure result in more force being exerted on arterial walls and triggers endogenous opioid release through this baroreceptor reflex mechanism. As such, there is a linear positive relationship between resting mean arterial blood pressure (MAP), defined as the average blood pressure during a single cardiac cycle, and pain thresholds, defined by the amount of stimulation until one first perceives pain (for a detailed review, see Bruehl & Chung, 2004). However, no study to our knowledge has examined whether the effect of MAP on pain thresholds also extend to pain tolerance (i.e., the ability to tolerate a painful noxious stimuli). Furthermore, no study has tested how personality variables moderate the relationship between MAP and pain tolerance. Because those high in neuroticism are known to be reactive to negative stimuli, and also acute monitors of internal sensations, one possibility is that the combination of high neuroticism and MAP may predispose individuals to misinterpret physiological cues as threatening and exhibit low pain tolerance (Costa & McCrae, 1987; Robinson & Liu, 2013). In other words,

* Corresponding author. Address: 111-B Kastle Hall, Lexington, KY 40506-0044, USA. Tel.: +1 859 257 2207.

E-mail addresses: ian.boggero@uky.edu (I.A. Boggero), lauramsmart@uky.edu (L. M. Smart), tckniffin@uky.edu (T.C. Kniffin), rlwo@uga.edu (R.L. Walker).

[1] Present address: Dept. of Psychology, University of Kentucky, Kastle Hall, Lexington, KY 40506-0044, USA.

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the same elevations in MAP that may make those low in neuroticism better able to tolerate pain may make those high in neuroticism quick to withdraw from it.

1.3. The current study

The current study aimed to explore the contribution of personality traits, blood pressure, and their interactions in pain tolerance. Based on the current literature, the following predictions were made:

1. Neuroticism would be negatively associated with pain tolerance whereas extraversion and openness would be positively associated with pain tolerance.
2. MAP would be positively associated with pain tolerance.
3. Those with high neuroticism and high MAP would demonstrate low pain tolerance.

2. Method

2.1. Participants

Participants were 41 undergraduate students who received course credit in an introductory psychology course for participation. To be eligible, participants had to meet the following inclusion criteria: not be on any medications with analgesic or vasoactive properties; have no history of cardiovascular disease, stroke, or fainting; not use any tobacco product; and not be pregnant or breastfeeding. Participants in the sample were primarily female (68.3%) and European American (82.9%). They ranged in age from 18 to 24 years (M = 19.41, SD = 1.55).

2.2. Measures and materials

2.2.1. Demographics

Participants self-reported their sex, age, and ethnicity.

2.2.2. Pain tolerance

The cold pressor task (CPT) was used to measure pain tolerance. Consistent with established guidelines, an insulated cooler was filled with ice water and an electric pump was used to circulate the water to maintain a constant water temperature of 0 °C ± 1° (von Baeyer, Piira, Chambers, Trapanotto, & Zeltzer, 2005). Participants were read the following instructions immediately prior to starting the task: "This task involves submerging your non-dominant hand in ice water for as long as you can tolerate up to 3 min. It is important that you keep your hand in the water for as long as possible. During the task, I will ask you to rate the pain you are experiencing on a scale from 1 to 10, with 1 being no pain at all and 10 being the most pain imaginable." Pain tolerance was operationalized as the time it took participants to withdraw their non-dominant hand from the ice water. Pain tolerance was timed manually by the same trained experimenter for all participants.

2.2.3. Blood pressure

Systolic blood pressure, diastolic blood pressure, and heart rate were measured twice at the start of the first session and once at the start of the second session. To increase reliability, averages of both session 1 and 2 readings were calculated for each participant. Measures were taken at the radial artery using a digital sphygmomanometer (Omron, HEM-629). MAP was calculated by adding diastolic blood pressure to one-third of the difference between systolic and diastolic blood pressure (Fillingim & Maixner, 1996). Internal consistency for the composite MAP measure was α = .91.

2.2.4. Personality

The NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992) is a well-validated self-report measure of personality. It consists of 60-items and assesses the domains of the five-factor model of personality: neuroticism, extraversion, agreeableness, conscientiousness, and openness. Participants rate themselves on each question using a 5-point scale ranging from "strongly disagree" to "strongly agree."

2.2.5. Affect

Self-reported affect was collected as a potential covariate and as a manipulation check. The Positive and Negative Affect Schedule-Expanded Form (PANAS-X) was used to measure positive and negative affect at the first session and before and after the CPT in the second session. The PANAS-X is a 60-item measure of affect that asks participants to rate how they have felt over the last week and in the present moment on a scale of 1 "Very slightly or not at all" to 5 "Extremely." Previous research has validated this measure for use in undergraduate populations (Watson & Clark, 1999). In the current study, only the positive and negative affect subscales were analyzed. These scales had good internal consistency on all measurement occasions (average α = .85, range α = .80–.89).

2.3. Procedures

All procedures were approved by the Institutional Review Board at the University of Georgia (approval number 2010-10841-0). Participants were asked to come in for two sessions to avoid carryover fatigue of filling out questionnaires on pain tolerance. In the first session, they signed an informed consent form, provided two consecutive blood pressure readings, and filled out the demographics, NEO-FFI, and PANAS-X questionnaires. They were then scheduled to return for the second session between one and fourteen days later. Participants were instructed to abstain from drugs, alcohol, and pain medications for twenty-four hours prior to their second session. In the second session, participants provided a blood pressure reading, completed the PANAS-X, and were then asked to sit next to the cold pressor apparatus. They were told that they would be engaging in a task requiring them to submerge their non-dominant hand in ice water for as long as they could tolerate (see instructions in Section 2.2). Following the task, participants were offered a towel with which to dry their hands and were asked to re-complete the PANAS-X. They were then debriefed and thanked for their participation.

3. Results

3.1. Data cleaning and descriptive statistics

All data were analyzed using IBM SPSS Statistics Software, Version 21. Questionnaires were scored by averaging across all items on relevant subscales. Prior to analyses, all predictor variables were standardized to facilitate interpretation and estimation of interactions. Bivariate correlations and descriptive statistics for all study variables can be found in Table 1.

3.2. Manipulation check

Repeated measures ANOVA were used to compare changes in positive and negative affect following the cold pressor task. Participants reported a significant decrease in positive affect from baseline (M = 3.38, SD = 0.50) after experiencing the cold pressor task (M = 2.54, SD = 0.75), $F(1,40)$ = 45.40, $p < .01$, η^2 = 0.53. There was also a marginal decrease in negative affect from baseline (M = 1.77, SD = 0.65) following the cold pressor task (M = 1.57, SD = 0.48, $F(1,40)$ = 3.92, p = .06, η^2 = 0.08).