Individual differences in glucose depletion are associated with individual differences in spinal nociception

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Introduction
Blood glucose is a limited resource and depletion of blood glucose can impair processes that rely on this energy source. For example, prior research has shown that reductions in blood glucose levels following cognitively demanding processes (i.e., executive function tasks) can impair subsequent task attempts. Additionally, other research suggests that pain may be associated with impairments in cognitively demanding tasks, and intact executive function may be important for pain regulation. These facts are not surprising, given the overlap in brain regions involved in both pain regulation and executive functioning. One previous study found that pain and spinal nociceptive responses were greater following a cognitively demanding task, suggesting pain regulation mechanisms may be less efficient after the performance of the task. However, no study has established experimental linkages between blood glucose, executive function, and modulation of spinal nociception. The present study measured blood glucose from finger sticks and a digital meter, executive function from the Stroop color-word test, and pain processing from the nociceptive flexion reflex (NFR, a physiological correlate of spinal nociception) and electrorcuitaneous pain threshold.

Objective
To determine the relationship between blood glucose, executive function, and modulation of spinal nociception.

Participants
• Healthy Pain-Free Adult Participants: N = 44
• Participant Characteristics: Female (71%), White non-Hispanic (78%), single (83%), employed (98%), average age = 23 yrs (SD = 4 yrs), 1 years of education = 15.8 (SD = 2.2)
• Exclusion Criteria:
  - Chronic pain (e.g., neck pain), cardiovascular, neurological, circulatory problems
  - Blood glucose dysregulation: diabetes, hypo or hyperglycemia
  - Consumption of food or liquids other than water or use of tobacco 2 hours prior to testing
  - Current use of analgesics, anxiolytic, antidepressant, and/or hypertensive medication

Procedure
• Overview, Informed Consent, Eligibility Determination, & Apply Sensors
• Stroop Color-Word Test #1
• Blood Glucose Check #1
• Stroop Color-Word Test #2
• NFR Threshold Assessment
• 3-Pulse Threshold (data not presented)
• Pain Threshold Assessment
• Blood Glucose Check #2
• Stroop Color-Word Test #2

Blood Glucose Assessment
• A finger prick test was administered to measure blood glucose levels before and after pain testing.
• Glucose depletion was calculated by subtracting glucose 2 score from glucose 1 score.

Stroop Color-Word Test
• Participants were asked to read as many words, color, and color-word with a 45 second time limit for each task.
• Instructions during color-word test, “name the color of the ink the words are printed, ignoring the word that is printed for each item.”
• NFR threshold was used to assess spinal nociception.

Data Analysis
• One-way Repeated Measures ANOVA with 2 levels (Trial 1, Trial 2).
• Pearson product-moment correlations were used to test the relationship between variables.

Blood Glucose Levels
• Results revealed blood glucose levels significantly decreased during pain testing (p < 0.001).

Stroop Color-Word Test
• Electrode stimulations increased in 2 mA steps until NFR was obtained and then stimulations decrease in 1 mA steps until no NFR.
• Repeated 2 more ascending/descending staircases in 2 mA steps until the stimulus was rated ≤30.
• NFR threshold was used to assess spinal nociception.

Pain Ratings
• Pain ratings made following each stimulation using a computer presented, vertically-oriented scale.
• Electrotactile Pain Threshold: Stimulations increase in 2 mA steps until the stimulus was rated ≥50 on the numerical rating and decrease in 2 mA steps until the stimulus was rated ≤30.
• Repeated 2 more ascending/descending staircases in 2 mA steps until ratings were obtained.
• Threshold = the average stimulus (in mA) of the three ascending/descending series.

Results revealed no significant change in Stroop performance following pain testing (although performance increased marginally, p = 0.06).

Relationship between Change in Stroop Performance and NFR Threshold
• Changes in Stroop performance were unrelated to NFR threshold (r = -0.05, p = 0.69).

Conclusions
Together, these results suggest that glucose depletion may impair performance of neurocircuitry involved with descending inhibition of spinal nociception, without impacting the perceptual detection of pain (i.e., pain threshold). Glucose depletion may be associated with changes in Stroop performance and other variables (i.e., NFR, blood glucose), the effects of glucose depletion on spinal nociception do not appear to be mediated by changes in executive function.

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