The influence of acute and chronic stress on glucose and protein utilization of a desert songbird

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Introduction

• An adaptive value of the stress response is the mobilization of energy stores. It is commonly accepted that this mobilized energy comes mainly in the form of glucose. Indeed, acute stress elicits hyperglycemia in rats, humans, bats, fish, snakes, turtles, and crocodiles.

• Birds are unique, however, in that they have a high metabolic rate and plasma glucose concentration, and primarily use fatty acids for energy.

• Our knowledge of the energetics involved during acute or chronic stress is limited, with no data available on free-ranging, sedentary species.

• Studies in captive European Starlings, *Sturnus vulgaris*, found that acute stress induces hyperglycemia only during the night and fails to elicit a change during the day. Furthermore, chronic stress does not increase plasma glucose in starlings.

• Migratory bird studies suggest lipids may be the most important energy source in birds. If fat stores are depleted, the second energy source protein catabolism. Accordingly, plasma uric acid, an end-product of protein catabolism, increases during endurance flight.

• We investigated acute and chronic stress-induced changes in glucose and uric acid in both urban and rural free-ranging Abert's Towhees, *Pipilo aberti*.

Methods

• Adult male Abert's Towhees, caught in June 2009 between 05:00 AM and 11:00 AM from urban and rural locations.

• Blood samples taken within 3 minutes of capture ('baseline') and 60 minutes later ('stressed').

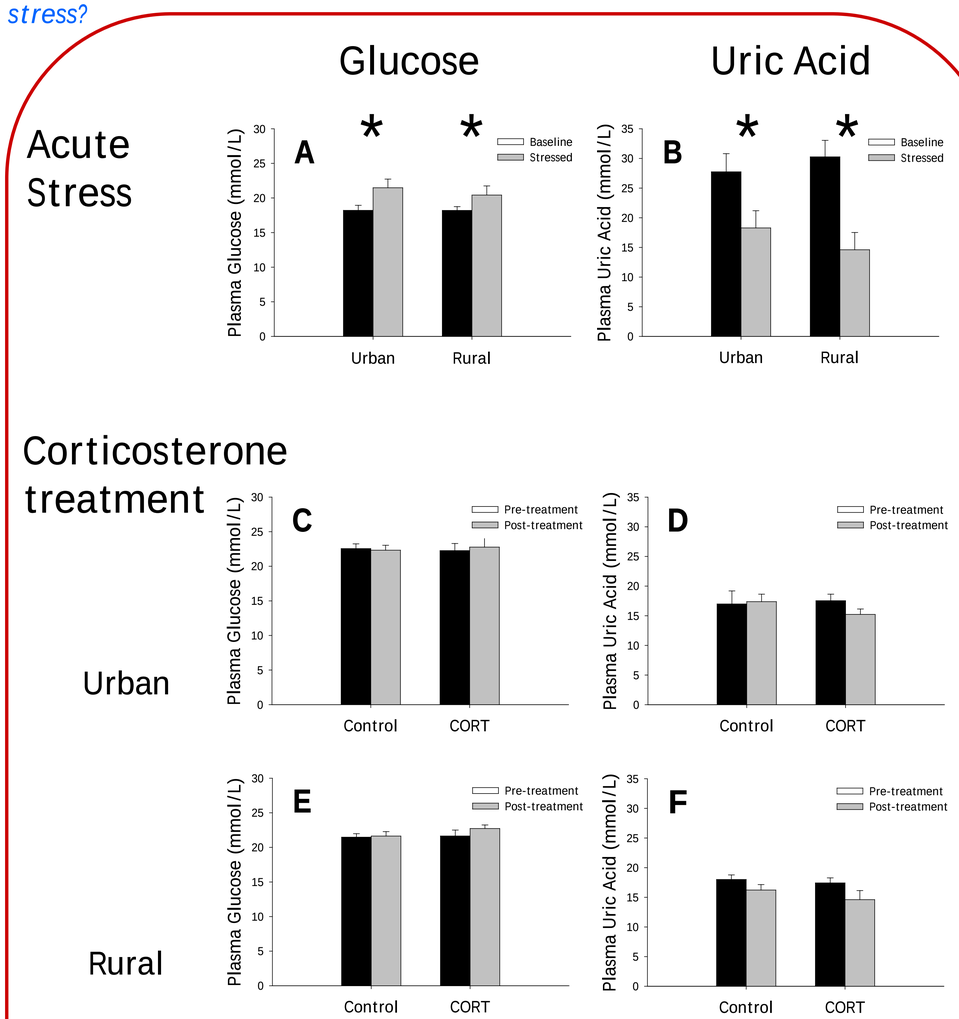
• Birds were brought into captivity and exposed to long days (14L:10D). To elevate plasma corticosterone, 14 towhees (7 urban; 7 rural) each received a corticosterone-filled subcutaneous Silastic capsule (20 mm, Dow Corning, Midland, MI). Control towhees received an empty capsule. Capsules were replaced after 7 and 14 days. Thus, CORT was elevated for 21 days.

• Glucose and uric acid were assayed using commercial kits (Cayman Chemical, Ann Arbor, MI; and BioAssay Systems, Hayward, CA, respectively).

Hypothesis & Research Question

Hypothesis: During acute and chronic stress, protein catabolism, as opposed to glucose, is the more important energy source.

Question: *Do birds that inhabit areas with putative disparities in resource abundance differ in the type and magnitude of energy utilization in response to acute or chronic stress?*



Baseline and acute stress-induced plasma glucose (**A**) and uric acid (**B**) in urban and rural Abert's Towhees. Pre- and post-treatment chronic stress-induced changes in plasma glucose and uric acid of urban (**C** and **D**) and rural towhees (**E** and **F**).

Summary

Glucose

• Acute stress increases plasma glucose by 15% (A).

• Transfer to captivity causes a further 5% increase in plasma glucose (C).

• Chronic stress does not affect plasma glucose (C & E).

Uric Acid

• Acute stress decreases plasma uric acid by 43% (B).

• Transfer to captivity does not further affect plasma uric acid.

• Chronic stress has no affect on plasma uric acid (D & F).

Urban/Rural

• Urban and rural birds have similar baseline and stressed-induced plasma glucose and uric acid.

Conclusion

• The results support the hypothesis that the primary energy source mobilized in response to stress in birds may not be glucose or protein.

• Protein catabolism appears to be a less important source of energy than glucose during acute stress.

• Birds inhabiting areas with putative disparities in resource abundance do not differ either in the type or magnitude of energy utilization in response to acute or chronic stress.

• The amplitude of the acute stress-induced increase in plasma glucose is relatively small, suggesting that plasma glucose either is tightly regulated or has a high turnover rate.

• Ongoing studies are aimed at determining whether acute stress promotes free fatty acid utilization.

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