

Effects of corticosterone and ACTH on the unken reflex in rough-skinned newts (*Taricha granulosa*)

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INTRODUCTION

•Stressful events such as a predator attacks stimulate a multitude of physiological events, including the activation of the hypothalamic-pituitary-adrenal (HPA) axis. The consequential release of glucocorticoids, such as corticosterone (CORT), from the adrenal glands stimulates the mobilization of energy stores for anti-predator behavior.

•One such important anti-predator behavior for rough-skinned newts (*Taricha granulosa*) is the unken reflex. When threatened, rough-skinned newts curl up to expose a brightly colored ventral side (Image 1 and 2). The exposed aposematic coloration warns potential predators of the newts' toxicity. Rough-skinned newts release tetrodotoxin (TTX), the same lethal toxin utilized by many pufferfish and the blue-ringed octopus [1].

•Previous pilot studies found a strong correlation between time in unken and increased levels of CORT. Additionally, previous studies on tree lizards found that elevated CORT in the blood enhanced anti-predator behaviors in male tree lizards [2].

•This study sought to uncover the role of CORT and the hormone that stimulates CORT, adrenocorticotropic hormone (ACTH), in the unken reflex of rough-skinned newts.

Methods

- Adult rough-skinned newts were injected with either CORT, ACTH, metyrapone (a corticosterone blocker), or a control (saline).
- Each animal was then tapped to stimulate a predator attack until they went into unken.
- Time in unken was recorded and as soon as the animals left unken, blood samples were taken.
- Blood levels of corticosterone were measured using a radioimmunoassay (RIA).



Image 1. and 2. The unken reflex of the rough-skinned newt (*Taricha granulosa*)

Results

- We found the time in unken was correlated to CORT levels for newts given CORT injections.
- However, those given ACTH, metyrapone, and saline had unken times that were not significantly correlated to CORT levels in the blood.
- While there was a large amount of individual variation, CORT and ACTH-injected newts had elevated levels of CORT, but suppressed time in unken.

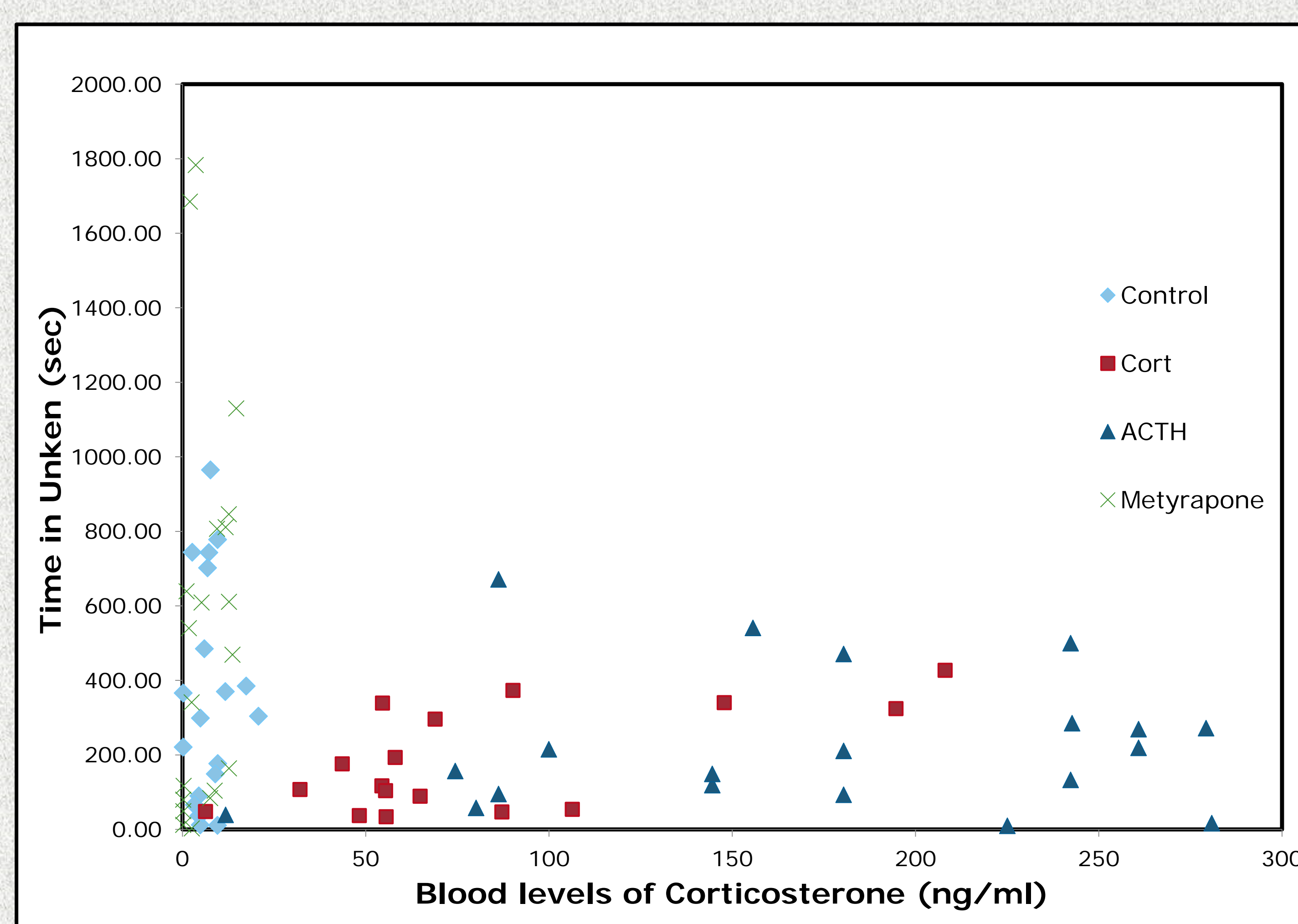


Figure 1. Animals given saline (control) and Metyrapone (CORT blocker) showed similar responses with low CORT levels and higher unken times. Animals given CORT and ACTH had higher levels of CORT in the blood, but spent less time in unken.

DISCUSSION

•Overall, this study provides evidence that CORT is involved in mediating anti-predator behavior in newts. The interplay between ACTH, glucocorticoids, and anti-predator behavior is poorly understood and like many other hormone-physiological response relationships, is complex.

•Animals given CORT and those given ACTH spent on average less time in unken than those that were given the control or the CORT blocker. As expected, those given saline or CORT blocker had much lower levels of circulating CORT when compared to those given ACTH or CORT. However, those given ACTH or CORT also spent less time in unken. Together, these trends suggest CORT could be inhibiting unken, although further tests would be needed to confirm this finding.

•Potentially, rough-skinned newts could benefit from limiting time in unken should their warnings fail to stop potential predators. For although some newts have been found to produce lethal levels of TTX, certain populations of Garter Snake (*Thamnophis sirtalis*) have developed a resistance to TTX and regularly consume the toxic newts [3]. If a newt was confronted by a TTX resistant or naïve predator it would be beneficial for the newt to abandon unken and attempt a different anti-predator defense, such as escape.

REFERENCES

- [1] Miyazawa, K. and T. Noguchi (2001). "DISTRIBUTION AND ORIGIN OF TETRODOTOXIN." *Journal of Toxicology Toxin Reviews* 20(1): 11.
- [2] Thaker, M. L., Steven L. ; Hews, Diana K. (2009). "Acute corticosterone elevation enhances antipredator behaviors in male tree lizard morphs." *Hormones and Behavior* 56: 51-57.
- [3] Brodie, E. D. and E. D. Brodie (1990). "Tetrodotoxin Resistance in Garter Snakes: An Evolutionary Response of Predators to Dangerous Prey." *Evolution*(3): 651.

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