What Hormonal States Drive Elite Victory?!

Abstract

We investigated the mind–body states that support winning in elite athletes by examining how pre-race hormonal states relate to performance in professional Formula car drivers in real competitions. Hormonal profile linked to high performance varies across individuals, suggesting that there is no single optimal competitive state for all athletes. Using field data collected at actual race events, we also established a practical method to predict and adjust competition-relevant hormone states. In one case, where lower cortisol was associated with better performance, a short pre-race nap successfully reduced the athlete's cortisol level. These findings may enable individualized psychophysiological adjustment strategies for high-pressure performance settings with potential benefits for athletic performance and coaching theory.

Hormonal States That Support Winning in Elite Athletes

Bold and cautious behaviors can affect competitive outcomes, and hormones help shape them [1,2].

Testosterone: A male hormones associated with **bold behavior (risk-taking)**.

Cortisol: A stress-related hormone associated with **cautious behavior (risk avoidance)**.

However, the optimal hormone states for high performance remain unclear, and practical adjustment methods are still lacking.

Our Study **To examine hormone–performance relationships in competitions and explore an on-site adjustment method**

Athlete-Specific Hormonal States Linked to High Performance in Real Competitions

Study Overview

We focused on motorsport, in which boldness and caution can affect performance, and collected data from **two elite professional drivers in the Super Formula, the highest tier of formula racing in Japan**.

Hormone Analysis

Saliva samples were collected before driving, frozen, and subsequently analyzed for hormone concentrations.

←Saliva collection before driving.

Performance Analysis

Lap time improvement between the two qualifying runs was analyzed.

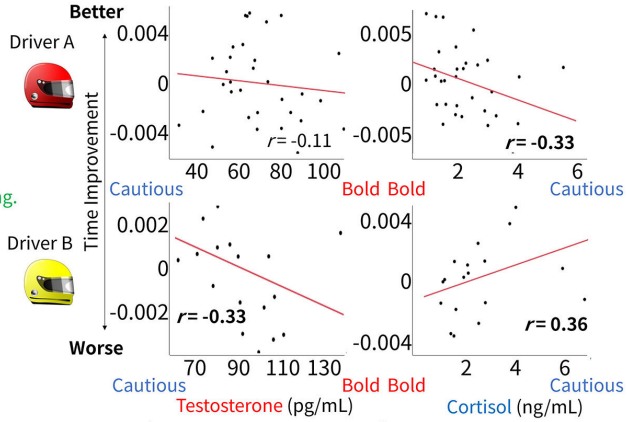
Course Record：T_r [s]

		Best Time in Each Qualifying Session	Time Relative to the Course Record
Qualifying 1	All Drivers (n = 20–22)	T_1 [s] ⟶	$S_{p1} = T_r / T_1$
Qualifying 2	Top 12 Drivers in Qualifying 1	T_2 [s] ⟶	$S_{p2} = T_r / T_2$

↑Performance was evaluated using best lap time.

Time Improvement: $S_{p2} - S_{p1}$ adjusted for environmental factors

* Positive values indicate improved performance on Qualifying 2.



	Testosterone	Cortisol
Driver A	No relationship	**Lower is better**
Driver B	**Lower is better**	**Higher is better**

Predicting and Adjusting Hormone States in Competition Settings

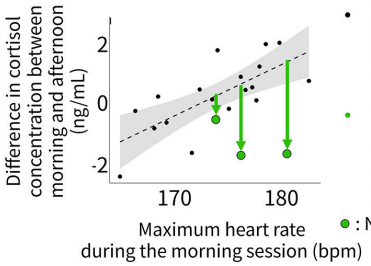
Case Study in Driver A: Lower Cortisol Linked to Better Performance

Prediction of afternoon cortisol:

Afternoon cortisol changes were predicted from the maximum heart rate during the morning session.

On-site adjustment:

Based on evidence that napping can reduce cortisol levels[3,4], napping was introduced during the midday break when high cortisol levels were predicted.



- Higher morning max heart rate predicted higher afternoon cortisol.
- **The nap successfully lowered the cortisol level below the predicted value.**

● : Nap before the afternoon race

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