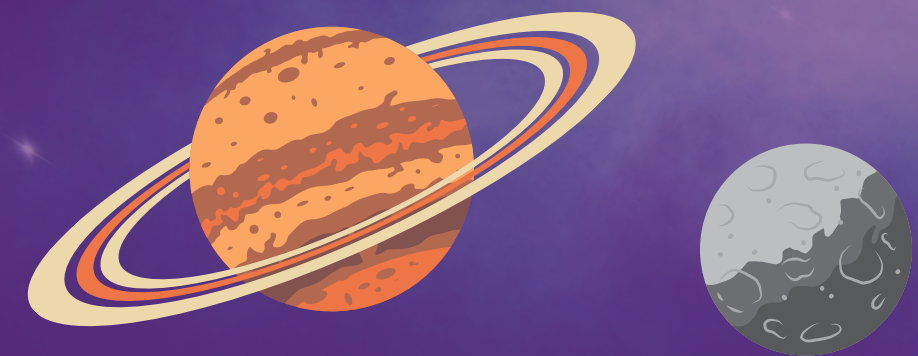




CAN EARTH TRAIN US FOR SPACE?

Cross-adaptation as a framework for astronaut function and rehabilitation

Isabella Perez | Downey High School | WEM26 Poster Competition

SYNTHESIS GAP: 0 OF 5 SELECTED STUDIES TESTED MISSION FUNCTION



QUESTION AND RATIONALE

Can adaptation to heat, cold, exercise, or hypoxia transfer to astronaut function or rehabilitation?

Microgravity alters sensorimotor and autonomic cues governing postural control, gait, and orthostatic tolerance. Effective countermeasures require demonstrable preservation of mission-essential functional performance.

METHODS

Targeted evidence synthesis completed 26 September 2026 using PubMed/MEDLINE and NASA sources. Human studies were included only when a defined conditioning exposure was followed by testing under a different environmental stressor. Five representative human cross-adaptation studies were selected to evaluate physiological transfer, performance, and mission-relevant function. One astronaut-function study was analyzed separately. Study design, exposure, outcomes, and limitations were extracted. No primary data were collected.

SELECTION CRITERIA

Selected human studies used a defined conditioning exposure followed by outcomes under a different environmental stressor. The astronaut study was analyzed separately because it measures mission-relevant function.

MISSION-RELEVANT FUNCTION

After landing, crews may need to stand, walk, maintain balance, carry equipment, or complete an emergency task before full physiological recovery.

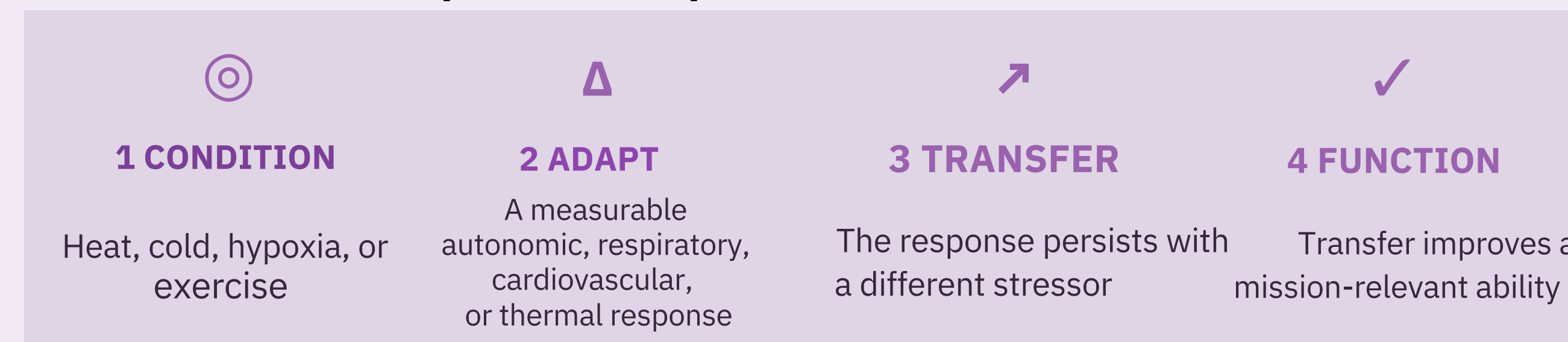
Primary outcomes

Orthostatic tolerance | Gait | Balance | Muscular endurance | Task completion | Recovery time



TRANSFER-TO-FUNCTION FRAMEWORK

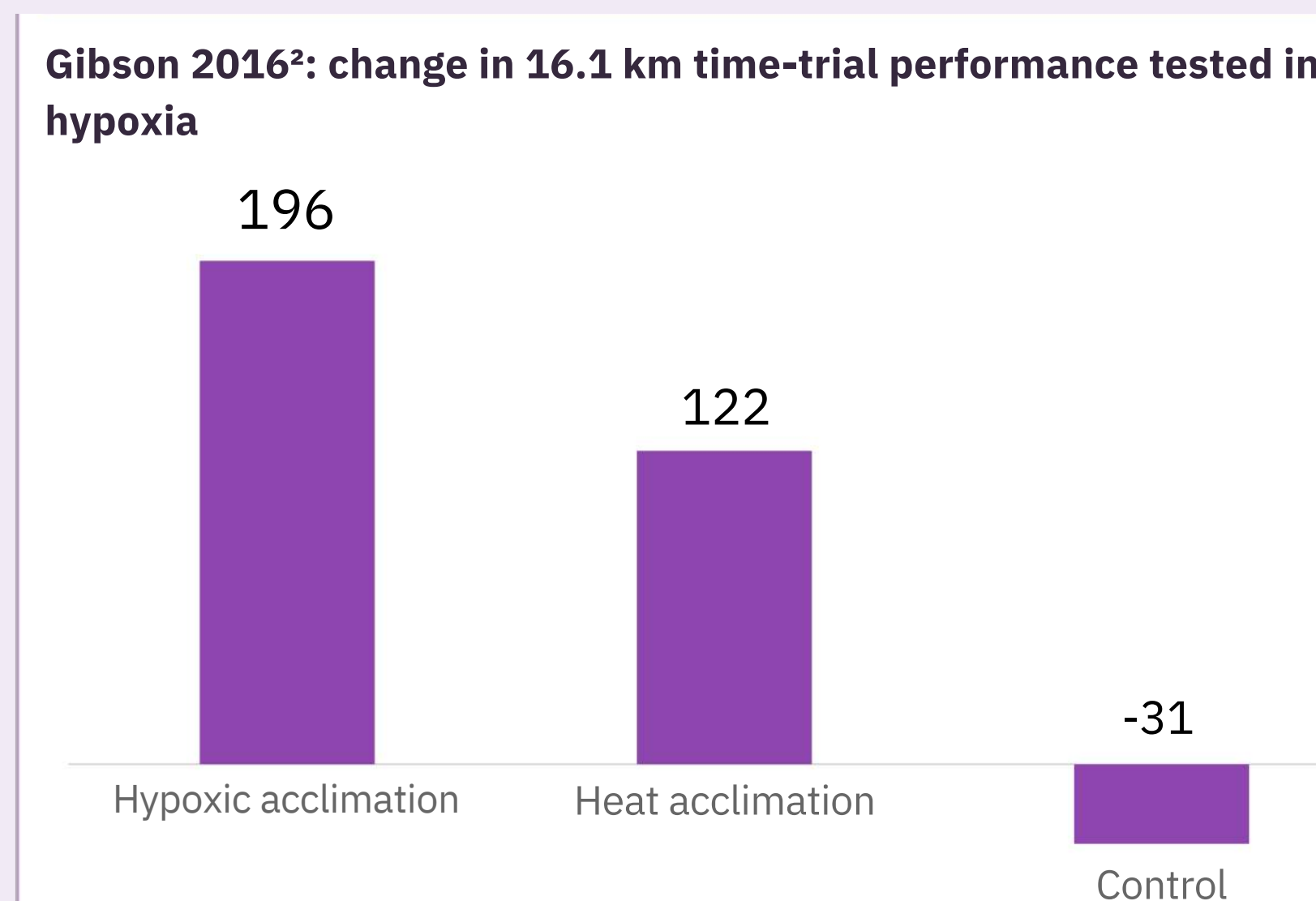
Cross-adaptation should be evaluated by whether physiological transfer preserves a predefined mission function.



FRAMEWORK CODING OF SELECTED STUDIES

Study	Adaptation	Cross-stressor transfer	Performance	Mission function
Lunt 2010 ¹	Yes	Physiological only	Not tested	Not tested
Gibson 2016 ²	Yes	Yes	Yes	Not tested
Sotiridis 2019 ³	Yes	No clear transfer	No	Not tested
Stevens 2025 ⁵	Yes	Mixed	Not tested	Not tested
Rodrigues 2026 ⁶	Yes	Mixed	Mixed	Not tested

EVIDENCE SNAPSHOT^{4,5}: PROMISING, BUT ENDPOINT-DEPENDENT



Seconds faster after 10 days; positive values indicate improvement.

LIMITATIONS OF SINGLE STUDY TRANSFER

Sotiridis 2019³

No VO₂peak improvement; hypoxic peak power P=.14.

Rodrigues 2026⁶

Time to exhaustion improved (d=1.2); peak power and VO₂peak did not remain significant after correction.

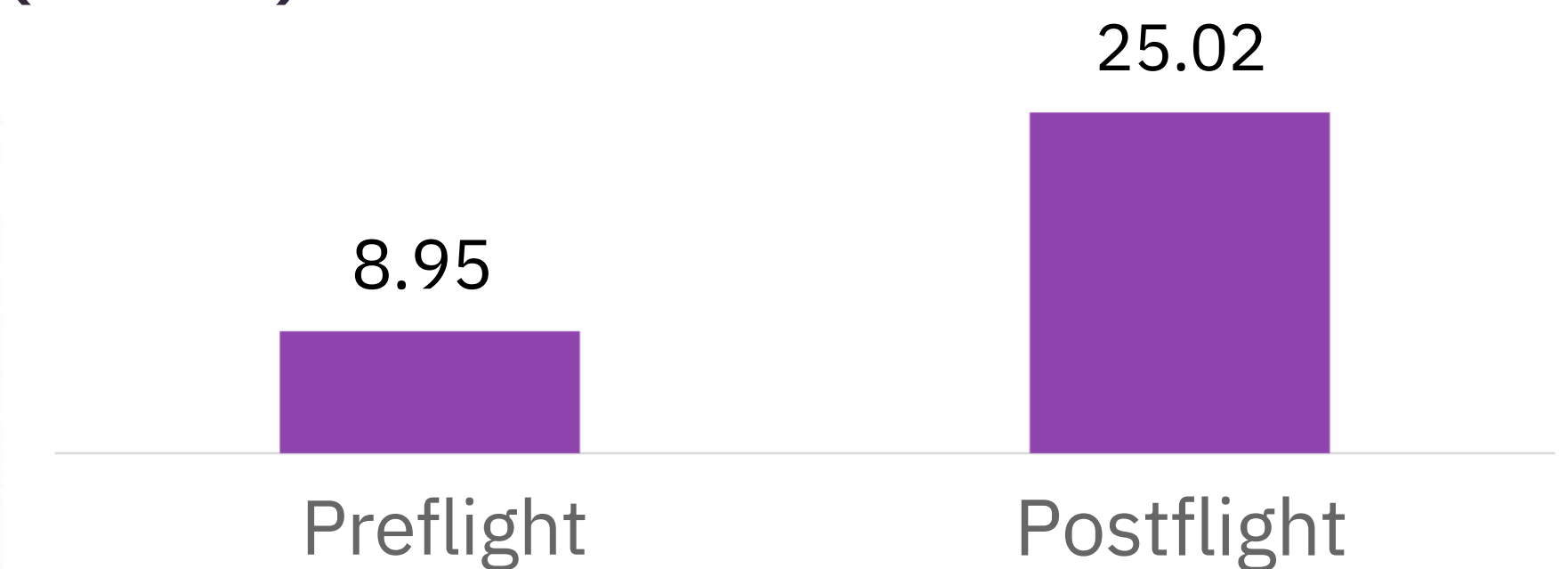
Positive transfer depended on protocol and endpoint.

FUNCTIONAL TRANSFER CRITERION

Cross-adaptation should be evaluated by whether physiological transfer preserves a predefined mission-relevant function.

POST-FLIGHT FUNCTIONAL DEFICITS

Long-duration astronaut walk-and-turn time⁷ (seconds)



PROPOSED EXPERIMENTAL DESIGN

Randomized, exercise-matched terrestrial study

1 CONDITION

10 x 60-min heat-acclimation sessions

2 TRANSFER

Standardized normobaric hypoxia

3 COMPARE

Heat group vs exercise-matched control

PRIMARY Walk-and-turn completion time + turn rate⁸

SECONDARY Sit-to-stand time, correct tandem steps, glove-resisted nut-and-bolt time + errors¹⁰

TERRESTRIAL TRANSLATION

The same function-first framework could be tested in rehabilitation populations with weakness or impaired mobility.

Test standing, walking, balance, and daily-task completion.

LIMITATIONS

Samples are small and mostly male. Protocols and endpoints vary. Terrestrial tests do not reproduce microgravity, and no selected cross-adaptation study tested astronauts.

CONCLUSION

No selected cross-adaptation study measured mission-relevant function. Astronaut mobility data motivate testing whether conditioning preserves performance on predefined tasks.

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