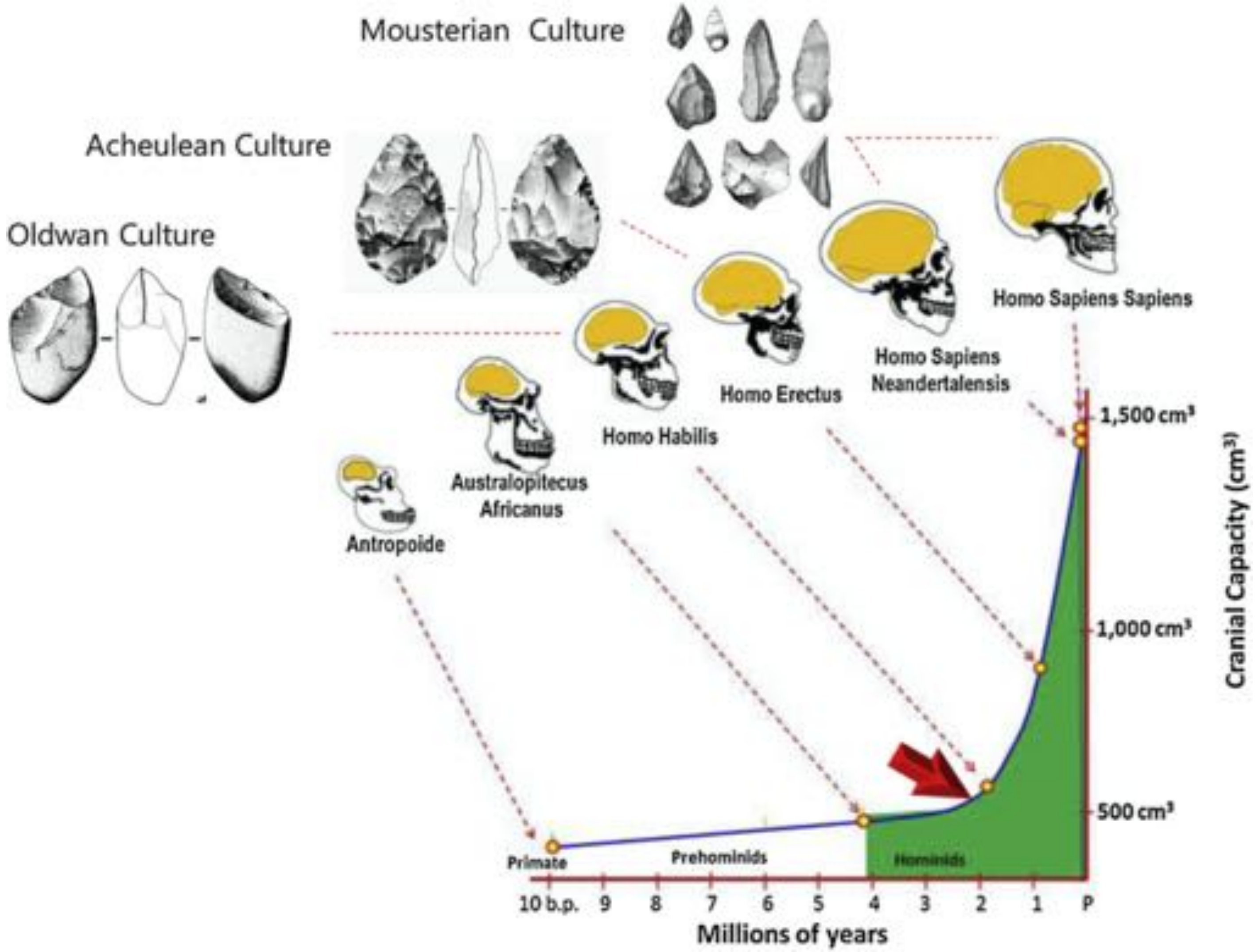
Adventure and adaptation:

A goal oriented journey toward resilience through stress

Bryce Carlson, PhD

Outline

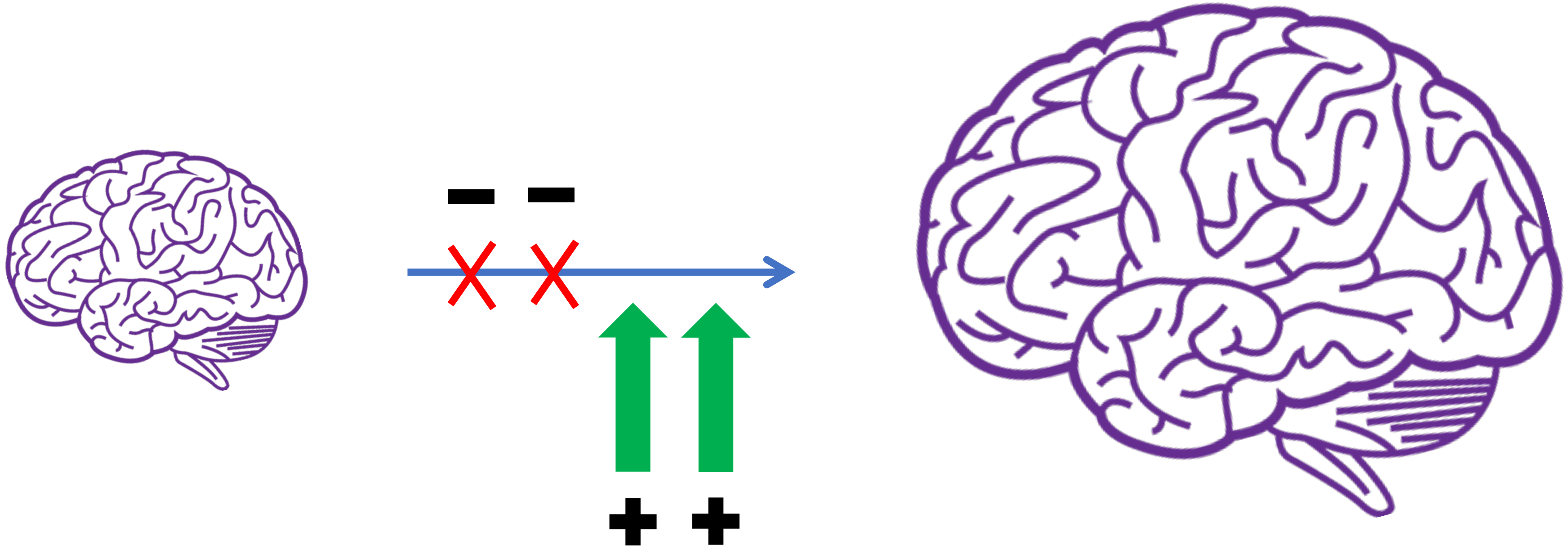
- Nutrition and human evolution as a gateway to adventure and adaptation
- Race Across USA
- North Atlantic Solo Row
- Resilience and unknown unknowns



Vieira Bretas R et al 2020 *Neurosci Res*

How to build a big brain...

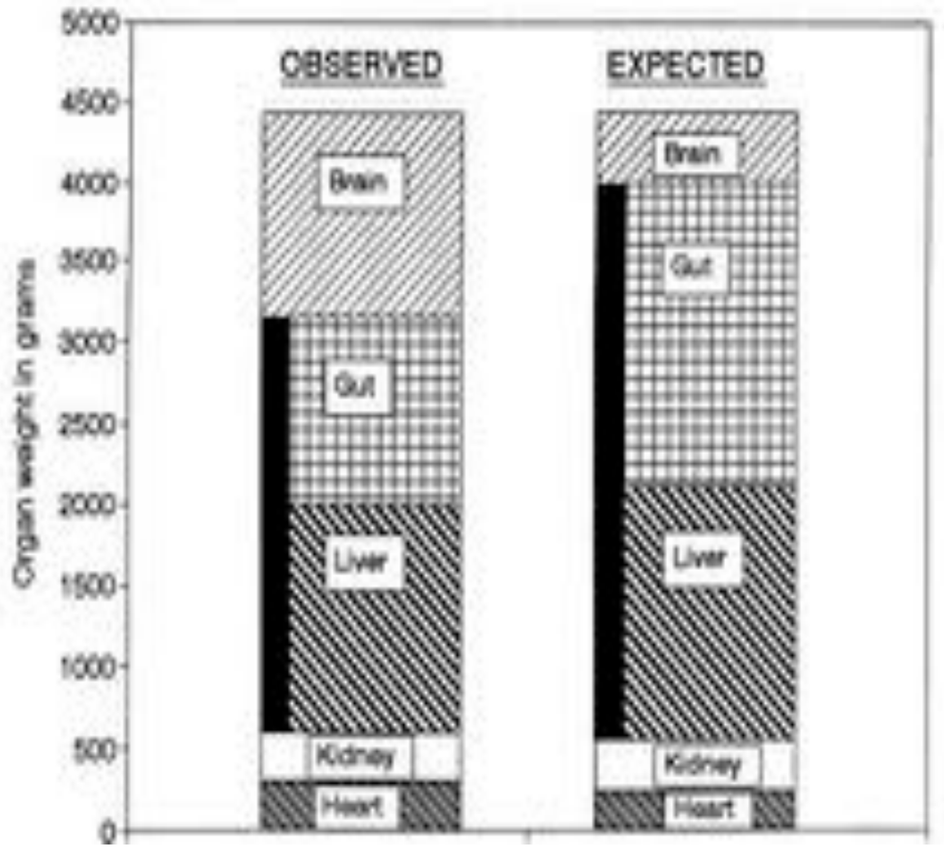
1. Remove evolutionary constraints
2. Apply selection pressure



Constraints:

Expensive tissue hypothesis

- Metabolically expensive tissues:
  brain, gut, liver, kidney, heart
- Humans BMR = expectation for body size
- Trade-offs:
  for brain size to increase something has to shrink
- In humans, an increase in dietary quality (reduction in dietary fiber, increase in protein, carbohydrates, and/or fat) reduction in gut size may have released such a constraint
- Increase in nutritional quality may have facilitated reduction in gut size



Aiello and Wheeler 1995 *Curr Anth*

Selection pressure

Ecological intelligence hypothesis

greater cognition required to forage or hunt for hard-to-find and process foods

- Clumped food resources (e.g. fruit and hunted animals) require a cognitive map
- Know which species are edible, where to find fruit, remember which sites have been visited
- Foods that are hard to access or process require extractive techniques
- Higher quality foods seasonally distributed across a landscape requiring greater processing may have driven pressure for greater cognition

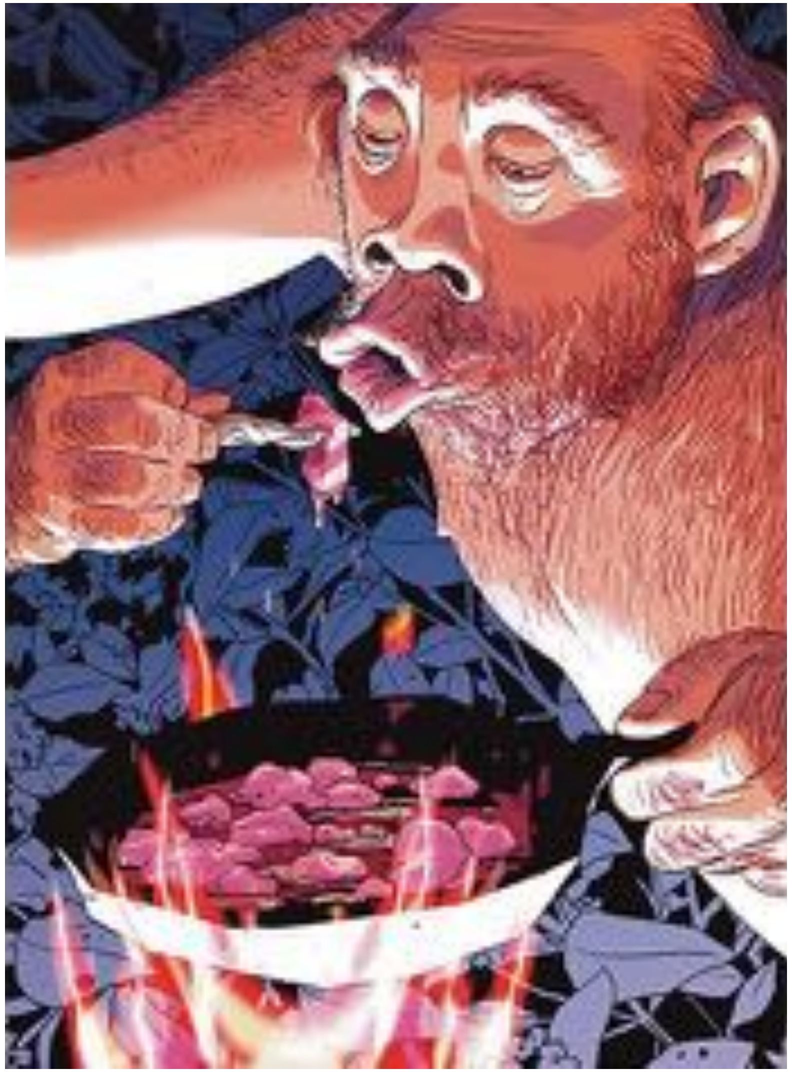


Photo: smithsonianmag.com

Goal-oriented adaptation vs. natural selection

Superior Sawtooth 100 mile

Midwest Ultra Grand Slam

Kettle Moraine 100 mile

Mohican 100 mile

Burning River 100 mile

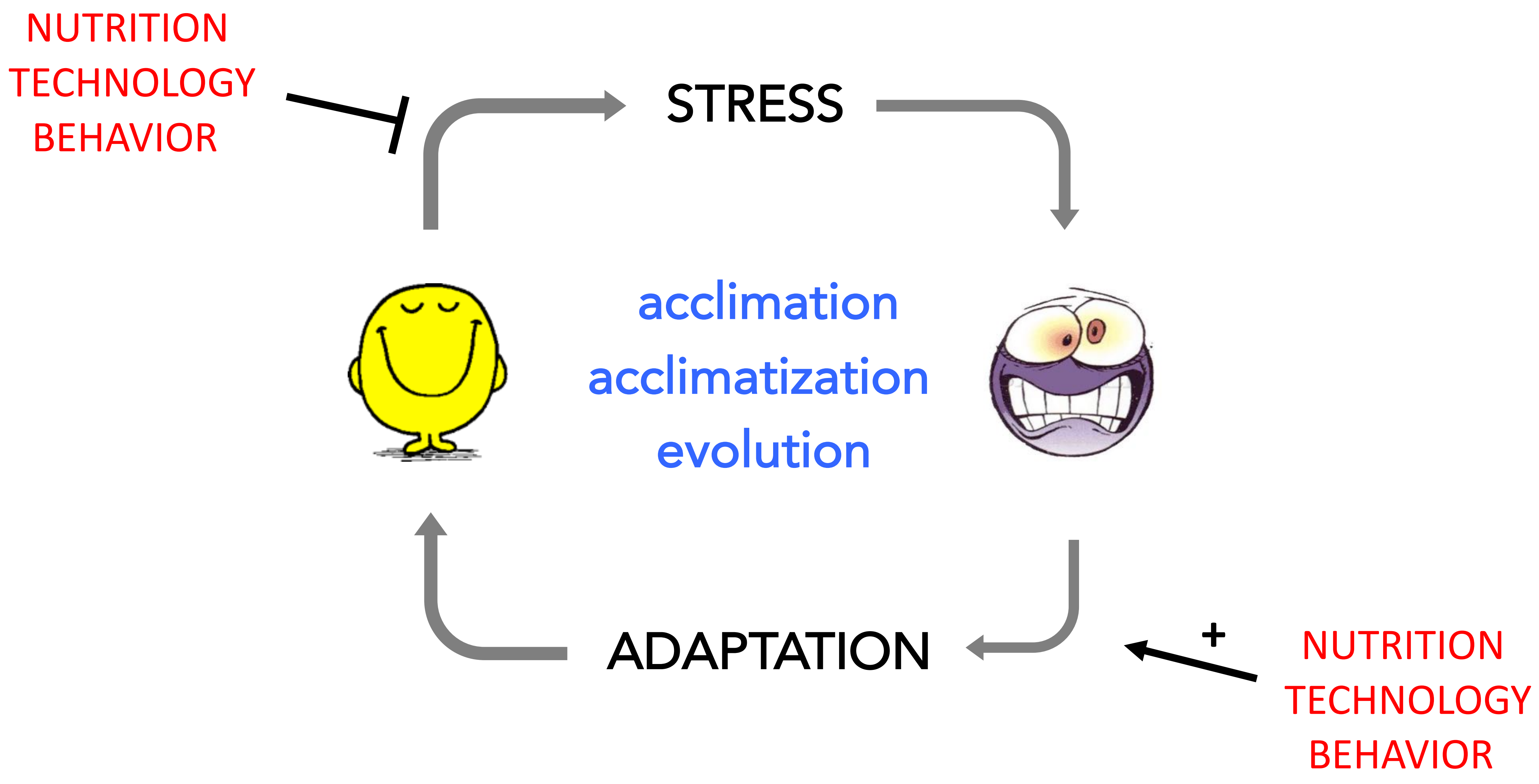
Hallucination 100 mile

Spartathlon (155 miles)

Athens to Sparta, Greece

Can we study the role of nutrition in processes of adaptation via living populations undergoing stress?

Ultra-endurance athletes routinely explore and seek to defy/expand human physiological and psychological limitations


NUTRITION
TECHNOLOGY
BEHAVIOR
STRESS
acclimation
acclimatization
evolution
ADAPTATION
+
NUTRITION
TECHNOLOGY
BEHAVIOR

Race Across USA

- 3100 mile footrace
- ~26.2 mile stages
- January 16 – June 2, 2015

- 12 runners, 3 assistants
- Runner + Research Director

- Energetics*, cardiovascular*, biomechanics*, nutrition, microbiome, epigenetics, psychology

Photo: raceacrossusa.org

Preparing to run

<u>Anticipated challenges</u>:

- Volume of activity
- Impact of road running
- Intensity of racing
- Heat stress
- Nutrition (fuel + recovery)

<u>Unanticipated challenges</u>:

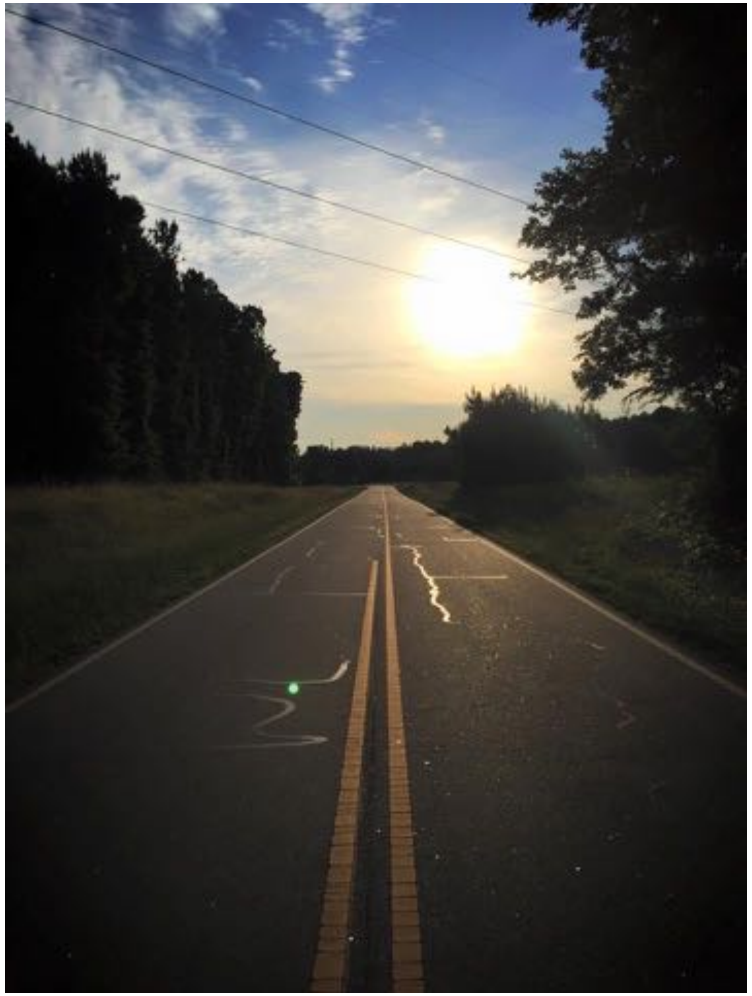
TBD

On the run

<u>Baseline data collected at UCLA</u>

- Doubly labeled H_2O
- Blood samples
- Heart scans
- Running biomechanics
- Stool samples
- Weight, body fat %
- Psychological survey

Follow-up data collected en route




TURN 1


RAUSA

Manifestations of stress

<u>Weeks 1-2</u>
Embodiment of stress

- Inflammation
- Joint pain
- Blisters

<u>Weeks 3-4</u>
Routine building

- Physical adaptation well underway
- Mentally adapting to routine


NSPCC
saucony

Received: 8 November 2018 | Revised: 27 December 2018 | Accepted: 29 December 2018
DOI: 10.1002/ajpa.23781

WILEY

BRIEF COMMUNICATION

Sustained high levels of physical activity lead to improved performance among "Race Across the USA" athletes

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Funding information
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Abstract

Objective: To investigate physiological and performance adaptations associated with extremely high daily sustained physical activity levels, we followed six runners participating in the 2015 Race Across the USA. Participants completed over 42.2 km a day for 140 days, covering nearly 5,000 km. This analysis examines the improvement in running speed and potential adaptation in mean submaximal heart rate (SHR) throughout the race.

Methods: Data were collected during three 1-week long periods corresponding to the race beginning, middle, and end and included heart rates (HRs), body mass, running distances and speeds. HR data were collected using ActiTrainer HR monitors. Running speeds and distances were also recorded throughout the entire race.

Results: Athletes ran significantly faster as the race progressed ($p < .001$), reducing their mean marathon time by over 63 min. Observed mean SHR during the middle of the race was significantly lower than at the beginning ($p = .003$); however, there was no significant difference between mean SHR at the middle and end of the race ($p = .998$).

Conclusion: These results indicate an early training effect in SHR during the first half of the race, which suggests that other physiological and biomechanical mechanisms were responsible for the continued improvement in running speed and adaptation to the high levels of sustained physical activity.

KEYWORDS
endurance exercise, submaximal heart rate, training adaptation

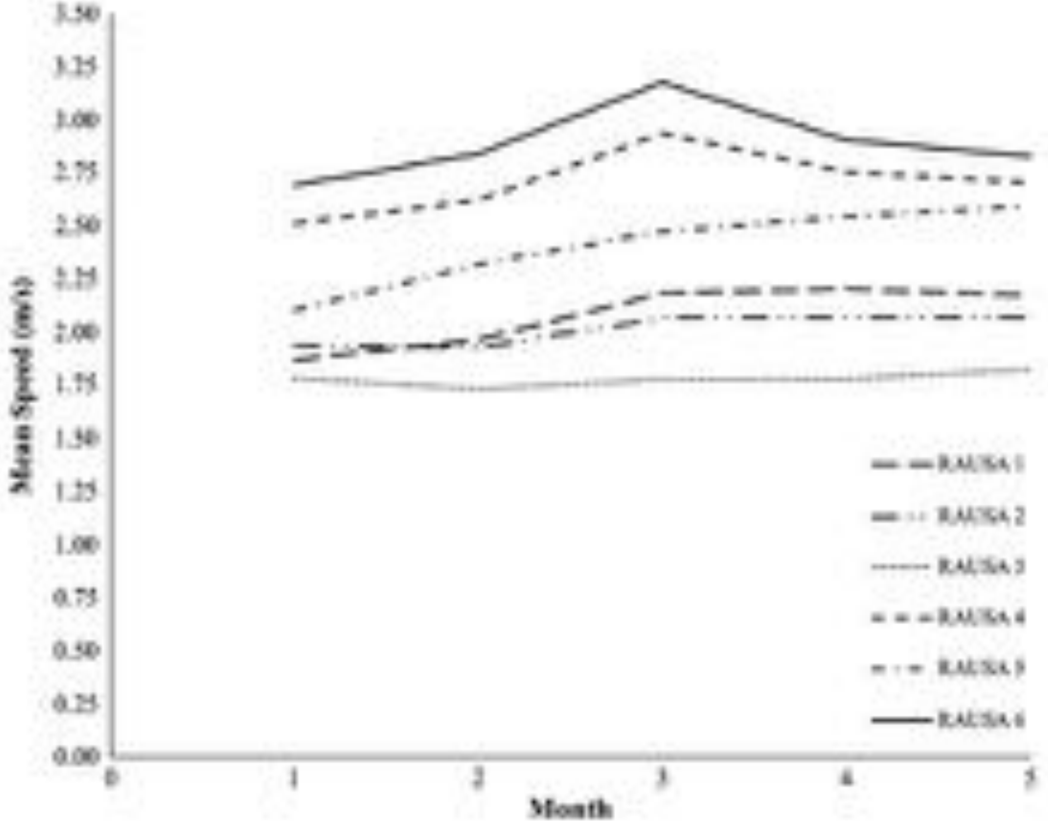


FIGURE 1 Mean monthly speed for each participating runner. Overall, subjects increased running speed throughout the race. RAUSA 4 and 6 decreased running speeds from the middle to the end of the race

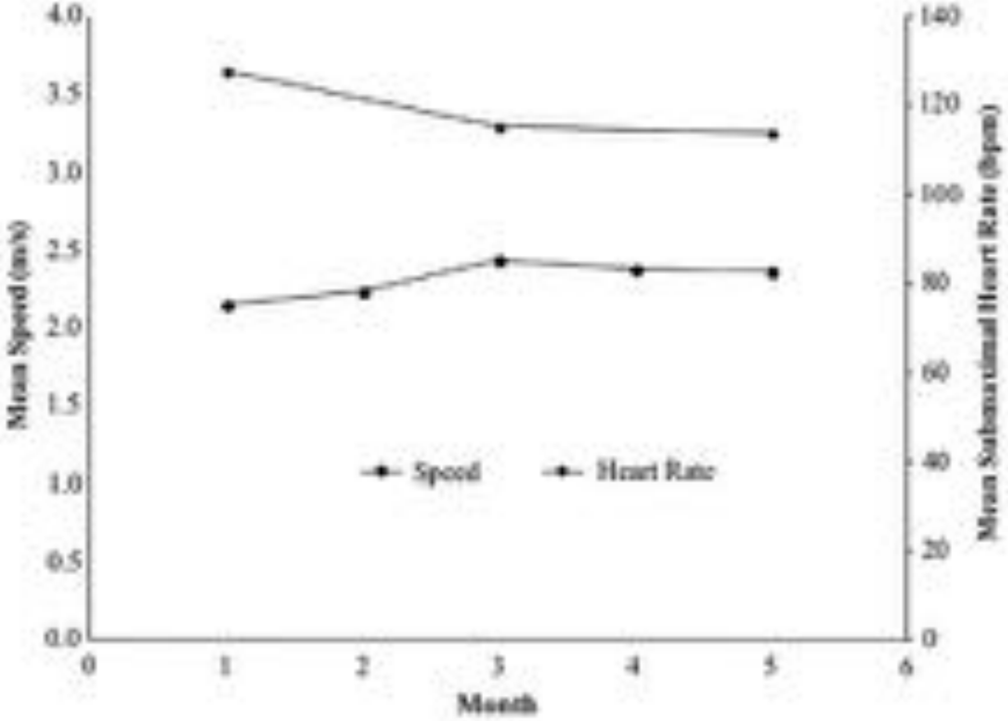


FIGURE 2 Mean monthly speed and mean SHR rates for each participating runner. Overall, subjects increased running speed throughout the race while mean SHR significantly decreased from the beginning to the middle of the race. Mean SHR did not significantly change from the middle of the race to the end

Ocobock et al 2019 *Amer J Phys Anth*

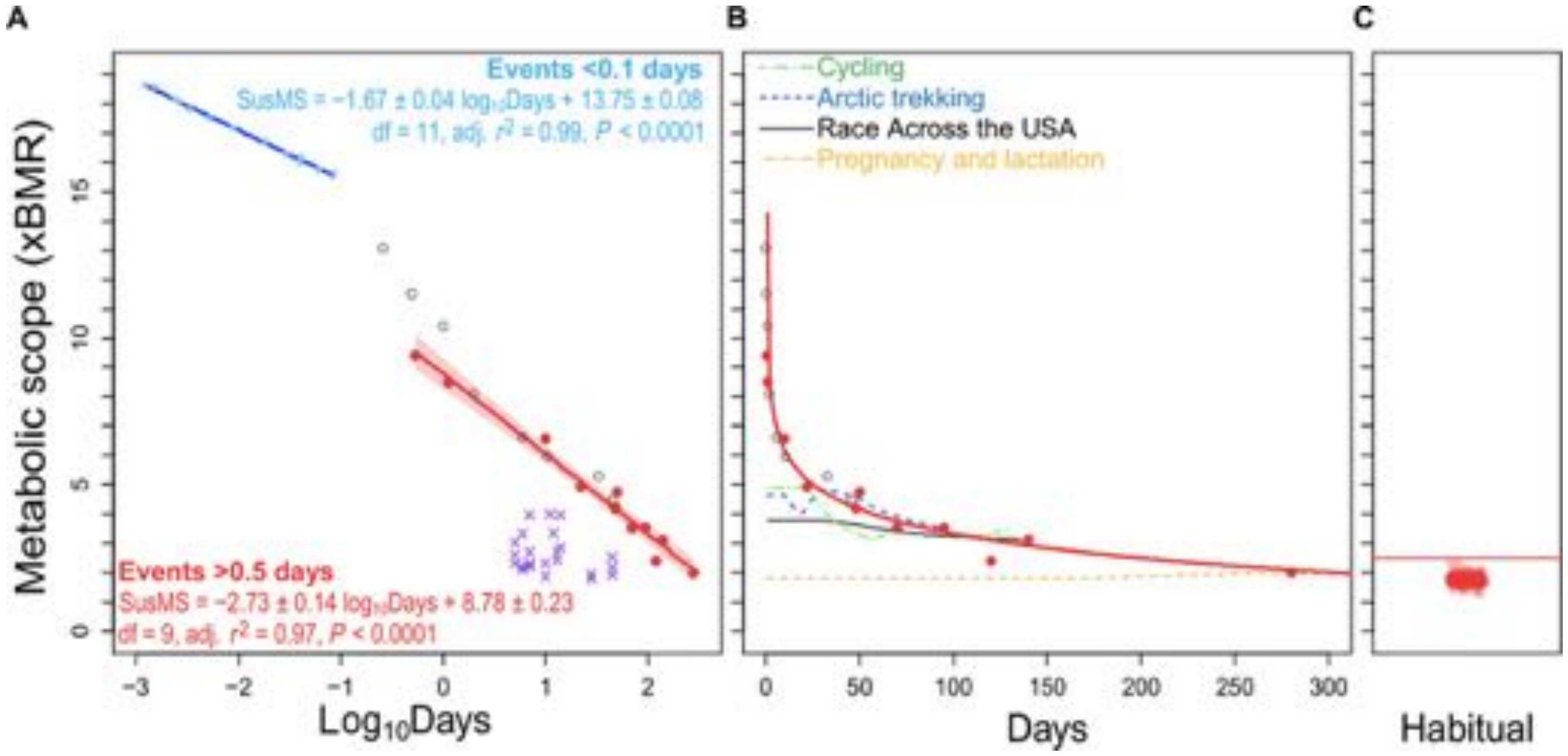
SCIENCE ADVANCES | RESEARCH ARTICLE

PHYSIOLOGY

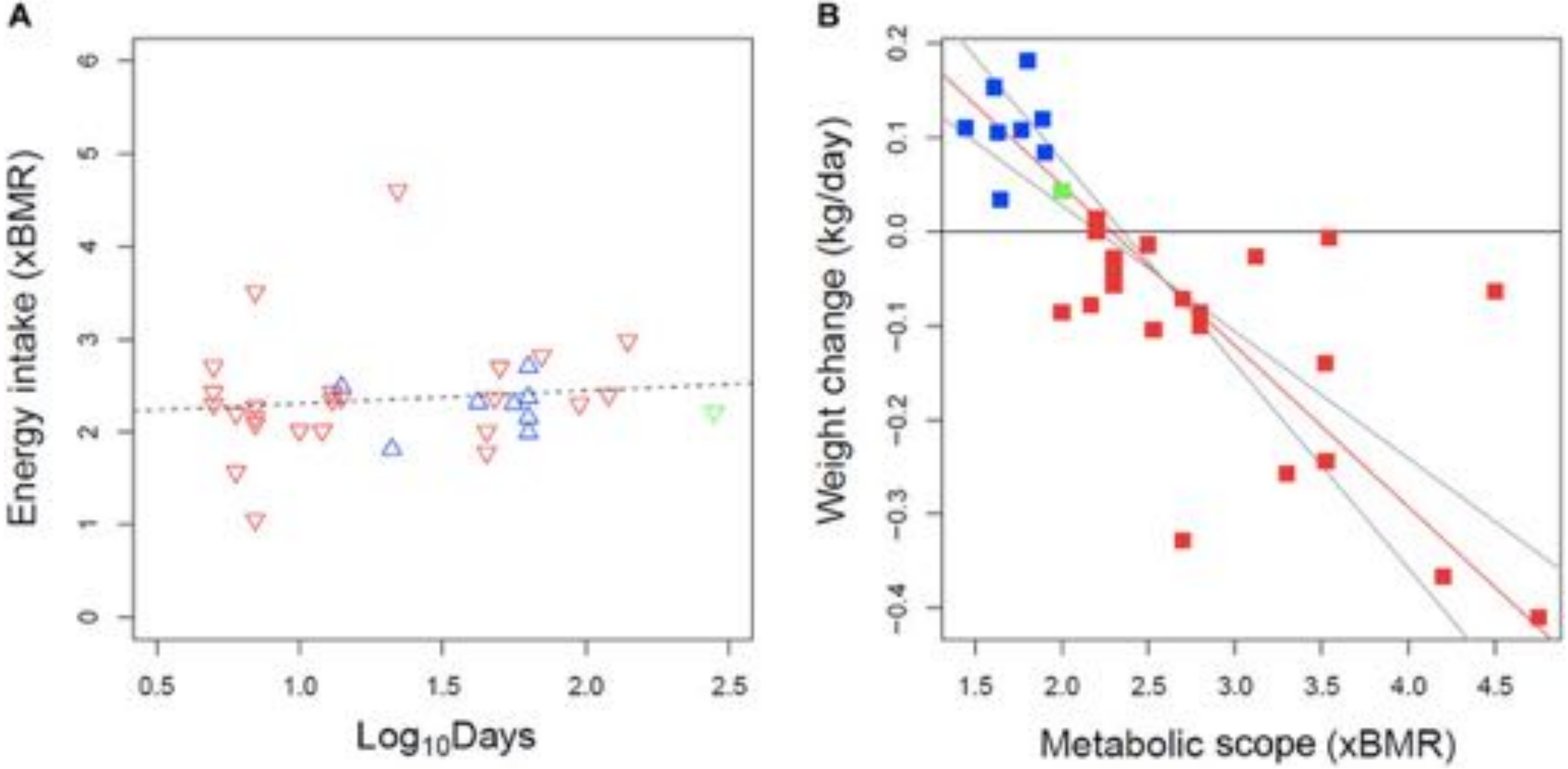
Extreme events reveal an alimentary limit on sustained maximal human energy expenditure

Caitlin Thurber[1], Lara R. Dugas[2], Cara Ocobock[3], Bryce Carlson[4], John R. Speakman[5,6*], Herman Pontzer[1,7,8*]

The limits on maximum sustained energy expenditure are unclear but are of interest because they constrain reproduction, thermoregulation, and physical activity. Here, we show that sustained expenditure in humans, measured as maximum sustained metabolic scope (SusMS), is a function of event duration. We compiled measurements of total energy expenditure (TEE) and basal metabolic rate (BMR) from human endurance events and added new data from adults running ~250 km/week for 20 weeks in a transcontinental race. For events lasting 0.5 to 250+ days, SusMS decreases curvilinearly with event duration, plateauing below 3× BMR. This relationship differs from that of shorter events (e.g., marathons). Incorporating data from overfeeding studies, we find evidence for an alimentary energy supply limit in humans of ~2.5× BMR; greater expenditure requires drawing down the body's energy stores. Transcontinental race data suggest that humans can partially reduce TEE during long events to extend endurance.



Thurber et al 2019 *Science Advances*



Thurber et al 2019 *Science Advances*

Personal lessons:

Stress can be positive


Personal lessons:
Perception is malleable

Personal lessons:

We absorb the energy around us

Personal lessons:

Fixating on variables we can’t control prevents us from adapting to them

North Atlantic

SOLO UNSUPPORTED ROW

| @brycerows | 2018

Preparing to row


Anticipated challenges:
- Volume of activity
- Psychology of isolation
- Safety
- Navigation
- Permits, customs
- Funding

Unanticipated challenges:
TBD

Psychological inventory

Complete daily, responding for previous 24 hours

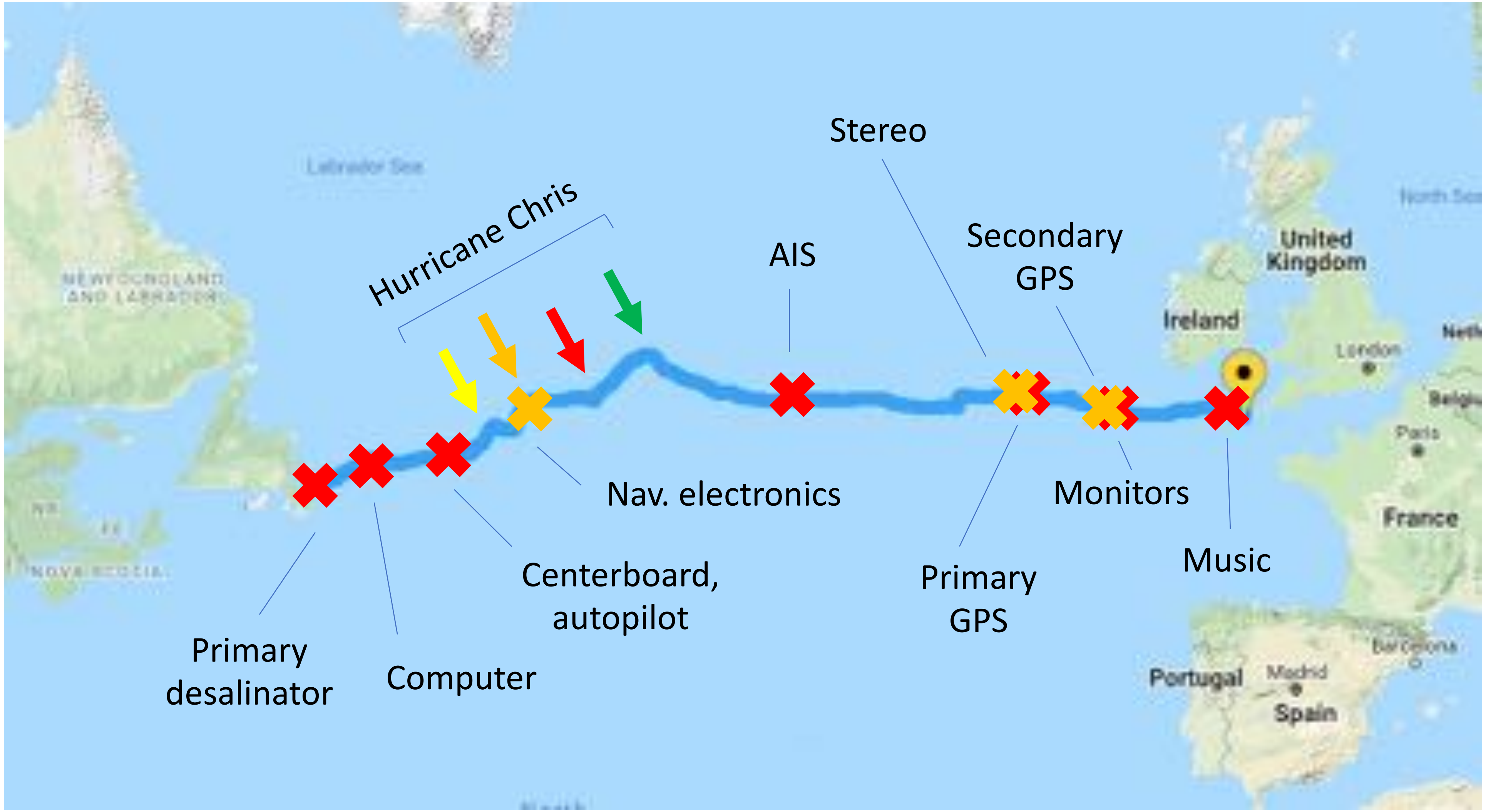
Quantitative

0 = least/never/not, 10 = most/always

- Rating of perceived exertion
- Worst pain
- Average pain
- Pain interference
- Fatigue
- Fatigue interference
- Sleepiness
- Restfulness
- Positive emotions
- Calmness
- Confidence
- Loneliness
- Boredom
- Anxious
- Frustration

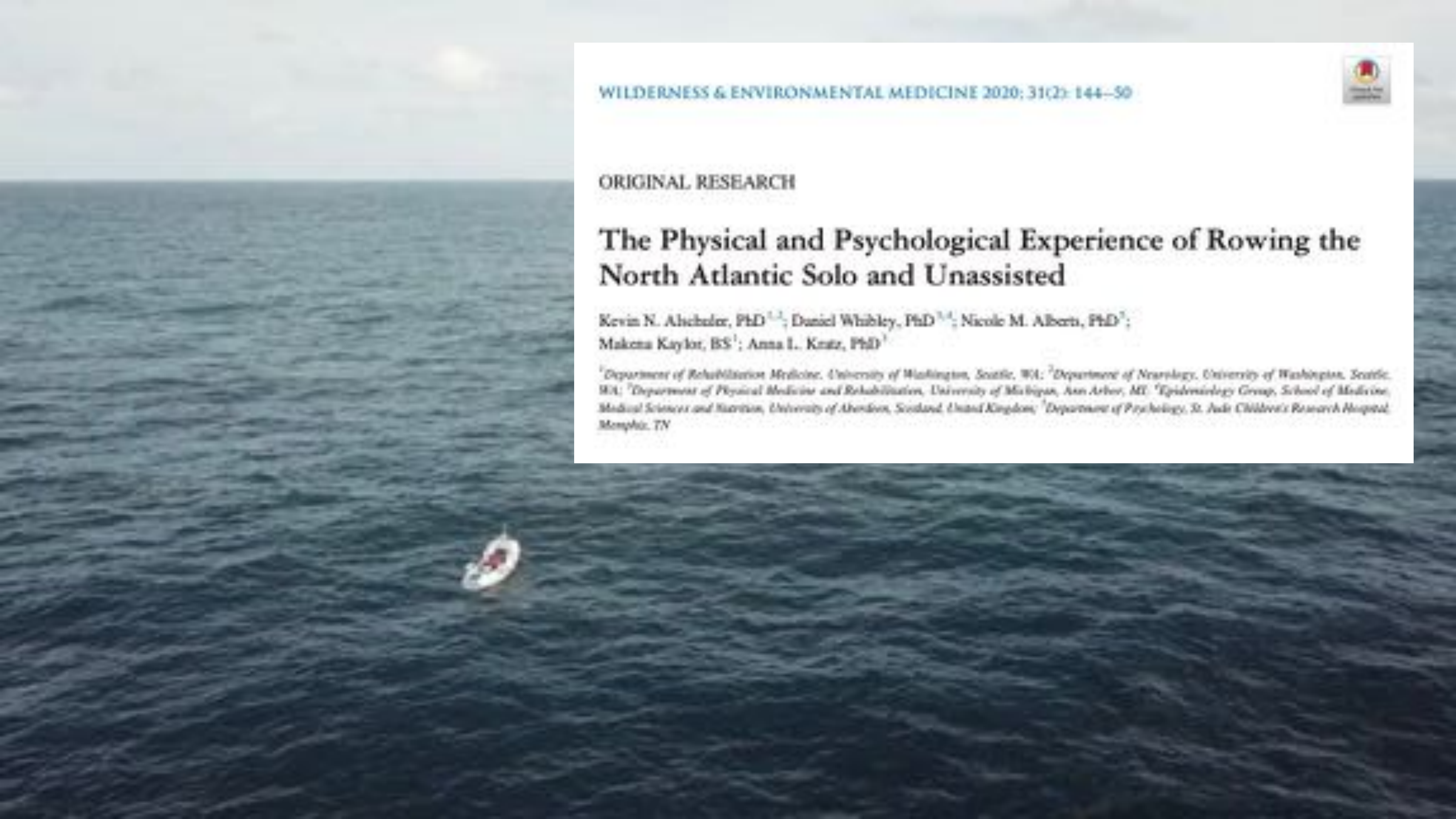
Qualitative

3 open-ended questions to inspire reflection on the past 24 hour experience



Labrador Sea
Newfoundland and Labrador
Nova Scotia
Hurricane Chris
AIS
Stereo
Secondary GPS
United Kingdom
Ireland
London
Paris
France
Portugal
Madrid
Spain
Barcelona
Nav. electronics
Monitors
Music
Primary GPS
Centerboard, autopilot
Primary desalinator
Computer


CZAR



WILDERNESS & ENVIRONMENTAL MEDICINE 2020; 31(2): 144–50

ORIGINAL RESEARCH

The Physical and Psychological Experience of Rowing the North Atlantic Solo and Unassisted

Kevin N. Alschuler, PhD[1,2]; Daniel Whibley, PhD[3,4]; Nicole M. Alberts, PhD[5]; Makena Kaylor, BS[1]; Anna L. Kratz, PhD[3]

[1]*Department of Rehabilitation Medicine, University of Washington, Seattle, WA;* [2]*Department of Neurology, University of Washington, Seattle, WA;* [3]*Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI;* [4]*Epidemiology Group, School of Medicine, Medical Sciences and Nutrition, University of Aberdeen, Scotland, United Kingdom;* [5]*Department of Psychology, St. Jude Children's Research Hospital, Memphis, TN*

Table 1. Descriptive statistics

Variable	*Mean*	*SD*	*Minimum*	*Maximum*
Rating of perceived exertion	11.1	3.6	6	17
Worst pain	2.6	2.0	0	9
Average pain	1.3	1.2	0	5
Pain interference	0.8	0.9	0	2
Fatigue	4.3	2.7	0	8
Fatigue interference	2.8	2.6	0	8
Sleepiness	2.2	2.3	0	7
Restfulness	6.9	2.0	3	10
Positive emotions	5.7	1.9	2	10
Calmness	6.4	2.2	1	9
Confidence	5.5	1.9	1	9
Loneliness	1.3	1.5	0	5
Boredom	2.7	2.8	0	8
Anxious	3.5	3.0	0	10
Frustration	2.2	2.7	0	9

Perceived exertion is scored 6 (no exertion) to 20 (maximal exertion); all other variables are 0 (least/never/not at all) to 10 (most/always).

Alschuler et al 2020 *Wild & Env Med*

Personal lessons

- “Crazy” is subjective
- The strength we seek is layered within and the number of layers is infinite
- Technology can buffer isolation, to an extent
- Logic and vigilance > emotion
  Survival necessitated focus on variables under my control, and maintenance of near constant vigilance. After the finish, it seemed to take a few days to “feel” again.

As we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don’t know we don’t know.

Donald Rumsfeld

February 12 ,2002

Known knowns

Anticipated challenges that we are currently prepared for

Known unknowns

Anticipated challenges that we are currently unprepared for

- May require new knowledge, skills, credentials, fitness, etc.
- Can work systematically to prepare for these challenges
- Cycles of mild to moderate stress + recovery (i.e. training)
- Transforming oneself into the kind of person capable of meeting these challenges, and thereby move them into the previous category of known knowns.

Unknown unknowns

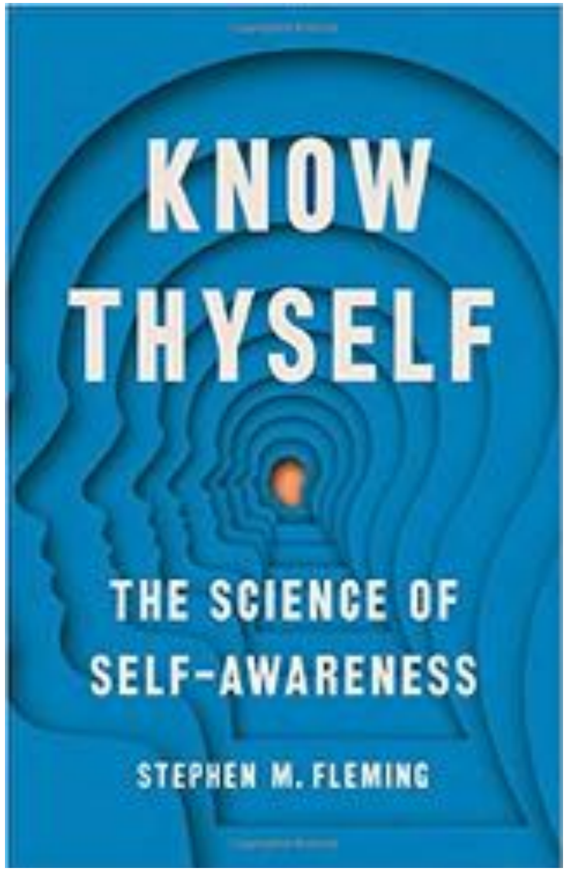
Unanticipated challenges that we are unprepared for

- These are trickier – how to prepare?
- Require active problem solving skills and resilience
- Problem solving and resilience are built from experience
- Tool kit of skills necessary to remain calm, focused, and active in the face of novel stressors
- RAUSA and N. Atlantic Solo Row

Identifying knowns from unknowns

- Requires self awareness and metacognitive sensitivity
- An ability to accurately assess one's abilities, and the gap between current knowledge/skills/fitness and what will be required for the challenge ahead
- Necessary to prepare for the challenges one might conceivably anticipate are coming

But once you've prepared for known unknowns, resilience is key to successfully navigating stress. And resilience may be a function of non-specific stress-adaptation experiences.



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- Kevin Alschuler, PhD
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  Samantha Upton
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