

# Current exercise-heat stress research impacting the Public Health England Heatwave Plan – heat alleviation

Dr Neil Maxwell



**University of Brighton**

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Centre for Sport and  
Exercise Science and  
Medicine



**Public Health  
England**

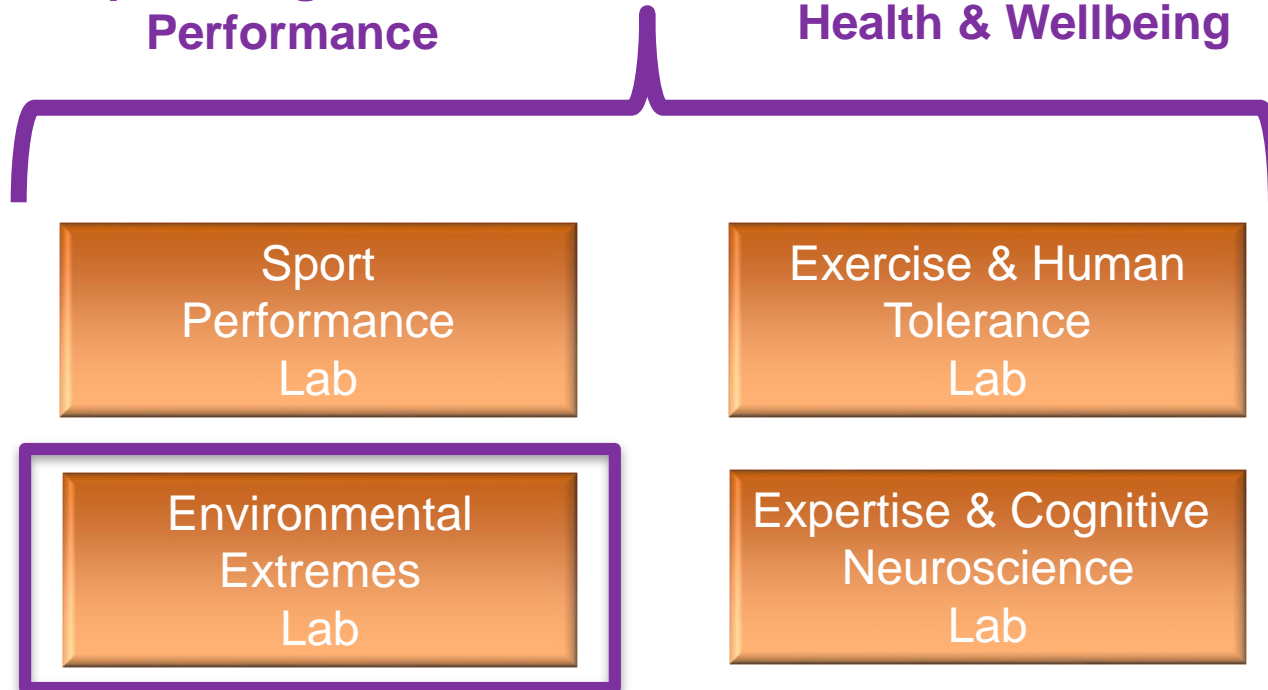
# Centre for Sport and Exercise Science & Medicine



**Optimising Human  
Performance**



**Exercise for  
Health & Wellbeing**



# Environmental Extremes Lab

**Aim:** Conduct research to optimize human performance, health and occupational activity under extreme conditions

## Theme 1 Optimising Performance in the Extremes



- Heat Acclimation
- Cold exposure preparation
- Pre, during and post-cooling
- Female orientated focus
- Exertional heat stroke
- Altitude awareness & training
- Cross tolerance
- Sleep deprivation

## Theme 2 Impact of Environmental Extremes on Health



- Hypoxia & cold insulin sensitivity & glucose tolerance in type II diabetes
- Hypoxia & fat metabolism
- Heat sensitivity with multiple sclerosis & breast cancer
- Heat waves in the elderly & the impact of acute/chronic alleviating strategies on health

## Theme 3 Occupational Activities & Safety in the Extremes



- Physiological, inflammatory, Immune function responses
- Heat tolerance screening
- Heat alleviating Interventions (hydration, precooling, undergarments)
- Education & awareness

# Presentation Aim & Structure

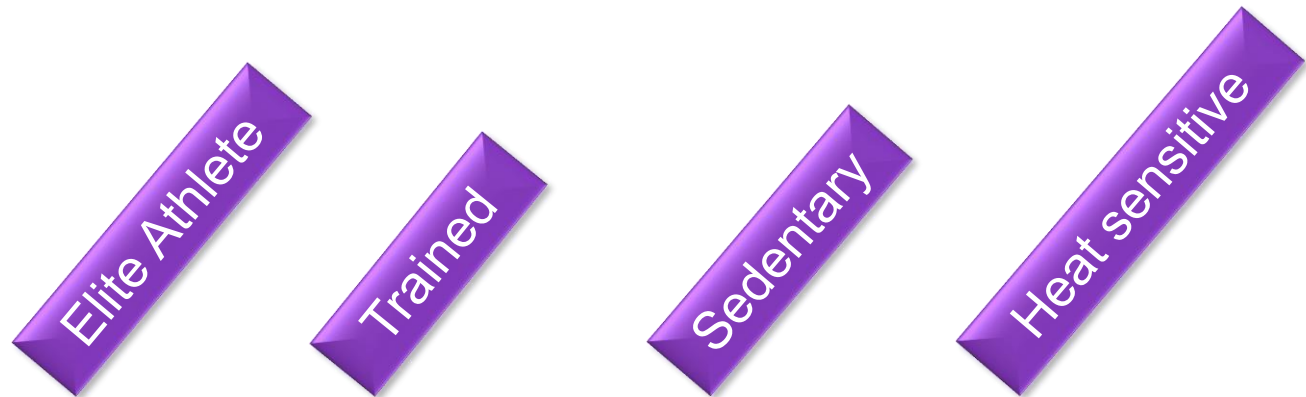
**Aim:** In reviewing PHE's Heatwave Plan, identify where there is scope for additional/stronger messages relating to exercise-heat stress and heat-alleviation

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- Heat Sensitive Populations / Individuals
- Can an index capture heat illness susceptibility?
- Heat Alleviation
  - Acute methods (e.g. cooling)
  - Chronic Methods (e.g. acclimation)
- Behavioural thermoregulation during exercise in the heat – 1<sup>st</sup> line of defence in maintaining heat balance
- Exercise is still important!



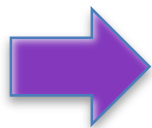
# Heat Reaction: A Continuum



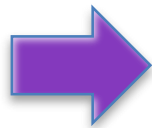
**Heat Stress:**  
External environmental conditions (WBGT)

**Heat Strain:**  
Internal response to the heat stress (core & skin temperature)

Heat Rash  
Heat Cramps  
Heat Oedema  
Heat syncope



Heat Exhaustion



Heat Stroke  
(classic / exertional)

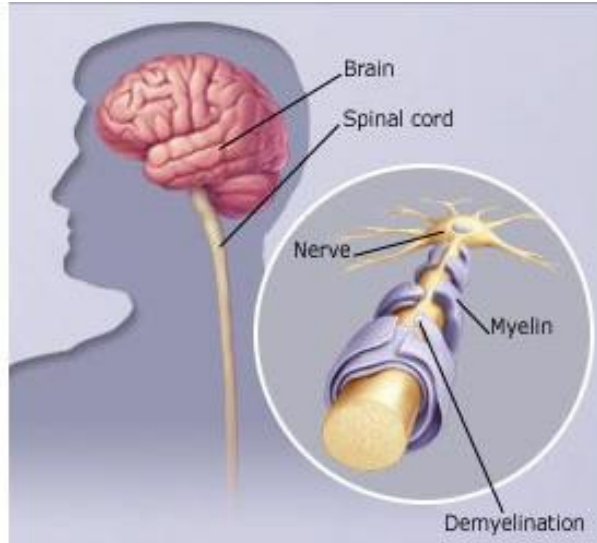
[Coris et al, 2006; Taylor, 2014]



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# Heat-Sensitive Populations

- **Multiple Sclerosis**
  - Uhthoff's Phenomenon



- Neurodegenerative disease
- 100,000 in UK
- 70% heat sensitive
- Symptom exacerbation
- 30% less active
- Benefits of exercise high

- **Breast Cancer Survivors**
  - Hot flash / Night Sweat

**Table 2. Prevalence and Severity of Symptoms Among Postmenopausal Women**

Symptom	No.*	%†	Symptoms Severity (%)‡		
			Mild	Moderate	Severe
<b>Vasomotor</b>					
Hot flashes (n = 183)§	119	65	29	37	34
Night sweats (n = 183)	81	44	41	24	35
<b>Gynecologic</b>					
Vaginal dryness (n = 180)	86	48	27	26	47
Difficulty with bladder control (n = 183)	66	36	55	22	23
Pain with intercourse (n = 171)	45	26	39	12	49
Genital itching or irritation (n = 183)	43	24	51	28	21
Vaginal discharge (n = 183)	41	22	66	19	15
<b>Other</b>					
Difficulty sleeping (n = 183)	81	44	32	38	30
Feeling depressed (n = 182)	80	44	44	28	28

\*Number of women who reported the symptom.

†Percent of women who reported the symptom.

‡Percent with the level of severity in women who have the symptom.

§Number of women who answered the question.

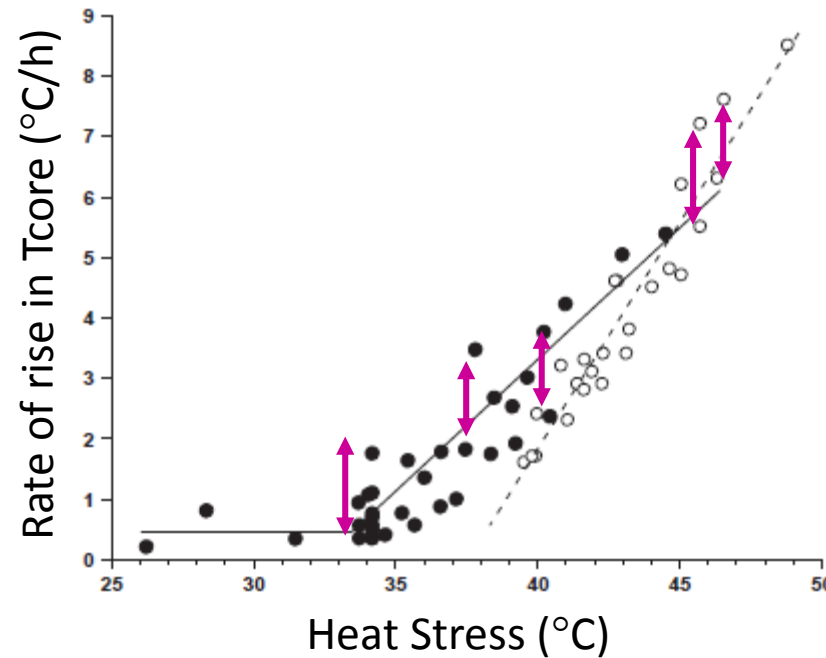
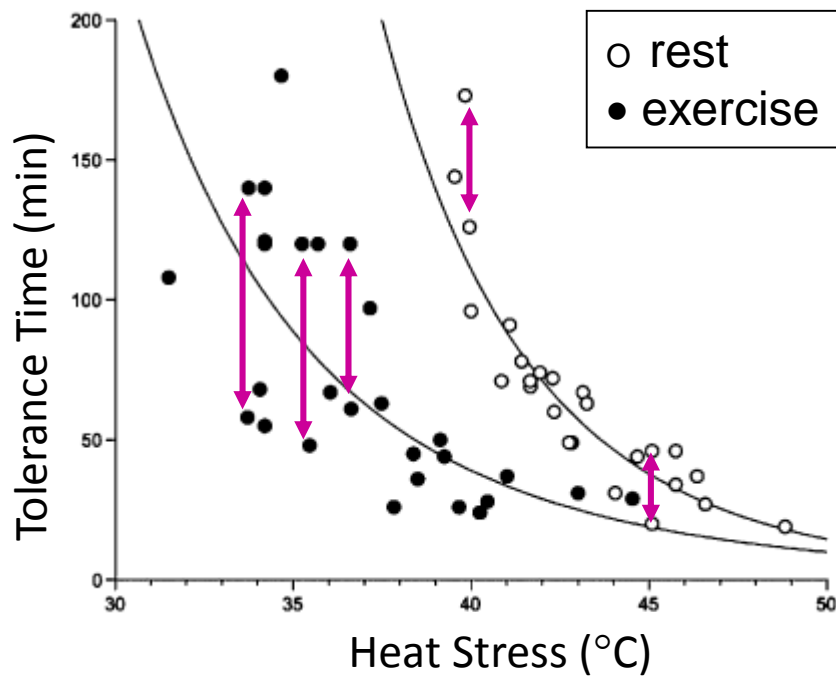
[Couzi et al, 1995]



# Heat Sensitive Individuals

- Heat intolerance

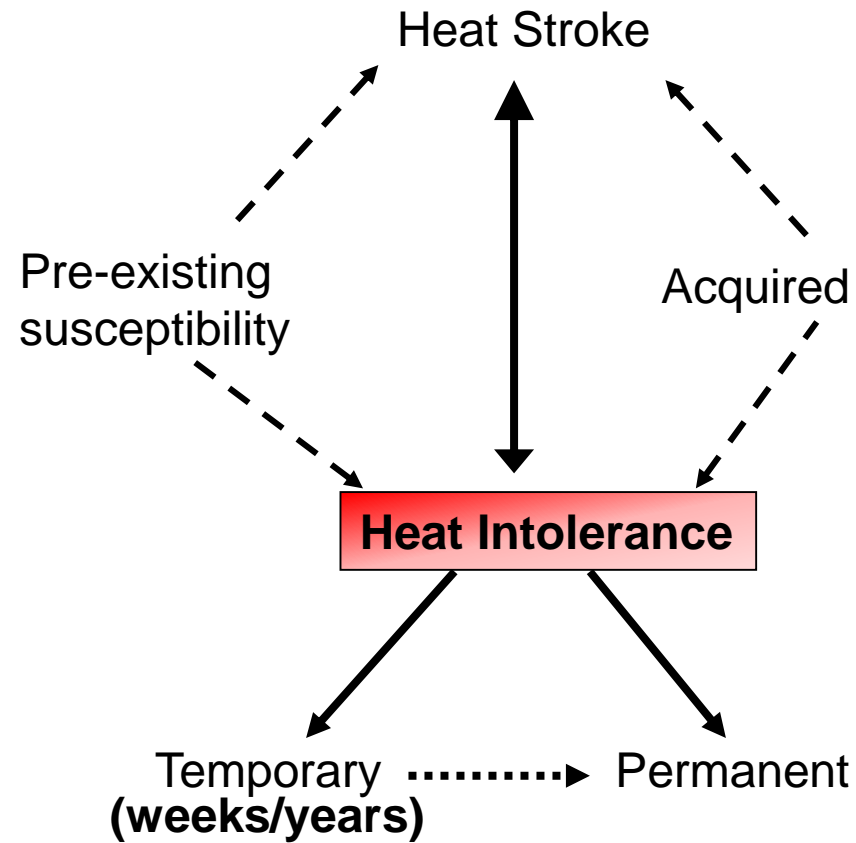
‘Individuals unable to sustain heat and body temperature rises early and at a higher rate than others’



Heat intolerance =  
higher risk of heat stroke



# Heat Tolerance - Predisposing Factors



**Genotypic & Permanent Characteristics:**  
 Different gene expression (HSP70, ACE I/D)  
 Congenital factors  
 Scarred burnt skin surface  
 Sweat gland dysfunction/diseases  
 Multiple sclerosis  
 Psychiatric illness

**Phenotypic & Temporary Characteristics:**

- insufficient degree of acclimatisation to heat
- sedentary lifestyle (i.e. low physical fitness)
- dehydration
- Overweight
- Maturation
- Sunburn
- Temporary heat illness



Acknowledgement in PHE's heat wave plan for heat intolerance being transient due to temporary event / illness



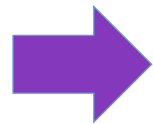
# Index of Heat Susceptibility

“Be on the look out for signs of heat related illness”

[PHE, 2016]

## Heat Illness Continuum

Heat Rash  
Heat Cramps  
Heat Oedema  
Heat syncope



Heat Exhaustion



Heat Stroke  
(classic / exertional)

## Heat Illness Susceptibility Questionnaire (HIS-Q)



Self-Report



Observer Assessment

[Waldock, 2017]

There is a rationale for PHE to encourage those supporting vulnerable people to capture heat illness through an index



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# Index for Acute Mountain Sickness

## Lake Louise Score (LLS) for the diagnosis of Acute Mountain Sickness (AMS)

A diagnosis of AMS is based on:

1. A rise in altitude within the last 4 days
2. Presence of a headache

**PLUS**

3. Presence of at least one other symptom
4. A total score of 3 or more from the questions below

**Total score of:**

- 3 to 5 = mild AMS
- 6 or more = severe AMS

Note:

- Do not ascend with symptoms of AMS
- Descend if symptoms are not improving or getting worse
- Descend if symptoms of HACE or HAPE develop

### SELF-REPORT QUESTIONNAIRE

Add together the individual scores for each symptom to get the **total score**.

<b>Headache</b>	No headache	0	
	Mild headache	1	
	Moderate headache	2	
	Severe headache, incapacitating	3	
<b>Gastrointestinal symptoms</b>	None	0	
	Poor appetite or nausea	1	
	Moderate nausea &/or vomiting	2	
	Severe nausea &/or vomiting	3	
<b>Fatigue &amp;/or weakness</b>	Not tired or weak	0	
	Mild fatigue/ weakness	1	
	Moderate fatigue/ weakness	2	
	Severe fatigue/ weakness	3	
<b>Dizziness/lightheadedness</b>	Not dizzy	0	
	Mild dizziness	1	
	Moderate dizziness	2	
	Severe dizziness, incapacitating	3	
<b>Difficulty sleeping</b>	Slept as well as usual	0	
	Did not sleep as well as usual	1	
	Woke many times, poor sleep	2	
	Could not sleep at all	3	
<b>TOTAL SCORE:</b>			



# What Heat Alleviating Methods are Recommended by PHE?

“Stay connected”

“Keep Well”

“Find somewhere cool”

“Watch out”

“Cool their skin with cool water, you could use a cool wet sponge or flannel, cool water spray, cold packs around the neck and armpits, or wrap them in a cool, wet sheet.”

“Have plenty of **cold drinks**...eat cold foods...keep cool and prevent dehydration...wear lightweight, loose-fitting light coloured cotton clothes.”

[PHE, *Beat the heat: staying safe in hot weather*, 2016]



The infographic is titled "Beat the Heat" and is published by Public Health England (PHE) and the NHS. It is organized into five horizontal sections, each with a title and three icons representing key advice:

- Stay connected:** Look after yourself, check on others especially the elderly; Listen to the weather forecast and the news; Plan ahead to avoid the heat.
- Keep well:** Drink plenty of water, avoid alcohol and caffeinated drinks; Dress appropriately for the weather; Slow down and avoid heavy activity.
- Find somewhere cool:** Know how to keep your home cool; Go indoors or outdoors, whichever feels cooler; Cars get hot, avoid closed spaces.
- Watch out:** Be on the lookout for signs of heat related illness; If you're too hot, cool your skin with water, slow down and rehydrate; Get help. Call NHS 111 or in an emergency 999.

At the bottom, it provides the website [www.nhs.uk/heatwave](http://www.nhs.uk/heatwave) for more information and includes the PHE publication number 201621.



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# Heat Alleviation Methods

Acute

Chronic

Hydration



Cooling

## Rationale for Cooling:

- to ↓ body's core temperature
- a greater body heat storage
- delays onset of sweating
- improved thermal comfort
- lower perception of effort

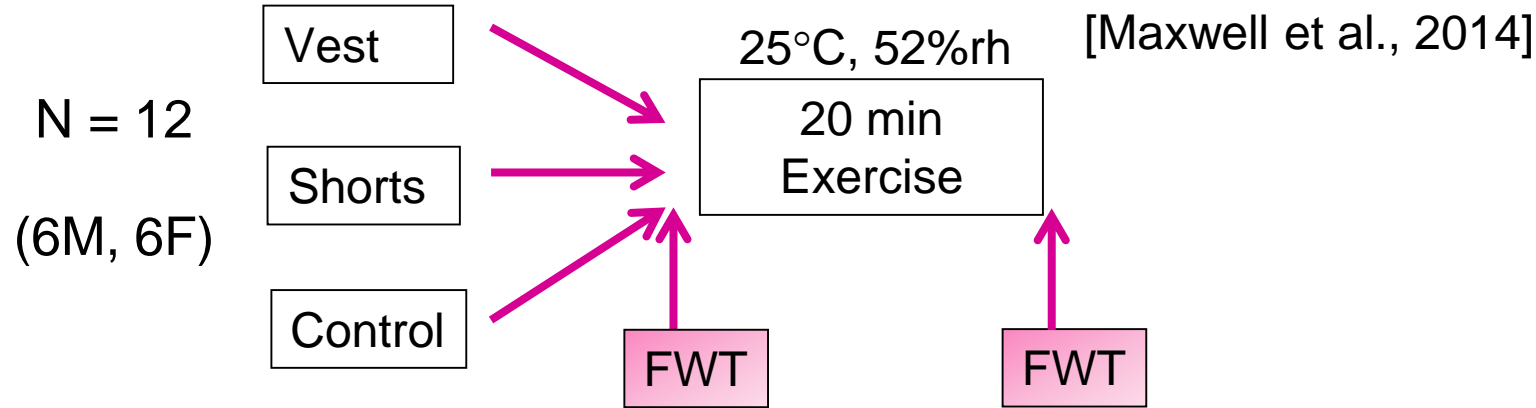
IceBath  
Go Anywhere Ultra Portables



Heat Adaptation



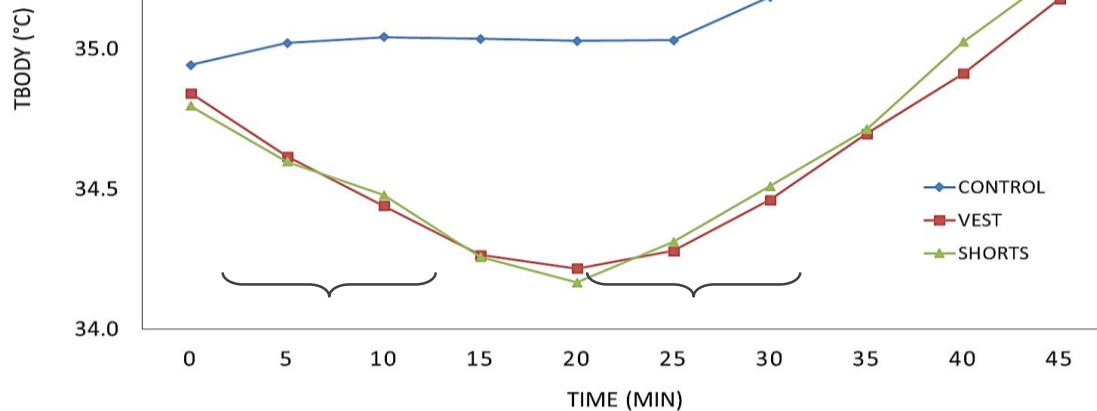
# Practical Precooling Strategies Help Heat Sensitive Individuals with Multiple Sclerosis



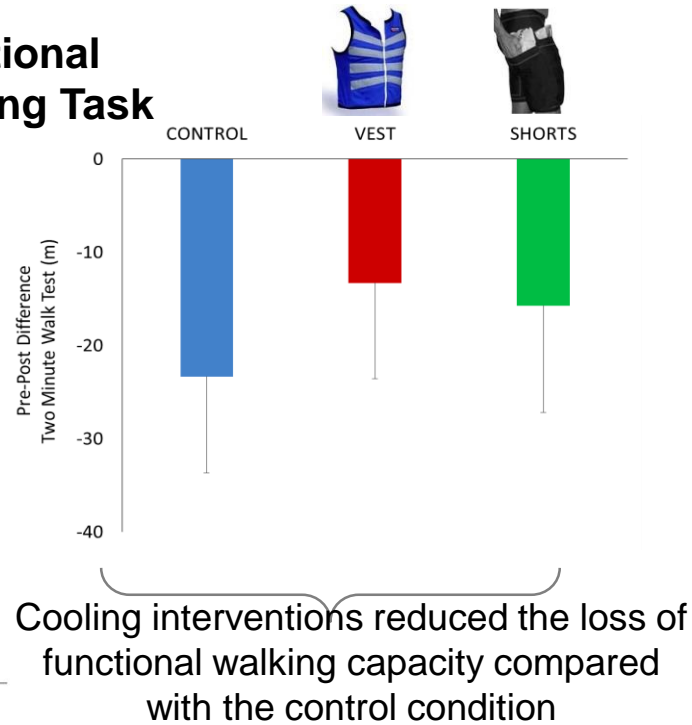
Precooling improved perceptions of thermal comfort and thermal sensation

## Body Temperature

Cooling interventions effective at reducing body temperature prior to exercise which remained evident during exercise



## Functional Walking Task



# A Portable Cooling Vest

a novel endothermic hypothermic device for core body cooling safety



CAERvest<sup>®</sup>  
COOLING DEVICE



## First Aid for Heat Illness

Know the signs

<b>HEAT EXHAUSTION</b> <ol style="list-style-type: none"><li>1. Dizziness</li><li>2. Headache</li><li>3. Sweaty skin</li><li>4. Fast heartbeat</li><li>5. Nausea, vomiting</li><li>6. Weakness</li><li>7. Cramps</li></ol> <b>TREATMENT</b> <ol style="list-style-type: none"><li>1. Use CAERvest</li></ol>		<b>HEATSTROKE</b> <ol style="list-style-type: none"><li>1. Red, hot dry skin</li><li>2. Fever</li><li>3. Confusion</li><li>4. Fainting &amp; finally...</li><li>5. Convulsions leading to death if not immediately recognised &amp; treated</li></ol> <b>TREATMENT</b> <ol style="list-style-type: none"><li>1. Use CAERvest</li><li>2. Call 999</li><li>3. Start CPR if there is no breathing</li></ol>
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CAERvest<sup>®</sup>  
CORE BODY COOLING

**Cools Anywhere Early Rapidly**

[www.CAERvest.com](http://www.CAERvest.com) @CAERvest



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# Should fans be used in a heatwave?

“Electric fans may provide relief, but when the temperature is above 35 °C, may not prevent heat-related illness”

[WHO, *Public health advice on preventing health effects of heat*, 2011]

“Use electric fans if the temperature is below 35 °C, but do not aim the fan directly at the body...”

“An electric fan could be helpful to create an electric current if the temperature is below 35°C, but fans can cause excess dehydration so they should not be aimed directly on the body and will not be enough to keep cool at temperatures above 35°C.”

[PHE, *Beat the heat: staying safe in hot weather*, 2016]



# Should fans be used in a heatwave?

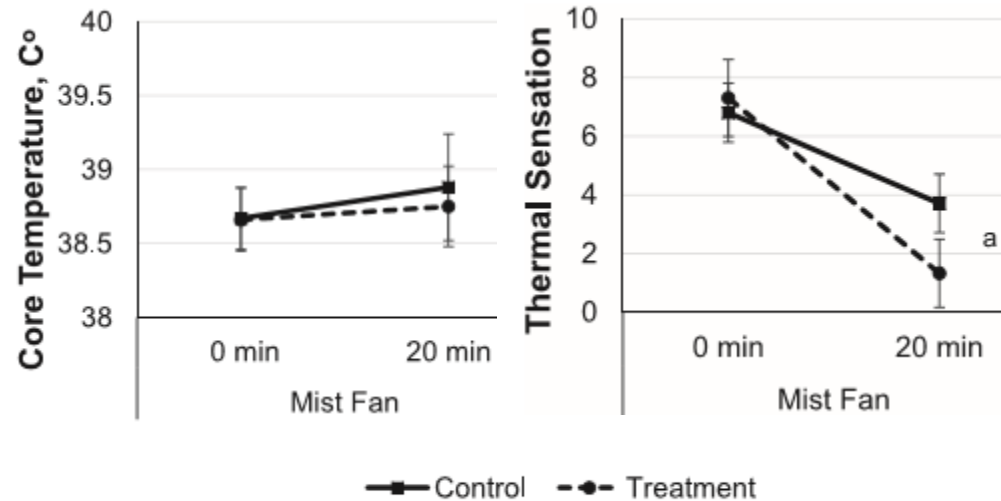
[Ravanelli et al., 2015]

Electric fans prevent heat-related increases in heart rate and core temperature in young people to ~ 80% rh at 36°C and 50% at 42°C.

[Gagnon et al., 2016]

In elderly (60 and 80 yrs) no benefit (and for some –ve effects) of the electric fan during heat stress.

[Sefton et al., 2016]



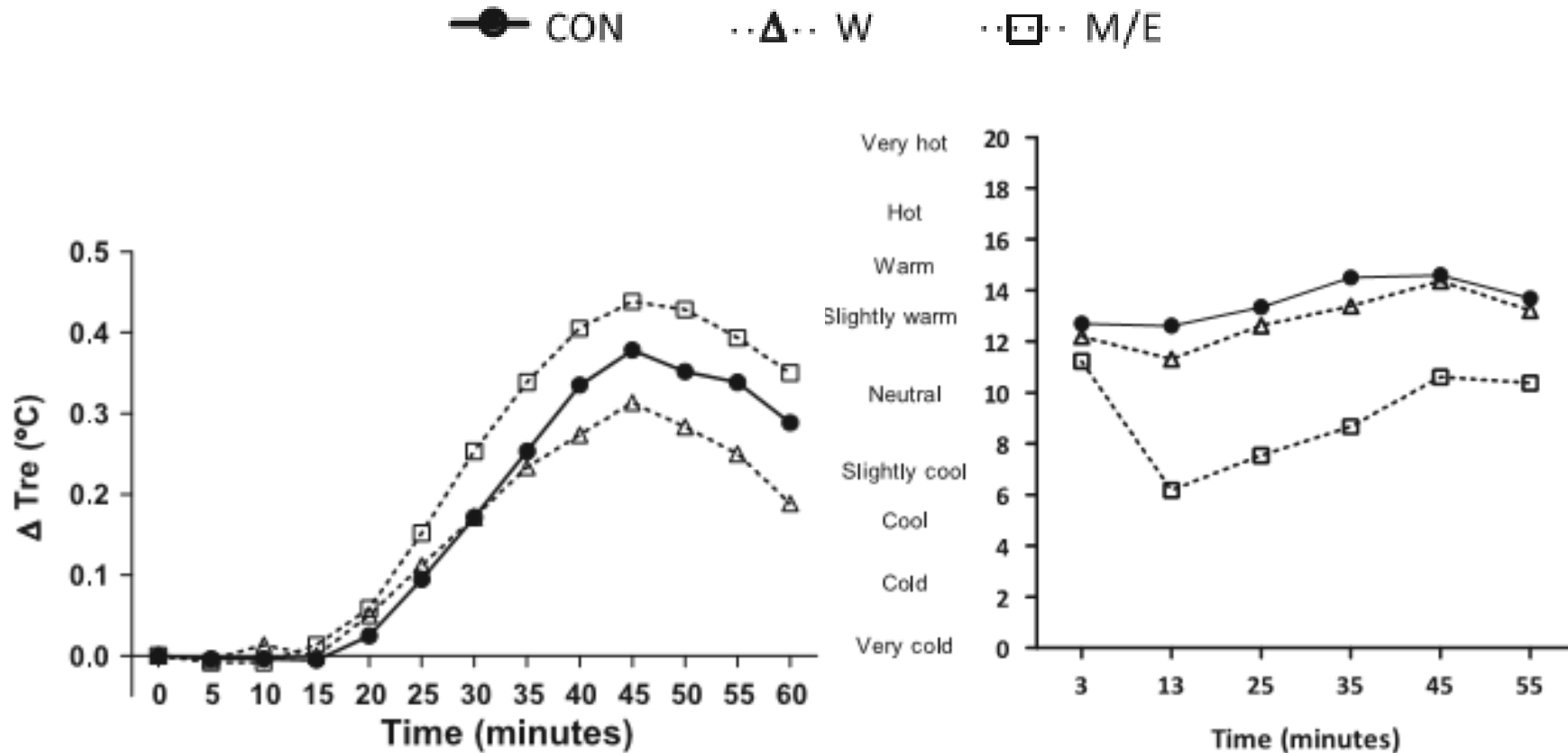
More research required across different populations using different ambient temperatures and fan speeds and misting for more prescriptive advice on the value of electric fans in heat waves





# Is Menthol the answer for keeping cool?

[Gillis et al., 2016]



Caution with perceptual manipulations, which may facilitate achievement of dangerously high body temperatures and mask signs and symptoms of heat-illness



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# An Ice-cream or a cup of tea?



“Under conditions permitting full sweat evaporation, body heat storage is lower with warm water ingestion”

[Bain et al, 2012]



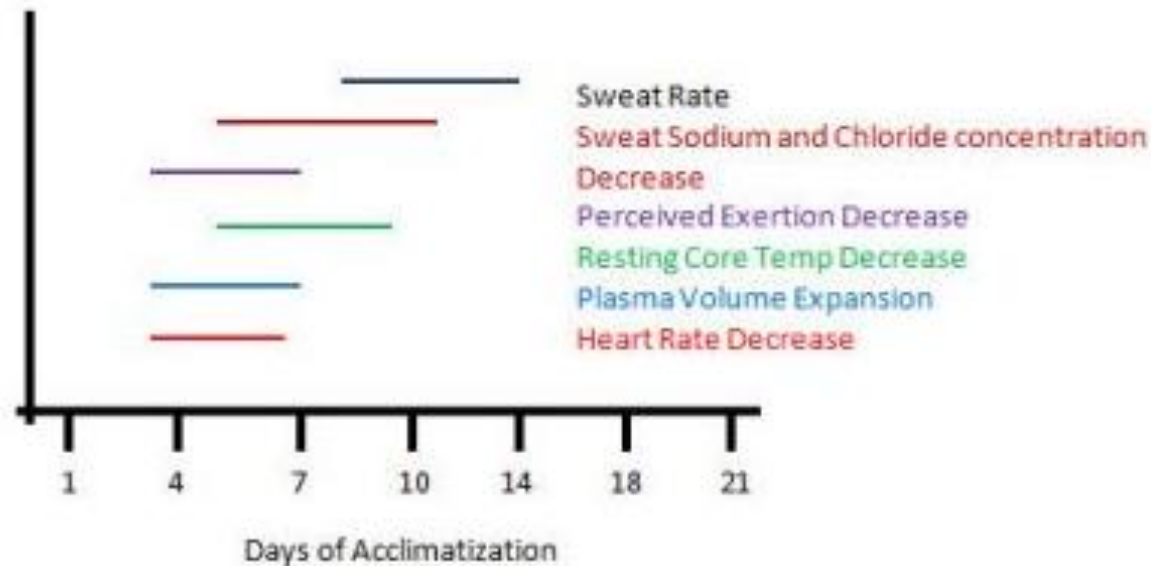
# Prevention is better than cure: Heat Adaptation

## Heat acclimation

Self-regulated

Constant work-  
rate  
(traditional)

Controlled-  
hyperthermia



In anticipation of a heatwave, could safe adaptation to the heat offer protection to some vulnerable populations?



# Females Take Longer to Adapt to the Heat

[Mee et al, 2015]



	Males		Females	
	5 days	10 days	5 days	10 days
<b>Core Temperature</b>	Adapted	No further adaptation	Not adapted	Adapted
<b>Heart Rate</b>	Adapted	No further adaptation	Not adapted	Adapted
<b>Sweat Rate</b>	Not adapted	Adapted	Adapted	No further adaptation

HA protocols should be designed to target sex differences in thermoregulation for optimal adaptation.

## EXCERSISE SUIT With Sauna Effect



Sauna suit accelerated heat acclimation state in females

[Mee et al., 2016]



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# Could hot baths be the answer?

[Zurawlew et al., 2015]

## Train Cool - Bathe Hot - Perform Better in the Heat!

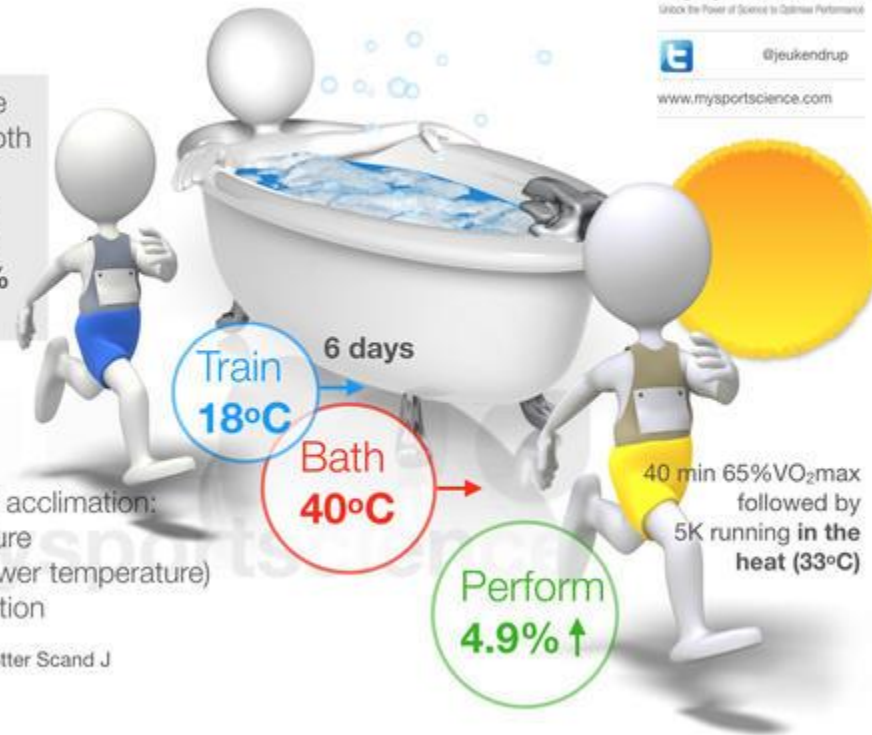
**Hot bath** after exercise for six days reduced both resting and exercising body temperature and **improved 5k running performance by 4.9% in the heat.**

17 males  
Hot water (n=10)  
Thermoneutral (n=7)

**Hot bath** induced heat acclimation:

- Lower core temperature
- Earlier sweating (at lower temperature)
- Lower perceived exertion

Zurawlew, Walsh, Fortes and Potter Scand J Med Sci Sports 2016



[Willmott et al., 2016]

Wearing sauna suits to restrict heat loss during exercise in temperate conditions comparable to typical heat acclimation



**Hot-water-immersion after exercise on 6-days presents a simple, practical and effective heat-acclimation strategy to improve endurance performance in the heat.**



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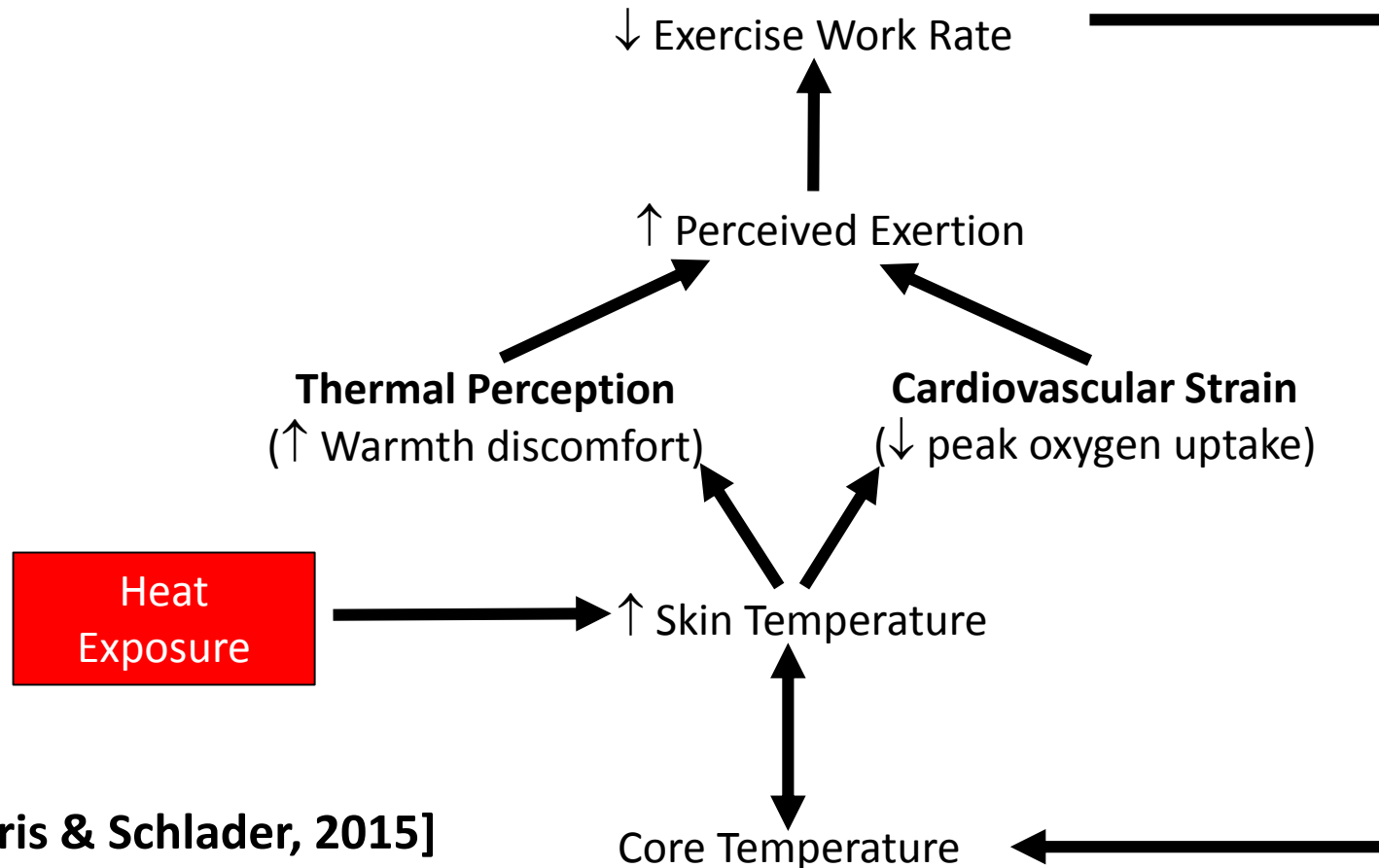
# Behavioural Thermoregulation

[Flouris, 2011]

“Behavioural thermoregulation can be defined as any conscious decision taken with the aim of maintaining thermal balance and it represents an **near-infinite resource** for human body temperature regulation”



Some populations do not pick up the cues (or have the same feelings) to alter thermal behaviour



[Flouris & Schlader, 2015]



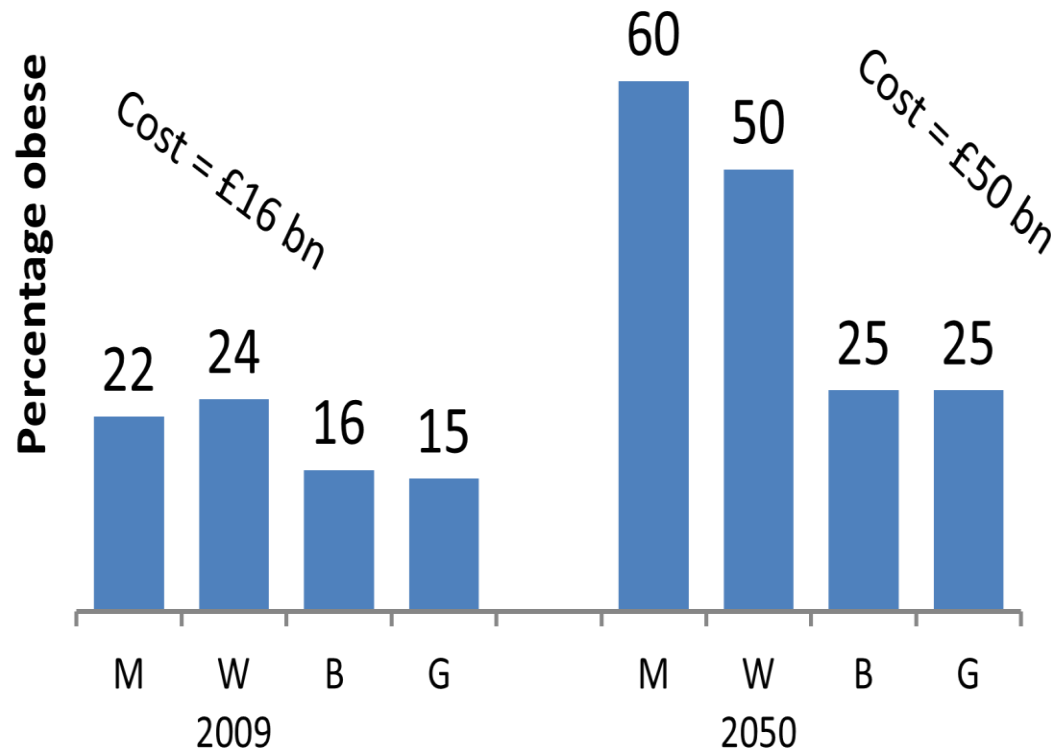
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# The Importance of Exercise

“Avoid extreme physical exertion. If you can’t avoid strenuous outdoor activity...keep it for cooler parts of the day...”

[PHE, 2016]

Percentage of adults and children obese in England in 2009 and 2050 (BIS, 2007; HSE, 2010)



“physical inactivity costs the NHS in England more than £450m a year”

[PHE, 2016]



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# The Importance of Exercise

Impairments in heat loss in older and middle-aged untrained males occur in a hot environment. These impairments in untrained middle-aged males can be **minimized through regular aerobic exercise training.**

[Stapleton et al, 2015]



Rationale in PHE's heat wave plan for a stronger message on the importance of safe exercise





Rationale to acknowledge 1) heat sensitive individuals, 2) use an index of heat illness susceptibility, 3) recommend a wider range of heat-alleviating methods, 4) be aware of behavioural thermoregulation differences, and 5) the importance of exercise in PHE's Heat Wave Plan

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**Thank you for Listening!**



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