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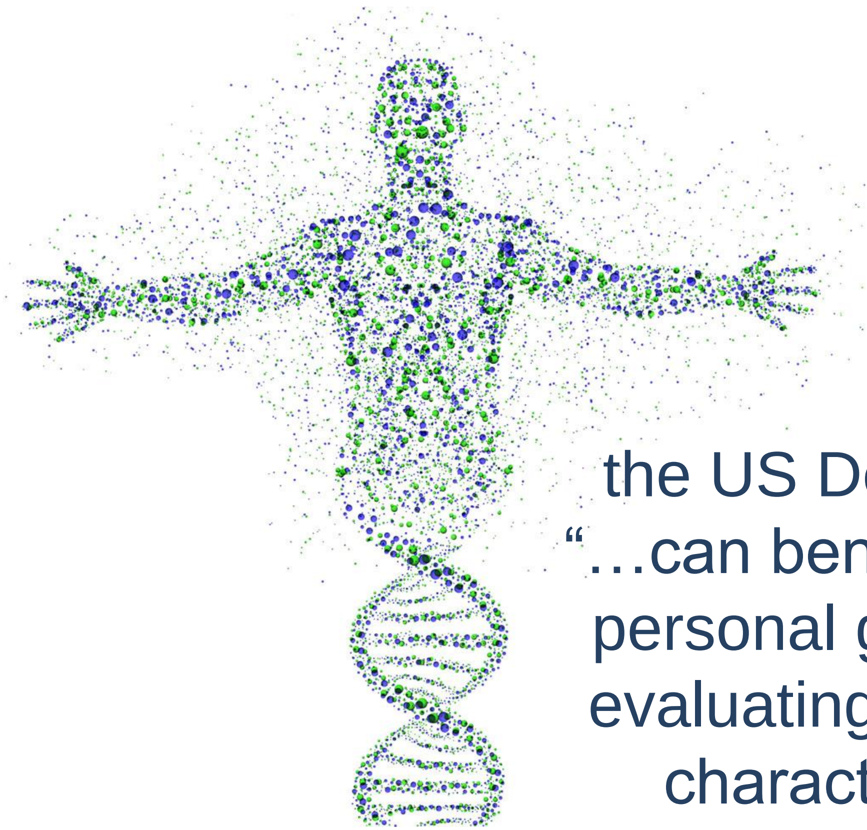
The $100 Genome: Implications for Defence



the US Department of Defence (DoD) "…can benefit significantly by employing personal genomics technologies when evaluating the health and performance characteristics of their personnel"

In **500 non-military personnel**, a subset of > 47 000 genes was able to predict approximately 60% of the variance for changes in aerobic fitness after 6 weeks of aerobic exercise training.

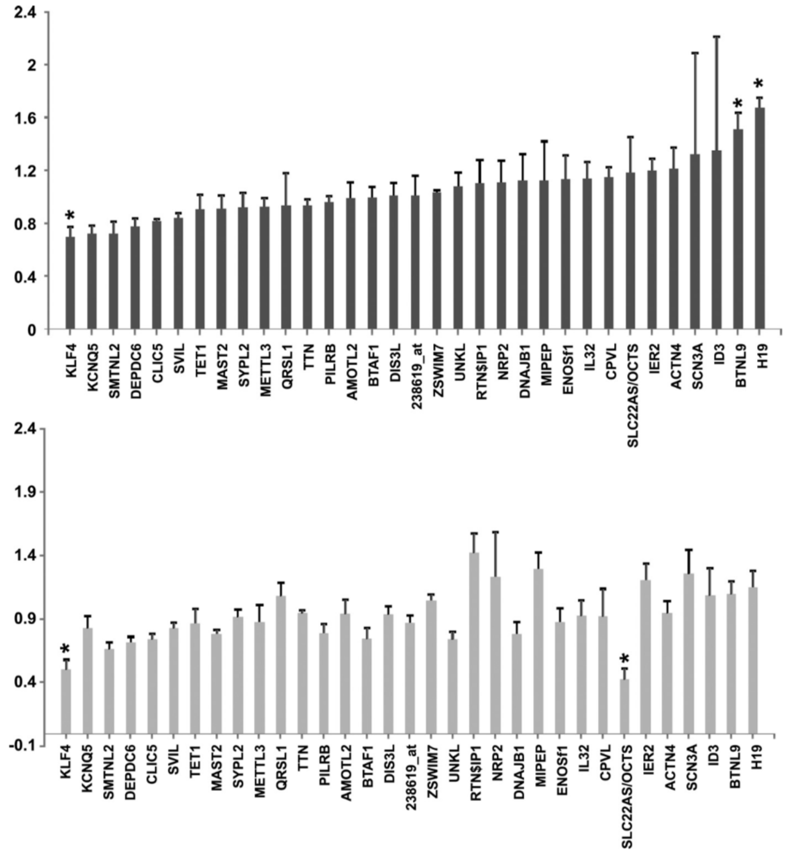


Fig. 3. Skeletal muscle expression of all the predictor genes (based on RNA), which together explain ~58% of the variance in exercise training-induced changes in $\dot{V}O_{2max}$ in young sedentary human subjects (n = 24) before and after 6 wk of aerobic exercise training. *Top*: high responders following 6 wk of aerobic training; *bottom*: low responders following 6 wk of aerobic training. Expression values are generated using Affymetrix U133 Plus 2.0 gene chips (>47,000 transcripts), normalized using MAS5.0, and corrected for multiple comparisons using the significance of microarrays analysis methodology. This analysis strategy avoids issues with unstable housekeeping genes. Only *H19, KLF4, OCT3, SMTNL2*, and *BTNL9* demonstrated a modest change in expression below a false discovery rate of 5% (*), and not consistently in high and low responders. All other genes (>90% of predictor genes) were unchanged.

Timmons, J.A., et al., *Using molecular classification to predict gains in maximal aerobic capacity following endurance exercise training in humans.* J Appl Physiol, 2010. **108**(6): p. 1487-96.

TABLE 5. Comparisons of CMJ and Aero3 increases (%) in response to resistance training between matched and mismatched groups.

Study	Group				P_3
	Matched athletes		Mismatched athletes		
Study 1	n =14	P_1 (paired test)	n = 14	P_2 (paired test)	
Change in CMJ, %	7.8 (5.9)	0.0005*	2.9 (7.2)	0.175	0.0596
Change in Aero3, %	4.0 (3.1)	0.0004*	2.8 (4.3)	0.0134*	0.2456
Study 2	n =20		n = 19		
Change in CMJ, %	7.1 (4.1)	<0.0001*	2.4 (3.5)	0.0053*	<0.0001*
Change in Aero3, %	7.7 (2.2)	<0.0001*	1.9 (1.8)	0.0004*	<0.0001*
Studies 1 and 2	n =34		n =33		
Change in CMJ, %	7.4 (4.9)	<0.0001*	2.6 (5.3)	0.0152*	<0.0001*
Change in Aero3, %	6.2 (3.2)	<0.0001*	2.3 (3.1)	<0.0001*	<0.0001*

Note: *P_1 and P_2 < 0.05 - significant increases in CMJ and Aero3 (paired test); *P3 < 0.05 - significant difference between matched and mismatched groups. Matched athletes - high-intensity trained with endurance genotype or low-intensity trained with power genotype; mismatched athletes - high-intensity trained with power genotype or low-intensity trained with endurance genotype.

Jones et al. A genetic-based algorithm for personalized resistance training. Biology of Sport, 2016. **33**(2): 117-126.

- **Very little research has investigated genetic predictors of physical performance in military personnel**.

- There is evidence that <u>single</u> genetic variations are associated with physical fitness test scores (Figure 1) and the response to training (Figure 2) in military personnel.

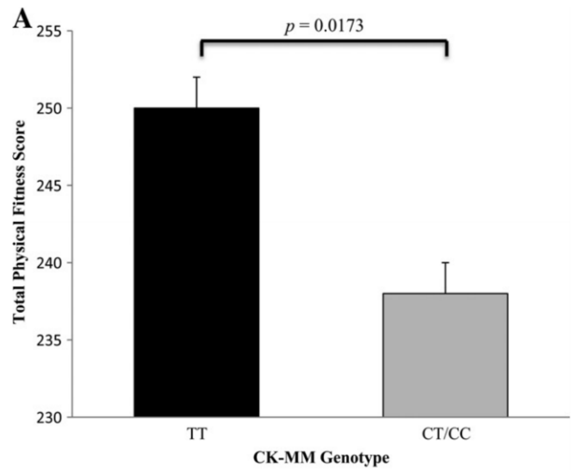


Figure 1. The CK-MM gene variant TT is associated with Total Physical Fitness score in **176** US recruits.

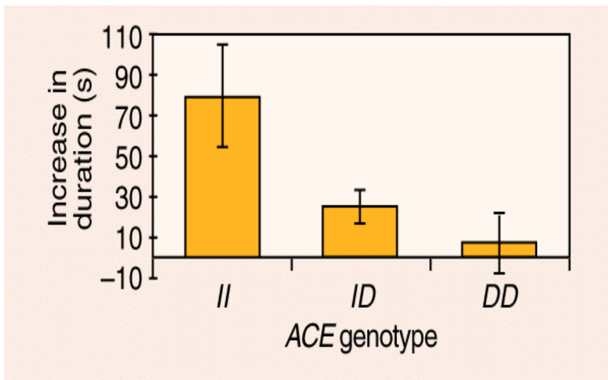


Figure 2. ACE genotype was determined in **78** Caucasian males recruited to the UK army consecutively, who completed an identical 10-week general physical training programme

Montgomery *et al*. (1998). *Nature*.

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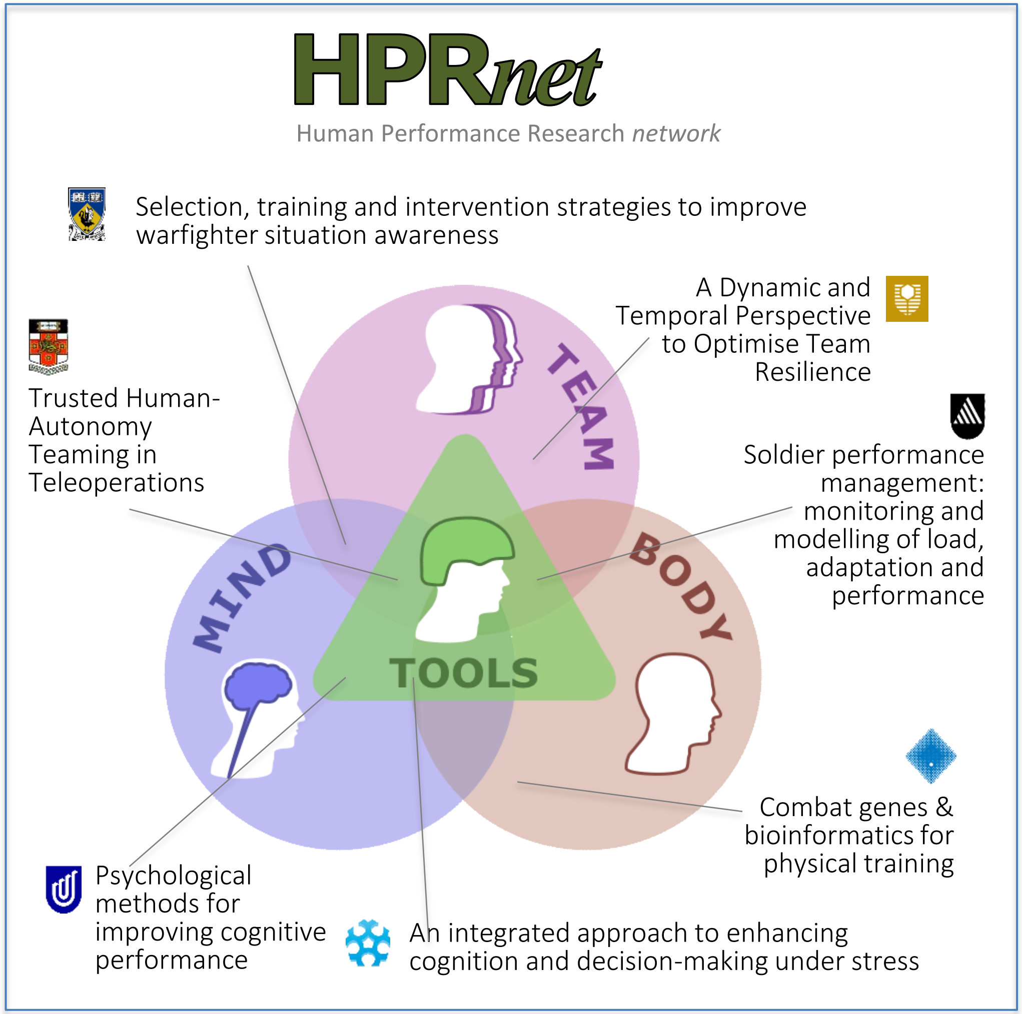
Discovering 'combat genes' to help identify, and optimise the training of, the future soldier

Aim 1 (Short Term): to use cutting-edge technologies to identify genetic predictors of <u>baseline</u> physical performance, relevant to the Army, in new recruits (**PP1**).

Aim 2 (Mid Term): to use cutting-edge technologies to identify genetic predictors of the response to physical training, and the likelihood of sustaining an injury during basic training, in Army recruits (**PP1** & **PP2**).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Selection, training and intervention strategies to improve warfighter situation awareness
A Dynamic and Temporal Perspective to Optimise Team Resilience
Trusted Human-Autonomy Teaming in Teleoperations
TEAM
MIND
BODY
TOOLS
Soldier performance management: monitoring and modelling of load, adaptation and performance
Combat genes & bioinformatics for physical training
Psychological methods for improving cognitive performance
An integrated approach to enhancing cognition and decision-making under stress

Project Design

1 Hypotheses

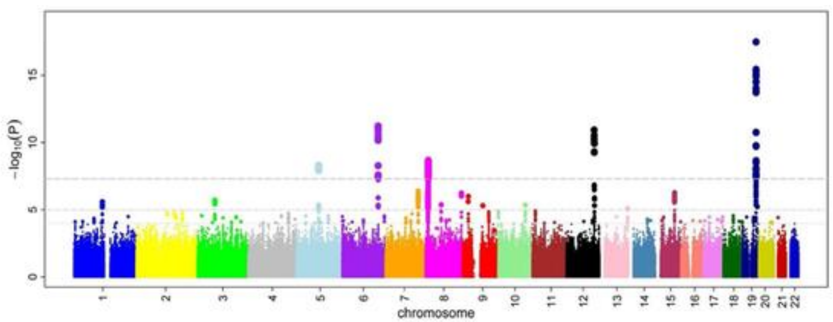
Using cutting-edge technologies we will be able to identify genetic predictors that predict baseline physical performance, the response to physical training, and the likelihood of sustaining an injury during basic training, in Army recruits

Project Design

2 Experimental methodology





Project Design

3 Deliverables

A review of literature on "Genes and the military"

Report of genetic predictors of physical performance in military personnel

Report of genetic predictors of trainability in military personnel

Report of genetic predictors of susceptibility to injury in military personnel

Project Design (fantasy)

4 Timelines

	June 2017	Dec 2017	June 2018	Dec 2018	June 2019	Dec 2019	May 2020
Task	Recruit RA/PhD	Draft Ethics	Collect data on recruits (PhD based at Kapooka)			Analyse genes	Write Up
Deliverable	Recruit RA	Submit Ethics Recruit PhD	Submit Review Draft	Data from Year 1	Data from Year 1.5	Analysis of genetic data	Reports /Papers
Progress	✓	✓ ✓					

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Progress to date (reality)

4 Timelines

	June 2017	Nov 2017	June 2018	Nov 2018	Feb 2019	Dec 2019	Aug 2020	Dec 2020	June 2021
Task	Recruit RA/PhD	Submit Ethics		Ethics Approval	Collect data on recruits (PhD based at Kapooka)			Analyse genes	Write Up
Deliverable	Recruit RA	Submit Ethics Recruit PhD	Submit Review Draft	Re-Recruit PhD	Start	Data from Year 1	Data from Year 1.5	Analysis of genetic data	Reports /Papers
Progress	✓	✓ ✓	✓	✓ ✓					

Challenges & opportunities

Challenges

- Working with Army & PTIs?
- Modifying the shuttle run test (repeat at end, maximal effort)
- Setting up a database
- Sharing data
- Ethics/Confidentiality for additional uses of the data

Opportunities

- Set up a database, and share genetic results with other members of HPRnet (and beyond)