

Pathways to Modernization: bridging research technology and stakeholder needs in silviculture

Optimizing Modern Silviculture Webinar

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Introduction: What's in a name?



“Modernisation can be an ergonomic, safety or technical intervention ranging from a better hand tool to a fully mechanised operation. Mechanisation is the introduction of machinery to an operation as part of modernisation.” Da Costa (2020)

















“Pathway is a trail or other walkway.” or “a way especially designed for a particular use”
Vocabulary.com



“We have seen the introduction and adoption of new technologies by local stakeholders driven by various reasons, such as the need to increase productivity and to reduce costs. However, even though silviculture has left us behind for several years, there is growing interest both locally and internationally in our innovations in this field,” Ramantswana 2020

Pathways to modernization: Drivers

- Costs
- Ergonomic risks
- Safety and Health
- Productivity
- Environmental impact
- Employment
- Communities?

	MANUAL	MOTOR-MANUAL	SEMI-MECHANIZED	MECHANIZED	AUTOMATED
<i>SITE PREPARATION</i>					
<i>TREE PLANTING</i>		—			
<i>STAND TENDING</i>					

Ramantswana et al. 2020

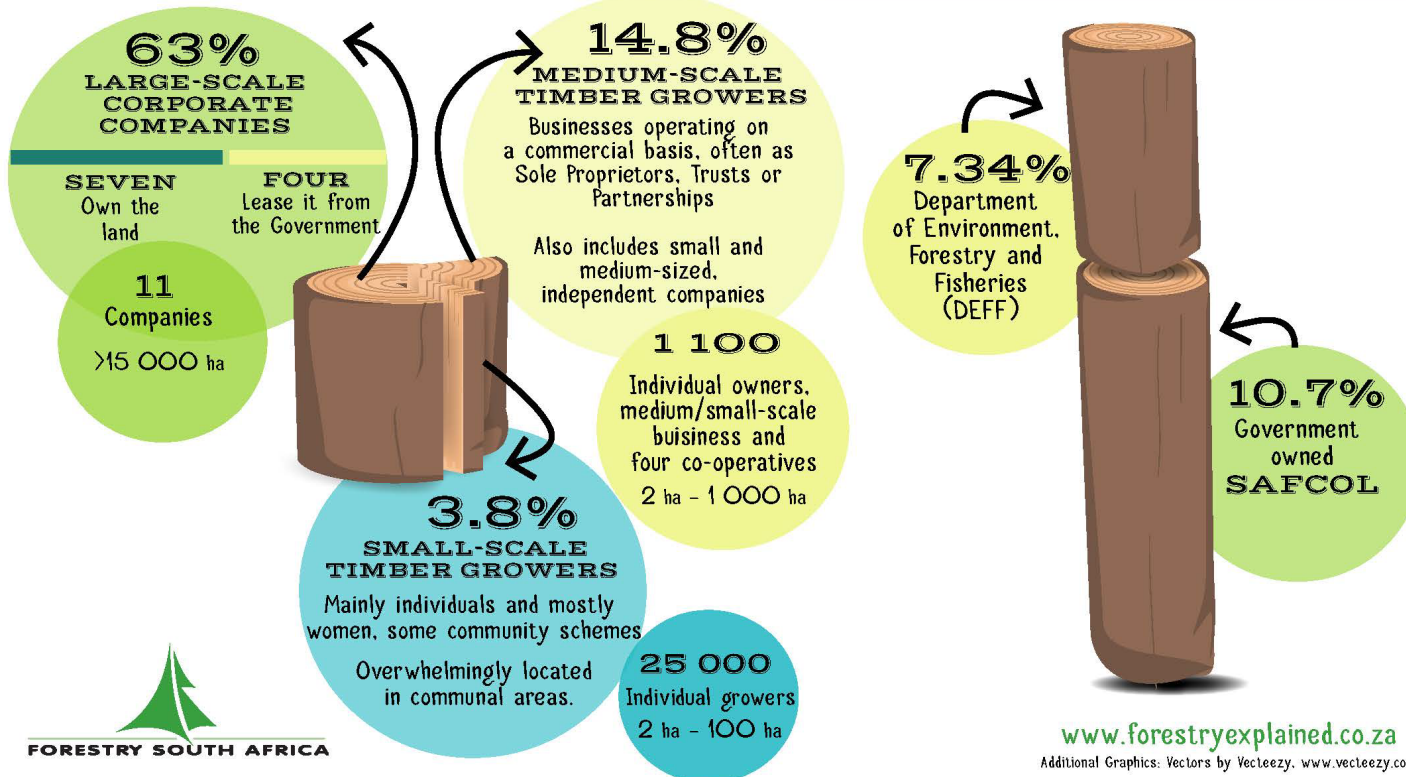
Stakeholder insights: Case Study

INTRODUCING THE TIMBER PLANTATION OWNERS

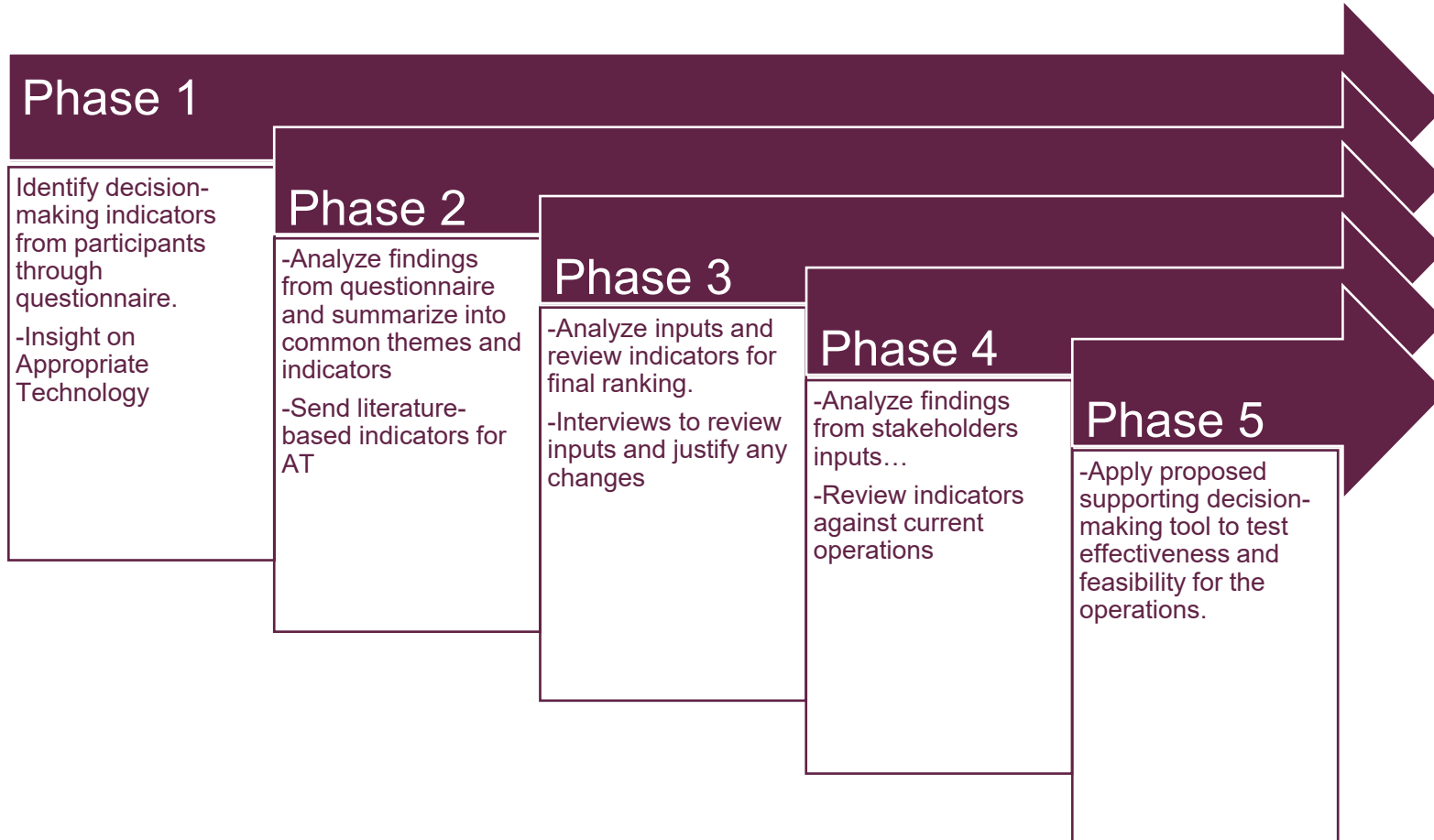
There are over 26 000 owners of timber plantations in South Africa, owning anything from **TWO** hectares to **HUNDREDS of THOUSANDS** of hectares.

81.6% Privately owned (972 377 ha)

18.4% Publicly owned (219 262 ha)



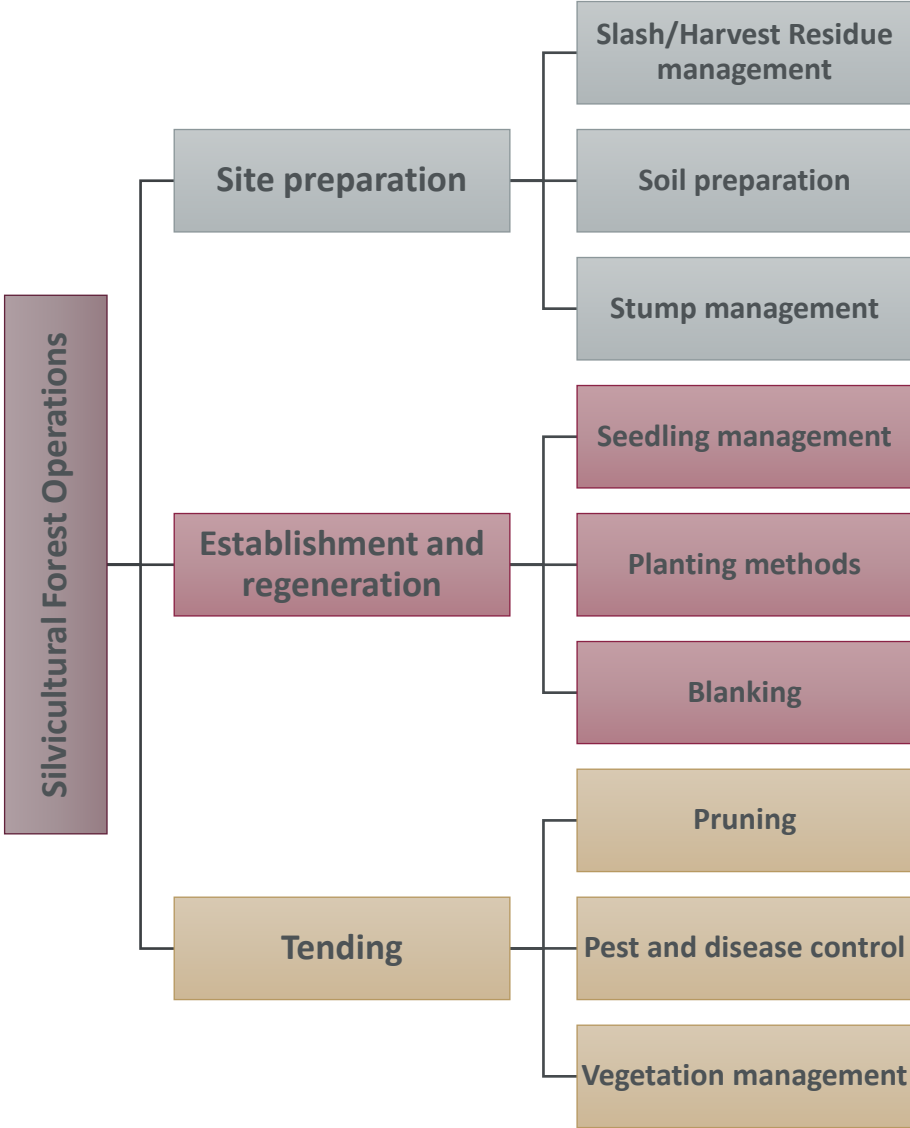
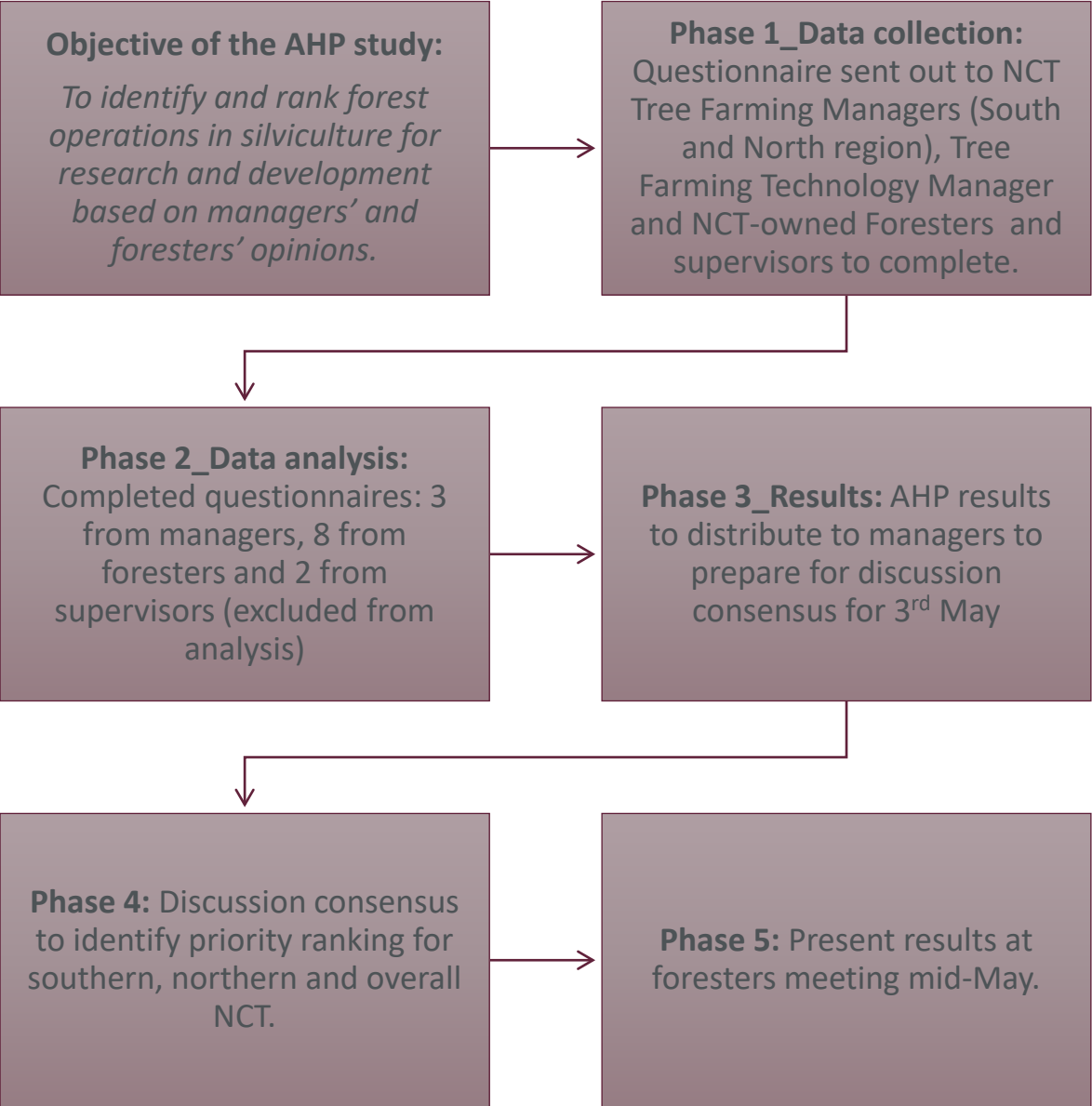
Understanding Strategic Alignment: In progress



To what extent do you agree with the following definition of Appropriate Technology by Grobbelaar (2000):

"Appropriate technology (AT) is a spectrum of basic, intermediate, and highly mechanized technology that is evaluated for a specific situation along agreed-upon social, environmental and economic criteria, supporting sustainable development."

AHP Hierarchy for Silvicultural Forest Operations Priority ranking for R&D





What needs more investment in R&D?

Small-scale Forestry (2023) 22:669–692
<https://doi.org/10.1007/s11842-023-09548-w>

ORIGINAL RESEARCH



Ranking Research and Development Needs of Silvicultural Operations for a Plantation Forestry Cooperative

Zimbili Bonisiwe Sibiya¹  · Carola Häggström² · Bruce Talbot¹ 

Accepted: 16 June 2023 / Published online: 20 July 2023
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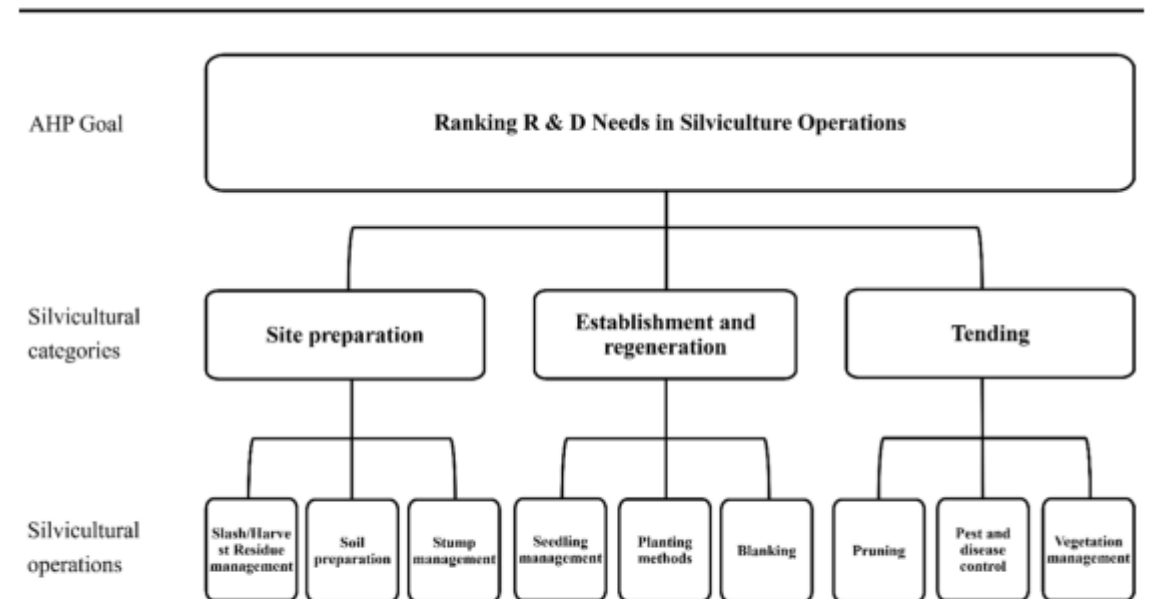
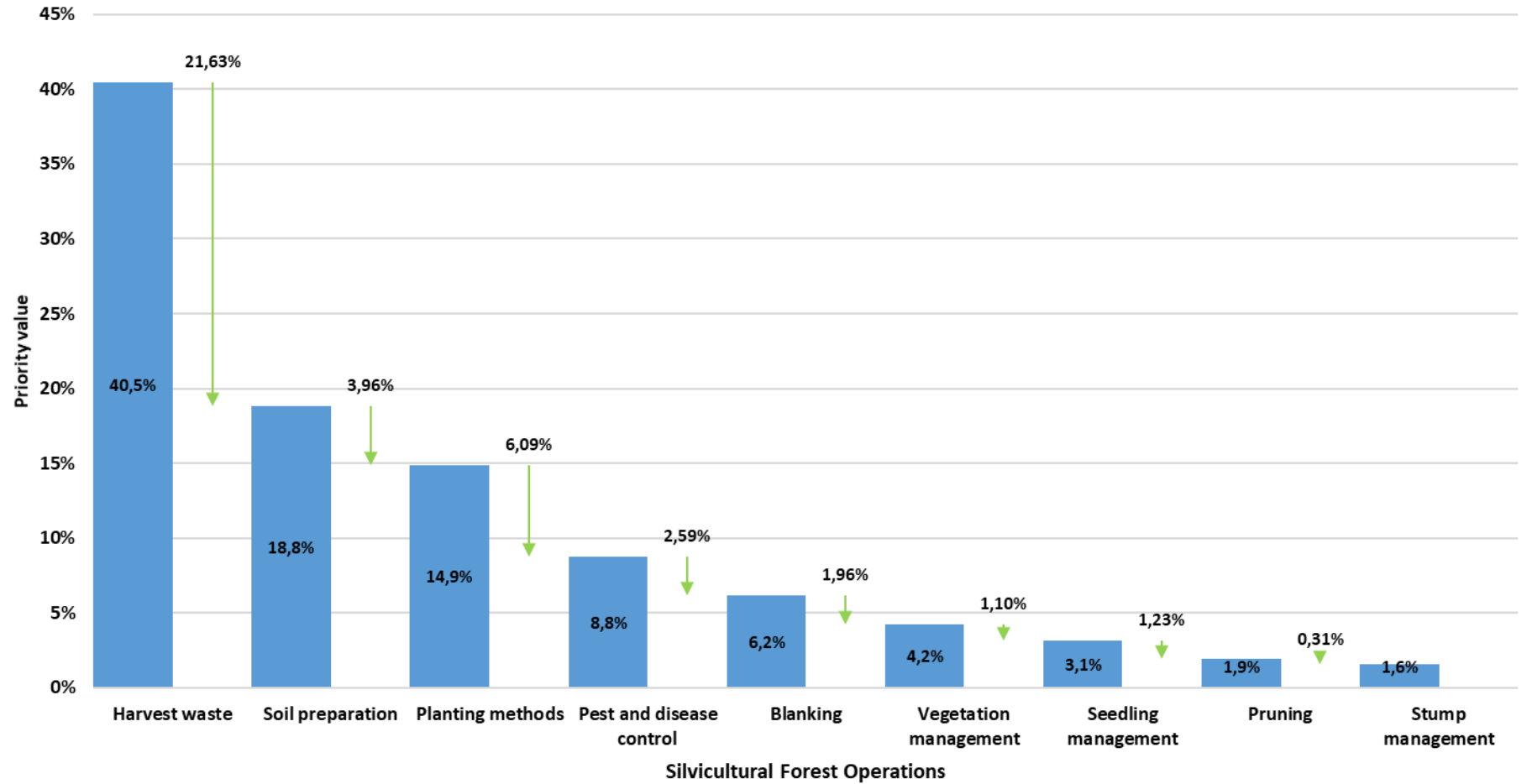


Fig. 2 AHP hierarchy for the R&D needs in silviculture operations. Categorization of silvicultural operations was based on the work of various authors (Du Toit and Norris 2012; Viero and Du Toit 2012; Ramantswana et al. 2020a, b, c)

Priority ranking of Silvicultural Forest Operations for R&D_NCT



This graph shows the final priority ranking by NCT managers taking into account input by foresters.

Pitting operations



Image source: Ramantswana et al. (2020)

Why manual equipment?

Benefits

- Economically favourable
- Labour-intensive (job opportunities)
- Low environmental impact

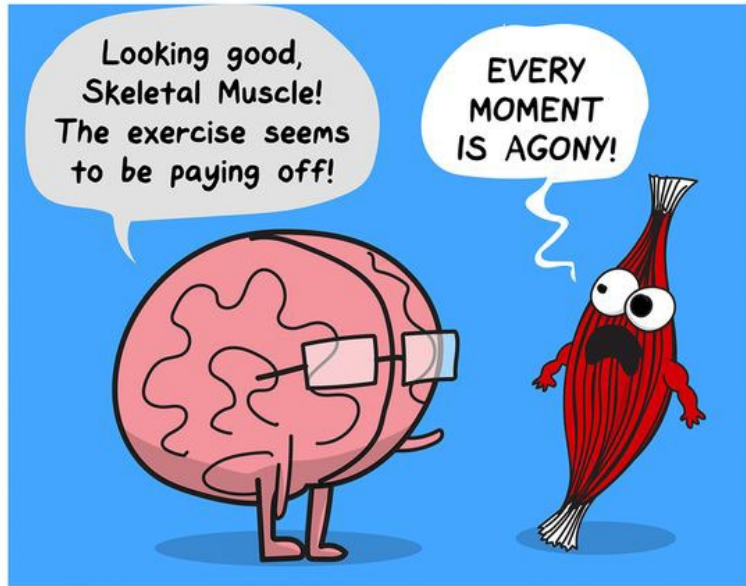
Concerns

- 494 pits/shift (8 hours)
- Terrain conditions
- Task-chasing (work speed)

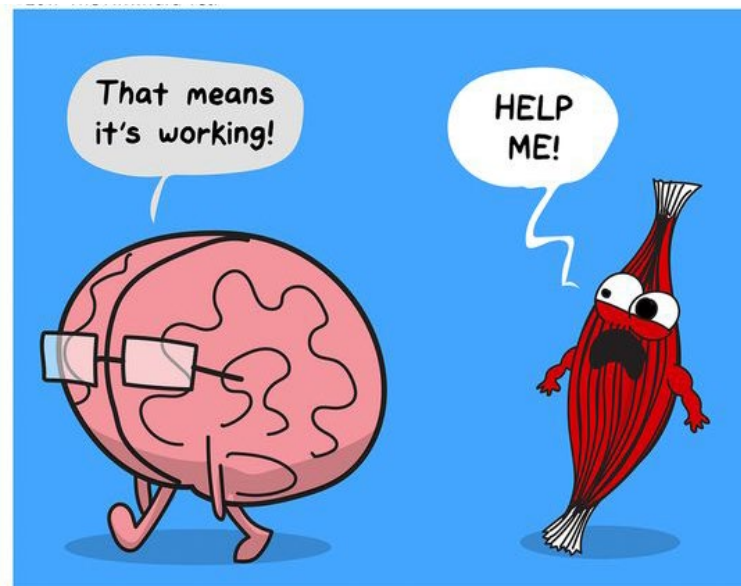
Ergonomically unfavorable

- High demand on spinal kinematics (medium to high risk) (Parker, 2019)
- Moderate to heavy workload (James, 2013)
- WMSDs risks (repetitive, engagement of upper body, and torso)

Study Objectives



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theAwkwardYeti

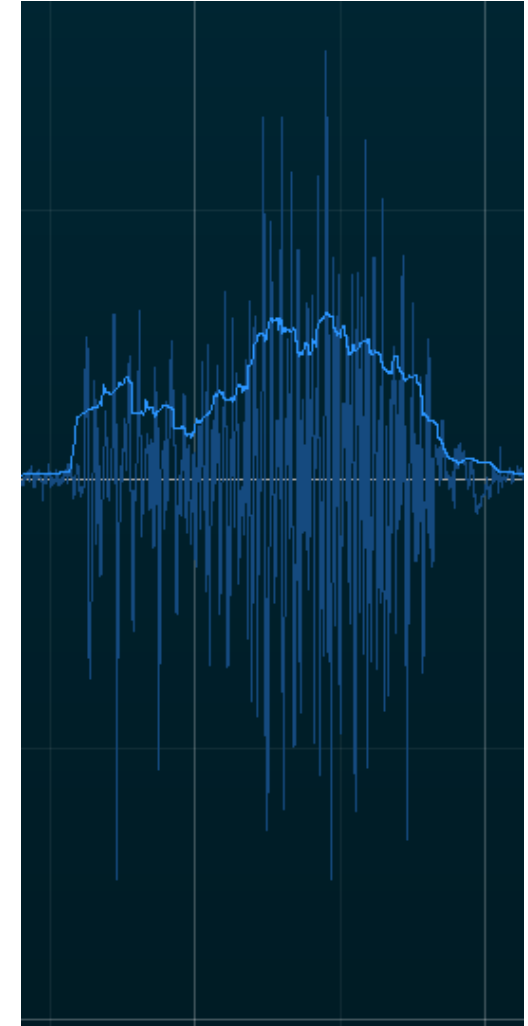


- ❖ Which muscle group (s) carry the most strain during manual pitting using different equipment?
- ❖ Which equipment has lower risk for work-related musculoskeletal disorders (WMSDs) in pitting operations?

What does EMG tell us?

- ❖ Is the muscle active?
- ❖ Is the muscle more or less active? (Left or Right)
- ❖ When is the muscle on/off?
- ❖ How much is the muscle active? (mV)
- ❖ Does the muscle fatigue?

Cite: Mrotzek (2020)

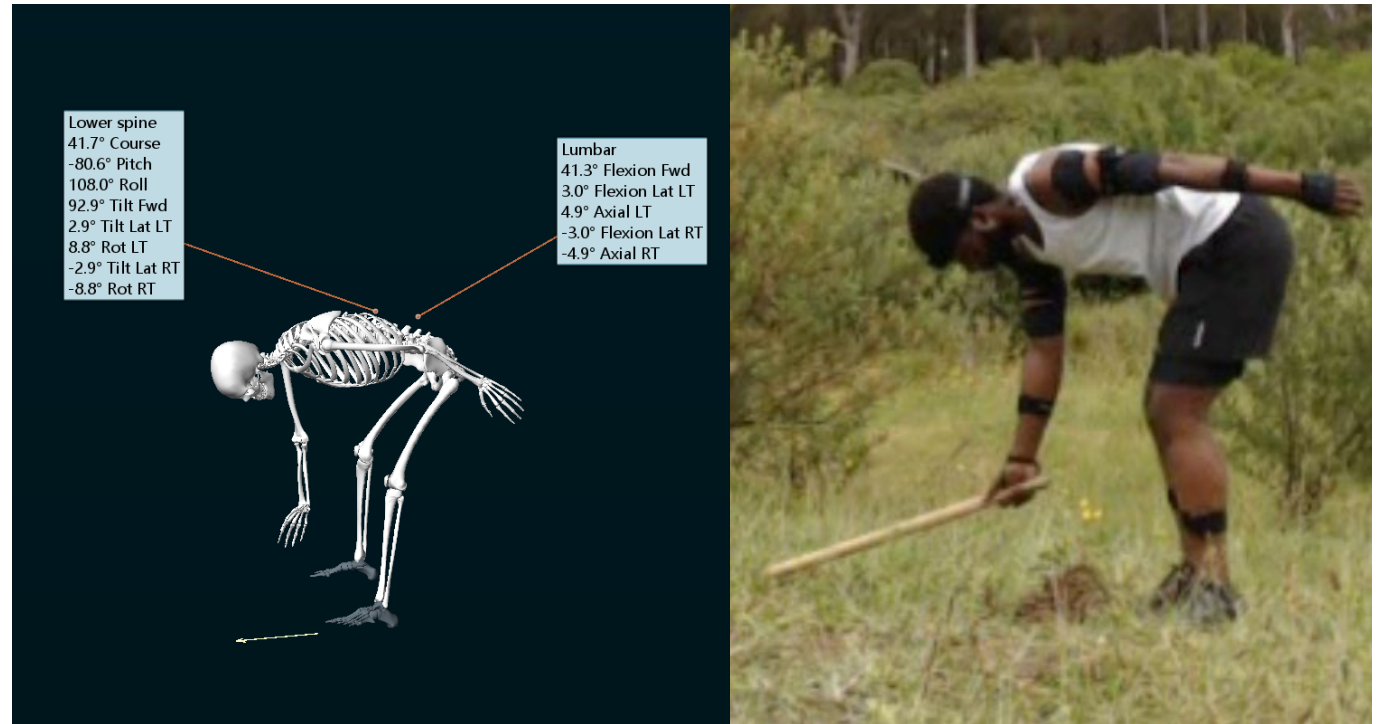


What does IMU tell us?

- ❖ Posture adopted during work?
- ❖ Duration of exposure to posture?
- ❖ How much deviation from neutral plane?

IMU sensor 3D data

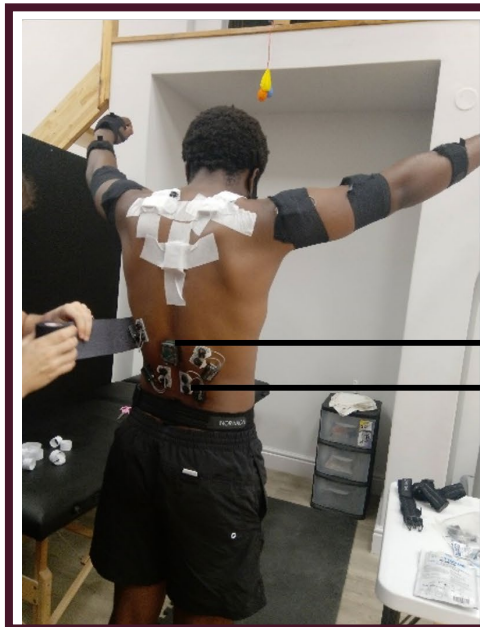
- ❖ Anatomical angles
- ❖ Orientational angles
- ❖ Acceleration



Data collection equipment

- ❖ Bipolar surface Electromyography (sEMG) sensors (muscle activation)
- ❖ Inertial and magnetic measurement units (IMUs) sensors for kinematics

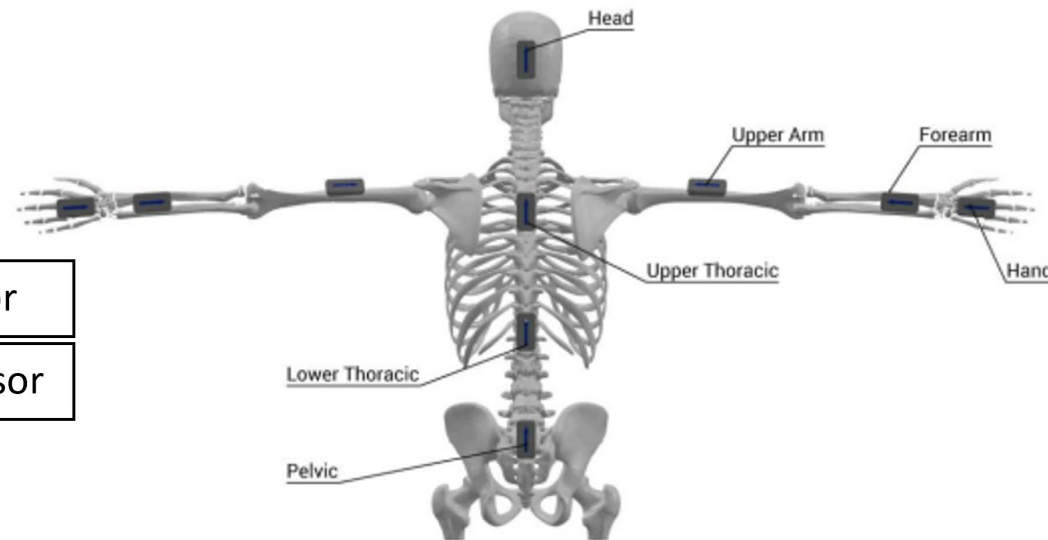
Sensor placement



IMU sensor

sEMG sensor

Standard practice for sensor placement

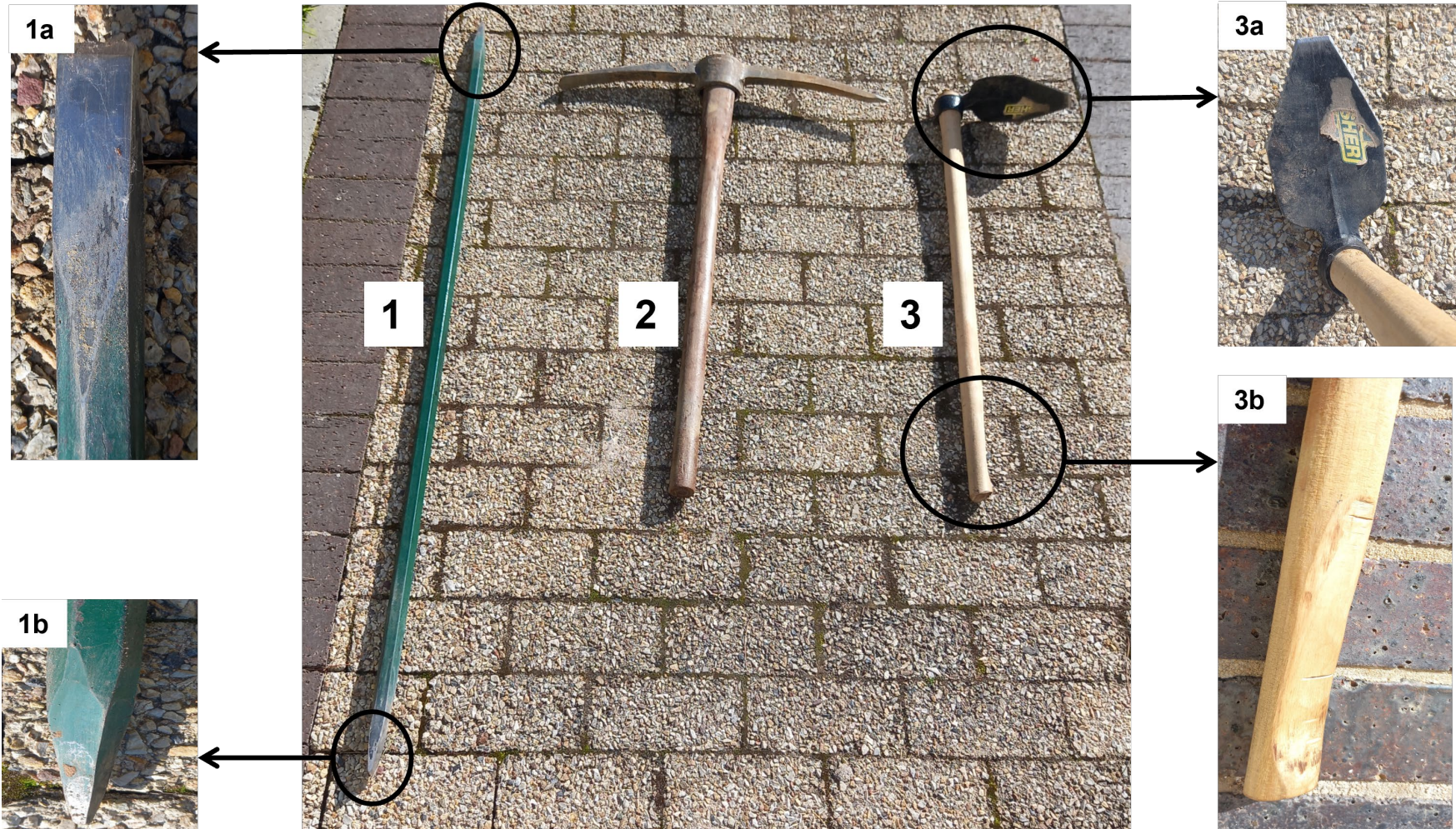


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Calibration



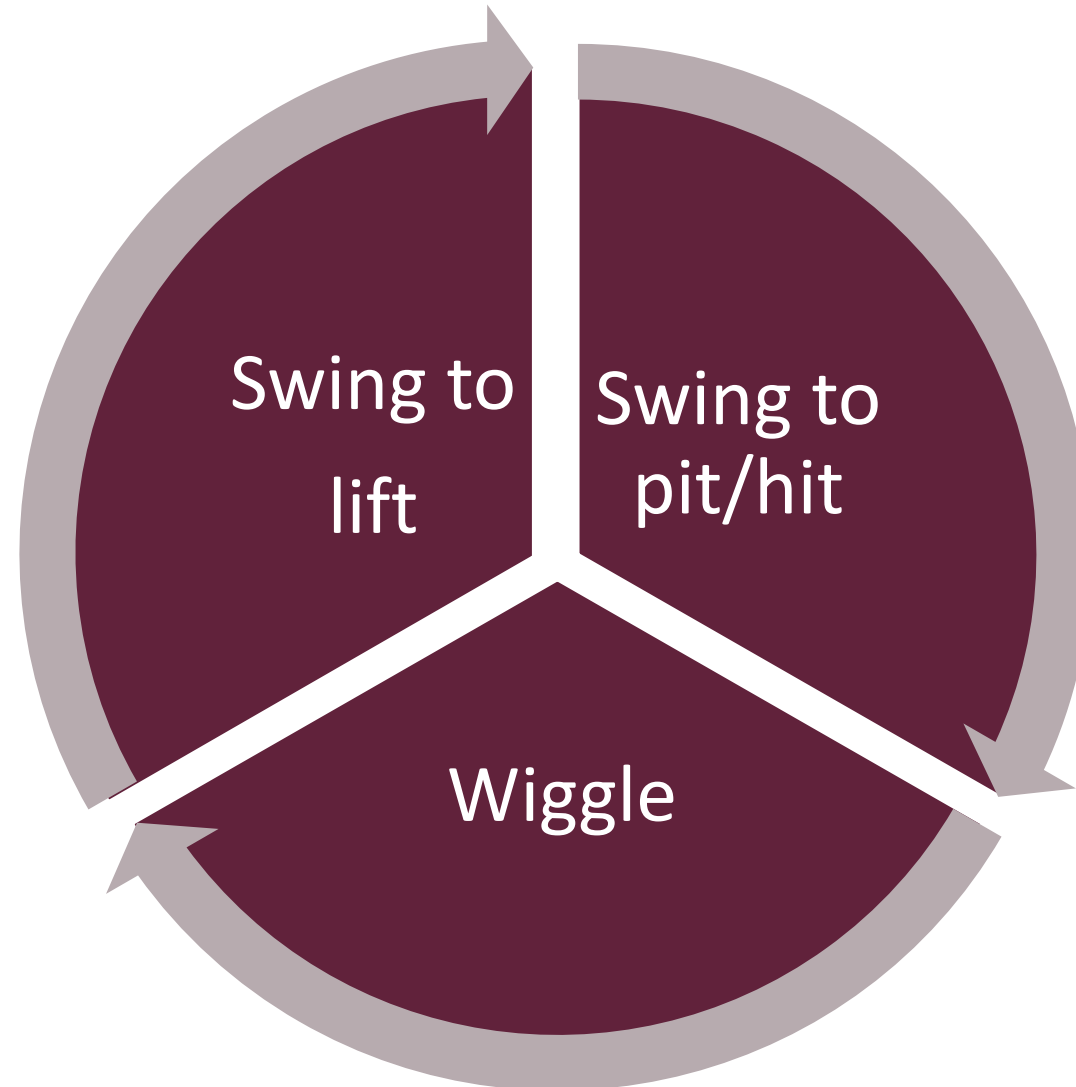
Pitting equipment



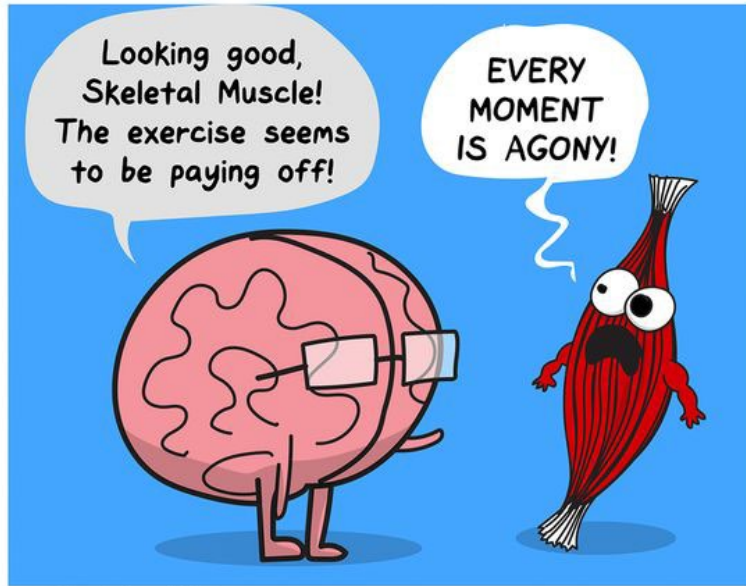
- ❖ The crowbar (1) has a chisel (1a) tapered point (1b).
- ❖ The roadpick (2) has similar tips to the crowbar, except the pickhead is mounted onto a wooden shaft.
- ❖ The single-handed hoe (3) is a commercial hoe modified with a grooved, narrower head with grooves (3a) mounted onto a smoothly carved wooden shaft (3b).

Data collection and analysis

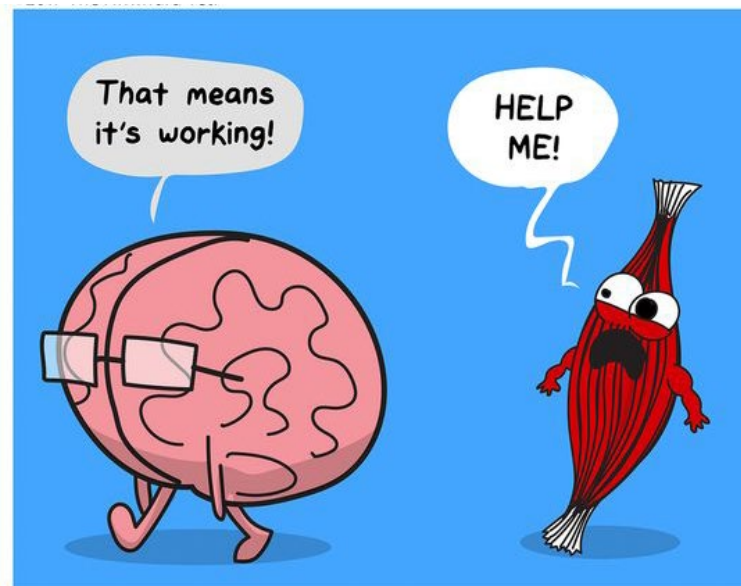
- ❖ Operator task
 - 15 hits with each tool
- ❖ Frequency of sampling 1500Hz (EMG)
- ❖ 100 Hz (IMU)
- ❖ Repeated movements



Study Objectives



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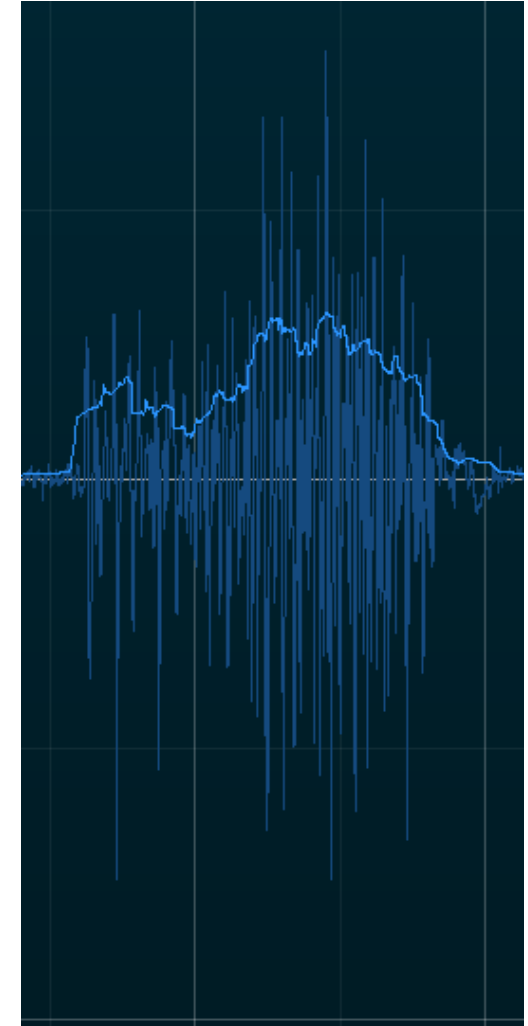


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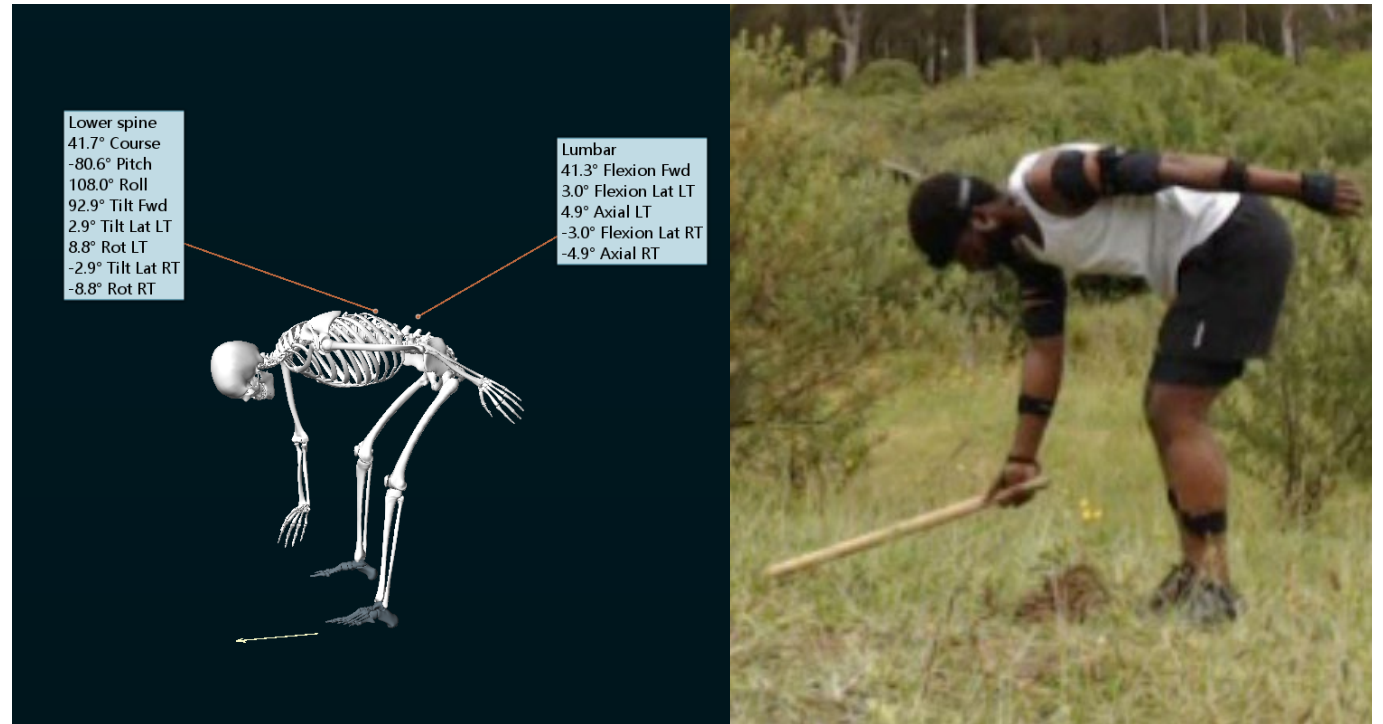


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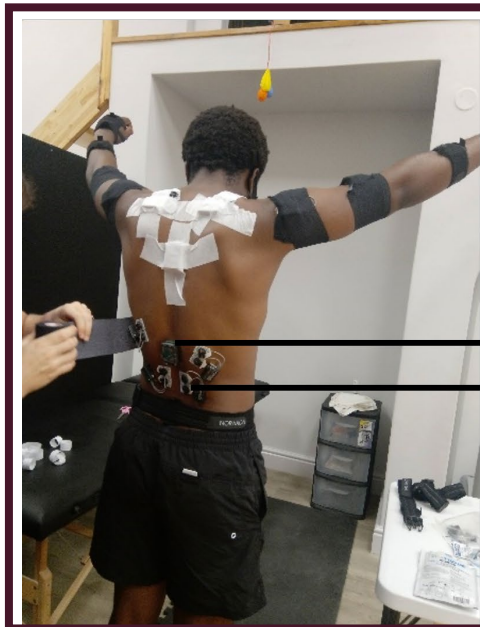
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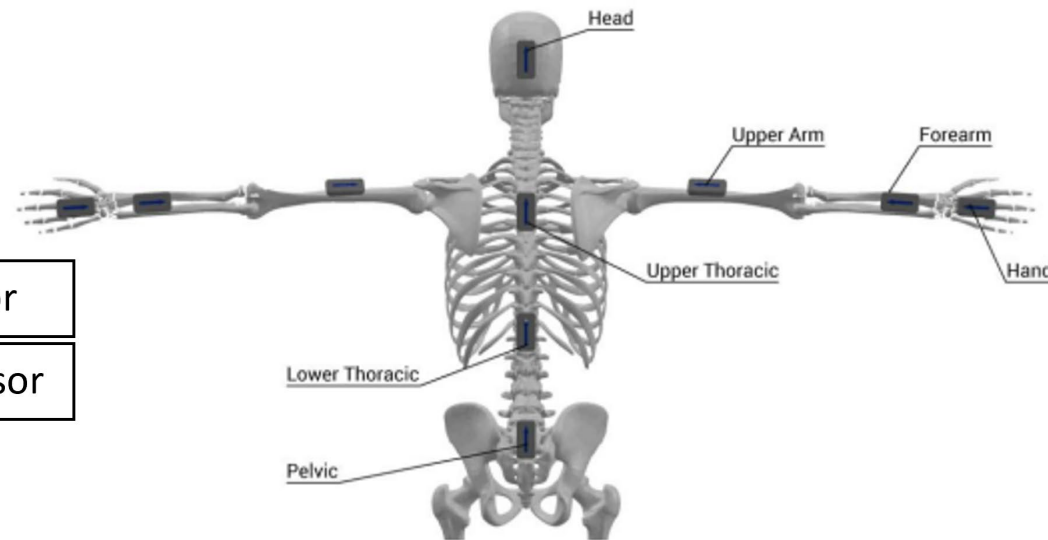
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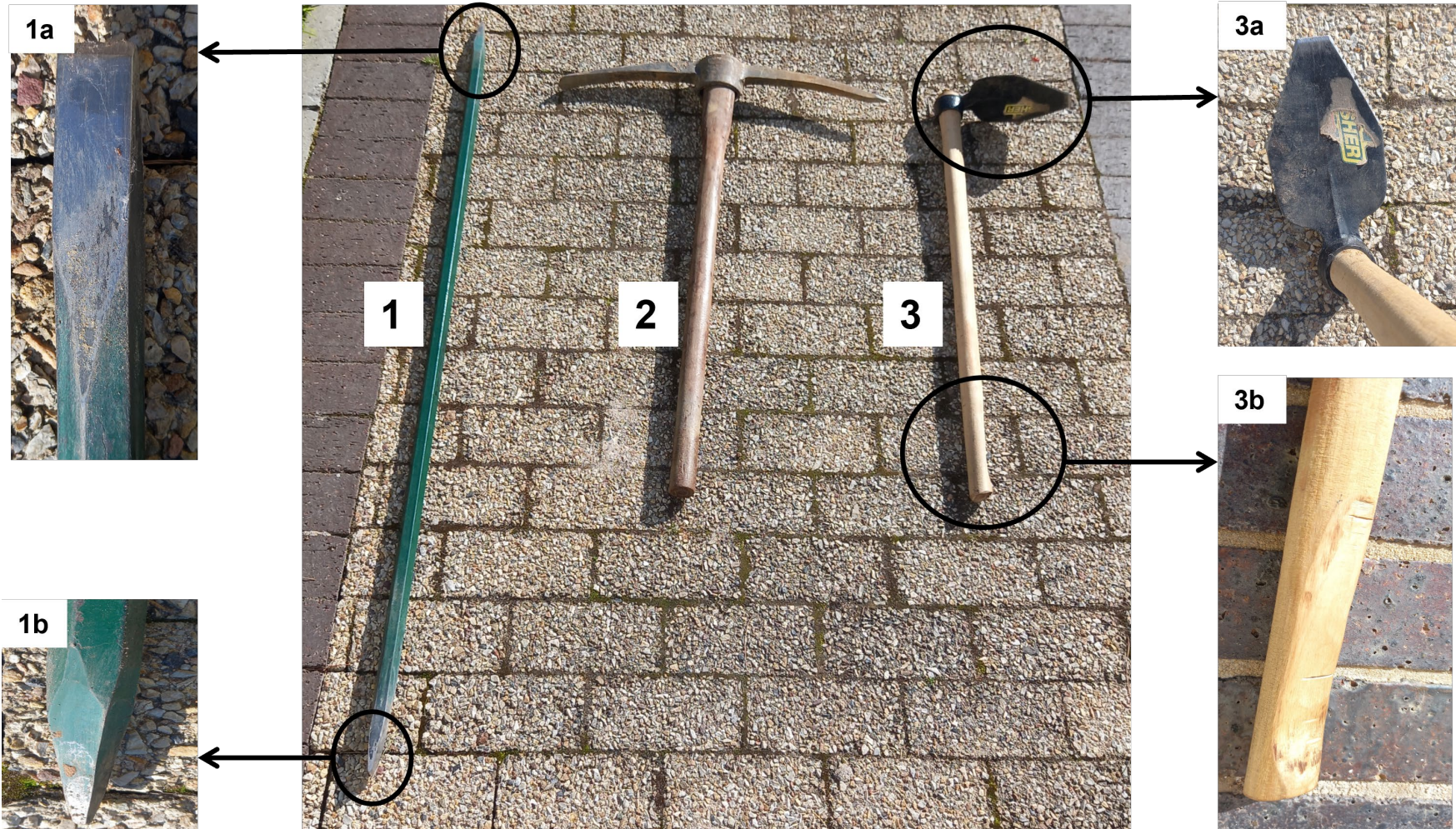


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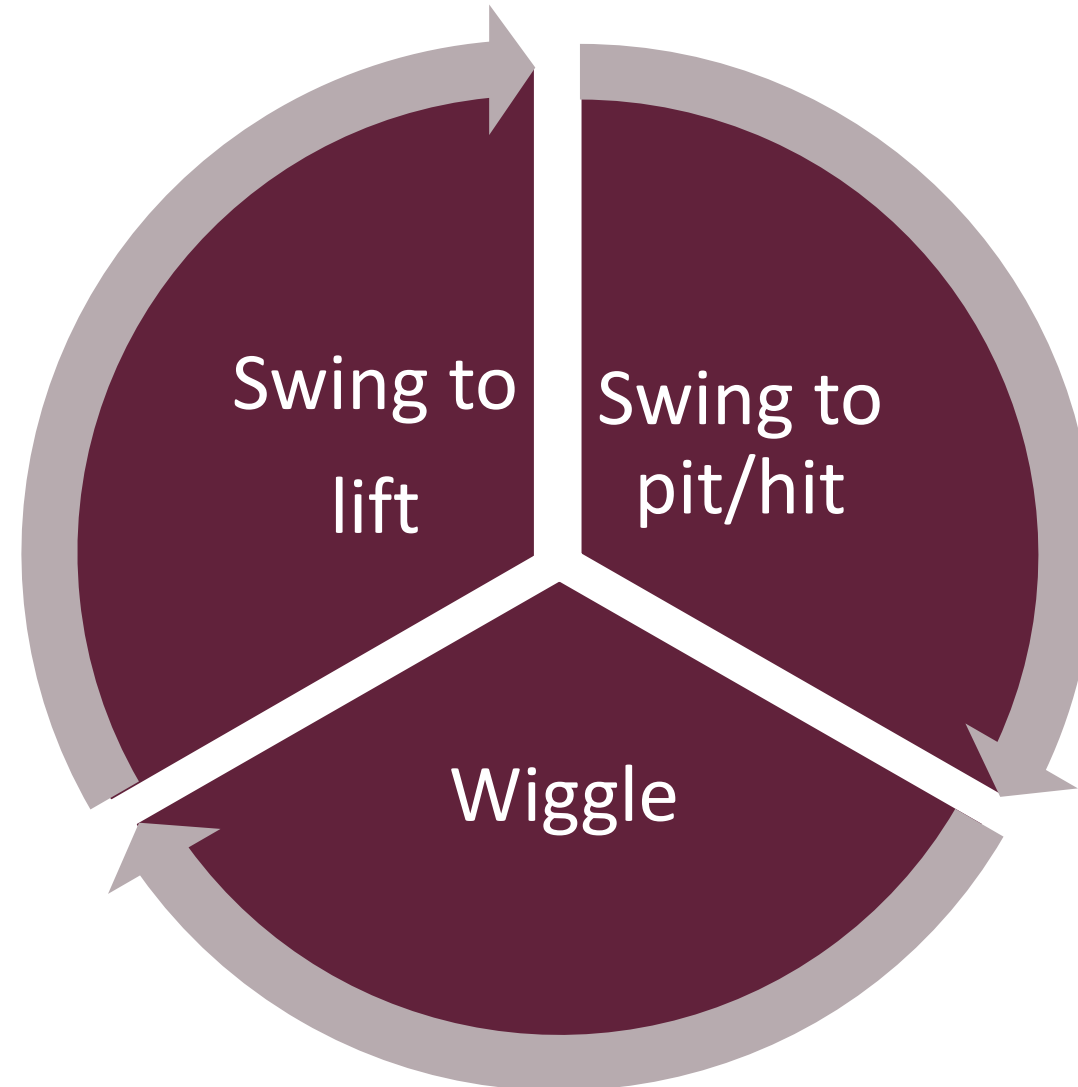
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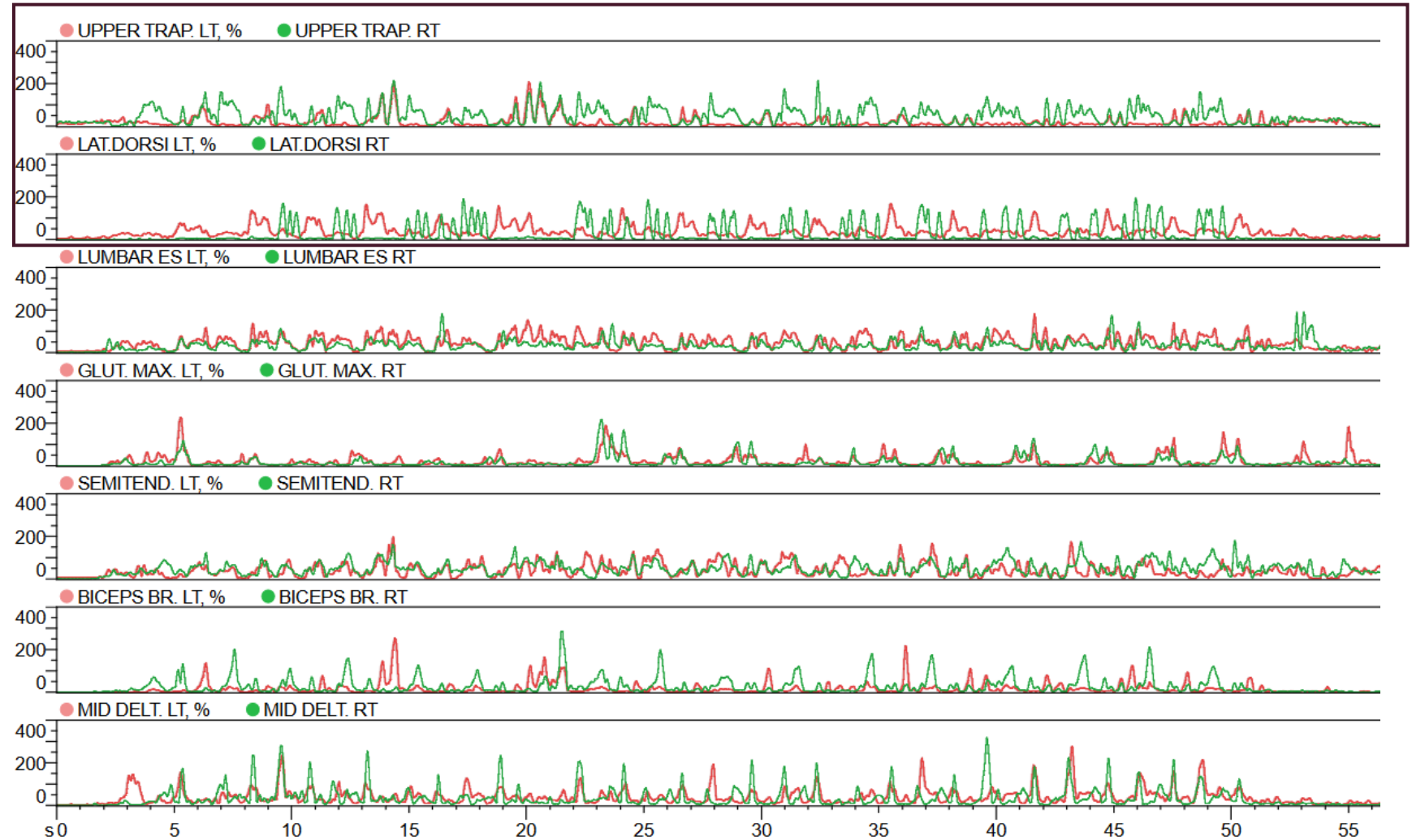
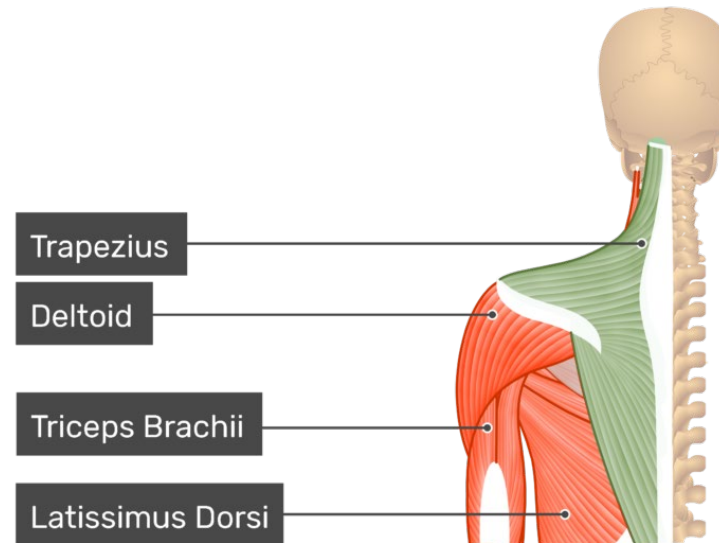
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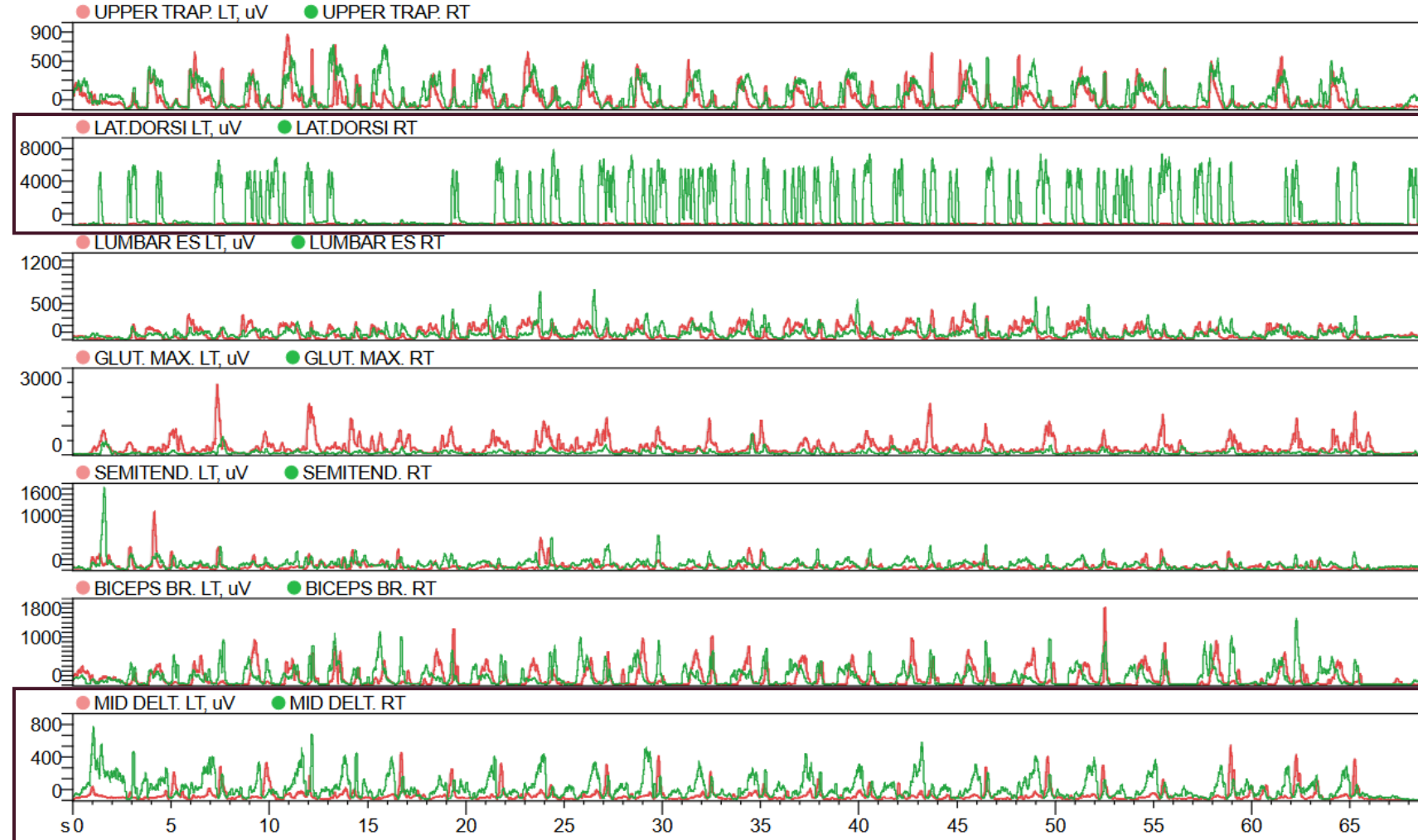
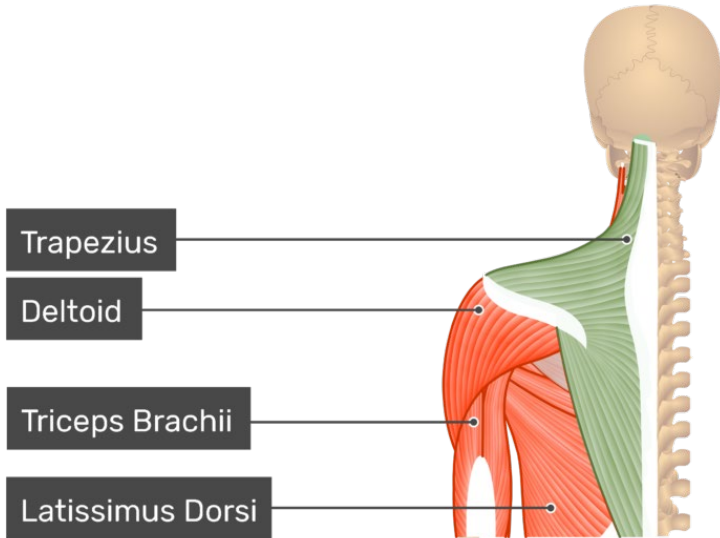
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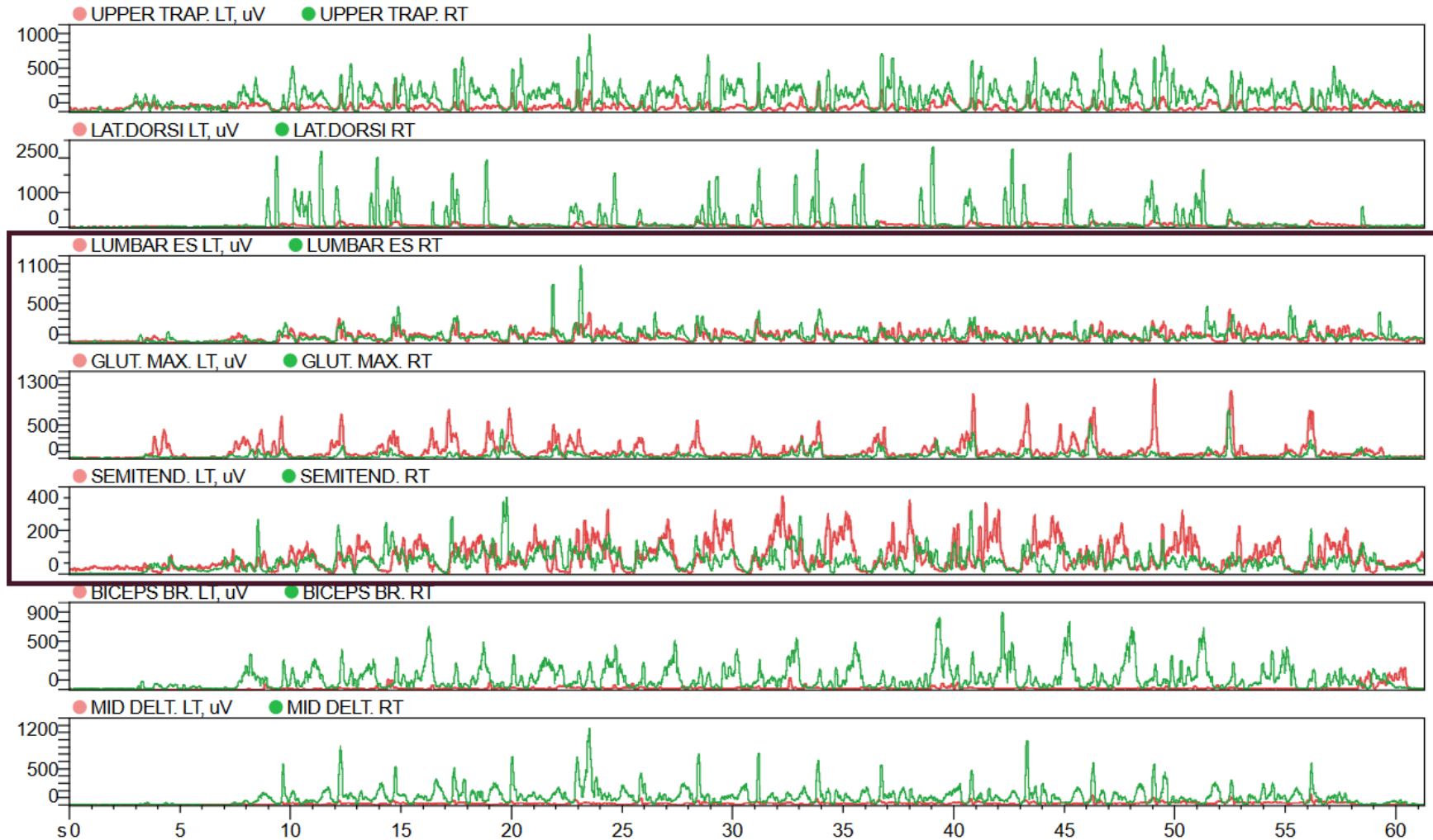
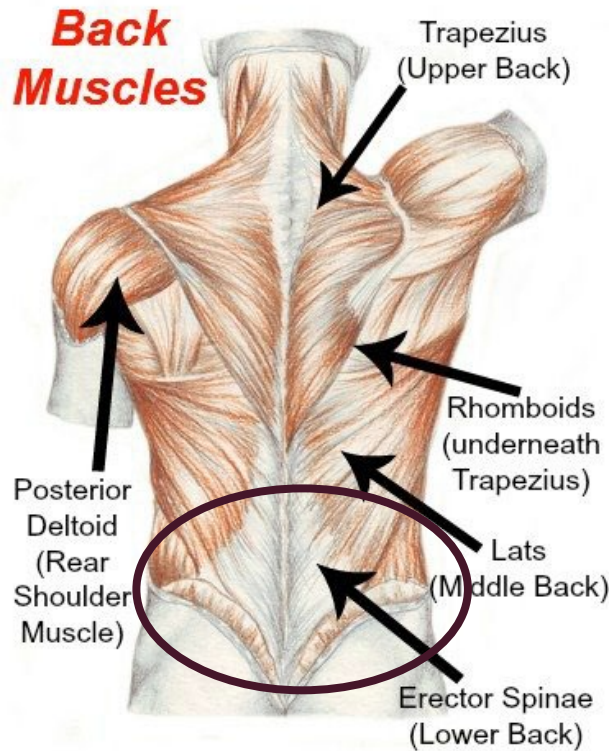
Results: Pickaxe



Results: Crowbar



Results: Single-handed how



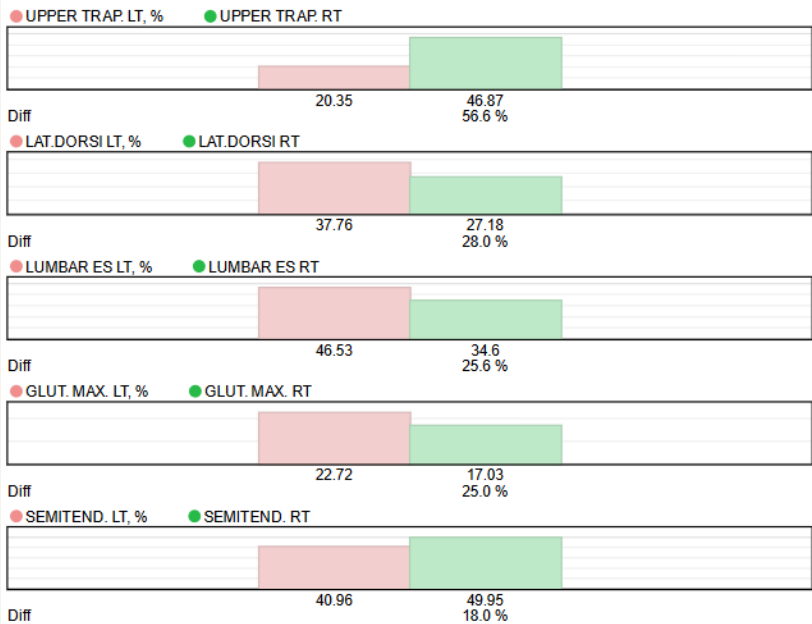
Mean activation and differences

Pickaxe

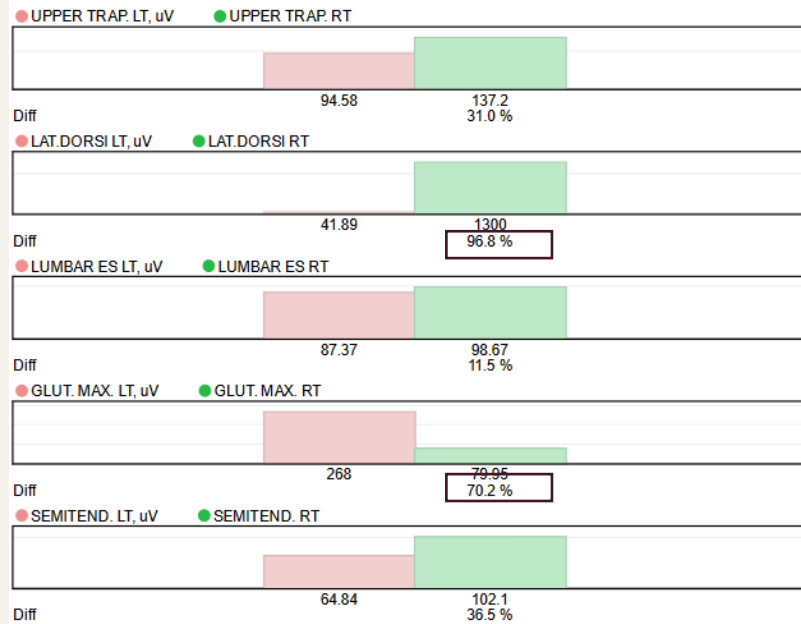
Crowbar

Single-handed hoe

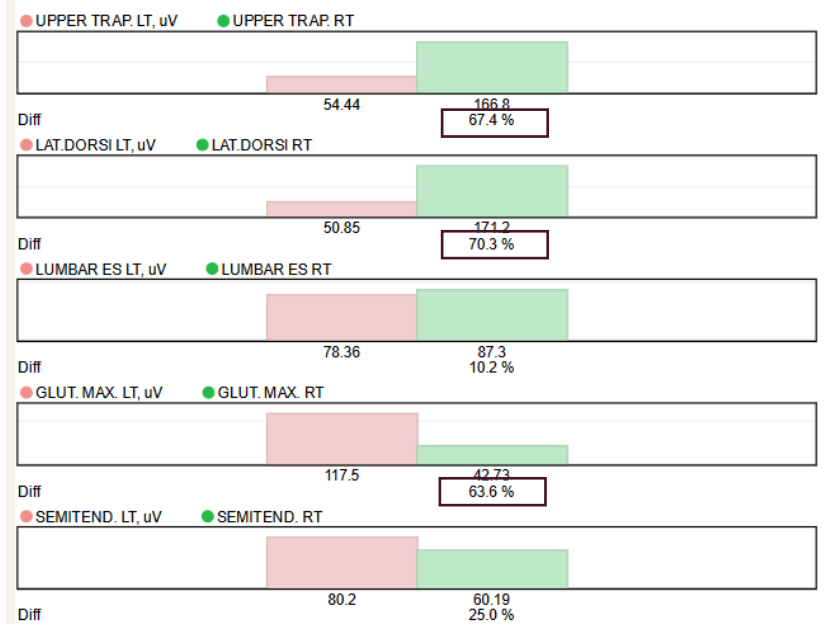
Mean



Mean



Mean



Conclusions so far...

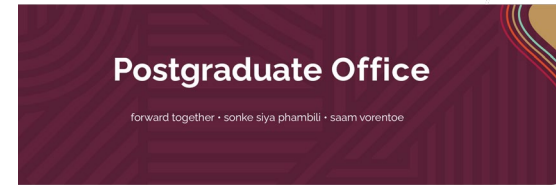
Non-bilateral
muscle activation

Dominant side
(high load)

Mid deltoids and
upper traps (all
three equipment)

Less lumbar
muscle activation
(crowbar)

Extreme flexion of
lower spine



forward together
sonke siya phambili
saam vorentoe

Acknowledgments

For sponsoring studies and conference attendance