



Feasibility Testing Supports Tablet-Based Neurocognitive Assessment During Cold Water Dives While Wearing Thermal Protective Gear

Justin D. Handy, PhD¹, Andrea Vincent, PhD²

¹Naval Submarine Medical Research Laboratory (NSMRL); ²Vista LifeSciences



Background

The **Hyperbaric Neurocognitive Assessment System (HNAS)** enables tablet-based cognitive testing of divers at depth.

In cold water, thermal protective gloves could degrade touchscreen usability or input accuracy decreasing validity relative to established bare-hand testing.



Objectives and Methods

Study Objectives

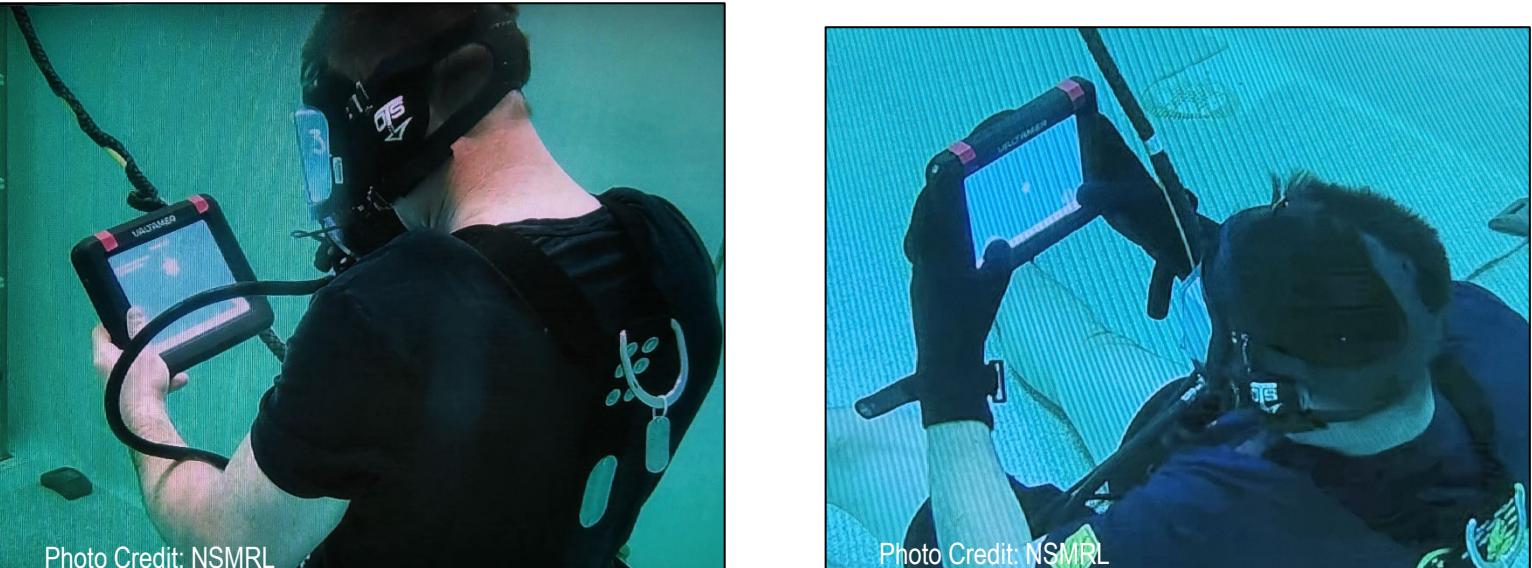
1. Compare neurocognitive performance on the HNAS while divers are bare-handed versus wearing dive gloves of increasing thickness (5mm, 7mm).
2. Assess differences in usability of the HNAS with and without dive gloves.

Method

Sample: 16 U.S. Navy divers

Test Environment: 10ft temperature-controlled pool held at 92°F ± 2°F (thermoneutral for comfort)

Test Battery: Five tests from the Automated Neuropsychological Assessment Metrics (ANAM) library



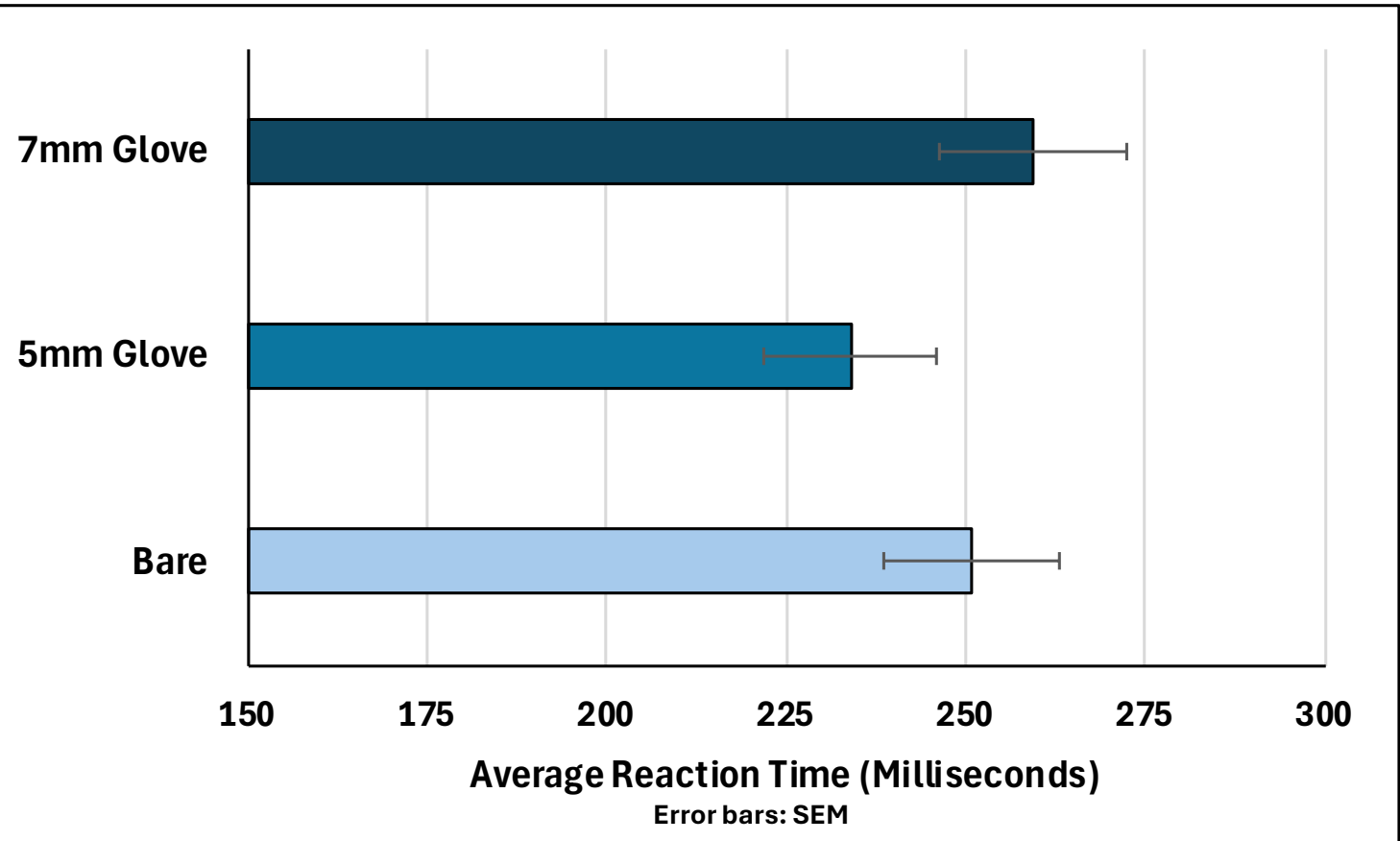
Test Battery Descriptions and Comparative Analyses

Simple Reaction Time (SRT)

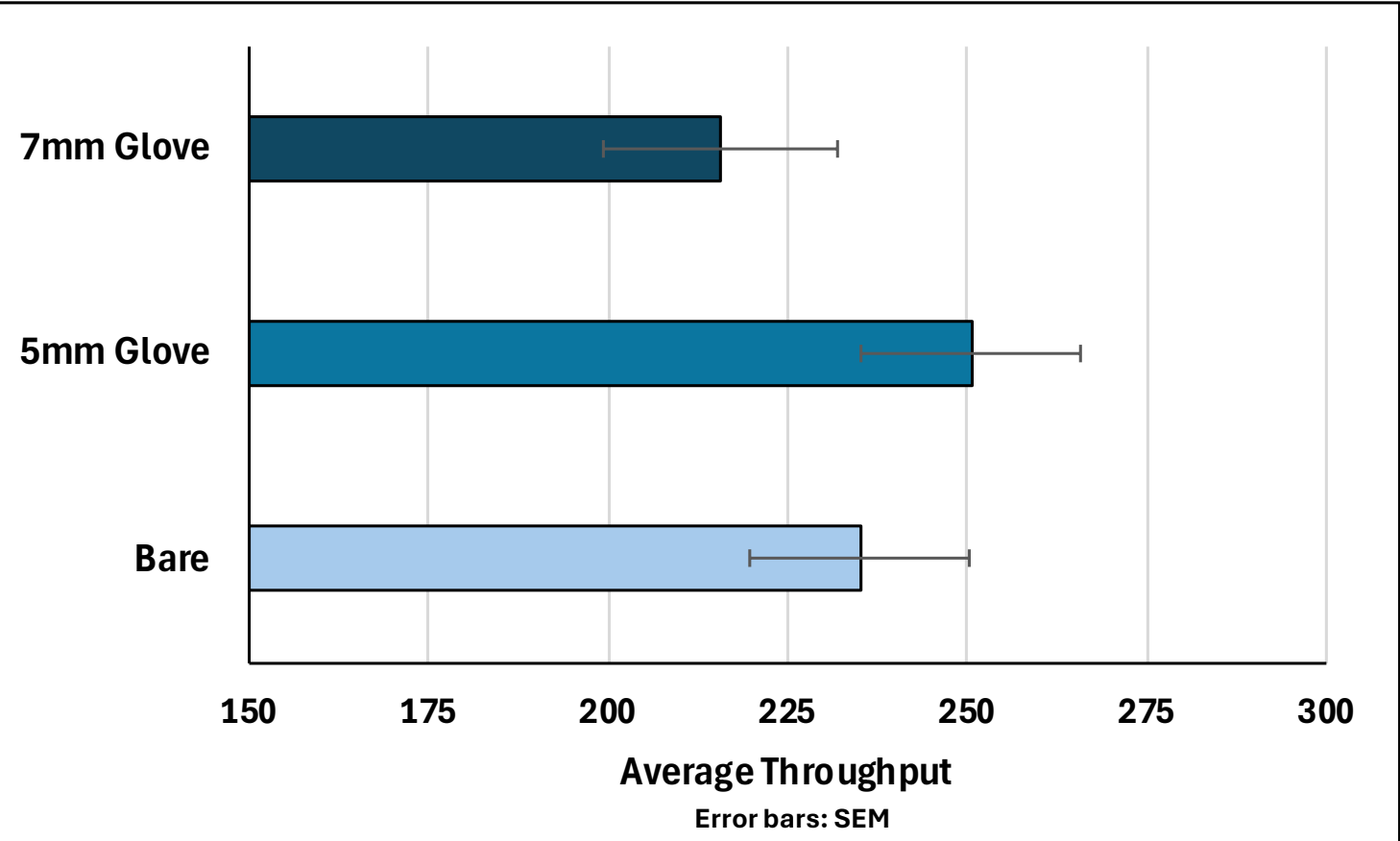


Task: Respond as quickly as possible each time a stimulus appears

Assesses: Visuomotor processing speed, simple motor speed, attention



Effect of Glove Condition Not Significant ($p = .73$)



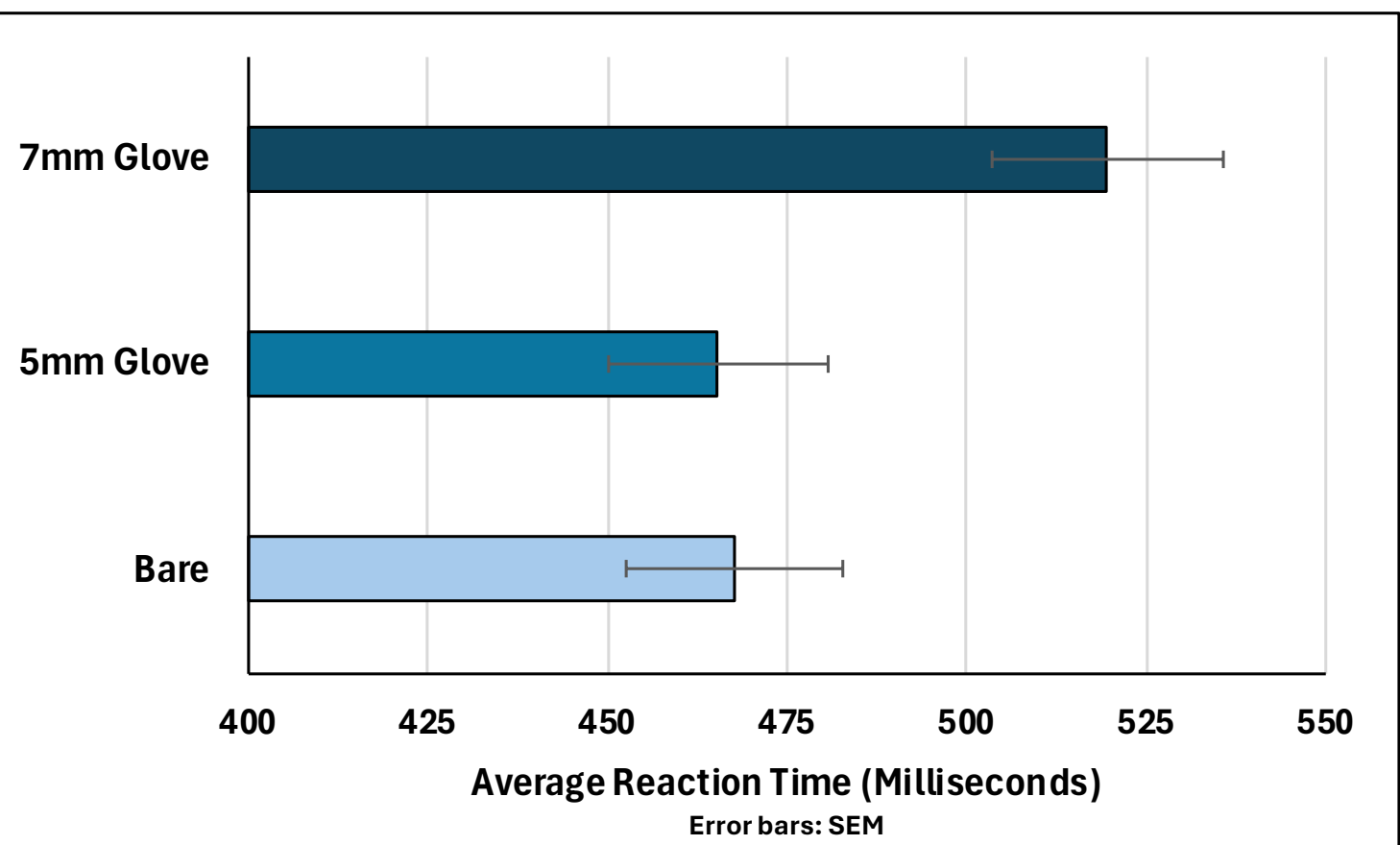
Effect of Glove Condition Not Significant ($p = .32$)

Flanker

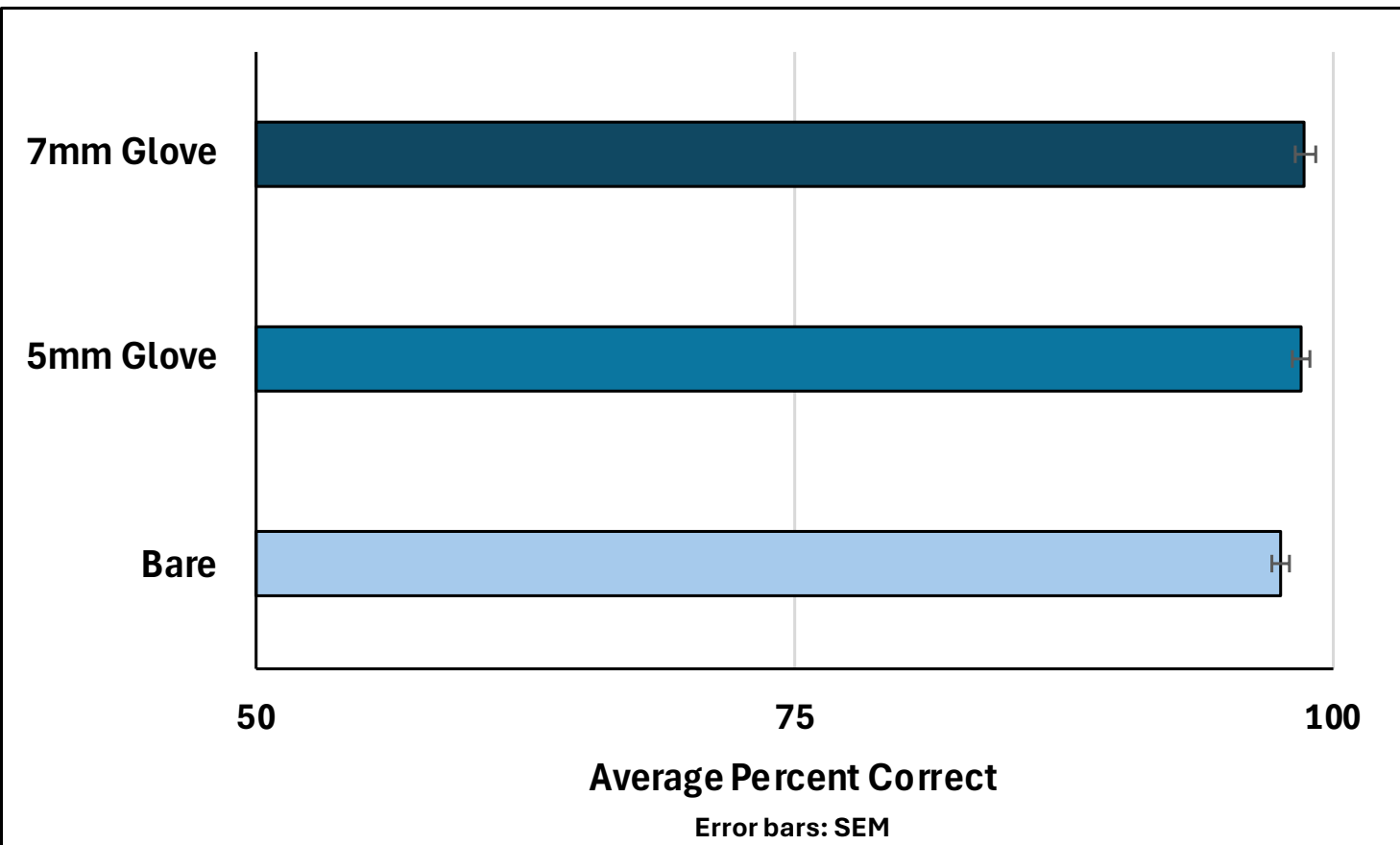


Task: Determine the direction of the central arrow while ignoring flanking arrows

Assesses: Inhibitory control, concentration, and attention

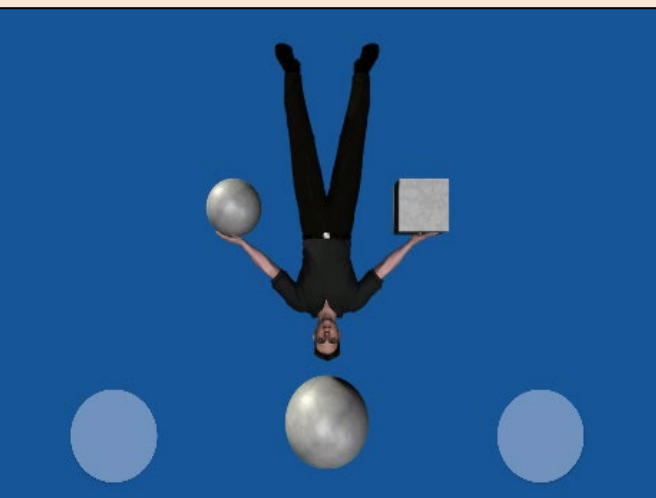


Effect of Glove Condition Significant ($p = .01$)



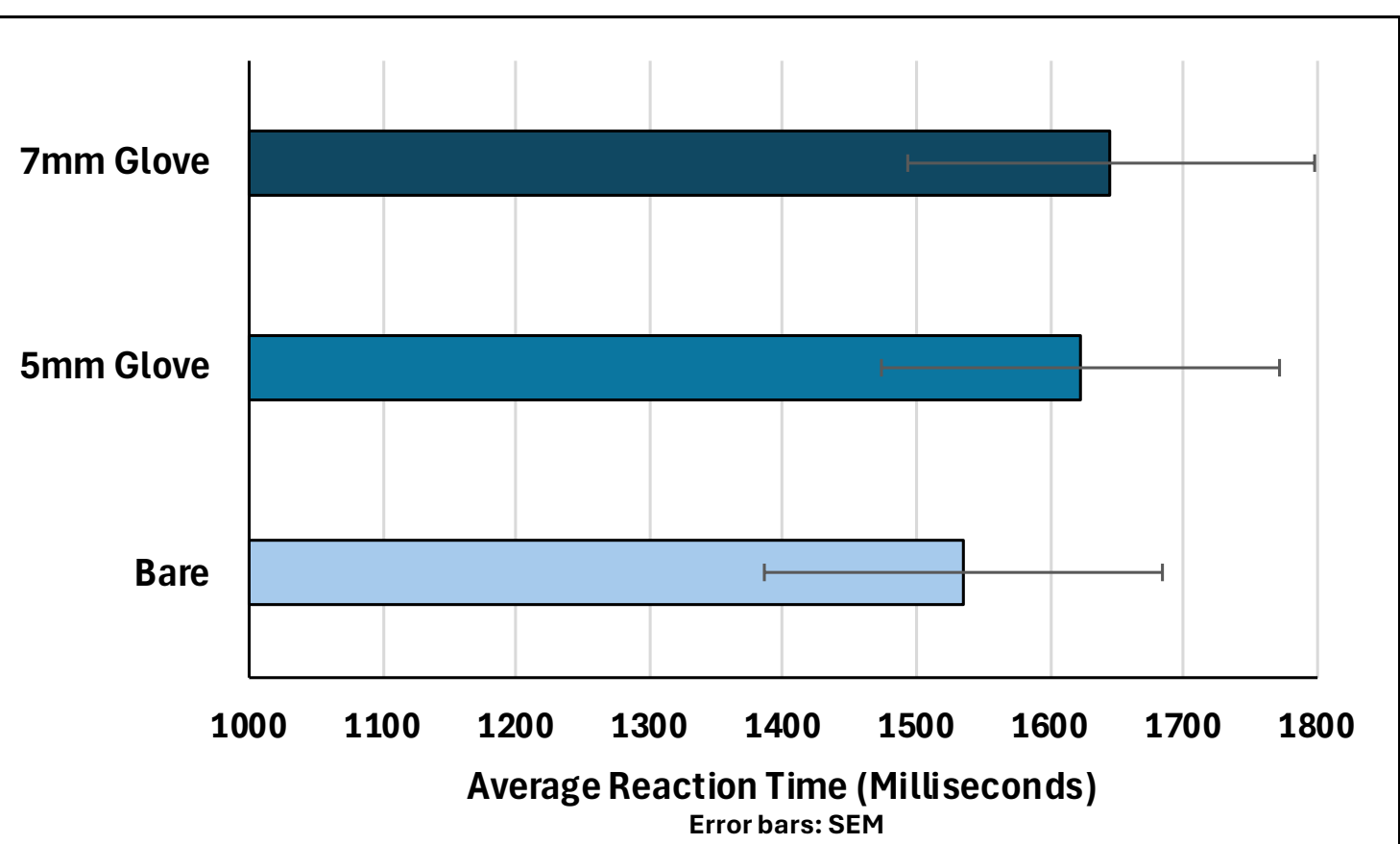
Effect of Glove Condition Not Significant ($p = .08$)

Manikin

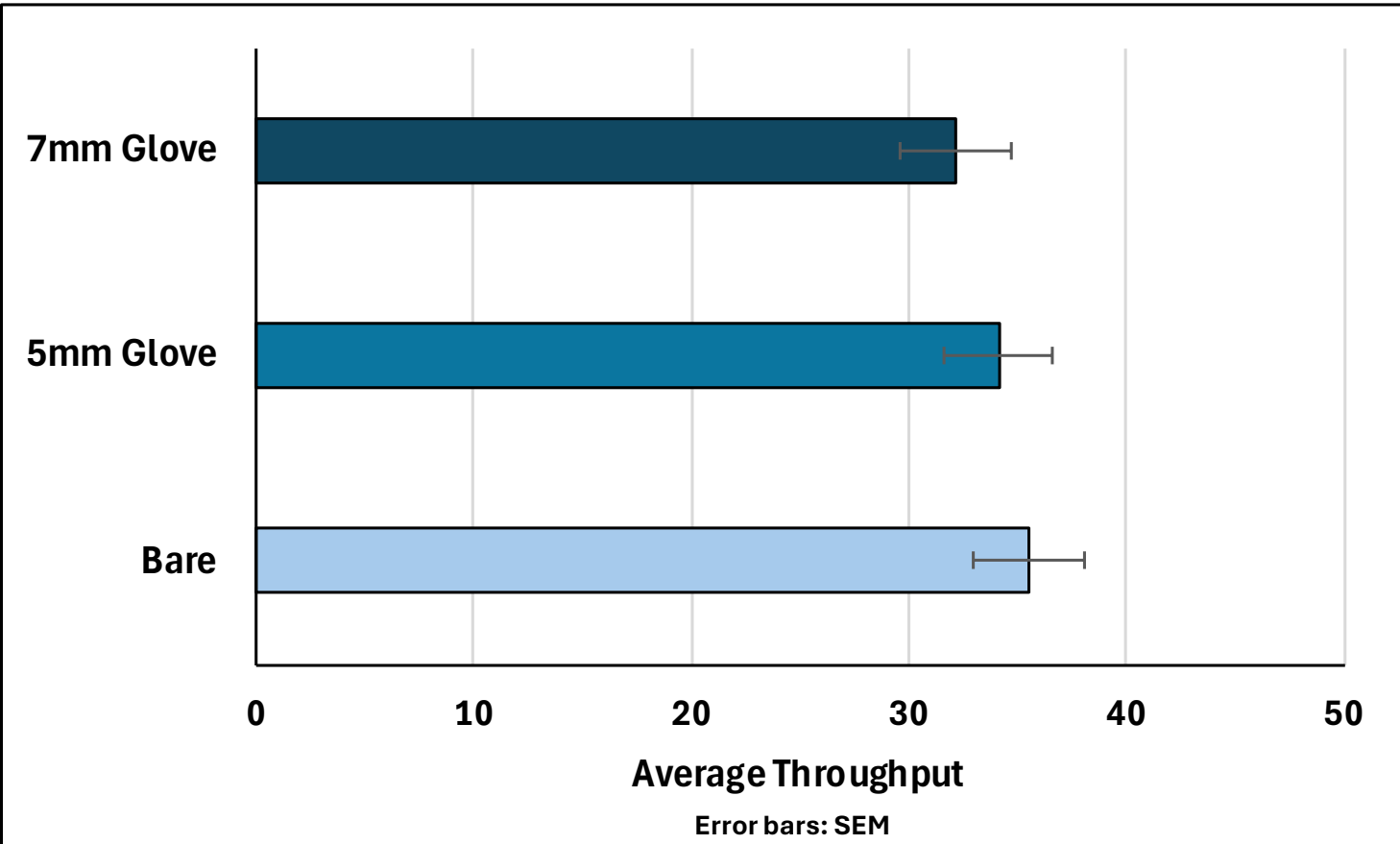


Task: Specify the hand (left/right) holding the object shown below the figure

Assesses: Spatial rotation, problem solving, attention

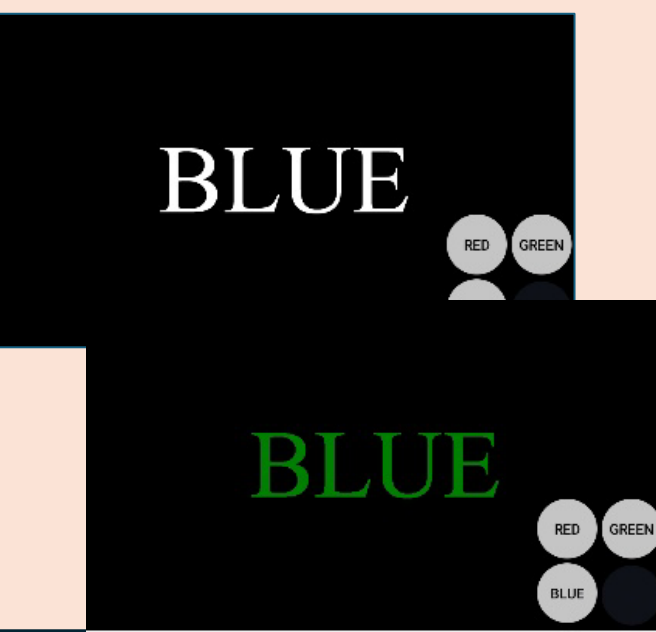


Effect of Glove Condition Not Significant ($p = .30$)



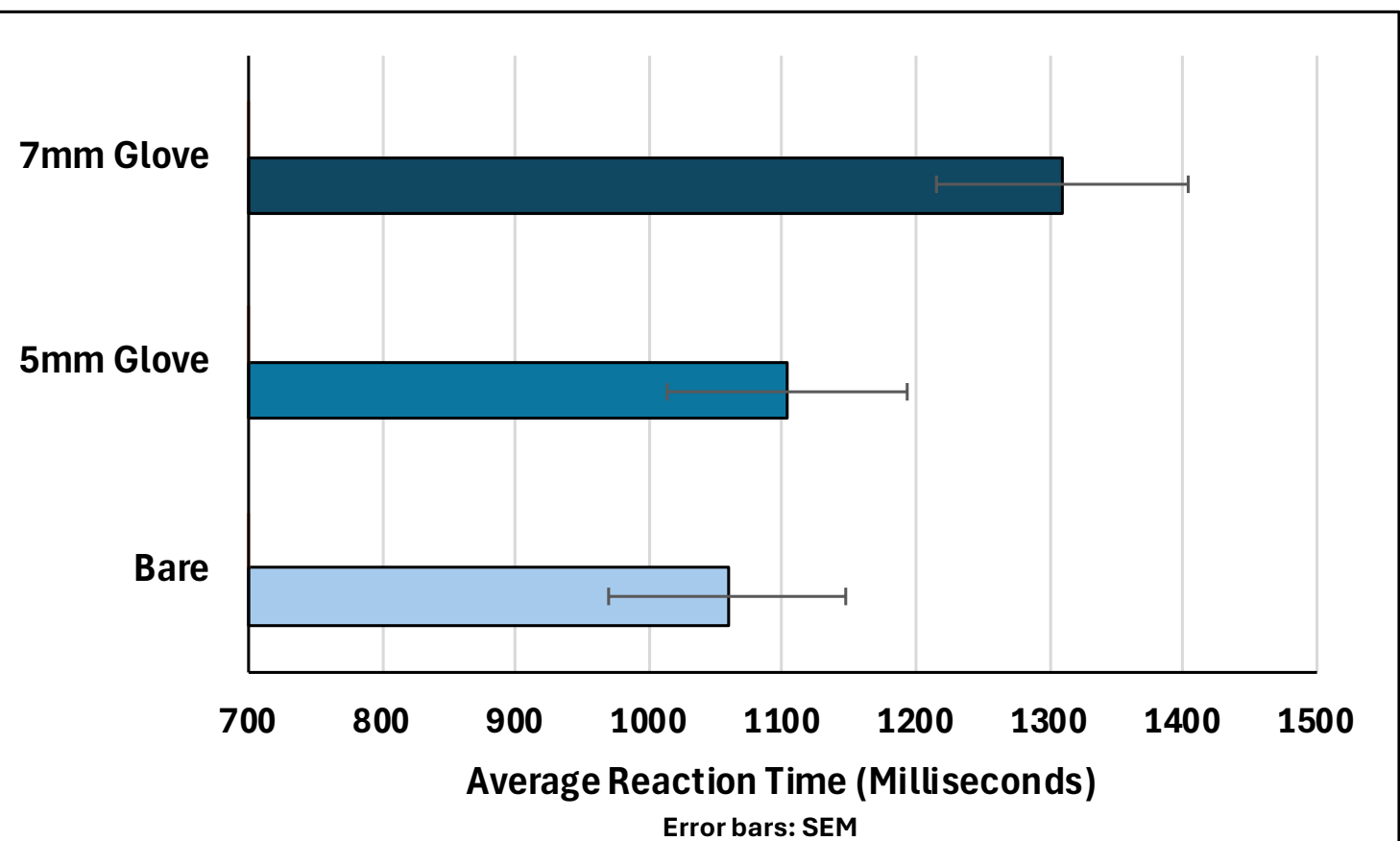
Effect of Glove Condition Not Significant ($p = .21$)

Stroop

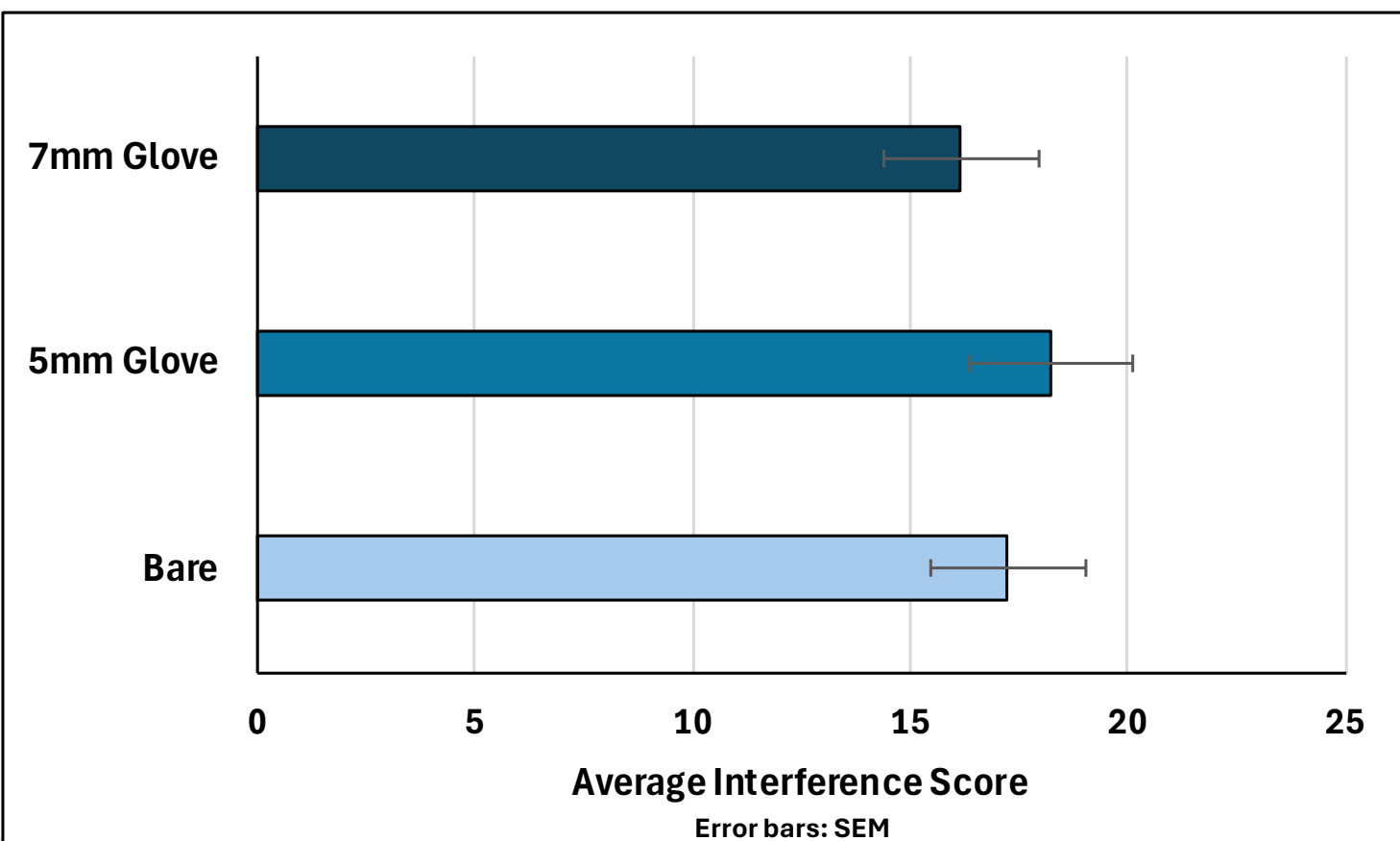


Task: Name the font color of the word, which may not match meaning

Assesses: Selective attention, interference, executive functioning

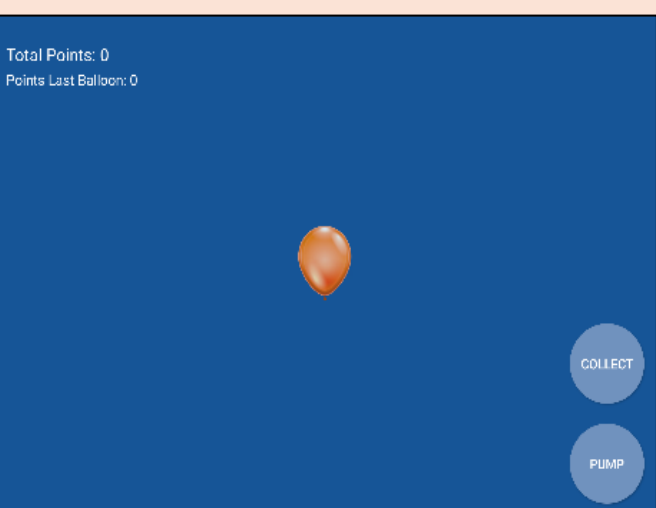


Effect of Glove Condition Not Significant ($p = .06$)



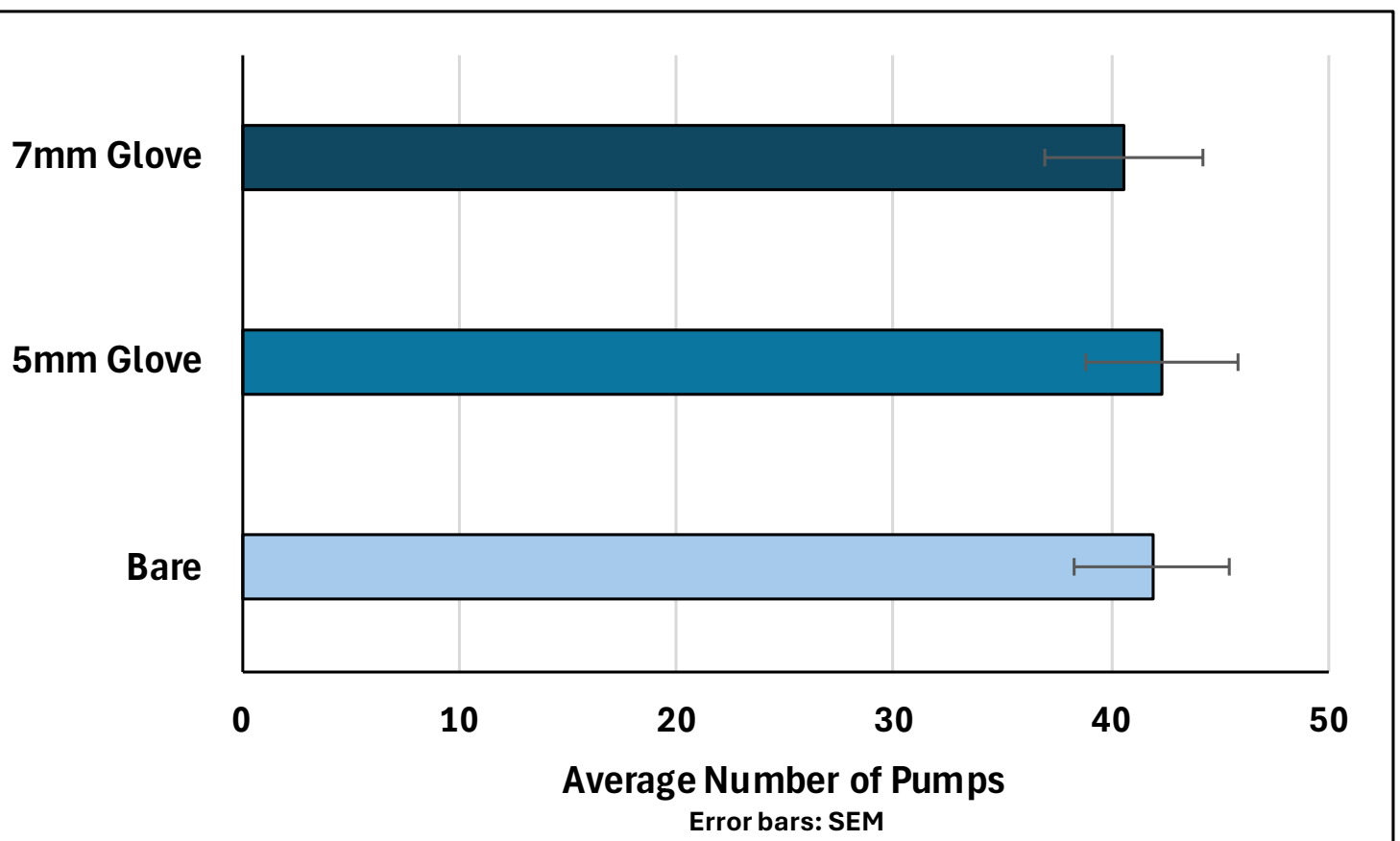
Effect of Glove Condition Not Significant ($p = .58$)

Balloon Analogue Risk Task (BART)

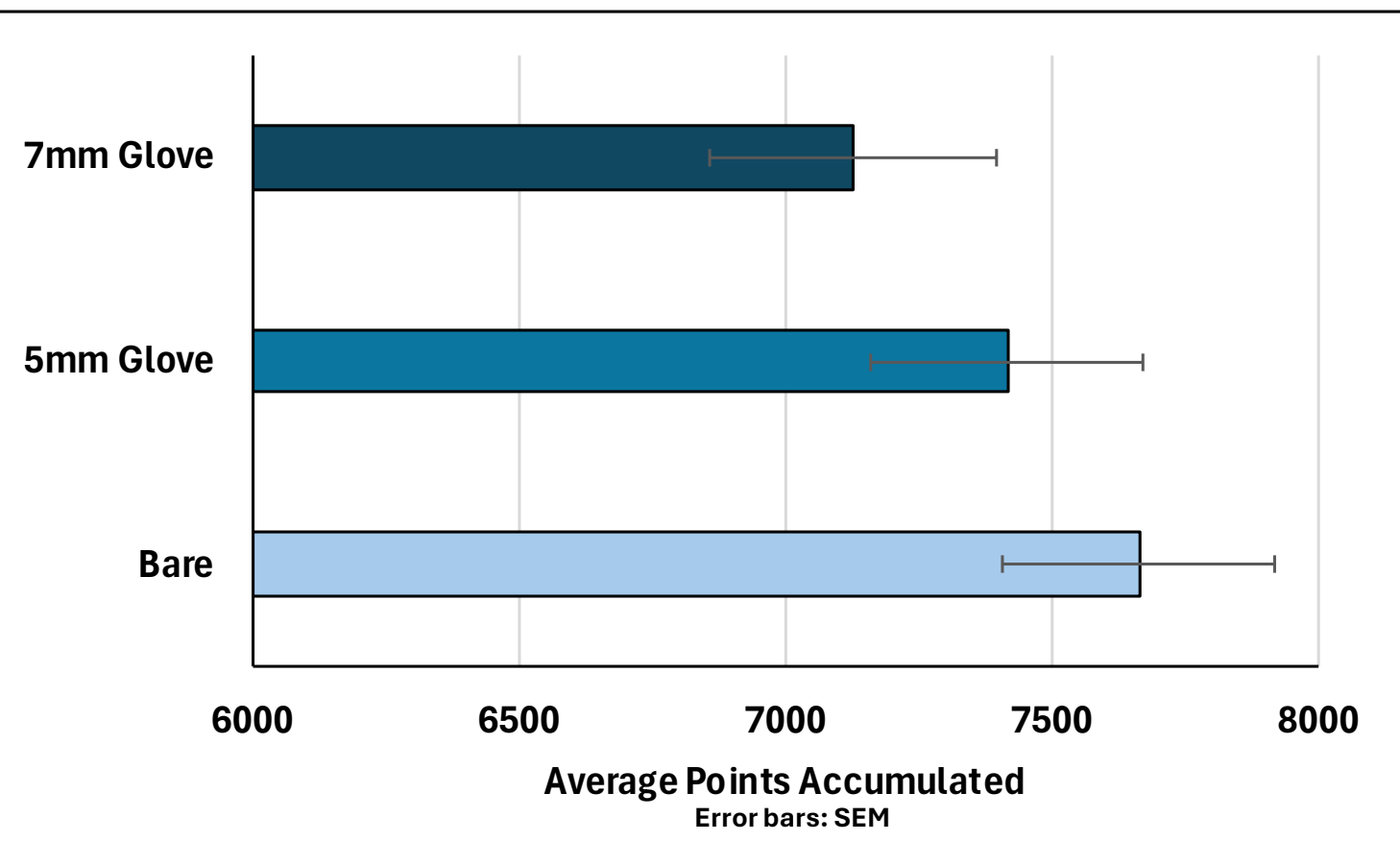


Task: Inflate balloons to accumulate points; thresholds for bursting are unpredictable

Assesses: Risk decision making (impulsivity and risk aversion)

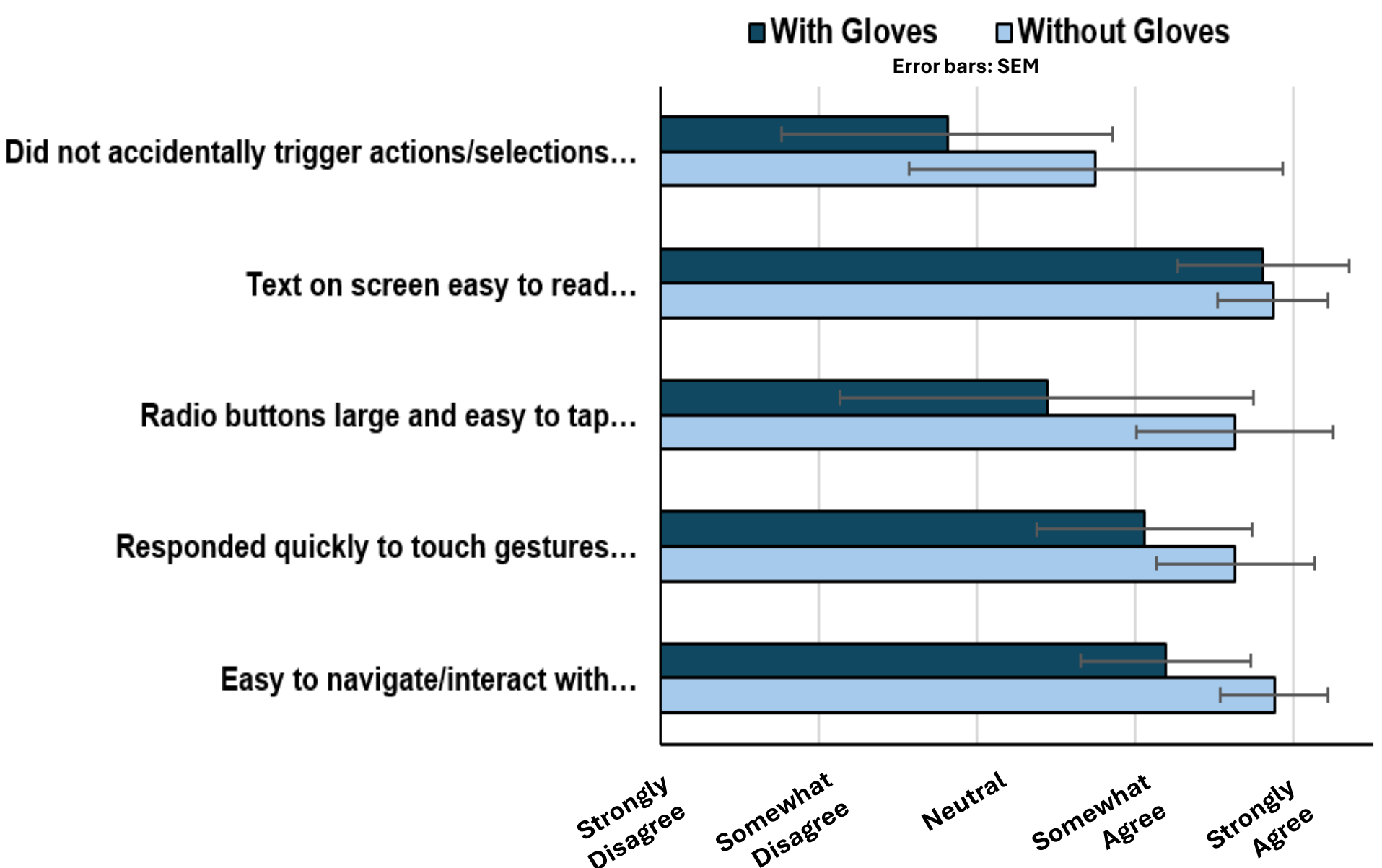


Effect of Glove Condition Not Significant ($p = .74$)



Effect of Glove Condition Not Significant ($p = .17$)

Usability Feedback



- 69% of participants agreed the HNAS touchscreen was compatible with dive gloves (25% neutral).
- 89% expressed satisfaction with their experience using the tablet while wearing dive gloves and all participants satisfied without gloves.
- Glove finger seams cited as common cause for inaccurate touches.
- Button placement on Stroop task cited as challenging with thicker, bulkier dive gloves.

Conclusions and Next Steps

- Performance remained generally comparable across bare-hand, 5mm, and 7mm glove conditions.
- Wearing 7mm gloves tended to slow reaction times, though the effect was not consistently statistically significant.
- Findings informed updates to ANAM to better support future releases.
- Refinements have been made to improve HNAS touchscreen responsiveness.

Partners/Collaborators

Sponsors and Program Support



Naval Medical Research
Command - Naval Advanced
Medical Development
(NAMD)



Collaborators

The authors acknowledge the invaluable contributions of Mr. Antti Häggman and the Haltian Ltd team, as well as collaborating support staff at Vista LifeSciences, Valtamer Ltd, and NSMRL.