MECHANISMS OF PREPARATION FOR TASK SWITCHING IN A FINGER PRESSING TASK

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INTRODUCTION

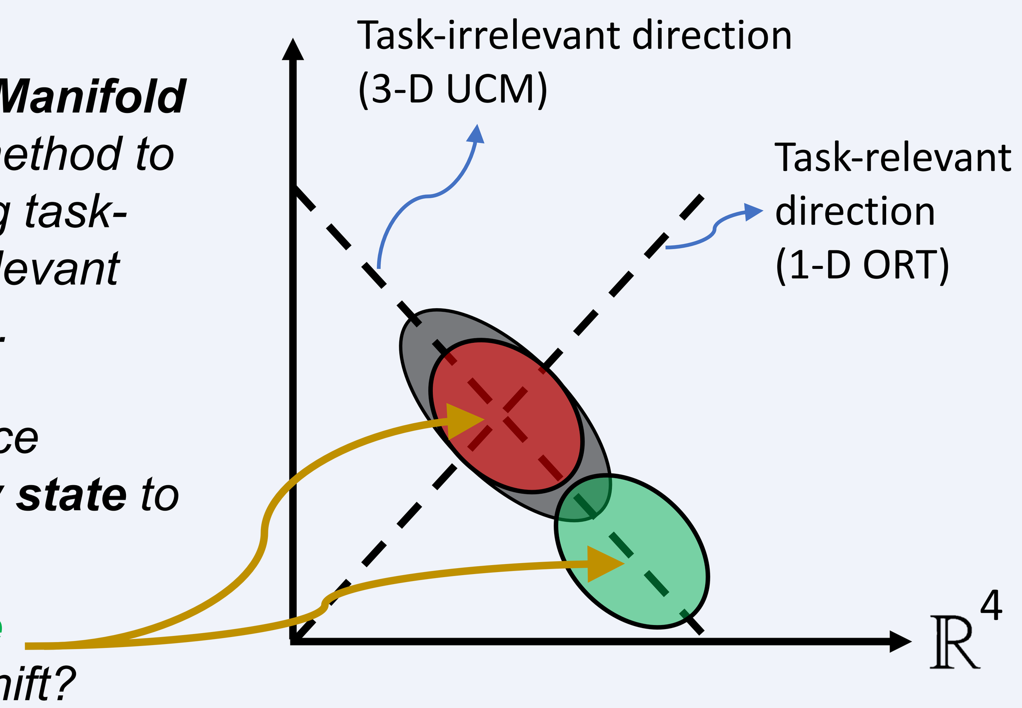
- **Stability** is the ability to reject disturbances to the current motor state.
- Maintaining stability of motor performance is vital for the success of movements and has been extensively studied.
- But when transitioning between movements, **maximizing the stability of the current state will inhibit the efficacy of the transition** [1].
- Previously we showed that in a finger pressing task, stability of the current state was reduced in anticipation of state change [2].
- We observed a reduction in finger force variance that translated to lower stability of the current state. The reduction was in within-finger compensation, i.e. along task-irrelevant directions in the finger-force space (**Fig.1**).

OPTIMAL SUBSPACE HYPOTHESIS: There exists a mean finger force configuration – a task-dependent subspace – that facilitates rapid change in total finger force.

Fig. 1 ***Uncontrolled Manifold (UCM) Analysis:*** *A method to quantify stability using task-relevant and task-irrelevant variance components.*

The change in variance structure from ***steady state*** *to* ***anticipatory*** *state.*

Does the ***mean force configuration*** *also shift?*



OBJECTIVE

To explore if mean finger force configuration changes in response to a cue to change total force.

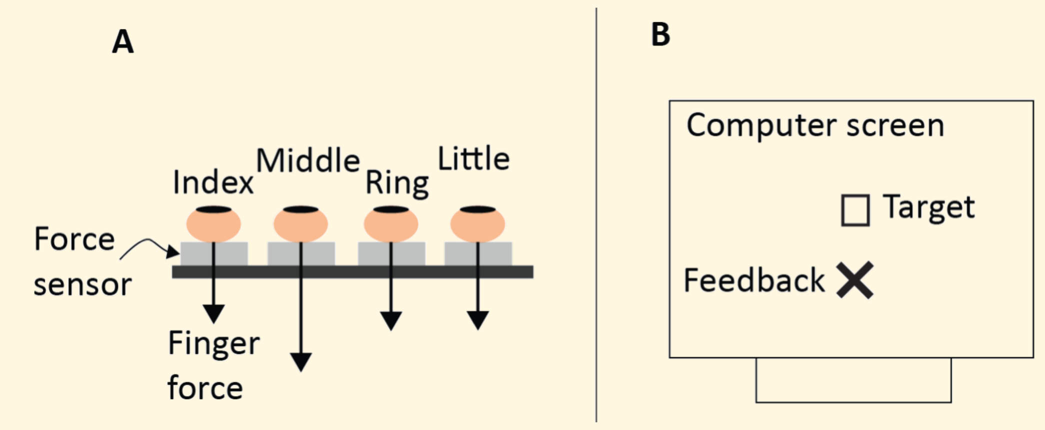
METHODS

- Subjects: 24 young adults (age = 20.4 ± 2.6 years; 19 female).
- Four finger isometric force production with the dominant hand (**Fig. 2**).
- Total force $F_T = \Sigma Fi$; i = {index, middle, ring, little}.
- Produce a constant F_T at 10% of maximum voluntary contraction (MVC). All conditions contain this component for at least 4 seconds.

Conditions (Fig. 3B, 3C)

1. **Steady:** 7-sec trials. The subject knows that the target will stay motionless.
2. **Dexterous:** 30-sec trials. The subject is instructed to chase the target as it moves vertically in an unpredictable manner.

Fig. 2 *Four force transducers registering the vertical downward forces of the four fingers (**A**). Visual feedback. Subjects tracked the square target (**B**).*



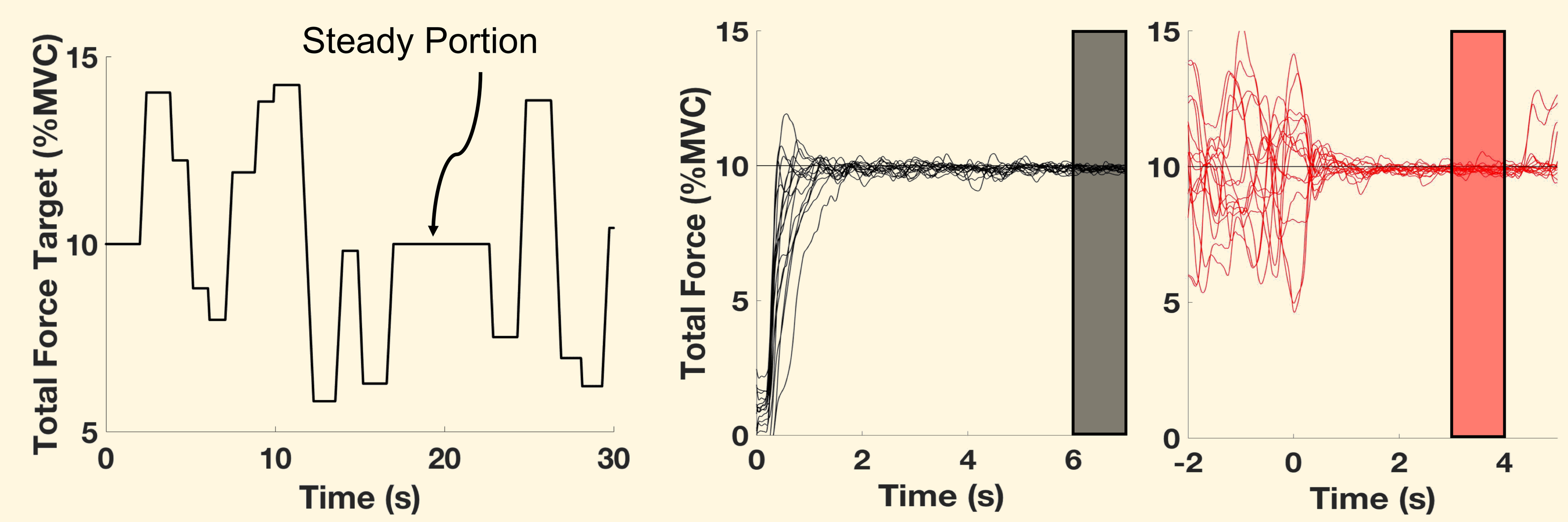


Fig. 3 *Sample trajectory for dexterous task (**A**). Subject's performance of the steady task (**B**). Subject's performance over 7 seconds of the dexterous task across 16 trials (**C**). The highlighted region was used for analyses.*

- The last 1s (6-7s) of the steady task, and the 1s from t = 3 to 4 of the time-aligned force profile in the dexterous task was used for analysis.
- We conducted 96 t-tests (24 subjects x 4 fingers) at α = 0.05 to determine significant differences in force configurations across tasks.

RESULTS

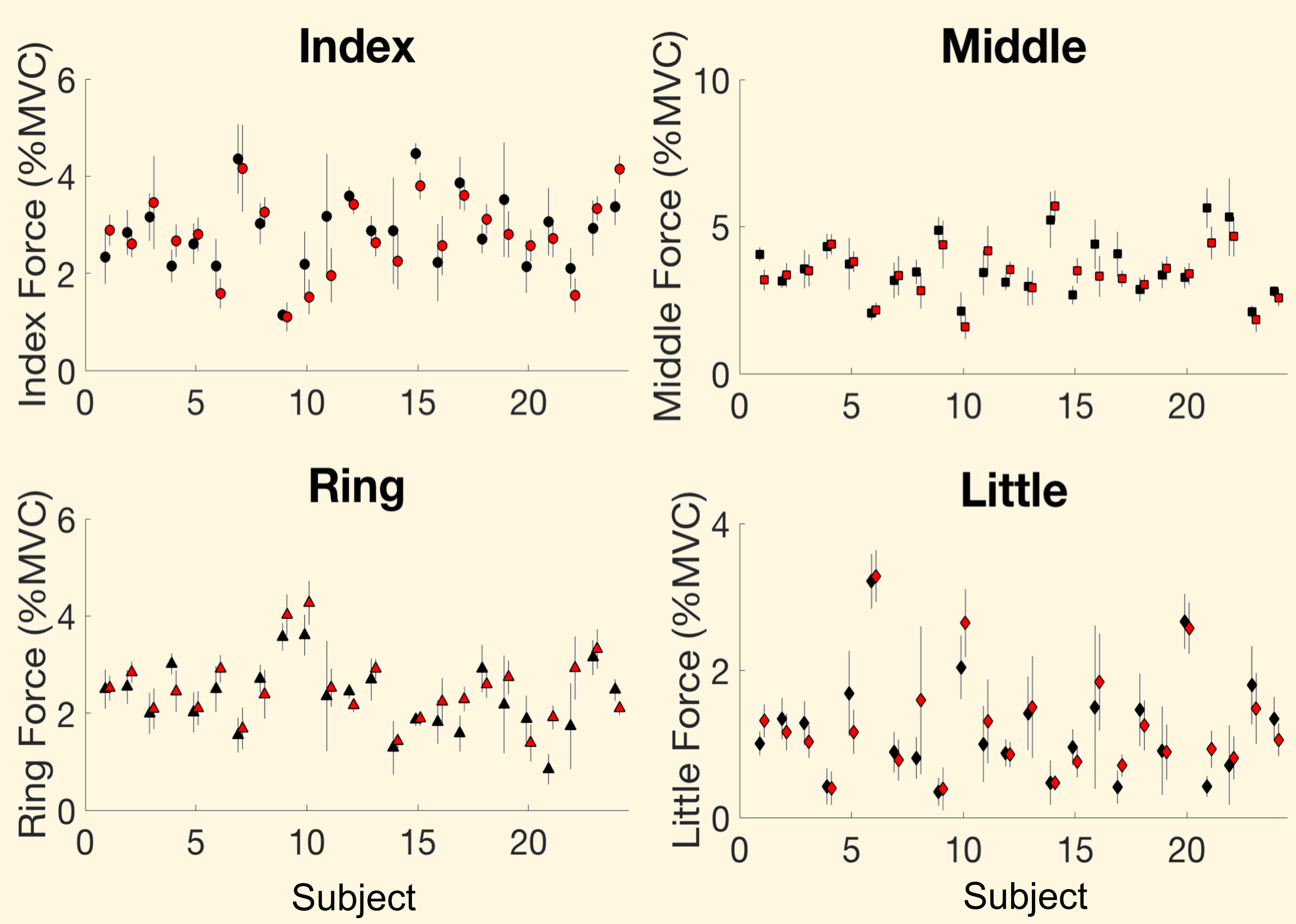
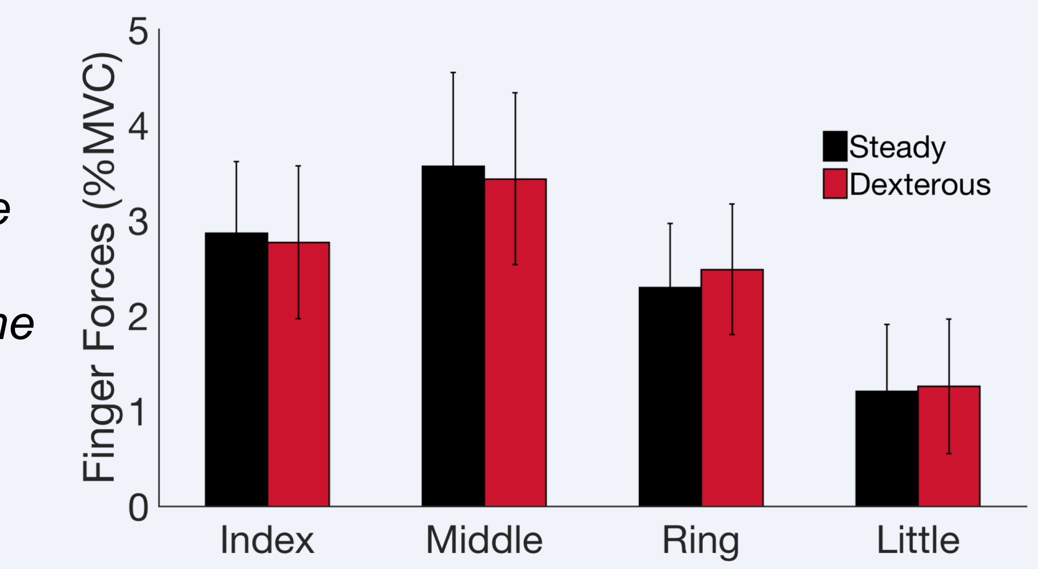


Fig. 4 *Each subject's mean forces for each finger for the* ***steady*** *and* ***dexterous*** *tasks.*

Fig. 5 *There is no significant change in the across-subject mean finger forces between the steady and dexterous conditions in any finger.*



- Individual subjects showed task-specific changes in finger forces.
- **23 / 24** subjects significantly changed at least one finger's force,
- **17 / 24** changed at least two, **8 / 24** changed at least three,
- **2 / 24** significantly changed all four finger forces.

ALTERNATIVE ANALYSIS

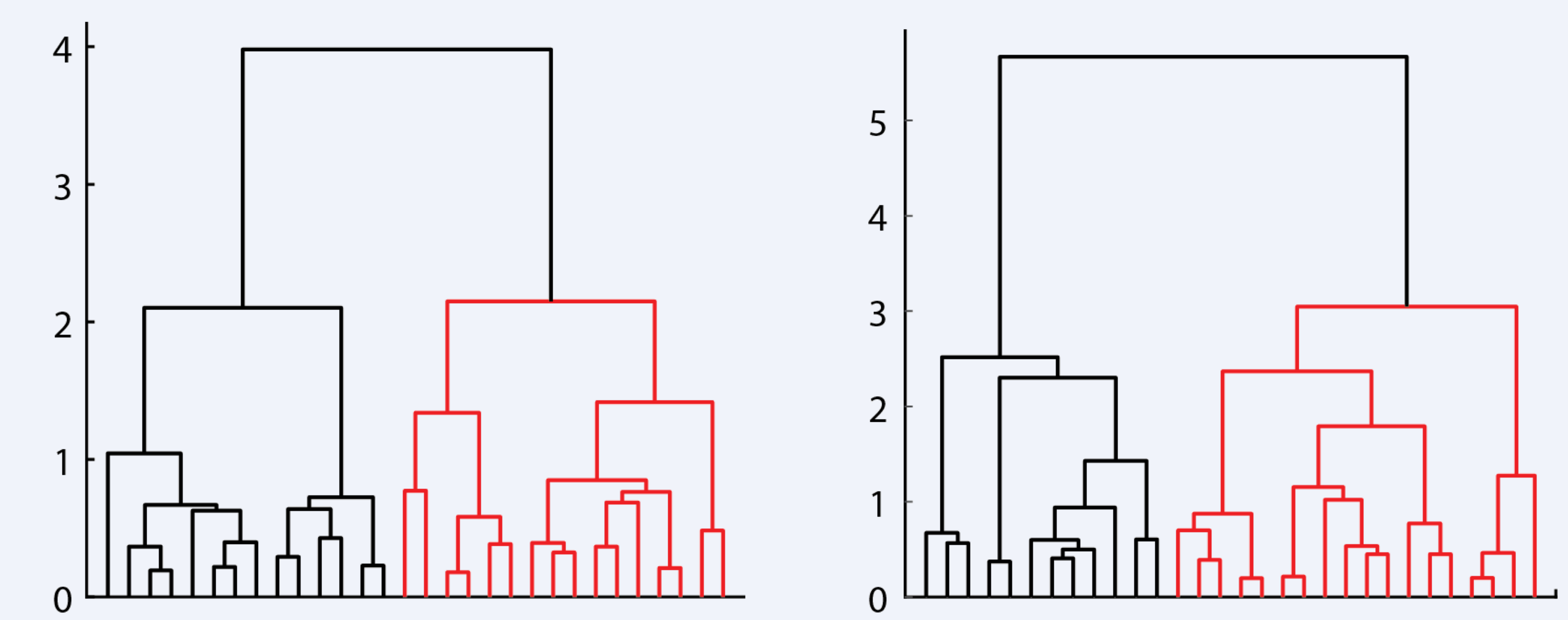


Fig. 6 *Dendrograms showing the expected number of clusters. Cluster analysis attempted to determine if the behavior could be classified into two subgroups that corresponded to task type.*

- We obtained 2 clusters in **15 / 24** (**62.5%**) of subjects
- Average clustering success rate: **Steady** 21.35%, **Dexterous** 55.21%
- Limited success in categorizing behavior into tasks

CONCLUSION

- The mean finger force configuration of the constant force production task depends on task type.
- The optimal subspace is likely determined by subject-specific properties such as neuromechanics of the muscles and finger impulse production abilities.
- Future studies will examine changes in performance associated with altered configurations.

REFERENCES

1. Hasan Z, *J Mot Behav*, 37(6), 484-493, 2005.
2. Tillman and Ambike, *J Neurophysiol*, 119:21-22, 2018.

Check out the HK Human Motor Behavior Group website →