Effects of Past and Future Motor Actions on Present Multifinger Pressing Behavior

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Background

Expectation of movement reduces the stability of the current motor state in a multifinger pressing task.

Purpose

Quantify the effects of recent movement history and expectation of impending movement on the stability of the current motor state.

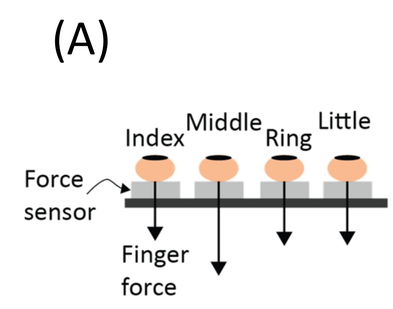
Findings

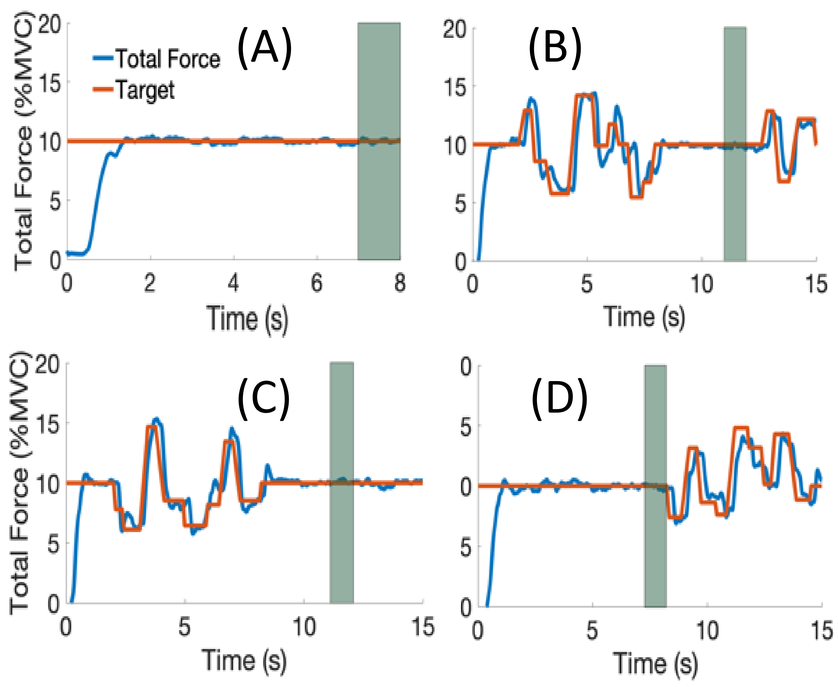
Effects of movement history dissipate rapidly. Stability of the current state reflects expectation of upcoming movements.

- Stability is the ability to reject disturbances to the current state and is often assumed to be maximized during motor action.
- However, maximal stability may impede efficient transitions between motor tasks [1].
- To transition from motor task 1 to task 2, task 1 must be destabilized before transitioning to task 2.
- I previously found that the expectation of transitioning to task 2 reduces the stability of performance of task 1 in a finger force production paradigm [2]. However, our earlier experimental protocol was unable to quantify the contributions of recent movement history and expectation of upcoming movements on stability of current performance.

PURPOSE: Quantify effects of past movements and expectation of future movements on the stability of the current motor state.

METHODS:



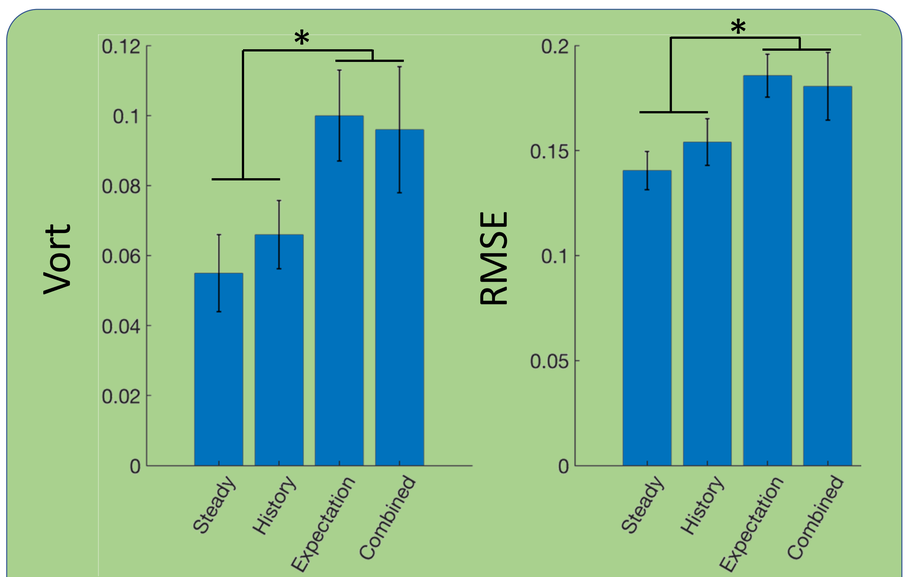


Top: 24 young adults (22.4 ± 3.1 yrs) press with four fingers **(A)** to produce a total force that controls a cursor to track a target on a screen **(B)**.

Bottom: Representative target and cursor timeseries of the four conditions. The **(A)** Steady and **(B)** Combined tasks replicate my previous study. The novel **(C)** History and **(D)** Expectation tasks isolate the effects of movement history and expectation on the current state, respectively.

Stability is quantified within the shaded regions by RMSE, and Vort from the **Uncontrolled Manifold (UCM)** analysis [3]. Higher RMSE and Vort indicates lower stability.

Statistics: One-way repeated measures ANOVA's on Vort and RMSE, with factor *Task* (4 levels).



Across-participant mean (SE) of Vort and RMSE. The Expectation and Combined tasks exhibit reduced stability compared to the Steady and History tasks in Vort [$F(3,66)=16.32$; $P=<0.001$] and RMSE [$F(3,66)=20.91$; $P<0.001$].
Therefore, only the expectation of future state change impacts the stability of current performance in a multifinger pressing task.

Scan the QR code to check out more work from Purdue's Motor Behavior Group on our website.

REFERENCES

1. Hasan Z., *J of Mot Behav*, 37(6), 484-493, 2005.
2. Tillman and Ambike, *J. Neurophysiol,* 119:21-22, 2018.
3. Scholz and Schoner, *Exp Brain Res*, 126:289-306, 1999.

Left-Side Of Poster Outline

- Methods
  - 4 finger pressing
  - Track target on computer screen
  - Compute stability in shaded regions
  - 4 tasks, 15 repetitions each
    - 2 are like previous study
    - PURPOSE OF CURRENT STUDY
    - 2 are unique to this study
- Figures
  - Stability = Repetition (traces of repeated hammering)
    - Caption: Stability is crucial for targeted movement. It is the ability to reject external disturbances to the current state. Here the current state is hammering.
  - Multifinger pressing to track a target on a computer screen
    - Caption: We examine the stability of the motor state of producing a constant total force in a multifinger pressing task. 23 participants (age:…) track the target with their total force (FT=F1+F2+F3+F4)
  - Steady & Tracking conditions timeseries with shaded area and one bar each to indicate degree of stability
    - Caption: It is commonly thought that stability should always be maximized. However, I previously found that stability reduces in response to expectation of motor state change
  - GOAL: Previous protocol could not parse effects of recent movement history vs. expectation of the future. We aim to accomplish that here.
  - 4 tasks timeseries with shaded regions.
    - Caption: The Steady (A) and Combined (D) tasks are similar to the previous study. The Anticipation (B) aims to isolate effects of expectation. The History (C) task isolates the effects of recent movement history.
  - Bar plot of DVz OR RMSE (and/or Vort?) RUN STATS
    - Caption: There was (not) a main effect of *Task*
  - [1] = Hasan