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Asymmetric Learning in an Asymmetric Bimanual Task

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The Action Lab

Background

Performing two different movements with the right and left hand is difficult as one has to overcome the inherent tendency for symmetric movements.[1,2]

Previous fMRI results revealed distinct mechanisms for discrete and rhythmic movements.[3]

- **Uni**-lateral cortical activation in **rhythmic** movement, confined to contralateral primary motor areas.
- **Bi**-lateral cortical activation in **discrete** movement, even in motor cortex.

We tested learning and retention of a discrete/rhythmic bimanual task over long-term practice (10-20 days) and 2-month follow-up retention sessions.

Methods

Experimental Setup:

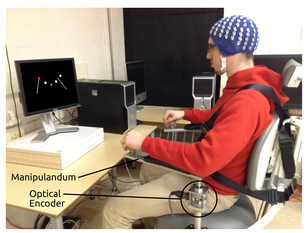
16 healthy, right-handed college students performed bimanual movements while seated with forarms on horizontal manipulanda. Elbow angle was recorded with an optical encoder. Arm position was shown in real time on a monitor. EEG was also recorded on some subjects for some sessions.

6 subjects performed the discrete task with the left arm and the rhythmic task with the left arm.
6 subjects performed with the arms reversed.
4 subjects performed with a fixed velocity for the discrete task.

Instructions:

Discrete Movement: "On randomly timed cue, move your arm to other target as quickly as possible."

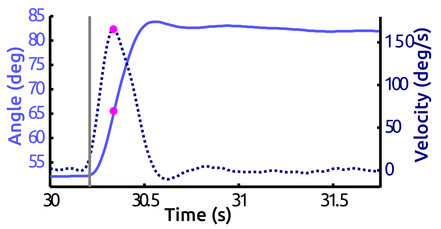
Rhythmic Movement: "Move your arm as smoothly as possible between the dots to the metronome beat of .75 Hz."



Performance Measures and Feedback:

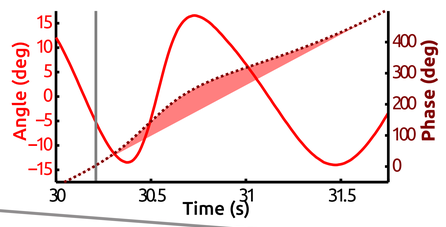
Discrete Arm: Peak Velocity

Peak Velocity during reaching



Rhythmic Arm: Perturbation

RMS error between actual sinusoidal phase profiles during discrete arm reaching

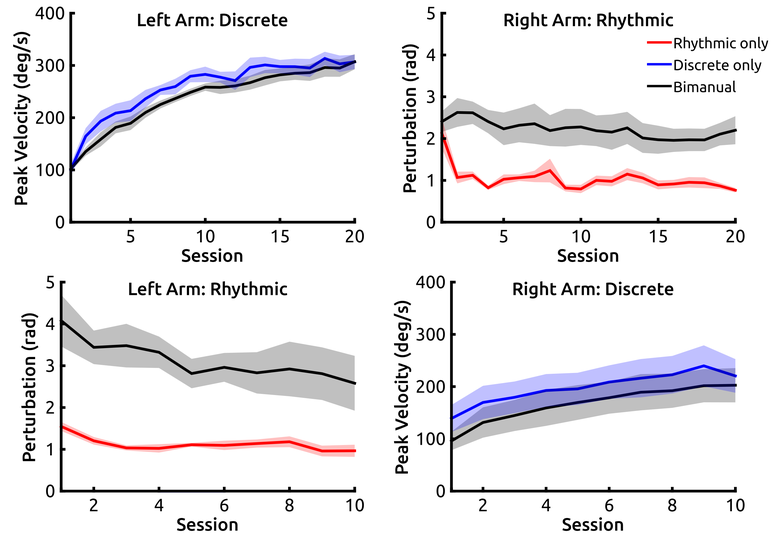


Results

Maximize Discrete Arm Velocity:

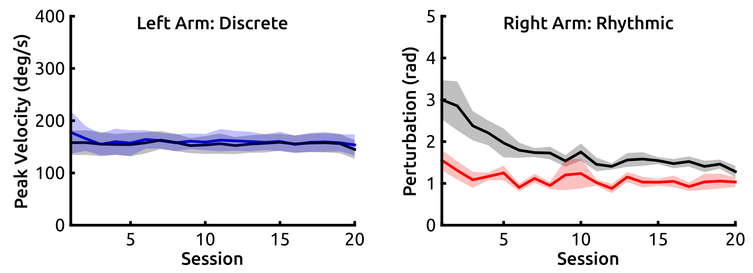
Discrete peak velocity increased similar to unimanual trials

No significant difference in learning was observed depending on which hand performed the discrete task.



Fixed Discrete Arm Velocity:

Perturbation did not reach the level of unimanual performance after



Shading represents standard error of mean

References

(1) Gerloff C, Andres FG (2002) Bimanual coordination and interhemispheric interaction. *Acta Psychologica 110*(2-3):161-186.

(2) Obhi SS (2004) Bimanual coordination: an unbalanced field of research. *Motor Control 8*:111-120.

(3) Schaal S, Sternad D, Osu R, Kowato M (2004) Rhythmis arm movements are not discrete. Nature Neuroscience 7, 10, 1136-1143.

(4) Wei K, Wertman G, Sternad D (2003) Interactions between rhythmic and discrete components in a bimanual task.
Motor Control 7:134-154.

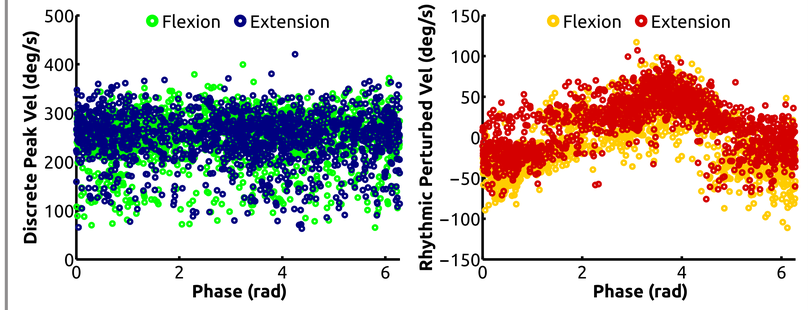
Results

Perturbation was not Mechanical:

Rhythmic arm perturbation was modulated by phase of rhythmic movement but was not sensitive to direction of discrete arm reaching. The modulation did not change with practice.

Discrete arm velocity was not affected by phase of rhythmic movement.

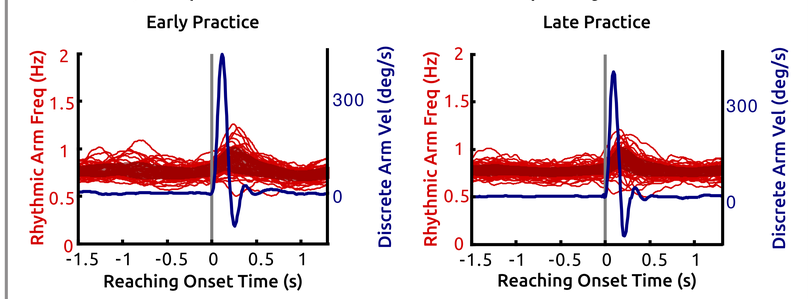
Therefore, purturbation was not a mechanical effect.



Perturbation was not Anticipatory:

Perturbation started after discrete movement onset. Timing did not change with practice.

Therefore, the perturbation was not an anticipatory effect.



Figures are from a single subject.

Conclusions

Discrete arm movement perturbs rhythmic arm movement and is not attenuated with practice. This asymmetry was not the result of hand dominance.

Perturbations in the rhythmic arm were neurological rather than mechanical in origin. They were also a result of the movement, rather than an anticipatory effect.

The differential learning of the tasks demonstrates that rhythmic and discrete movements are fundamentally different.

Even extended learning cannot overcome the interhemispheric communication that limits the independent movement of the two hands