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Attentional vs. Intentional Biases in Hand Movements; Hand-Specific Coupling & Bimanual Reaching

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Hand-Specific Coupling & Bimanual Reaching

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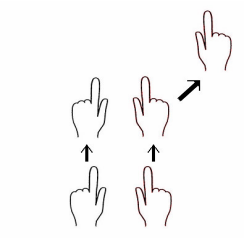
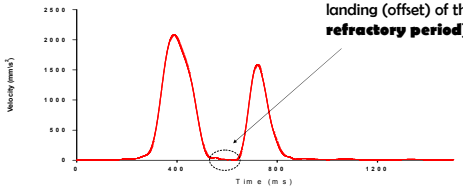
Introduction

Most of the population is dextral, showing a clear preference for performing the vast majority of tasks with their right hand. Peters (1981) suggested that an asymmetrical bias in **attention** (toward the right hand in right handers) could account for many manual asymmetries in bimanual task performance, with the left hand unable to perform the attentionally demanding portion of the task. Likewise, Honda (1982) demonstrated preferential monitoring of the dominant hand during a bimanual reaching task. Recent evidence has also shown an **intentional** (i.e. output related motor attention) bias toward the dominant hand (Bestelmeyer & Carey, 2004), another possible factor in the coordination of the hands. Evidence of unimanual performance decrements across the hemispace (Carey et al. 1996) suggests that the interaction between the side of space reached to and the temporal coupling of the hands may be a crucial factor determining the bias of attention. Therefore, the purpose of the current study is to investigate if attention is preferentially allocated toward the right hand, and whether this bias changes across the hemispace.

Study 1 Method





Right handed participants (n=20) performed bimanual reaches on a horizontal LED board to equidistant target pairs in left, right and middle space. Movements were recorded by a 3 camera 240hz ProReflex system (Qualisis inc.). In 50% of trials another single target appeared distal to the initial target pair which participants had to make a unimanual reach to *after* landing the initial bimanual movement in the form of a discontinuous double-step. The hand closest to the newly appearing unimanual target made the reach.

If attention is divided equally between the hands, it should be equally demanding to reach to the newly appearing target with the left or right hands. However, if attention is preferentially allocated toward the right hand (as suggested by Peters, 1981) the left hand should remain 'stuck' longer, while attention is shifted from right to left. Therefore the time between the landing (offset) of the first (bimanual) reach and the onset of the unimanual reach (the **refractory period**) was compared between the hands.

In addition, separate unimanual reaches were made to identical targets (as the initial bimanual reach), allowing for direct comparison of temporal asymmetries across the hemispace in bimanual vs. unimanual reaching.

Study 1 Results

•Comparisons between the bimanual and unimanual reaches remain inconclusive:

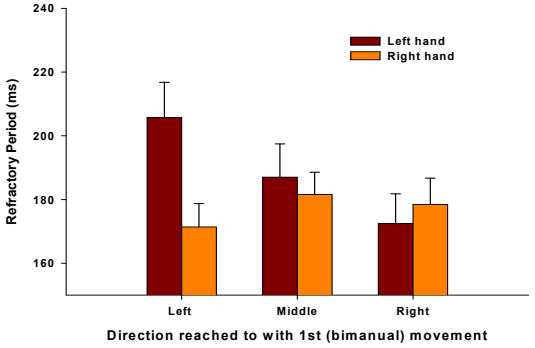
-No condition by hand interaction shown for input (RT) or output (PV, duration) measures.

•**The left hand refractory period is significantly longer than the right hand refractory period**, but only in left space ($p<0.005$).

-Why would the left hand perform worst in left space?

-The task is to easy; participants may be using strategies that are overwhelming a default asymmetry.

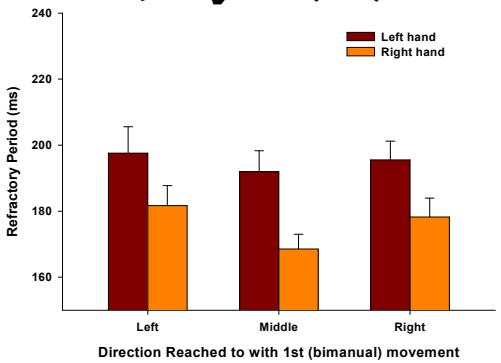
-Second study investigated by increasing the attentional demands of the initial bimanual movement providing ideal conditions for an asymmetry in attention.



Study 2 Method

Right handed participants (n=17) performed bimanual reaches to **30** different target pairs on the same LED board. These target pairs varied in inter-target distance as well as orientation (i.e. the hands had to move slightly different distances in some trials). Trials with a second step also appeared in only **25%** of the trials (i.e. much less frequent than in study 1). No double-step target combinations were repeated. The purpose of these manipulations was to force attention to be divided between the hands by making the bimanual reach as attentionally demanding (at a task level) as possible.

Study 2 Results



•The **left hand shows a significantly longer refractory period** than the right hand ($p<0.05$)

•This asymmetry is **constant across all sides of space** (no interaction).

•This increased refractory period is indicative of a shift in attention from one hand to the other...

•Therefore indicating a **bias in attention toward the right hand**.

Discussion

Although study 1 showed tentative evidence for an attentional bias toward the right hand, the effect of space remained unclear. Although no specific predictions were made regarding the hemispace an attentional bias would be most visible in, it would not be expected for the left hand to show poorest performance in ipsilateral space. Study 2 however show a much clearer picture of an attentional bias toward the dominant hand. The right hand's refractory period is smaller across the hemispace, suggesting that when making unconstrained bimanual reaches the right hand receives a greater share of attention than the left hand. A bias in attention may explain the configural choices of bimanual tasks (i.e. opening a bottle; buttoning a shirt), and may be a useful index of cerebral lateralisation.

It is not clear whether this task truly examines a bias in attention as opposed to intention – pre-cuing techniques may allow for a clear distinction of the input and output asymmetries.

Further testing will hope to determine at what level this bias in attention/intention manifests by (further) direct comparisons between bimanual and unimanual reaches. Asymmetries in the degree of between-hand coupling may also allow separation of input and output biases.

References

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