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A NOVEL TOOL FOR MEDIOLATERAL BALANCE ASSESSMENT.

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SUMMARY
A novel zero order visual tracking task (VTT), using the centre of pressure (CoP), was used to assess balance performance. The VTT consisted of tracking a target signal on a screen in front of the subject, by a projection of the ML displacement of the CoP. The frequency of the target increased from 0.3 to 2.0 Hz. Two targets were used: a predictable target that used single sines or an unpredictable that used multisines with a bandwidth of 0.6 Hz, increasing at steps of 0.1 Hz. For the predictable task, significant learning effects were found at 1.5 and 1.7 Hz in phase shift, and at 0.3-0.4 and 1.1-1.2 Hz in gain (all $p<0.01$). For the unpredictable target, significant learning effects were observed for phase shift at all frequencies analyzed ($p<0.01$), except at 0.3 and 0.4 Hz, while gain exhibited a significant learning effect only at 0.4 and 0.5 Hz. Overall, close to optimal values and no major learning effects indicate that physical constraints do not limit performance when tracking the predictable target. When comparing both tasks, larger phase shifts and lower gains in unpredictable tracking indicate a visuomotor delay. For the unpredictable task, the phase-shift decreased substantially over sessions, indicating that information processing can be improved with a single session and the effect can be maintained up to one week.

INTRODUCTION
It is thought that mediolateral balance control impairment may affect performance of important daily life activities such as walking, especially in the elderly [1, 2]. It has also been proposed that balance training in the frontal plane may reduce the incidence of falls in the elderly population [3]. Quantification and training of one's capacity to dynamically control mediolateral balance might therefore be a powerful tool in fall prevention. For this purpose, a zero order visual tracking task (VTT), using the centre of pressure (CoP), which demands the integration of multiple sensory inputs, is proposed. Balance performance during either a predictable or a unpredictable VTT can be described in the frequency domain in terms of phase shift, and gain. The aim of this study was to determine whether learning effects occur in these tasks.

METHODS
For this experiment, 20 healthy young subjects (28±3 yrs) stood barefoot on a force plate (Kistler) and performed a series of 4 VTTs with a predictable target and 4 with a unpredictable target, preceded by 2 practice trials for each task. The VTT consisted of tracking a target signal on a screen in front of the subject, by a projection of the ML displacement of the CoP. The frequency of the target increased from 0.3 to 2.0 Hz. For the predictable target, the frequency increased with steps of 0.1 Hz every 5 seconds. For the unpredictable target, multisines with a bandwidth of 0.6 Hz and lowest frequency increasing from 0.3 to 1.5 Hz at 0.1 Hz were used. D-Flow (Motek Medical, The Netherlands) was used to produce target signals and project CoP feedback (spheroids). Performance was expressed as the gain and phase-shift between the target and CoP projection. Repeated measures ANOVAs were performed to assess learning effects at frequencies from 0.3 To 2.0 Hz, with an alpha of 0.01.

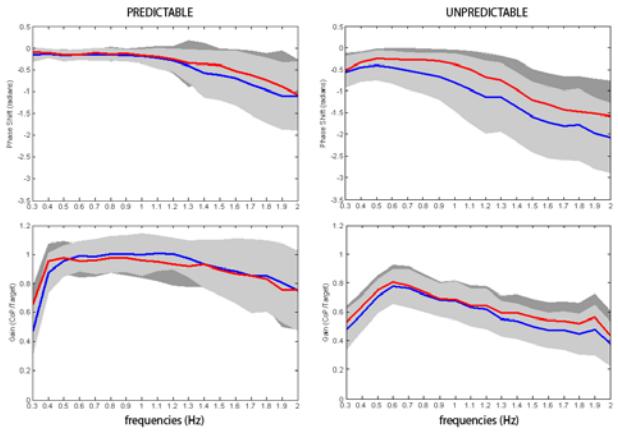

Figure 1: Averaged curves (± sd) for PS (top panel), G (bottom panel) measures using both, predictable target (left column) and unpredictable (right column) during first (blue lined) and second (red line) sessions.

RESULTS AND DISCUSSION

For the predictable task, significant learning effects were found at 1.5 and 1.7 Hz in phase shift, and at 0.3-0.4 and 1.1-1.2 Hz in gain (all $p<0.01$). For the unpredictable target, significant learning effects were observed for phase shift at all frequencies analyzed ($p<0.01$), except at 0.3 and 0.4 Hz, while gain exhibited a significant learning effect only at 0.4 and 0.5 Hz.

CONCLUSIONS

Overall, close to optimal values and no major learning effects were found over the range of frequencies for the predictable task, indicating that physical constraints do not limit performance in CoP tracking up to 2 Hz. When comparing both tasks, larger phase shifts and lower gains in unpredictable tracking indicate that information processing may be a limiting factor. For the unpredictable task, the phase-shift decreased substantially over sessions. This may indicate the information processing required in the unpredictable task can be improved with a single session and the effect can be maintained up to one week.

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