MOTOR CONTROL LEARNING AT THE LUMBAR SPINE USING SENSOR-BASED POSTURAL FEEDBACK: A RANDOMIZED CONTROLLED TRIAL

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Background

Extrinsic feedback can be provided in different ways during motor control exercises for patients with low back pain (LBP). It is thought that providing objective and accurate feedback could improve the learning process. However, little is known about the most effective form of feedback.

Aims

(1) To evaluate whether sensor-based postural feedback is more effective than conventional feedback to learn a motor control task for the lumbar spine.
(2) To assess whether there is a carry-over effect from an analytical to a functional task.

Methods

Subjects

30 healthy subjects
No LBP in the past year
No spinal stabilization excercises in the past year
No other conditions that could interfere with the tasks (e.g. serious knee pain)

Protocol (Fig. 1)

Subjects performed a **lifting task** (= functional task) and **waiter's bow task** (= analytical task) at baseline. They were asked to keep the physiological lordosis in the lumbar spine during the tasks. Each task was repeated five times, and both conditions were standardized to the subject's height. **Lumbopelvic kinematics** (deviation from the starting position in the lumbar spine and hip) were measured with inertial sensors (ValedoMotion, version 1.2) placed at L1, S1 and the femur (Fig. 2). After the baseline evaluation, participants were **randomized into three groups**: the **sensor-group (SG)** received sensor-based postural feedback on a computer screen, **the mirror-group (MG)** received mirror-based feedback and the **control-group (CG)** received no feedback (Fig. 3). After randomization, subjects practiced the waiter's bow (3 trials of 6 repetitions), during which they received their assigned form of feedback. Lumbopelvic kinematics of the waiter's bow task were obtained during these trials. Lumbopelvic kinematics of both tasks were re-assessed immediately after the learning phase .
After the post-intervention kinematic assessment, the usefulness of the feedback, pain and fear of pain during the exercise trials were obtained with a numeric pain rating scale (0-10). Fatigue was measured with the Borg scale (6-20).

Fig. 2: sensor placement

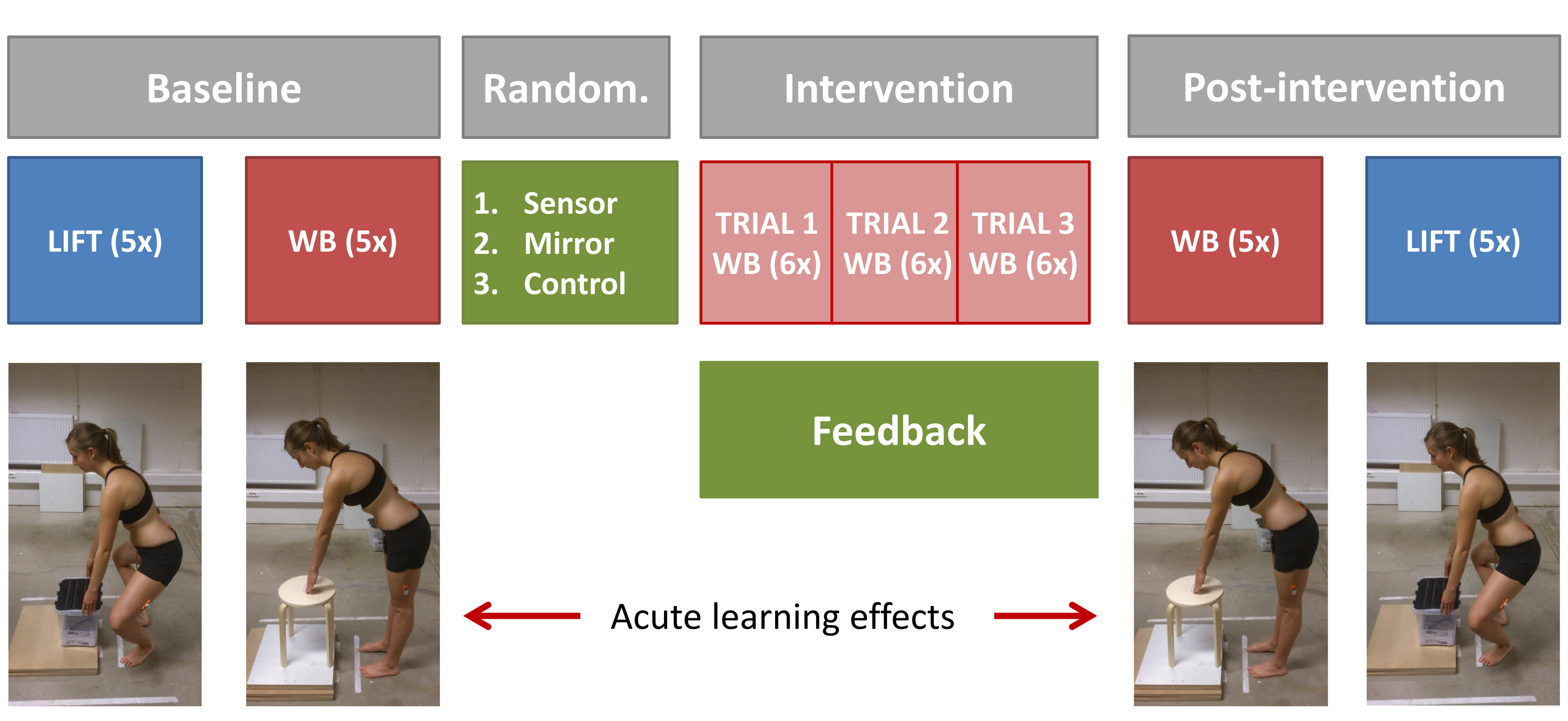


Fig. 1 Protocol of the study. LIFT = Lifting task; WB = Waiter's bow.

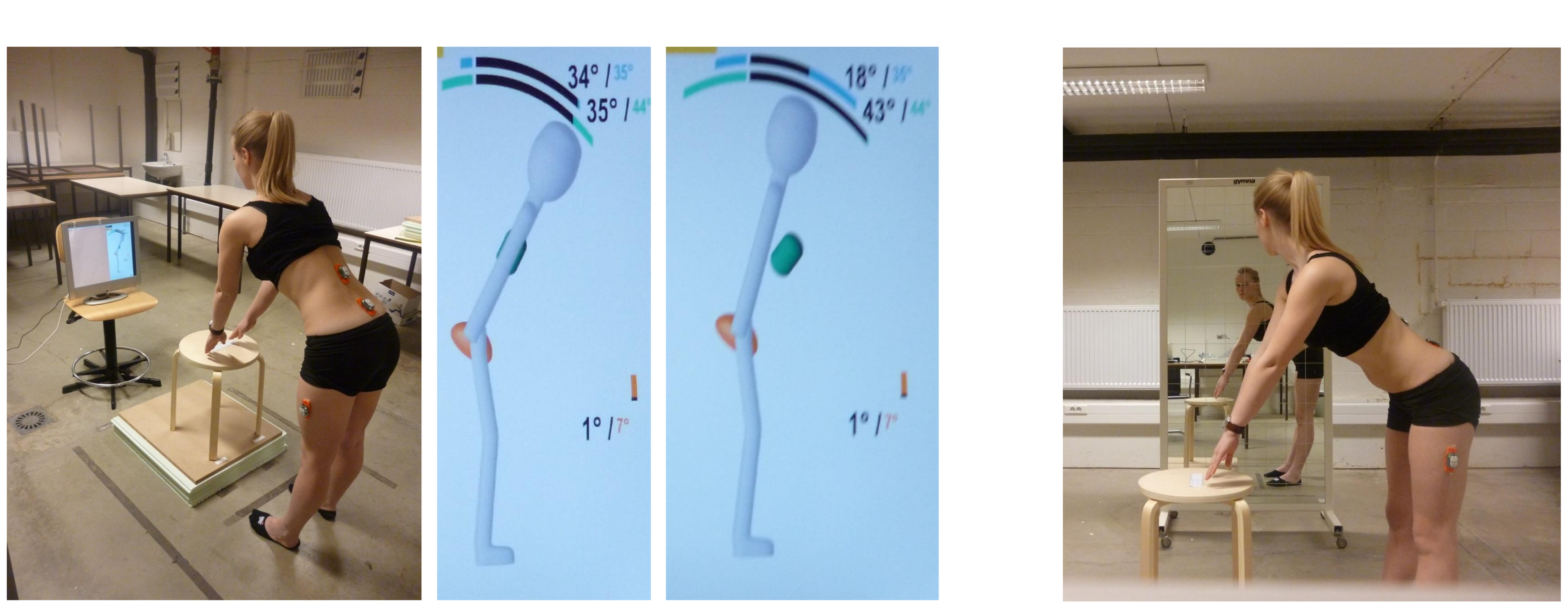


Fig. 3 Different forms of feedback**. Left**: Sensor-based feedback. Subjects were instructed to keep the green dot on the stick man's body. When the green dot moves forward relative to the stick man, this indicates a lumbar flexion. **Right**: Mirror-based feedback.

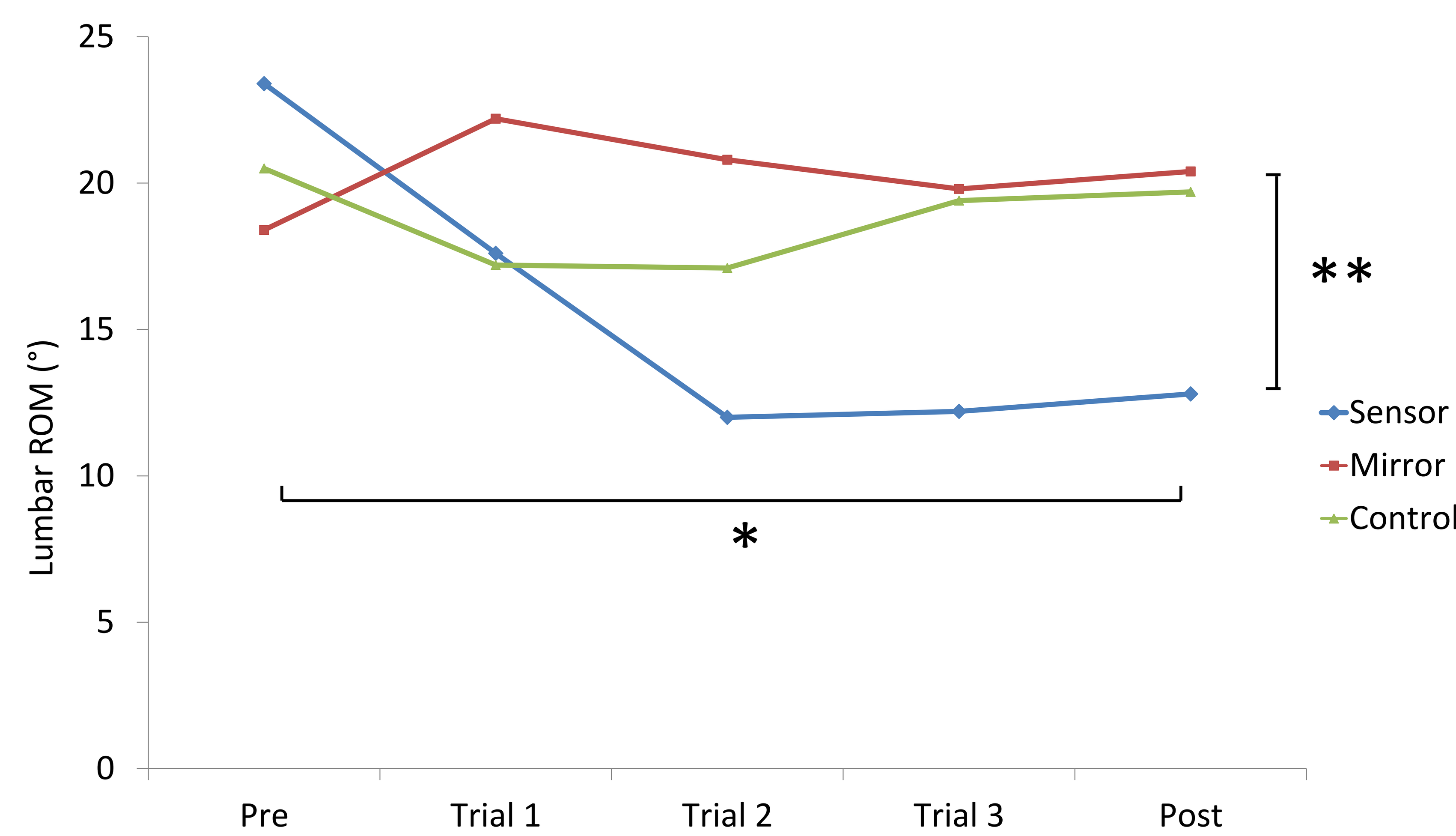
Results

Table 1. Subject Characteristics

	Control	Mirror	Sensor	*p*-value
Age (years)**	42.1 (13.8)	43.8 (12.9)	33.6 (16.0)	0.39
Height (cm)*	174.6 (6.3)	173.2 (9.3)	173.8 (10.4)	0.92
Weight (kg)*	75.8 (10.1)	67.8 (14.4)	74.8 (13.9)	0.31
BMI (kg/m²)**	24.9(3.2)	22.5 (4.1)	24.6 (2.3)	0.19

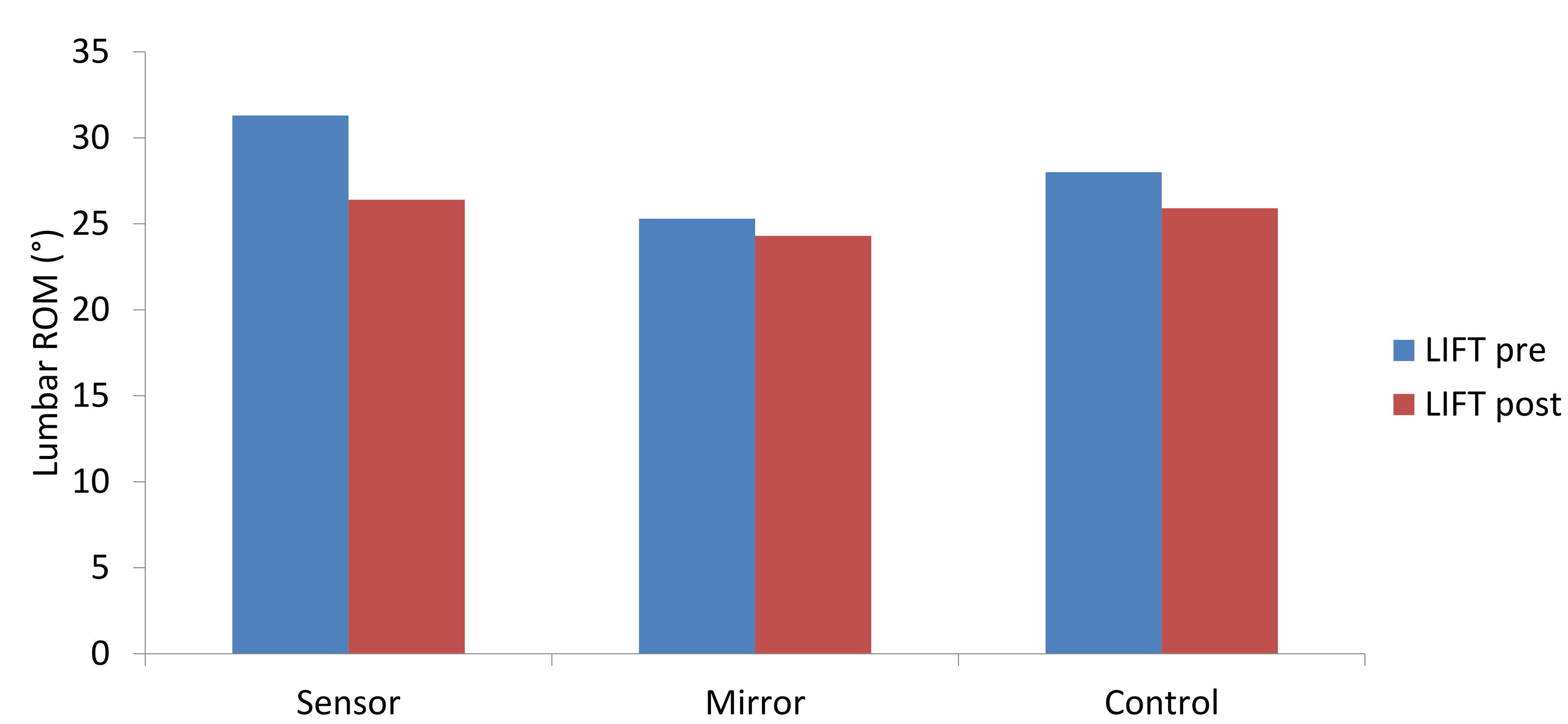
* one-way ANOVA; ** Kruskal-Wallis

Waiter's bow



* The sensor group improved over time ($p = 0.005$)
** Pre-Post between groups difference in favour of SG group, compared to CG and MG ($p < 0.05$)

Lifting task



No within or between group differences were found for the Lifting task ($p > 0.05$)

Table 2. Post-intervention questionnaires

	Control	Mirror	Sensor	P-value
Usefulness FB (/10)*	-	7.1 (1.7)	8.2 (1.4)	0.14
Pain (/10) *	0.3 (0.9)	0.3 (0.7)	0.8 (1.0)	0.37
Fear of pain (/10)**	0.0 (0.0)	0.0 (0.0)	0.5 (1.3)	0.13
Borg scale (6-20)**	6.6 (0.7)	7.1 (1.3)	8.5 (2.1)	0.09

* one-way ANOVA; ** Kruskal-Wallis. FB = Feedback

Discussion & Conclusions

Sensor-based postural feedback seems more effective to learn a motor control task compared to mirror-feedback or no feedback. However, there was no carry-over from the analytical task to the functional task as none of the groups showed improvements in the lifting task. Further, no significant correlation could be found between improvements in the Waiter's bow and the Lifting task over the whole group (ρ = -0.12, $p = 0.52$). This suggests that motor control training should be task-specific, or that the intervention period was not long enough to induce a carry-over effect. The mirror group did not improve, which could possibly be explained by the fact that it might be difficult for lay-people to assess the lumbar spinal curvature in a mirror. The results found in this study should be confirmed in a low back pain population.

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