Does a small perturbation created by an upper-limb exoskeleton impact our coordination in reaching tasks?

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To cite this version:

Océane Dubois, Agnès Roby-Brami, Ross Parry, Nathanael Jarrasse. Does a small perturbation created by an upper-limb exoskeleton impact our coordination in reaching tasks?. Progress in Motor Control, Sep 2023, Rome, Italy. hal-04228833

HAL Id: hal-04228833
https://hal.science/hal-04228833
Submitted on 4 Oct 2023

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Does a small perturbation created by an upper-limb exoskeleton impact our coordination in reaching tasks?

Océane Dubois
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Ross Parry
Nathanaël Jarrassé

A low-magnitude perturbation applied by an exoskeleton at the joint level still alters joint coordination once the disturbance is removed, even though task performance is unchanged.

The impact of perturbations applied at the human end-effector level has been widely studied as well as the learning process which results from it [1]. However, the effect of perturbations at the joint level and the learning process related to it has been poorly investigated [2] [3]. Indeed, due to the redundancy of human limbs, perturbations at the joint level do not necessarily affect the task and therefore, the central nervous system might adapt differently. This study investigates the impact of a low-amplitude joint-level perturbation on our coordination strategies while performing a reaching task.

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**Set-up**

**Protocol**

11 Subjects per force field (55 in total)

**End effector and joints results**

- No significant differences on the end-effector metric nor on range of motions of joints.
- Only the Viscous Force Field is statistically significant (*) for the end-effector metric and joint range of motion 3

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<tr>
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</thead>
<tbody>
<tr>
<td>Torque (Nm)</td>
<td>0.165±16</td>
<td>0.064±17</td>
<td>0.087±17</td>
<td>0.156±18</td>
</tr>
<tr>
<td>Speed (rad/s)</td>
<td>-0.040±17</td>
<td>-0.030±17</td>
<td>-0.034±17</td>
<td>-0.040±18</td>
</tr>
<tr>
<td>ROM (°)</td>
<td>60.0±5.34</td>
<td>60.0±5.34</td>
<td>60.0±5.34</td>
<td>60.0±5.33</td>
</tr>
</tbody>
</table>

FORCE FIELDS HAVE NO IMPACT ON THE TASK'S PERFORMANCE...

**Inter-joint coordination results**

Table 1: Number of participants (out of 11 per group) that modifies their coordination strategy to each force field.

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<tbody>
<tr>
<td>JcPCA Δθ</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>JcCRP Δθ</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

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**Short exposition of low-magnitude force field impacted coordination strategies!**

- There is no differences in the task performance before and after exposition to the force field regarding the end-effector and the joints ROM.
- The coordination strategies is most impacted by the viscous force field. The increase of gravity force field created greater change in the coordination strategies for more than half of the subjects.

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**References**