EFFECT OF LIFTING CONDITIONS ON THE PRE-LIFTING PHASE

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INTRODUCTION
The feed-forward control during pre-motor phase has been widly discussed in the field of movement science. However, many tasks analyzed in the movement studies were purposefully simple and performed under highly controled environment. The effect of environmental features under more reasonably practical motor tasks on the feed-forward control is unexplored. In the field of occupational biomechanics, liftng heavy weight has been one of most popular tasks and the unknown liftng weight found to affect the mechanical load on the back during lifting [1, 2] but the feed-forward control mechanism during lifting has not been thoroughly analyzed yet.

The aim of this study is to explore how the environmental features of lifting task, such as lifting pace, box weight and target size, influence the range of motion (ROM) and the electormyography (EMG) during pre-lifting phase.

METHODS
Thirty nine healthy participants performed a total of 24 lifts (2 lifting paces/2 box weights/2 target sizes/3 lifting trials per condition) from waist to shoulder level. Kinematic data of the box, elbow, and shoulder and EMG of trunk, shoulder and elbow muscles were collected. EMG of each muscle was normalized to their recruitment level during individual isometric lifting capacity test at shoulder level. The pre-lifting phase was defined from the initial contact of hands to the box to the initial movement of the box. The effects of lifting conditions on the ROM and EMG were analyzed using repeated-measures MANOVA
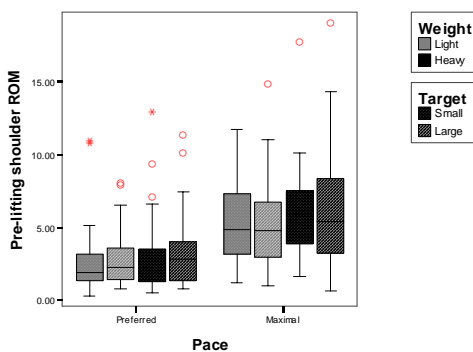

Figure 1: Box plot of the pre-lifting shoulder ROM by lifting pace, box weight and target size.

RESULTS AND DISCUSSION
The pre-lifting shoulder (Figure 1) and elbow ROM were increased at the maximal pace (p<0.001). Effect of the box weight on the shoulder ROM was significant (p=0.017) There was no significant effect of target size or of interaction on either of ROM.

The effects of environmental factors on the pre-lifting EMG were varied by the function of each muscle in lifting. Agonist muscles were affected by both of the lifting pace and the box weight (Figure 2). Antagonist muscles were not affected by any of the environmental factors (Figure 3).
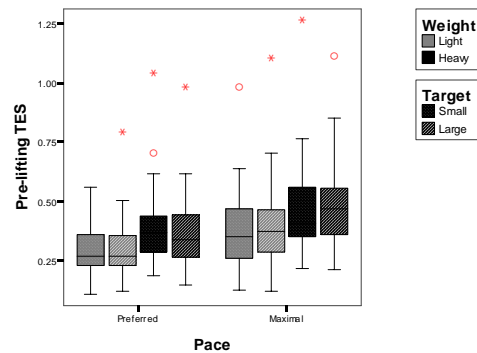
Figure 2: Box plot of the EMG of thoracic erector spinae muscle (TES) by lifting pace, box weight and target size.
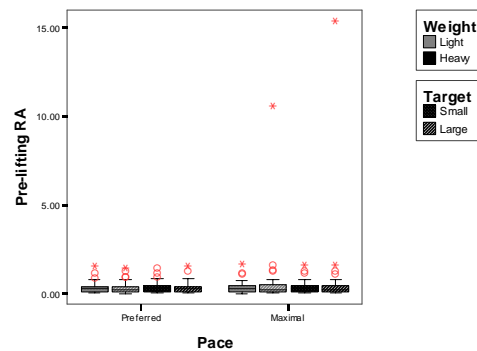
Figure 3: Box plot of the EMG of rectus abdominius muscle (RA) by lifting pace, box weight and target size.

CONCLUSIONS
The upper extremity movement and the muscle recruitment during the pre-lifting phase were influenced by the environmental features of lifting. The feed-forward control during pre-motor phase in the experienced workers needs to be studied to figure out the learning effect from experience.

ACKNOWLEDGEMENTS

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