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Does the instruction influence voluntary force production regardless of gender during a handgrip exercise?

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The aim of this study was to compare the results of maximal voluntary contraction (MVC) and maximal rate of force development (MRFD) in women and men during handgrip exercise performed following three different instructions: Oral instruction (OI): Started with audible tripping and accompanied by encouragement during the whole muscle contraction. Triggered instruction (TI): Same as oral instruction, but without encouragement. Self-initiated instruction (SI): The subject himself decided to start and to stop the contraction. Women's MVC and MRFD with OI were higher than SI. No significant difference has been found between instructions in men. Our results suggested that women are more sensitive to the instruction effect compared to men. Further explanations will be proposed using surface EMG and fMRI measurements.

Key words: Instruction, gender, MVC, MRFD, handgrip

INTRODUCTION

Force production depends on central and peripheral nervous system. Maximal voluntary contraction (MVC) and Maximal rate of force development (MRFD) are defined as peripheral measures of neuromuscular performance during isometric contractions (Blackburn and al., 2009). Many studies have demonstrated that performance during isometric contraction is influenced by the type of instruction given to the subject (Hard and Fast, Slow and gradual, Fast) (Bemben et al., 1990; Sahaly et al., 2001). Furthermore, MVC and MRFD are higher in men than in women (Häkkinen et al., 1991). This gender effect is explained by anatomical (cross-sectional area of muscle), physiological (muscle type), cognitive difference, etc. To our knowledge, no study has examined the possible prospective difference in the treatment of cerebral information associated with muscle response between men and women, and the influence of the instruction during muscle contraction. The aim of the present study was to compare the response of men and women to instruction during maximal handgrip contraction.

METHOD

23 right-handed adults participated in the study: 12 women (30.4 ± 7.6 years, 61.5 ± 8.3 kg) and 11 men (29.4 ± 3.9 years, 84.0 ± 14.4 kg). The subjects performed 5 maximal voluntary contractions of 4.4 s each, with 44-s recovery between exercises at each instruction: i) Oral instruction (OI), an audible signal at the beginning of the contraction followed by a pre-recorded vocal encouragement. ii) Triggered instruction (TI), same as oral instruction, but without encouragement. iii) Self-initiated instruction (SI), the start and the stop of the contraction initiated by the subject himself. At each instruction, the 3 best values of MVC and MRFD were averaged and included in the statistical treatment of data. MVC and MRFD were expressed in absolute units (kg and $\text{kg}\cdot\text{s}^{-1}$), reported to body mass ($\text{kg}\cdot\text{kg}^{-1}$ and $\text{kg}\cdot\text{s}^{-1}\cdot\text{kg}^{-1}$) and reported to body mass^{0.67} ($\text{kg}\cdot\text{kg}^{-0.67}$ and $\text{kg}\cdot\text{s}^{-1}\cdot\text{kg}^{-0.67}$).

The instruction effect was tested using a one-way ANOVA with repeated measures in men and women separately.

RESULTS

In women's MVC results, the one-way ANOVA with repeated measures showed a significant effect of instruction whatever the expression of results [in kg ($P=0.023$), in $\text{kg}\cdot\text{kg}^{-1}$ ($P=0.016$) and in $\text{kg}\cdot\text{kg}^{-0.67}$ ($P=0.018$)]. The post-hoc Bonferroni t-test showed that MVC was higher with OI instruction compared with SI instruction ($P=0.023$, $P=0.015$, $P=0.017$, for MVC in kg, $\text{kg}\cdot\text{kg}^{-1}$ and $\text{kg}\cdot\text{kg}^{-0.67}$, respectively). There was also a trend of superiority of the TI

instruction compared to the SI instruction, whatever the expression of MVC (kg , $\text{kg}\cdot\text{kg}^{-1}$ and $\text{kg}\cdot\text{kg}^{-0.67}$) ($P < 0.1$).

In women's MRFD results, the one-way ANOVA with repeated measures showed a significant effect of instruction whatever the expression of data [$\text{in kg}\cdot\text{s}^{-1}$ ($P = 0.013$), $\text{in kg}\cdot\text{s}^{-1}\cdot\text{kg}^{-1}$ ($P = 0.010$) and $\text{in kg}\cdot\text{s}^{-1}\cdot\text{kg}^{-0.67}$ ($P = 0.011$)]. The post-hoc Bonferroni t-test showed that MRFD was higher with OI instruction compared to SI instruction ($P \leq 0.021$). In addition, MRFD was higher with TI instruction compared to SI instruction ($P \leq 0.046$).

In men, whatever the expression of data, there was neither effect of instruction on MVC nor on MRFD ($P > 0.05$).

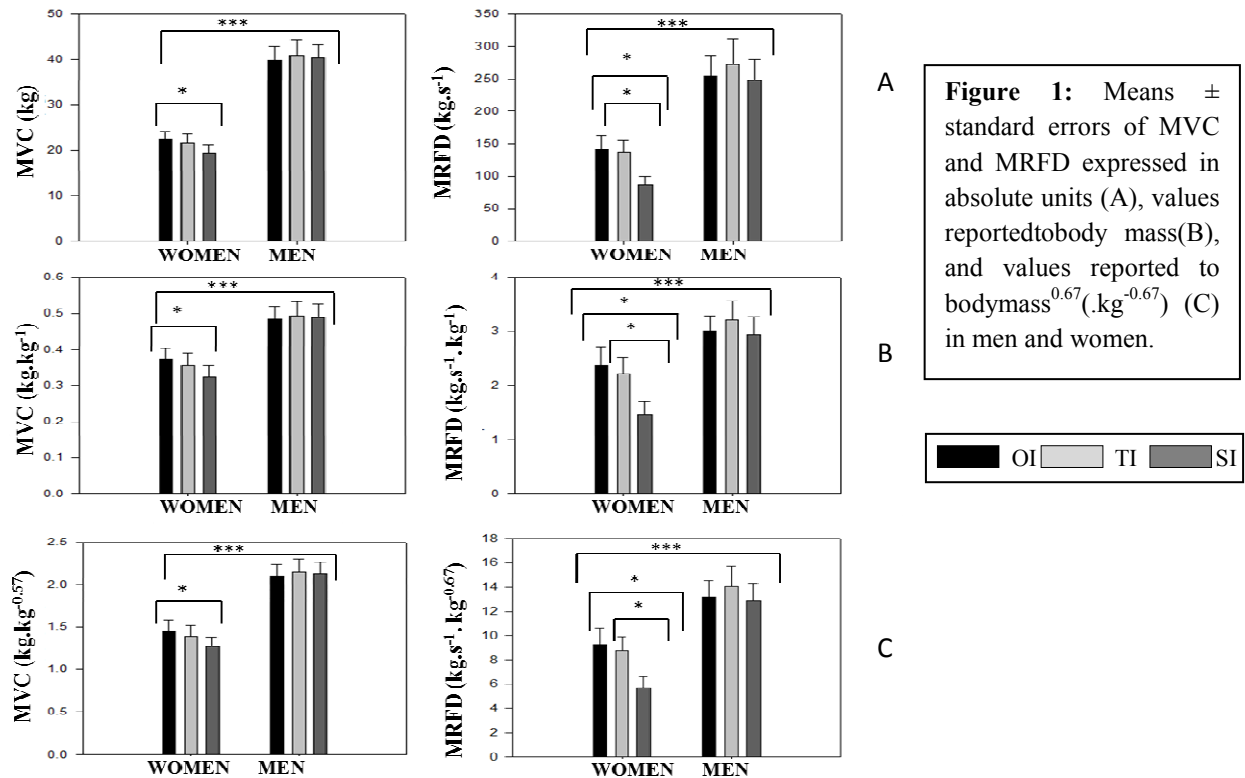


Figure 1: Means \pm standard errors of MVC and MRFD expressed in absolute units (A), values reported to body mass (B), and values reported to body mass^{0.67} ($\text{kg}^{-0.67}$) (C) in men and women.

Legend: OI (black bar), TI (light gray bar), SI (dark gray bar)

DISCUSSION

In accordance with our hypothesis, this preliminary study indicated that the impact of instruction was greater in women than in men, especially with OI instruction compared to SI instruction. This finding could be explained by muscle organization and differences in cognitive strategy between men and women.

That's what we intend to highlight by the analysis of the recorded data during the present study of the agonist and antagonist muscles EMG signals and the brain activity using functional magnetic resonance imaging (fMRI).

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