# Presentation of target torque level and error information enhance maximal voluntary elbow flexion torque

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## Introduction

Maximal voluntary contraction (MVC) is influenced not only by structural factors such as the cross-sectional area and fiber types of muscle but also by functional factors such as brain activation (Ikai & Steinhaus, 1961). MVC force exerted with the performer's shout exceeds that without shout, which suggests the possibility of controlling psychological suppression that limits muscle force (Ikai & Ishii, 1961). It has also been shown that subjects improve their performance and brain activation with a feedback of the error from the target task (Kawashima et al, 2000). The maximal long jump distance is enhanced when the goal is visually presented to the subject (Sadamoto & Ohtsuki, 1977). We hypothesized that visual feedback of exerted torque with the error information (VFB) increases brain activation and muscle force. We tested this hypothesis by investigating the relationship between neural activity and MVC enhancement with VFB.

## Methods

Thirteen male and two female subjects (23.9±1.8yrs 162.7±24.9cm , 68.5±32.1kg, mean ± SD) volunteered to participate in this study. The subject was seated on a chair with their dominant forearm in neutral position and their wrist fixed onto a custom-built device (Static Torque Model Vte-002R, Vine, Japan). The maximal voluntary isometric elbow flexion torque (MVT) was measured with the elbow flexed at 90°. A value of 110% MVT was calculated and shown on an oscilloscope as a target that was visually fed back to the subject. The subject was instructed to exceed the target value by using torque feedback. For non-visual feedback condition (nVFB), the subjects performed the same MVT task without VFB. Surface electromyographic signals (EMG) were recorded from the biceps brachii (BB) and brachioradialis (BR) muscles.

## Results

Figure 1 shows MVT of the subjects with and without VFB. Thirteen out of 15 subjects increased MVT by VFB. Both the peak and mean torque for 5seconds were significantly higher for VFB ($p<0.05$). The mean EMG amplitude of BB and BR during VFB condition was significantly higher than those in nVFB. Figure 2 shows the relationship between MVT and EMG amplitude of BB in VFB. The EMG amplitude of BB was correlated positively with MVT ($p<0.05$).

## Discussion

Our results suggest that VFB condition enhanced the subject's brain activation. It is possible that the brain activation is enhanced due to increasing motivation (Ikai & Steinhaus, 1961). Since the EMG signal is the final form of motor command, it is suggested that increasing MVT with VFB is due to the increased motor command to BB. It has been suggested that the right prefrontal cortex is related to the motivation in depressed patients (Elliot et al, 1997). Activation of the primary motor area that controls muscle activity is correlated with muscle force (Thickbloom et al, 1998). Based on these findings, it is suggested that the VFB condition increased activation of the right prefrontal cortex that augmented activation of the primary motor area for BB.

## References


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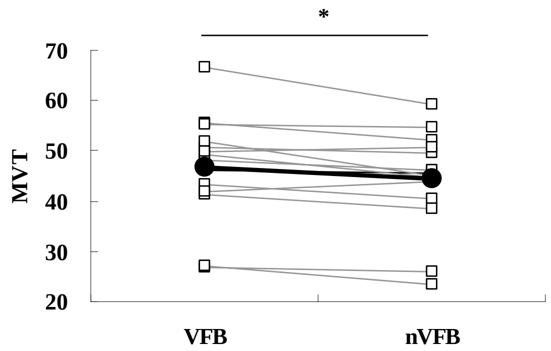


Figure 1: Mean maximal voluntary elbow flexion torque (MVT) of all subjects in VFB (left) and nVFB (right). MVT in VFB was significantly higher than nVFB ($p<0.05$).

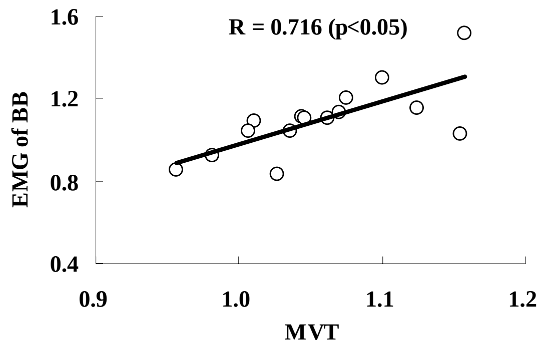


Figure 2: The relationship between relative MVT and EMG activity. The MVT and EMG amplitude in VFB condition was normalized to those in nVFB.