VARIATION IN REACTION TIMES & ACTIVATION PATTERNS BETWEEN DIFFERENT MUSCLE GROUPS

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INTRODUCTION

Reaction time (RT) is dependent on several factors. The contribution of stages such as afferent and efferent conduction times and the delay between the onset of muscle action potentials and contraction have been considered in investigations of reflexes [1]. The different conduction times and muscle fibre activation times have a marked effect on the duration of reflexes. Little research has evaluated RTs involved with different muscle groups. It would appear reasonable to assume that the distance an action potential must travel and the properties of the muscles it is innervating play an important role in a similar way to reflexes. This study aimed to evaluate RTs and activation patterns between various muscles groups.

METHODS

Seven healthy adults gave informed consent (age 27 ± 4 years). Surface EMG was recorded from 7 upper body muscles: deltoideus p. acromialis (DPA), deltoideus p. scapularis (DPS), pectoralis major (PEC), biceps (BB), triceps (TB), flexor carpus ulnaris (FCU), interosseus (INT), whilst the subjects performed simple RT tests. Seven different conditions were utilized, each designed to use a different muscle group as the primary agonist in each test. Examples of 6 tests are shown in Figure 1. For each trial an LED was randomly activated with a remote control within a 10 second period following a warning. The response was measured with a force transducer. EMG, force and LED trigger data were collected through a common ADC at 1000 Hz. Force and EMG onset were determined automatically when the value exceeded 3 stdev of the resting level. A simple computer RT test was also included. T-test and ANOVA were used with a significance level of $p = 0.05$.

RESULTS AND DISCUSSION

The standard deviation of mean RTs within subject muscle group trials was on average 35 ms (not presented in Table 1). Variability, Stdev in Table 1, was significantly greater between the same muscle for different subjects than different muscles for a subject. There was generally no correlation, $R^2 < 0.2$ between the force RTs and the computer tests, although for INT Vs computer $R^2 = 0.3$. More athletic subjects, (1-3, self reported) had the lowest average force measured RTs and these were lower than the computer test times. For the other subjects the computer tests gave lower RTs than the average of the force tests.

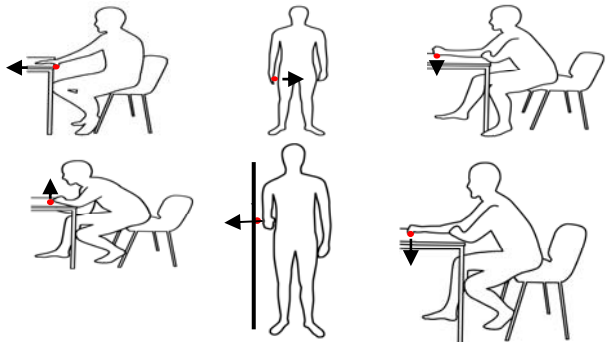

Figure 1: Illustration of movements to test specific muscles (top left clockwise: INT, PEC, TB, FCU, DPA, BB)

For each movement of each subject the EMG onset time was regressed against muscle, in a proximal to distal order, once the primary antagonist had been removed. Across all subjects INT and FCU movements generally had flat profiles while the larger muscles typically had obvious positive gradients, with some significantly different from INT and FCU (Figure 2). This variation in activation pattern with preferred primary agonist could indicate that a stabilizing sequence of events occurred with larger muscle groups that was not required for well supported movements of the hand. Differences in activation pattern with RT and athleticism need further quantifying from this data.

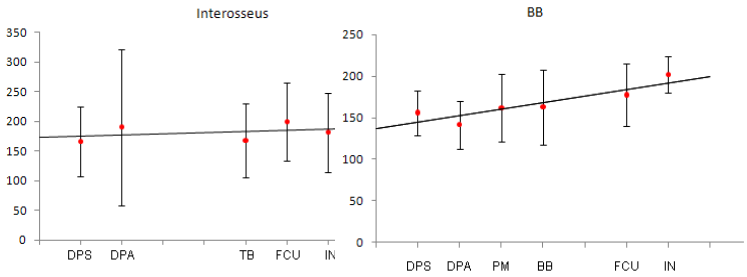

Figure 2. Activation time Vs. muscle group for 2 conditions.

CONCLUSIONS

Inference of RT in athletic activities from computer tests may not be wholly justified as different muscles have different reaction times and coordination patterns.

REFERENCES

1. Holmes, O. *Human Physiology*, London: Chapman & Hall, 1993.

Table 1: Mean reaction times per 10 trials, for all muscle groups and the computer tests, per subject.

	Reaction times (milliseconds)									
Subject	PEC	DPA	DPS	BB	TB	FCU	INT	Ave	Stdev	Comp
1	**210**	**157**	**180**	**162**	**170**	**172**	**170**	*174*	*17*	**231**
2	**173**	**214**	**203**	**186**	**188**	**184**	**165**	*188*	*17*	**188**
3	**231**	**251**	**X**	**209**	**196**	**203**	**212**	*217*	*20*	**242**
4	**231**	**191**	**221**	**216**	**227**	**210**	**224**	*217*	*13*	**199**
5	**229**	**252**	**225**	**217**	**X**	**214**	**203**	*223*	*17*	**219**
6	**277**	**253**	**221**	**208**	**252**	**248**	**209**	*238*	*26*	**186**
7	**340**	**330**	**322**	**329**	**304**	**232**	**209**	*308*	*37*	**256**
Ave	*242*	*235*	*229*	*218*	*223*	*209*	*212*			*217*
Stdev	*53*	*55*	*49*	*53*	*49*	*26*	*44*			*27*