

# Relationship between playing strategy and surface electromyograms in playing drums

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Skills in controlling drumsticks correctly are required to play rhythms without making any mistakes at suitably dynamic levels of sound. Results obtained by analyzing drummers' movements using visual information, such as motion capture or camera recordings, have been reported in past studies, but analysis using biological information has been the focus of fewer studies. To play rhythms without making mistakes at suitably dynamic levels of sound throughout a piece of music, trained drummers are assumed to use different playing strategies: a short-term playing strategy (e.g. every stroke) and a long-term playing strategy (e.g. every piece of music). The aim of this study was to investigate the relationship between trained drummers' playing strategies and muscle movements by recording their surface electromyograms (EMGs) when playing the drums. Three trained drummers and three non-drummers participated in an experiment to record their surface EMGs when playing single-strokes. As a result, it was confirmed that trained drummers play the drums under both short-term and long-term playing strategies.

*Keywords:* electromyogram; drums; strain and laxity; movement analysis; playing strategy

In drumming, the skill of controlling drumsticks correctly is required to play rhythms without making any mistakes at suitable dynamic levels of sound. Results of analysis concerning drummers' movements from visual information, such as motion capture or camera recordings, have been reported in past studies (e.g. Dahl 2006), but analysis using biological information has been studied much less. Movements of arms and hands when playing the drums are understood to be complex, so the actual way muscles control these movements has not been clarified. To play rhythms without making mistakes at

suitable dynamic levels of sound throughout a piece of music, a drummer needs to consider how to perform. Such consideration is called a “playing strategy.” Trained drummers are thought to have different playing strategies: a short-term playing strategy (e.g. every stroke) and a long-term playing strategy (e.g. every excerpt). In addition, a playing strategy is based on a drummer’s skill and experience, so it is implemented with or without a drummer being conscious of it. The aim of this study was to investigate the relationship between trained drummers’ playing strategies and muscle movements by recording their surface electromyograms (EMGs) when playing the drums. The amount of EMG signals is proportional to the amount of muscle strain. Therefore, by analyzing the EMGs of arms and hands when playing the drums, it is possible to investigate the way arms and hands control drumsticks, in terms of muscle laxity and strain. In addition, by recording the EMGs, information can be obtained about drummers’ conscious and unconscious movements, so analyzing the EMGs is thought to be suitable for investigating drummers’ playing strategies.

## METHOD

### Participants

Three trained drummers and three non-drummers participated in an experiment to record their surface EMGs when playing single-strokes under three different tempi of 80, 100, and 120 bpm. All the participants were right-handed.

### Procedure

They were asked to play four beats for three minutes under the tempi denoted above. The musical score played in this experiment is shown in Figure 1. All the participants were allowed to rest for a minimum of one minute after each performance. The flexor carpi ulnaris muscle of both arms, extensor carpi ulnaris muscle of both arms, metronome signal, and oscillation of drumhead were all measured. The movement of flexor carpi ulnaris muscle corresponds to the movement of bending the wrist forward, and the movement of extensor carpi ulnaris muscle corresponds to the movement of bending the wrist backward.



Figure 1. The musical score.

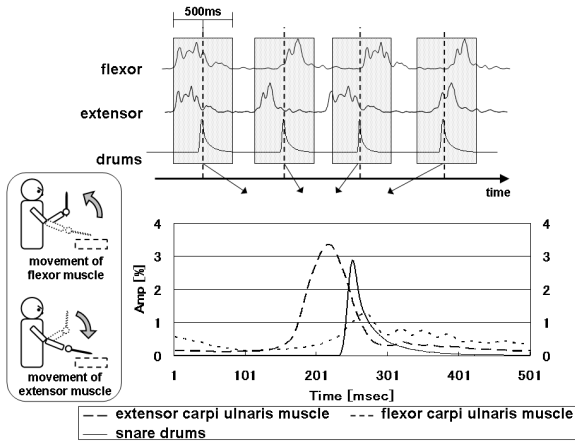


Figure 2. Example of one-stroke mean EMG.

## RESULTS

To investigate the relationship between playing strategies and muscle movements, the short-term and long-term playing strategies were individually analyzed.

### Short-term playing strategy

To analyze the short-term playing strategy, mean EMG of the range of around 500 ms centered at the time a drumstick strikes a drum is called “one-stroke mean EMG” and is compared among each measured muscle and each drummer (see Figure 2). The results of the analysis of one-stroke mean EMG are shown in Tables 1 and 2. Table 1 shows the results of a comparison between the one-stroke mean EMGs of the flexor carpi ulnaris muscles and those of extensor carpi ulnaris muscles for all participants. Table 2 shows the styles of arm movement in terms of muscle for each participant. Table 2 confirms that significant differences in the one-stroke mean EMG of all participants’ extensor carpi ulnaris muscles are less/more than those of flexor carpi ulnaris muscles. “Flexor dominance” is when the one-stroke mean EMG of the extensor carpi ulnaris muscle is less than that of the flexor carpi ulnaris muscle. “Extensor dominance” meanwhile is when the one-stroke mean EMG of the flexor carpi ulnaris muscle is less than that of the extensor carpi ulnaris muscle.

*Table 1.* Results of comparison between one-stroke mean EMG of flexor carpi ulnaris muscle and one-stroke mean EMG of extensor carpi ulnaris muscle.

<i>Player</i>	<i>Tempo (bpm)</i>	<i>Left arm</i>	<i>Right arm</i>
D1	80	flexor>extensor**	flexor>extensor**
	100	flexor>extensor**	flexor>extensor**
	120	flexor>extensor**	flexor>extensor**
D2	80	flexor>extensor**	flexor>extensor**
	100	flexor>extensor*	flexor>extensor**
	120	-	flexor>extensor**
D3	80	flexor<extensor**	flexor<extensor**
	100	flexor<extensor**	flexor<extensor**
	120	flexor<extensor**	flexor<extensor**
ND1	80	flexor<extensor**	flexor>extensor**
	100	flexor<extensor**	flexor<extensor**
	120	flexor<extensor**	-
ND2	80	flexor<extensor**	flexor<extensor**
	100	flexor<extensor**	flexor<extensor**
	120	flexor<extensor**	-
ND3	80	flexor<extensor**	flexor<extensor**
	100	flexor<extensor**	flexor<extensor**
	120	flexor<extensor**	flexor<extensor**

*Note.* \*\*= $p < 0.01$ , \*= $p < 0.05$ , - =not significant.

## DISCUSSION

### Short-term playing strategy

Tables 1 and 2 confirm that four players have the same style of motor control in both arms. Specifically, all trained drummers have this feature, whereas just one non-drummer has it, indicating that trained drummers use the same style of motor control in both arms when playing the drums. Conforming right arm movements to left arm movements is thought to be essential to play the drums without making mistakes throughout a piece of music. In short, trained drummers play drums with the same style of motor control in both arms under the short-term playing strategy.

### Long-term playing strategy

Table 3 confirms that non-drummers' mean EMGs during the last one minute were significantly higher than those of the first one minute. Such results were

Table 2. Style of arm movement (flexor dominance or extensor dominance).

<i>Player</i>	<i>Left arm</i>	<i>Right arm</i>
D1	flexor dominance	extensor dominance
D2	flexor dominance	extensor dominance
D3	extensor dominance	extensor dominance
ND1	extensor dominance	-
ND2	flexor dominance	extensor dominance
ND3	extensor dominance	extensor dominance

Table 3. Results of comparison between mean EMGs during first and last one minute.

<i>Player</i>	<i>Tempo (bpm)</i>	<i>Flexor of left arm</i>	<i>Extensor of left arm</i>	<i>Flexor of right arm</i>	<i>Extensor of right arm</i>
D1	80	**	**	**	-
	100	**	-	-	-
	120	-	*	*	*
D2	80	-	*	-	**
	100	-	*	-	**
	120	**	**	**	**
D3	80	-	-	-	-
	100	-	**	-	-
	120	-	-	**	-
ND1	80	*	**	*	**
	100	-	**	-	*
	120	**	*	*	**
ND2	80	*	**	-	**
	100	-	**	-	**
	120	**	**	*	*
ND3	80	*	**	-	*
	100	**	-	**	-
	120	-	-	**	*

Note. \*\*= $p < 0.01$ , \*= $p < 0.05$ , - =not significant. Ratio of significant differences for D1, D2, and D3=17/36 (42%). Ratio of significant differences for ND1, ND2, and ND3=26/36 (72%).

obtained only for the non-drummers. This demonstrates that only non-drummers' mean EMGs during the last one minute were significantly higher than those of the first one minute, indicating that trained drummers are suffi-

ciently relaxed when playing the drums throughout a piece of music. That is to say, trained drummers play the drums with less strain in terms of muscle control under the long-term playing strategy.

### **Acknowledgments**

This study was partly supported by the High-Tech Research Center Project for Private Universities matching fund subsidy from the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and Research for Promoting Technological Seeds from the Japan Science and Technology Agency (JST).

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