THE DISCRIMINATION OF BARBELL WEIGHT FOR WEIGHTLIFTERS

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Ten college weightlifters were recruited in this study. The standard barbell weight (Ws) of each participant was set at 80% of personal best snatch record. The test barbell weights that include Ws, Ws±1kg, Ws±2kg, and Ws±5kg were given randomly, then each lifter was asked to identify the difference between the test weight and standard weight. The discrimination was over 86% when the test weight was Ws±5kg. For the test weight equal to the standard weight, the discrimination was significantly less than that of other test weights (p<.01). Based on the results, the weightlifter seems to have good discrimination in the barbell mass at the difference of 5 kg. It seems that they could not be aware of the slight difference (ex: less than 2kg) of barbell mass by 80% of their best snatch record.

KEY WORDS: snatch, first pull, paired comparison, relative barbell mass

INTRODUCTION: Taiwanese female weightlifter Su-Ching Hsu broke the world record and won the golden medals of 53 kg category at the Asian Games 2014 in Incheon. Hsu lifted record-breaking clean & jerk 132 kg at the last attempt. She lifted the barbell mass that she had never tried before, neither at practice nor at competition. From the interview of both Hsu and her coach, Hsu didn't know the exact barbell mass before going last record-breaking clean & jerk attempt. In other words, Hsu seemed to have good discrimination of barbell mass after lifting the barbell off and perceived that how much force she needs to snatch the barbell successfully. This ability is especially important in snatch for weightlifters because inappropriate force would cause the barbell fall down anteriorly or posteriorly, which results in fail attempt. Elite weightlifters seem to have good discrimination of barbell weight, the ability that the coach called it "the lifter's domination on barbell mass".

Since the 2005 IWF (International Weightlifting Federation) Youth World Championships, the mass of the barbell has added with the minimum increment of 1 kg instead of 2.5 kg in the competition. This change has made the barbell mass discrimination more important for the weightlifters and also challenged the coach to determine the barbell mass of the lifter's first attempt more precisely.

Previous studies have shown that the discrimination of small weight for normal people. Norman et al. (2009) used 2-alternative forced-choice method to obtain the thresholds of twelve youngers and twelve elders for lifting weights compared with the standard weight. The standard weight was 100g, test weight were from 85 to 115g. The results showed that the average threshold of the elder was 57.6% greater than that of the younger. Holmin et al. (2012) used weight compared-ratio estimation test for seventeen elders and seventeen youngers to evaluate the ability in discriminating small weights. For each judgement, participant could lift up the objects in any directions up to 30 seconds by finger and forearm with elbow on the table to estimate the weight ratio of each paired test weight. Researchers found that the elder had less accuracy than the younger. Participants could not discriminate from visual information (e.g., the volume of the objects) in those two studies. There were also some studies discussed the impact of visual information on discrimination in weight, however the test weight were relatively light and tested by lifting task with fingers (Chouinard et al., 2009). There has been no any study to examine the discrimination in heavy weight, such as the barbell in weightlifting.

The purpose of this study was to assess the discrimination of barbell mass for weightlifters. The hypothesis of this study is that the weightlifter that has better snatch performance would have better discrimination of barbell mass.

METHODS: Ten college weightlifters participated in this experiment. Eight were male (age: 21.3±3.0 years, height: 166.9±5.7cm, body weight: 97.1±20.1 kg and snatch experience: 7.1±1.9 years) and two were female (ages: 19.5±0.7 years, height: 157.5±6.4cm, weight: 64.0±8.5 kg and experience: 7.5±2.1 years). All participants had no severe musculoskeletal injury history and free of injury within the testing sessions. This study has been approved by the local ethics committee and all participants signed informed consent before the test.

On any given trial, a weightlifter consecutively lifted the standard barbell weight and test barbell weight. In each lift, the participant set up at ready position to snatch and then lifted the barbell off to floor until the knee height, then put down the barbell slowly (Figure 1). After lifting the standard and test weight, the lifter was asked to indicate the test weight was heavier, lighter than, or equal to standard weight. The number of lifts for test weight was also recoded. The standard weight (Ws) of each lifter was set at 80% of personal best snatch performance weight, which was 89±19 kg for all lifters. The test weights include Ws, Ws±1kg, Ws±2kg, and Ws±5kg. To prevent from seeing the barbell during lifting, lifters were asked to put on taped laboratory goggles during the tests.

Each lifter should complete five sessions. In each session, subject would lift the standard weight for several times as a warm-up and getting familiar with barbell-lifting movement. No more than the test weight ranged from Ws-5kg to Ws+5kg was notified to the lifter. Totally seven test weights were given in a random sequence (Figure 2). For each comparison trial, the lifter performed at most five lifts for both Ws and Wt. In total, each subject had to complete 35 comparison trials (7 trials × 5 sessions) for each test weight in this experiment. The time of changing bumper plates was about 20-30 seconds. The rest time between each comparison trial was about 3-5 minutes, depends on the participant. Considering the daily training session and preventing the effect of fatigue, the five sessions were completed on 3 or 5 different days.

Relative barbell mass (RBM) was applied to evaluate and compare the performance between different classes of lifters. RBM was defined as the ratio of personal best snatch performance to the lifter's body weight (Chiu et al., 2010).

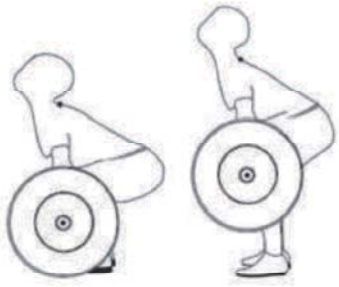

Figure 1: The barbell lifting task in this experiment.

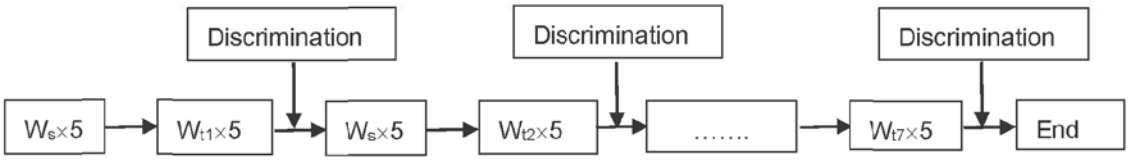

Figure 2: The protocol of the experiment for each session. Each lifter should complete five sessions.

One-way ANOVA was applied to compare the correct judgement percentage under lifting the different test weights. Linear regression was used to describe the trend in correct percentage of discrimination over RBM. Statistical significance was set at $p < .05$.

RESULTS: Figure 3 presents the data of the discrimination of each test weight for the lifters. The discrimination was more than 86% in lifting the test weight of Ws±5kg. Under the test weight equal to standard weight, the discrimination was significantly less than that of other test weight conditions (p<.01). For lifting test weight of Ws±1kg or Ws±2kg, the correct percentage was by 60%, which was close to randomly guessing probability. These results suggest that the weight difference less than 2 kg is not perceptible for the weightlifters.
There was no significant difference for the number of lifts under lifting each test weight, indicating no appreciable relationship between lifts and barbell weight. The slope of linear regression for the relationship of the RBM and correct percentage of judgement was not significantly different from zero (Table 1).

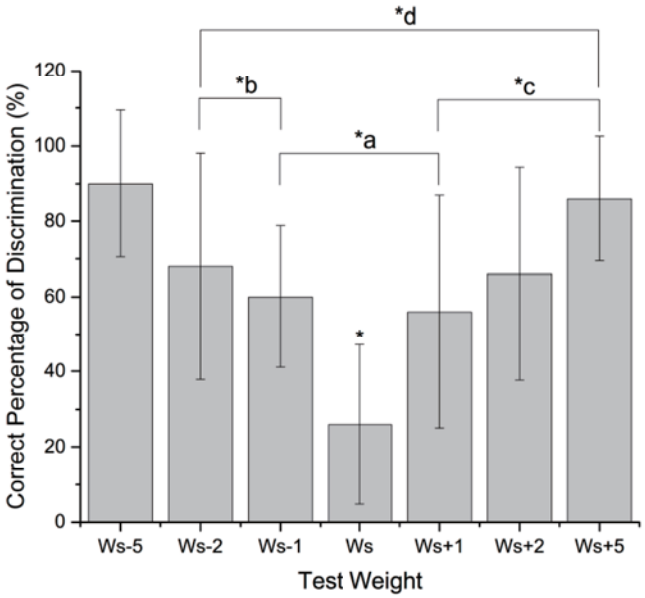

Figure 3: The correct percentage of discrimination in each test weight.
***: p<.01, *a: p=.007, *b: p=.018, *c: p=.007, *d: p=.018**

Table 1
Relationship of Correct Percentage and RBM

Test weight	r^2	p
Ws-5	.302	.100
Ws-2	.032	.622
Ws-1	.094	.388
Ws	.003	.881
Ws+1	.244	.147
Ws+2	.027	.648
Ws+5	.094	.388

DISCUSSION: The discrimination over 80% indicates that the lifter could make correct judgement over 4 times in totally 5 trials. The result implied that the difference of 5 kg

between Ws and Wt is perceptible for the weightlifters. As the difference of test weight from the standard weight of 80% personal best snatch performance reduced to less than 2 kg, the lifters couldn't be aware of the slight difference of barbell weight.
The regression results indicated that the null hypothesis cannot be rejected. A possible explanation for these results is that the discrimination is not so precise in relative lighter barbell mass, for example 80% of the personal best snatch record, for weightlifters. Usually, the first snatch attempt in weightlifting competition sets at 90% of personal best performance. If the standard weight is closer to the competition situation, the lifters perhaps could have better discrimination of the barbell mass.

CONCLUSION: This study investigated the discrimination of barbell mass for the weightlifters. Based on the results, the weightlifter seems to have good discrimination in the barbell mass at the difference of 5 kg. The lifters could not be aware of the slight difference (ex: less than 2kg) of barbell mass by 80% of their best snatch record. Future research should set the standard barbell weight at 90% of personal best snatch performance that mimics the first attempt of real competition.

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