

Influence of Positive Psychological Factors on Bench Press Performance using EMG, IMUs, and VBT Technology

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Abstract

Investigating the psychological influences of music and verbal encouragement on bench press performance in five participants, utilizing Electromyography (EMG), Inertial Measurement Units (IMUs), and a Velocity Based Training device (VBT).

1 Introduction

This study explores the impact of music and verbal encouragement on bench press performance using EMG, IMUs, and VBT. Our analysis aims to investigate the contributions of auditory and verbal cues to muscular engagement and overall bench press efficacy. This investigation contributes insights to the exercise science field, guiding individuals aiming to optimize resistance training or athletic performance.

2 Design

Participants were familiarized with the equipment and performed 2 sets of 8 repetitions of a bench press. Each participant completed repetitions at a 70% percentage of their one-repetition maximum (1RM) to standardize the intensity of the exercise across participants.

2.1 Bench Press Protocol:

Warm-up: Participants underwent a standardized routine, completing ten unweighted barbell bench press repetitions to activate musculature and establish a baseline physiological state, ensuring data accuracy and reproducibility.

Experimental Conditions: The normal set was executed without music, verbal encouragement, or a spotter, in contrast to the encouragement set which incorporated these elements. The normal set preceded the encouragement set, with an 10-minute rest period between the two.

Participants: Five healthy, recreationally active adults (20-36 years) who autonomously selected their music for their respective encouragement sets.[1]

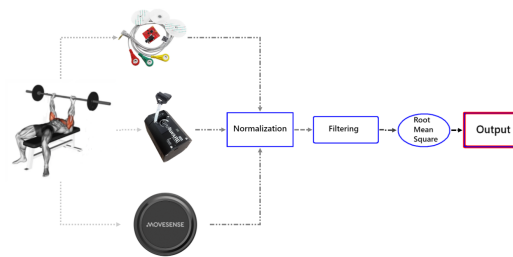


Figure 2.1: Flow Diagram

2.2 Evaluation

- Six EMG sensors were used – two for each pair of triceps (long head), shoulders (anterior deltoid), and chest (pectoralis major) muscle.
- The IMU was positioned on the bar to capture acceleration data along the z-axis, representing the vertical dimension or the up-and-down motion of the barbell.
- The VBT system measured the barbell velocity throughout the bench press by connecting the VBT cable to the end of the barbell.

2.3 Data Collection and Analysis:

Data was processed using manufacturer software. VBT, IMUs, and EMG data was recorded simultaneously during the protocol.

Barbell velocity, acceleration, and EMG data underwent normalization, filtration, and root mean square analysis, followed by Python analysis using pandas, numpy, and matplotlib libraries.

3 Results

3.1 VBT:

VBT data revealed a consistent pattern where average bar speed in normal sets trailed behind encouragement sets. Notably, during the third and fourth repetitions of encouragement sets, the average barbell speed either matched or exceeded the second set average speed of the normal protocol. See Figure 3.1 for the average barbell speed.

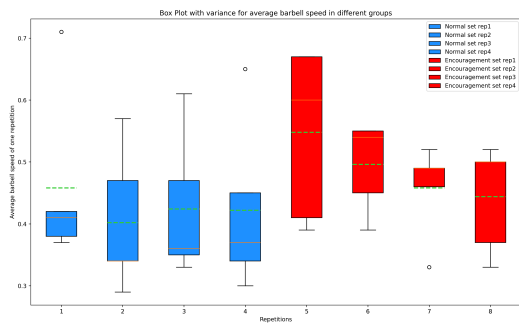


Figure 3.1: Average Bar Speed Across 5 Participants

3.2 IMU:

Based on the IMU data, the normal set took longer on average than the encouragement set, with the latter completing the sets 40% faster. Additionally, there's a contrast in peak acceleration, reflecting a larger explosiveness and force exerted during the encouragement set.

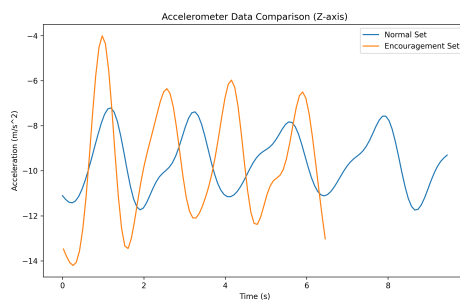


Figure 3.2: Accelerometer Data Comparing Normal and Encouragement Set

IMU data related to z-axis acceleration, confirms a larger muscular activation in Encouragement set compared to Normal set. The range of acceleration on the z-axis by Encouragement set is approximately 15.8 cm/s^2 , whereas the acceleration for Normal set at approximately 8.7 cm/s^2 .

3.3 EMG

As for the EMG data, greater muscle activation could be perceived through the mean values of the 4 repetitions cycle on each of the test subjects. For 3 out of 5 subjects, the mean value of the encouragement set was superior than the mean of the normal set. For 1 out of 5 it was around the same as the mean of the normal set and for the remaining was lower than the normal set. The behaviour in the encouragement set seems that the muscle activation of each contraction is wider or less variable throughout the cycle of repetitions, which makes it appear that each contraction gathers the muscles (PM, DA, TB) to last longer or to make them contract in a more synchronized manner. One clear example of this

effect could be appreciated in the figure 3.3 between the 5% and 20% of the cycle.

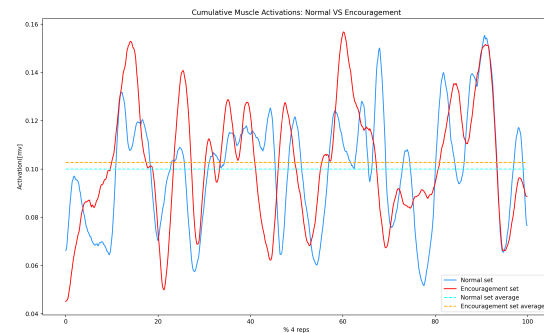


Figure 3.3: Muscle Activation for a Test Subject in Normal and Encouragement Set

4 Conclusion

Our investigation into the impact of verbal encouragement, music, and a spotter during bench press exercises seems to reveal an influence on resistance training.

The results from the synchronized data acquisition enabled a comprehensive analysis of the interplay between external stimuli and muscle activity and show enhanced performance, suggesting a positive influence from the encouragement factors.

Our results revealed how positive psychological factors were observed to significantly enhance performance, particularly becoming evident after the third repetition where participants exhibited increased bar speed and improved motion metrics. These results underscore the potential benefits of integrating both verbal encouragement and music into bench press routines, emphasizing their synergistic effects in promoting sustained effort and performance gains, particularly during more challenging phases of the exercise.

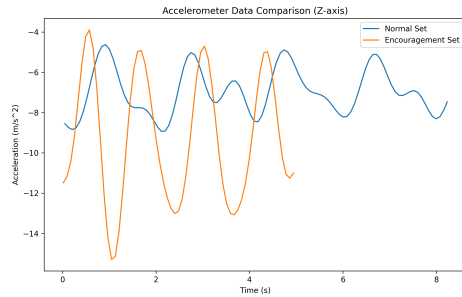
Our EMG results may indicate positive psychological factors can increase muscle activity. Another interesting finding of these EMG measures is that for the peak values in both sets, there is no significant difference.

Subsequent studies could explore larger sample sizes or randomized control groups, alternately assigning normal and encouragement sets as the first set. This design could explore whether encouragement influenced performance or this was a placebo effect. Alternatively, further studies could explore whether music, verbal encouragement, and the presence of a spotter contribute equally, or if some exhibit stronger correlations with positive athletic performance than others. Our findings underscore the importance of motivation and advocate for a combined approach integrating personalized motivational strategies, such as auditory and social cues, for increased performance and refine personalized training strategies for optimizing results.

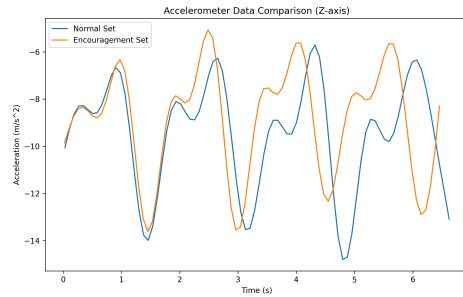
5 References

- [1] C. G. B. A. J. Pearce, "The influence of music preference on exercise responses and performance: A review," *Journal of Functional Morphology and Kinesiology*, p. 33, 2021.

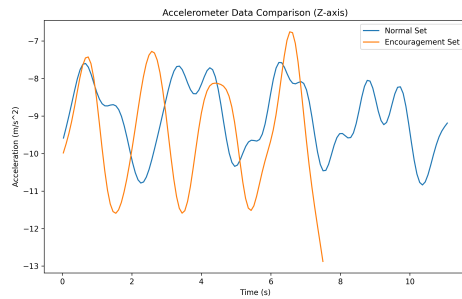
A Appendix



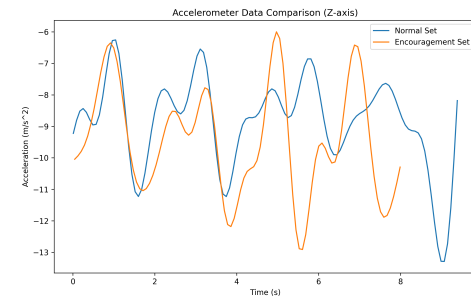
(a) Accelerometer data for a test subject# 2 in normal and encouragement set



(b) Accelerometer data for a test subject# 3 in normal and encouragement set

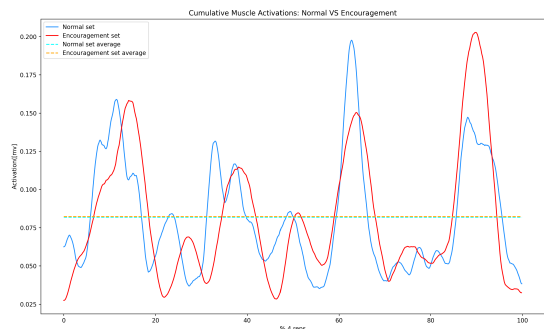


(c) Accelerometer data for a test subject# 4 in normal and encouragement set

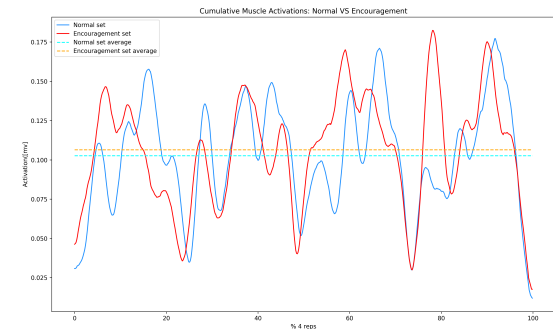


(d) Accelerometer data for a test subject# 5 in normal and encouragement set

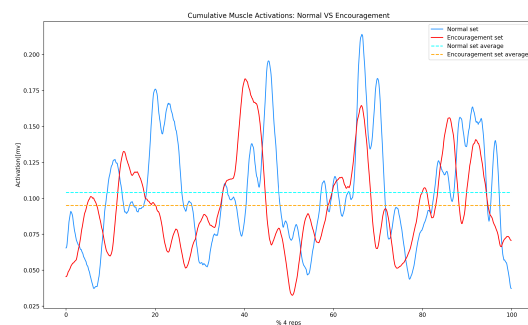
Figure A.1: Accelerometer Data Comparison between Normal Set and Experiment Set



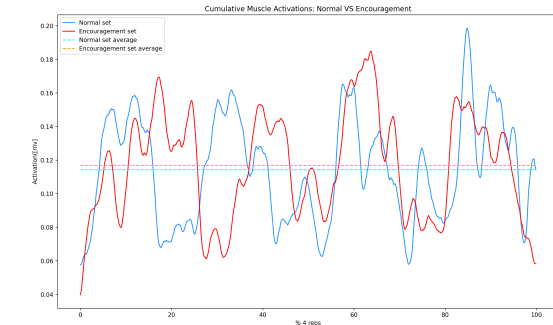
(a) Muscle activation for a test subject# 2 in normal and encouragement set



(b) Muscle activation for a test subject# 3 in normal and encouragement set



(c) Muscle activation for a test subject# 4 in normal and encouragement set



(d) Muscle activation for a test subject# 5 in normal and encouragement set

Figure A.2: EMG Data Comparison between Normal Set and Experiment Set

A.1 Instructions

- 1) Position yourself at eye level with the barbell. Open your legs at a 45-degree angle.
- 2) Most of your back must touch the seat during bench press. A big arch like this, although it is being used at powerlifting, is for a shorter range of motion that doesn't have the highest chest muscles activation.
- 3) Grasp the barbell with a wider than shoulder-width grip, wrapping your thumbs around the bar. Hold the barbell at arm's length above your upper chest area. (1*)
- 4) A spotter will help you with unloading the weight.

1. During the eccentric phase inhale.
2. The isometric position is the hardest one requiring your maximal effort.
3. During the concentric phase you will have to exhale and try to push as much as you can.
4. You succeed in the lift once you reach the point that you started from in fully flexed arms.
- 5) You succeed in the lift once you reach the point that you started from in fully flexed arms.

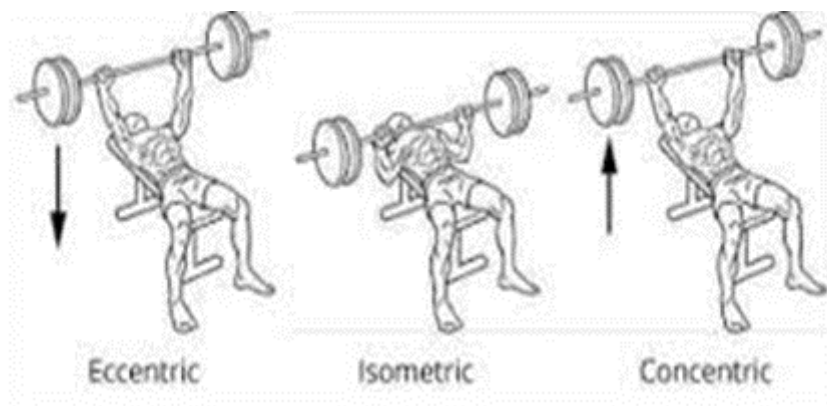


Figure A.3

subject number	1RM[kg]	70% 1RM[kg]
1	80	55
2	85	60
3	80	55
4	85	60
5	90	65

Table A.1: Barbell weight