

PAPER • OPEN ACCESS

The Effects of Focus Attention Instructions on the Movement Kinetics, Muscle Activation and Performance during Resistance Exercise

To cite this article: Ali Md Nadzalan *et al* 2020 *J. Phys.: Conf. Ser.* **1529** 022008

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

The Effects of Focus Attention Instructions on the Movement Kinetics, Muscle Activation and Performance during Resistance Exercise

Ali Md Nadzalan¹, Jeffrey Low Fook Lee¹, Nur Ikhwan Mohamad¹, Mohamad Shahrul Azzfar¹, Nor Fazila Abd Malek¹ & Ebby Waqqash²

¹Faculty of Sports Science and Coaching, Sultan Idris Education University, Perak, Malaysia

²Centre for Sport & Exercise Sciences, University Malaya, Kuala Lumpur, Malaysia

ali.nadzalan@fsskj.upsi.edu.my

Abstract. The aim of this study was to compare kinetics, muscle activation and performance during resistance exercises between internal focus attention instructions, external focus attention instructions and control condition. Thirty ($n = 30$, mean age = 21.40 ± 0.93 years old) healthy men were recruited as participants and were asked to perform resistance exercises in three conditions; i) internal focus, ii) external focus and iii) control (no focus attention instruction). Participants performed 10RM squat and deadlift assessment in which kinetics, muscle activation and number of repetitions completed were recorded and analyzed during the exercises. Findings of this study revealed that external focus attention instruction produced greater force production and number of repetitions completed while at the same time lower muscle activity compared to the internal focus conditions. To conclude, external focus attention instructions were suggested to be adopted during resistance training due to its effectiveness to make movement more economic while producing greater performance in which will be more advantages for future adaptations.

1. Introduction

Verbal instruction is one of the teaching approaches used during resistance training session. Using verbal instructions, instructor (i.e. coaches, personal trainers, and lecturers) can provide information on what the individuals (i.e. athletes, clients, students) need to do during the resistance training session/class to enhance their exercise techniques while at the same time to improve their ability in performing the exercises. An effective verbal instruction is believed to benefit an individual's progression whilst ineffective instructions might possibly impair the learning process that will result in undesirable outcomes in mastering the exercise techniques.

Wulf [1] found the performance of a task was influenced by the direction of focus attention during performing the task. Athletes were found not to choose or learn the most effective focus of attention, instead, they were prone to give their attention based on what the coach instruct [2]. Therefore, it can be concluded here that the verbal instructions provided by the instructor will play a big role by influencing the individuals' direction of focus attention that will next might affect the task outcome.



What is actually a focus attention? Focus attention refers to what an individual choose to focus while executing a task. Based on Makaruk and Porter [3], individuals tend to focus their attention to three directions; neutral, external or internal. Focusing on the movement effects or environment specific features is what we termed as external focus. Meanwhile, focusing on own body parts is what we termed as internal focus attention. On the other hand, neutral focus attention refer to an unconsciously focus on anything during task/skill execution. Internal focus type of instructions has been the normal form of instruction utilised by instructors as well as in the literature on physical conditioning.

The advantages of external focus compared to internal focus has been referred to the constrained action hypothesis [4, 5]. Based on this hypothesis, individual will perform better if they direct their focus attention to the movement effect. In contrast, directing focus internally will cause individual to consciously manage their own movements, in which will make the motor system constraint and next will unintentionally affected the autonomic control processes.

Despite has been proven in several studies that directing focus externally provide more benefits in many tasks, there had been also study that demonstrate the effectiveness of internal focus in improving task performance especially among the novice [6].

Resistance training is a form of training mainly done to improve muscle strength, hypertrophy, power and muscular endurance. Researches investigating the way to improve resistance training effectiveness have increased from time to time to various populations [7-12]. Not to be exempt is how manipulating the focus attention affects the performance in resistance training [13-18]. The knowledge is needed as resistance training requires the performer to not only have the strength, but the techniques need to be performed correctly as fault techniques may lead to injuries. Currently, not much study has been conducted on the biomechanical responses of different focus attention during resistance exercises.

Questions exist whether are there any differences of kinetics, muscle activation and performance between internal and external focus attention. The objective of this study was to compare kinetics, muscle activation and number of repetitions between internal and external focus attention. In addition, this study also compared the focus attentions instructions with the neutral focus attention (will be termed as control condition), to look if there is a possibility the performance would be better without any focus attention instructions. The findings of this study will provide information on the teaching/coaching methodology to improve individual's acute ability in mastering a skill or technique.

2. Methodology

2.1. Participants

This research involved male students (age: 20-25 years old) that enrolled in resistance training class that volunteered to participate in this study (N = 30). At the time of testing, all participants should be able to perform all the exercises involved with correct technique. Physical activity readiness questionnaire (PAR-Q) was used to screen the ability of participation. Each participant should read and signed an informed consent before data collection. All participants were informed that they were allowed to withdraw from the study without having to give any justification.

2.2. 1-RM test

One repetition maximum (1RM) test was conducted to obtain the maximum loadings that the participants can lift during both squat and deadlift exercises. This test is important, as the loadings that the participants need to lift during the data collection will be 80% from the 1RM value. The procedures of this 1RM test was based on the guidelines provided by the National Strength and Conditioning Association (NSCA) [19].

2.3. Deadlift and Squat Test

Deadlift and squat were performed using a barbell and weight plates. The weights of barbells and weight plates were measured before data collection. The basic procedures of squat and deadlift exercise were referred from NSCA manual [20]. All the focus conditions (internal, external and control) were given common task instruction that is ‘perform as many repetitions as you can’. For deadlift, during both external and internal focus condition, participants were given additional instructions; i) external focus: “focus your attention on pulling the bar up”, ii) internal focus: “focus your attention on extending your knees and hips”. Participants were asked to follow the instructions during performing both tasks. The instructions were given verbally prior the tasks execution. During performing both tasks, as participants were seem to achieve failure, they were provided with additional instructions; i) external focus: “pull the bar up”, ii) internal focus: “extend your knees and hips”. This is a way to ensure that they still giving their focus to the supposed direction.

Squat exercise testing was conducted similar to deadlift. As additional to the general instruction “perform as many repetitions as you can”, during both internal and external focus condition, participants were given specific instruction; i) external focus: “Focus on moving and exerting force through and against the barbell”, ii) internal focus: “Focus on moving and exerting force with your legs”. As participants were seem to achieved failure, participants were instructed to; i) “push the bar up” for the external focus and, ii) internal focus: “extend your knees and hips”.

2.4. EMG Collection and Analysis

Wireless Trigno Delsys electromyogram (EMG) was used to record EMG signals from vastus lateralis and biceps femoris muscles based on the surfaces EMG for non-invasive assessment of muscles (SENIAM) guidelines [21]. Recorded signals were fully-wave rectified and filtered using a dual-pass, sixth-order, 10-500 Hz band-pass Butterworth filter, and then a linear envelope were created using a low-pass, second order Butterworth filter with a cut-off frequency of 6 Hz. EMG signals were recorded from the start until the end of movement. The EMG value were reported as per maximum voluntary contraction (MVC).

2.5. Movement Kinetics

During the study, participants performed the squat and deadlift on tri-axial force platform (BP400600HF-2000, AMTI Inc., USA) (width: 400 mm X length: 600 mm X height: 82.5 mm). Data sampling rate were set at 200Hz with filter cut-off frequency rate of 10Hz. The kinetics data that were measured in this study were the concentric ground reaction force that was the average of force produced between the beginning of concentric phase and the end of concentric force.

2.6 Data Collection

The experiments were held at a well-equipped biomechanics laboratory. To ensure the study outcome (results) was from the study objectives (comparison of instruction and focus attention), participants were briefed about the purpose of the study before the data collection. During data collection, participants were given ten minutes of warm up which consist of light cardiovascular exercise and lifting 50% of the weight that should be lifted for each exercises. Only full repetitions were counted for data analysis.

2.7 Statistical Analysis

Physical characteristics and mean score were analysed using descriptive statistics while the comparison of kinetics, muscle activation and number of repetitions during squat and deadlift between the focus attention was analysed using repeated measures analysis of variances (ANOVA). Statistical significance were accepted at an α -level of $p \leq 0.05$. All statistical analyses were conducted using SPSS version 23 (IBM, New York, USA).

3. Results

3.1 Physical characteristics

Table 1. Physical Characteristics of Participants

Variables	Mean \pm SD
Age (years)	21.40 \pm 0.93
Body Mass (kg)	69.06 \pm 3.34
Height (cm)	172.80 \pm 3.50
Squat 1RM (kg)	106.17 \pm 13.12
Deadlift 1RM (kg)	122.78 \pm 13.33

Table 1 showed the physical characteristics (age, body mass, height, squat 1RM and deadlift 1RM) of participants involved in this study.

3.2 Muscle activation

The muscle activation data that were measured in this study were the average muscle activity of vastus lateralis and biceps femoris. Analysis of muscle activation showed significant main effects were found in: i) vastus lateralis during squat, $F(2,58) = 86.37$; $p = 0.000$, ii) biceps femoris during squat, $F(2,58) = 51.25$; $p = 0.000$, iii) vastus lateralis during deadlift, $F(2,58) = 95.13$; $p = 0.000$, and iv) biceps femoris during squat, $F(2,58) = 22.91$; $p = 0.000$.

Table 2. EMG data during squat and deadlift

Exercises	Muscles	Internal focus	External focus	Control Condition
Squat	VL (% MVIC)	110.60 \pm 8.14 ^{bc}	101.80 \pm 4.06 ^{ac}	104.80 \pm 5.22 ^{ab}
	BF (% MVIC)	67.90 \pm 4.03 ^{bc}	62.90 \pm 5.31 ^{ac}	65.10 \pm 4.67 ^{ab}
Deadlift	VL (% MVIC)	109.50 \pm 7.60 ^{bc}	100.00 \pm 4.92 ^{ac}	105.70 \pm 3.37 ^{ab}
	BF (% MVIC)	70.30 \pm 5.57 ^{bc}	67.90 \pm 5.18 ^a	68.40 \pm 3.35 ^a

^a = significantly difference from Internal Focus, $p < 0.05$

^b = significantly difference from External Focus, $p < 0.05$

^c = significantly difference from Control Condition, $p < 0.05$

Table 2 showed the EMG value during the two exercises' execution. During squat, results showed the EMG of vastus lateralis during internal focus was significantly greater compared to external focus ($p = 0.000$), and control condition ($p = 0.000$). External focus EMG was significantly lower compared to control condition ($p = 0.000$). EMG of biceps femoris during internal focus was also significantly greater compared to external focus ($p = 0.000$) and control condition ($p = 0.000$). External focus EMG was significantly lower compared to control condition ($p = 0.000$).

Similar to squat, during deadlift, results showed the EMG of vastus lateralis during internal focus was significantly greater compared to external focus ($p = 0.000$) and control condition ($p = 0.000$). External focus EMG was significantly lower compared to control condition ($p = 0.000$). EMG of biceps femoris during internal focus was also significantly greater compared to external focus ($p = 0.000$) and control condition ($p = 0.001$). External focus was not significantly different compared to control condition ($p = 0.636$).

3.3 Kinetics

The kinetics data that were measured in this study was the concentric ground reaction force (CGRF). CGRF was defined as the average of force produced between the beginning of concentric phase and the end of concentric force. Analysis of CGRF showed significant main effects were found in squat, $F(2,58) = 11.36$; $p = 0.000$, and deadlift, $F(2,58) = 7.28$; $p = 0.002$.

Table 3. Kinetics data during squat and deadlift

Exercises	Variables	Internal Focus	External Focus	Control Condition
Squat	CGRF (N)	1602.00 ± 48.81^{bc}	1621.00 ± 59.69^a	1617.00 ± 54.51^a
Deadlift	CGRF (N)	1713.00 ± 49.46^{bc}	1787.50 ± 64.43^a	1768.30 ± 49.06^a

^a = significantly difference from Internal Focus, $p < 0.05$

^b = significantly difference from External Focus, $p < 0.05$

^c = significantly difference from Control Condition, $p < 0.05$

Table 3 showed the CGRF value during the two exercises protocols. During squat, results showed the CGRF during internal focus was significantly lower compared to external focus ($p = 0.001$) and control condition ($p = 0.01$). External focus was not found significantly different from control condition ($p = 0.496$). Similar to squat, during deadlift, results showed the CGRF during internal focus was significantly lower compared to external focus ($p = 0.004$) and control condition ($p = 0.009$). External focus was also not found to be significantly different from control condition ($p = 0.231$).

3.4 Number of repetitions

Number of repetitions was counted as the total number of repetitions that was completed (upward and downward phase) during the exercises. Analysis showed significant main effects were found in squat, $F(2,58) = 32.59$; $p = 0.000$, and deadlift, $F(2,58) = 157.43$; $p = 0.000$.

Table 4. Number of repetitions during squat and deadlift

Exercises	Variables	Internal Focus	External Focus	Control Condition
Squat	Reps	6.50 ± 0.68^{bc}	7.80 ± 0.61^{ac}	7.20 ± 0.41^{ab}
Deadlift	Reps	6.40 ± 0.50^{bc}	8.40 ± 0.50^{ac}	7.20 ± 0.61^{ab}

^a = significantly difference from Internal Focus, $p < 0.05$

^b = significantly difference from External Focus, $p < 0.05$

^c = significantly difference from Control Condition, $p < 0.05$

Table 4 showed the number of repetitions value during the two exercises protocols. During squat, results showed the repetitions of internal focus was significantly lower compared to external focus ($p = 0.000$) and control condition ($p = 0.001$). Number of repetitions during external focus was significantly higher compared to control ($p = 0.001$). Similar to squat, during deadlift, results showed the repetitions during internal focus was significantly lower compared to external focus ($p = 0.000$) and control condition ($p = 0.000$). Participants were also found to gain significantly greater repetitions during external focus compared to control conditions ($p = 0.000$).

4. Discussions

This study was conducted to compare the effects of focus attention on kinetics, muscle activation and performance during resistance exercises. Thirty trained participants were recruited from a resistance training class and were needed to perform the exercises in three conditions; i) internal focus, ii) external focus, and iii) control.

Average muscle activity of vastus lateralis and biceps femoris were recorded during all focus conditions. During squat and deadlift, results showed the EMG of vastus lateralis during internal focus was significantly greater compared to external focus and control condition. Control condition recorded greater vastus lateralis EMG value compared to external focus. For biceps femoris, during both exercises, it was also found that the EMG during internal focus was significantly greater compared to external focus and control condition. External focus EMG was significantly lower during squat but was found to be no different during deadlift when compared to control condition.

Concentric ground reaction force (CGRF) was recorded as the kinetic data in this study. CGRF was defined as the average of force produced between the beginning of concentric phase and the end of concentric force. During both squat and deadlift, results showed the CGRF of both external focus and control conditions were significantly greater compared to internal focus.

Number of repetitions is counted as the total number of repetitions that was completed (upward and downward phase) during the exercise. During both squat and deadlift, results showed the external focus attentions managed to produce more number of repetitions compared to internal focus and control condition. Control condition on the other hand produces greater number of repetitions compared to internal focus.

If we based our findings solely on the EMG results, adopting internal focus while doing resistance exercise was seen to be better as it had been shown that EMG activity during a task was associated to better long-term muscle size improvement [22]. Thus, for those that aimed for increasing muscle size that is associated with more muscle strength, adopting internal focus would be more preferable.

However, hypertrophy and strength adaptations are not solely depend on the EMG activity. Looking at the results of force production and number of repetitions completed, it can be seen that despite internal focus attention caused the participant to increase their muscular effort during the exercise execution, their force production and number of repetitions completed were still lower compared to the other two focus conditions (i.e. external focus and control conditions). Thus, internal focus attention is not economically effective in terms of movement production.

Internal focus attention result in decreased capability to produce maximal force, and this is related to inefficient muscular activation that limits force production. Several previous studies had suggested that directionally focus internally is associated with an increase in “noise” in the motor system as quantified through greater muscular activity [23, 24]. Increased noise in the motor system means that the observed increased muscular activity is not transferred to the movement output. Looking at the reduced force production, conscious movement control might has interfered with participant's ability to effectively coordinate and produce maximal force during both squat and deadlift movements. These results provide additional evidence that focusing on anticipated movement effects enhances performance compared with internally focusing on the movements being executed [13].

The generally greater EMG activity demonstrate that more energy was used to produce movement during internal focus compared to external focus condition. Because the movement outcome (number of repetitions completed) was found to be smaller during internal focus, this showed that adopting internal focus caused the movement to be less economic.

This study provides converging evidence that movement efficiency or the physical effort exerted to produce a given outcome varies greatly with an individual's focus of attention. When an individual adopts an external focus, movements not only are more effective but also are produced more economically, with the consequence that the force production and number of repetitions completed during the resistance exercises are greater [13], the same forces are produced with less muscular energy [23, 25].

Conclusion

As the conclusion, we can see that adopting external focus attention provide more advantages in enhancing force production and increase performance during resistance exercise. Although internal focus attention was found to be not as effective as the external focus, there is a need to further examine

the greater muscle activities that were produced during the condition that might be more advantages for hypertrophy. Athletes, physical trainers, coaches and individuals should be aware of the different effects of different focus attention direction. Based on the findings of this study, it is recommended to adopt external focus attention in order to increased force production and exercise performance. However, instructing individuals to direct their focus internally will limit the movement effectiveness but do result in greater activation of muscles.

Acknowledgement

This study was part of research funded by Universiti Pendidikan Sultan Idris (Code: 2017-0243-107-01).

Conflict of interest

The authors declare no conflict of interest exist in this study.

References

- [1] Wulf, G., *Attentional focus and motor learning: a review of 15 years*. International Review of Sport and Exercise Psychology, 2013. **6**(1): p. 77-104.
- [2] Porter, J., W. Wu, and J. Partridge, *Focus of attention and verbal instructions: Strategies of elite track and field coaches and athletes*. Sport Science Review, 2010. **19**(3-4): p. 77-89.
- [3] Makaruk, H. and J.M. Porter, *Focus of attention for strength and conditioning training*. Strength & Conditioning Journal, 2014. **36**(1): p. 16-22.
- [4] McNevin, N.H., C.H. Shea, and G. Wulf, *Increasing the distance of an external focus of attention enhances learning*. Psychological research, 2003. **67**(1): p. 22-29.
- [5] Wulf, G., N. McNevin, and C.H. Shea, *The automaticity of complex motor skill learning as a function of attentional focus*. The Quarterly Journal of Experimental Psychology: Section A, 2001. **54**(4): p. 1143-1154.
- [6] Nadzalan, A.M., et al., *The effects of resistance training with different focus attention on muscular strength: Application to teaching methods in physical conditioning class*. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2019. **8**(8): p. 16-19.
- [7] Firdaus, W., G. Kuan, and O. Krasilshchikov, *The effects of using complex training method on muscular strength among male weightlifters*. Jurnal Sains Sukan dan Pendidikan Jasmani, 2018. **7**(1): p. 1-12.
- [8] Tajudin, A.S., M.H.N. Rosni, and J.L.F. Low, *Effects of augmented feedback on squat technique among eleven years old children*. Jurnal Sains Sukan dan Pendidikan Jasmani, 2016. **5**(1): p. 1-8.
- [9] Mohamad, N.I., K. Nosaka, and J. Cronin, *Effect of stretching during the inter-set rest periods on the kinematics and kinetics of high and low velocity resistance loading schemes: implications for hypertrophy*. Jurnal Sains Sukan dan Pendidikan Jasmani, 2014. **3**(1): p. 45-57.
- [10] Mahfudz, N.N., et al., *The effects of HIIT on physical abilities among special education students*. International Journal of Recent Technology and Engineering (IJRTE), 2019. **8**(1): p. 1276-1278.
- [11] Mohamad, N.I., et al., *Comparison between student centered (classroom technology) versus lecturer centered (hands-on) learning approach in physical conditioning short course*. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2019. **8**(7): p. 1485-1486.
- [12] Shazana, N., et al., *Electromyographical analysis and performance during bench press exercise: The influence of self-talk*. International Journal of Recent Technology and Engineering (IJRTE), 2019. **8**(1): p. 1279-1281.

- [13] Marchant, D.C., M. Greig, and C. Scott, *Attentional focusing instructions influence force production and muscular activity during isokinetic elbow flexions*. The Journal of Strength & Conditioning Research, 2009. **23**(8): p. 2358-2366.
- [14] Marchant, D.C., *Attentional focusing instructions and force production*. Frontiers in Psychology, 2011. **1**: p. 210.
- [15] Marchant, D.C., et al., *Instructions to adopt an external focus enhance muscular endurance*. Research Quarterly for Exercise and Sport, 2011. **82**(3): p. 466-473.
- [16] Halperin, I., et al., *The effects of attentional focusing instructions on force production during the isometric mid thigh pull*. The Journal of Strength & Conditioning Research, 2016. **30**(4): p. 919-923.
- [17] Nadzalan, A.M., J.L.F. Lee, and N.I. Mohamad, *The Effects of Focus Attention Instructions on Strength Training Performances*. International Journal of Humanities and Management Sciences, 2015. **3**(6): p. 418-423.
- [18] Ghazalli, A.F., M.Y. Abdul Rani, and J.F.L. Low, *Kesan fokus luaran dan dalaman ke atas angkatan 'press behind neck' atlet angkat berat*. Jurnal Sains Sukan dan Pendidikan Jasmani, 2016. **5**(2): p. 53-60.
- [19] Haff, G.G. and N.T. Triplett, *Essentials of strength training and conditioning 4th edition*. 2015: Human Kinetics.
- [20] Sands, W.A., J.J. Wurth, and J.K. Hewitt, *Basics of strength and conditioning manual*. The National Strength and Conditioning Association's (NSCA), 2012.
- [21] Hermens, H.J., et al., *Development of recommendations for SEMG sensors and sensor placement procedures*. Journal of Electromyography and Kinesiology, 2000. **10**(5): p. 361-374.
- [22] Wakahara, T., et al., *Nonuniform muscle hypertrophy: its relation to muscle activation in training session*. Medicine and Science in Sports and Exercise, 2013. **45**(11): p. 2158-2165.
- [23] Zachry, T., et al., *Increased movement accuracy and reduced EMG activity as the result of adopting an external focus of attention*. Brain Research Bulletin, 2005. **67**(4): p. 304-309.
- [24] Vance, J., et al., *EMG activity as a function of the performer's focus of attention*. Journal of Motor Behavior, 2004. **36**(4): p. 450-459.
- [25] Marchant, D., et al. *Attentional focusing strategies influence muscle activity during isokinetic bicep curls*. in *Poster presented at the annual conference of the British Psychological Society, Cardiff, UK*. 2006.