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ORIGINAL ARTICLE

## Differential effects of attentional focus strategies during long-term resistance training

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### Abstract

The purpose of this study was to investigate the effects of using an internal versus external focus of attention during resistance training on muscular adaptations. Thirty untrained college-aged men were randomly assigned to an internal focus group (INTERNAL) that focused on contracting the target muscle during training ( $n=15$ ) or an external focus group (EXTERNAL) that focused on the outcome of the lift ( $n=15$ ). Training for both routines consisted of 3 weekly sessions performed on non-consecutive days for 8 weeks. Subjects performed 4 sets of 8–12 repetitions per exercise. Changes in strength were assessed by six repetition maximum in the biceps curl and isometric maximal voluntary contraction in knee extension and elbow flexion. Changes in muscle thickness for the elbow flexors and quadriceps were assessed by ultrasound. Results show significantly greater increases in elbow flexor thickness in INTERNAL versus EXTERNAL (12.4% vs. 6.9%, respectively); similar changes were noted in quadriceps thickness. Isometric elbow flexion strength was greater for INTERNAL while isometric knee extension strength was greater for EXTERNAL, although neither reached statistical significance. The findings lend support to the use of a mind-muscle connection to enhance muscle hypertrophy.

**Keywords:** Mind-muscle connection, cueing, muscle hypertrophy

### Highlights

- An internal focus enhances hypertrophy of the elbow flexors during single joint elbow flexion, conceivably by increasing activation of the musculature.
- Attentional focus did not affect hypertrophy of the quadriceps during single joint knee extension; this may be due to a reduced ability for untrained individuals to develop a mind-muscle connection with the lower body musculature.
- It is not clear how adopting an internal versus external focus during resistance training over time affects maximal isometric strength when testing is carried out under neutral attentional focus conditions.

### Introduction

Attentional focus is a well-established concept of motor learning, and its use has potentially important implications for promoting exercise-induced muscular adaptations (Schoenfeld & Contreras, 2016). Attentional focus can be operationally defined as what an individual thinks about when performing a given activity (Schoenfeld & Contreras, 2016). The

topic can be sub-classified into two primary focus-related strategies: internal focus and external focus. An internal attentional focus involves thinking about bodily movements when performing an activity; for example, directing an individual to “squeeze” their muscle. Conversely, an external attentional focus involves visualizing the outcome during the performance; for example, directing an individual to move the weight.

The body of the literature appears to indicate that an external focus of attention optimizes the execution of performance-oriented tasks. A recent review by Wulf (2013) concluded that an external focus showed better improvements in motor learning compared to an internal focus in more than 90% of published studies on the topic. Superior outcomes were observed across an array of physical activities in a variety of different populations, providing strong support for the use of an external focus for enhancing performance-related measures.

While a myriad of data on attentional focus exists for performance-oriented tasks, research into the use of attentional focus during resistance training (RT) is in its infancy. Acutely, the external focus is beneficial for force production, while internal focus increases agonist and antagonist surface electromyography (sEMG) amplitudes (Marchant, Greig, & Scott, 2009). Although the more economical movement patterns observed during external focus conditions appear to enhance skill acquisition, they may be suboptimal for hypertrophic adaptations. Indeed, electromyographic (EMG) studies report greater EMG amplitudes of the target musculature during resistance exercise with the use of an internal focus (Snyder & Fry, 2012; Snyder & Leech, 2009). Thus, it has been speculated that an internal focus, referred to as a “mind-muscle connection” in bodybuilding circles, should be adopted when the goal is to maximize muscle development (Schoenfeld & Contreras, 2016). However, drawing inferences concerning adaptation from previous studies should not be met without scrutiny. First, previous acute studies that employ isoinertial loading do not control for relative loading; effort differed between conditions because the same absolute external load was used, while one cue produces more “economical” movement than another. This means participants may have been utilizing a different percentage of maximum for each condition, which is supported by isokinetic data (Marchant et al., 2009). Second, drawing inferences from acute measures, such as sEMG, has recently been a topic of criticism, and a call has been made for more longitudinal research to draw more definitive conclusions (Halperin, Vigotsky, Foster, & Pyne, 2017).

Currently, there is a paucity of data investigating the effects of attentional focus during RT on long-term changes in strength. Moreover, to the authors’ knowledge, no study to date has compared RT-induced hypertrophic outcomes when employing different attentional focus strategies, as is needed for training recommendations. Thus, the purpose of this study was to investigate the effects of using an internal versus external focus during RT on muscular adaptations. We hypothesized that the internal focus

would lead to greater increases in muscle hypertrophy while the external focus would result in greater strength gains.

## Materials and methods

### *Subjects*

Subjects were 30 male volunteers (age =  $21.7 \pm 3.7$  years; height =  $176.3 \pm 9.1$  cm; mass =  $78.2 \pm 18.4$  kg) recruited from a university population. Subjects were between the ages of 18–35, had no existing cardiorespiratory or musculoskeletal disorders, claimed to be free from consumption of anabolic steroids or any other legal or illegal agents known to increase muscle size currently and for the previous year, and had not performed any regimented RT for at least the past year. Table I provides anthropometric data for each group.

Participants were pair-matched according to baseline muscle thickness (MT) (a composite of values of the elbow flexors and quadriceps) and then randomly assigned to one of two experimental groups using online software (randomizer.org): an internal focus group (INTERNAL) that focused on contracting the target muscle during training ( $n = 15$ ) or an external focus group (EXTERNAL) that focused on the outcome of the lift during training ( $n = 15$ ). Approval for the study was obtained from the college Institutional Review Board. Informed consent was obtained from all participants prior to beginning the study.

### *Experimental design*

The investigation was carried out over a period of 10 weeks, with 8 weeks dedicated to the RT programme and 2 weeks allocated for testing. Pre-study testing was carried out in week 1 and post-study testing was carried out in week 10. A supervised progressive RT was performed between weeks 2–9.

### *RT procedures*

The RT protocol consisted of two exercises: Standing barbell curl and machine leg extension. These exercises were chosen because it is easier to direct focus internally during the performance of single-joint movements, therefore helping to preserve internal validity. Subjects were instructed to refrain from performing any additional resistance-type or high-intensity anaerobic training for the duration of the study.

Training for both conditions consisted of 3 weekly sessions performed on non-consecutive days for 8 weeks. All routines were directly supervised by the

Table I. Participant demographics.

	<i>n</i>	Age (years)	Stature (cm)	Mass (kg)
INTERNAL	14	21.7 ± 3.7	175.8 ± 9.3	75.9 ± 20.1
EXTERNAL	13	21.8 ± 3.1	176.8 ± 9.1	81.0 ± 16.6
Combined	27	21.5 ± 3.3	176.3 ± 9.1	78.2 ± 18.4

research team, which included a National Strength and Conditioning Association Certified Strength and Conditioning Specialist and certified personal trainers, to ensure proper performance of the respective routines. Subjects performed 4 sets of 8–12 repetitions per exercise. The supervising research staff member provided relevant cues to subjects on each repetition to reinforce the given focus of attention. For INTERNAL, subjects were cued to “squeeze the muscle!” on each repetition; for EXTERNAL, subjects were cued to “get the weight up!” on each repetition. All sets were carried out to the point of momentary concentric muscular failure, operationally defined as the inability to perform another concentric repetition while maintaining proper form. Cadence of the concentric portion of repetitions was carried out in a fashion that allowed subjects to best achieve the given attentional focus; eccentric actions were performed at a ~2 second tempo to ensure controlled lowering of weights. Subjects were afforded 2 min rest between sets. The loads were adjusted for each exercise as needed on successive sets to ensure that subjects achieved failure in the target repetition range. Attempts were made to progressively increase the loads lifted each week within the confines of maintaining the target repetition range. Prior to training, subjects underwent 10-repetition maximum (RM) testing to determine individual initial training loads for each exercise. The RM testing was consistent with recognized guidelines as established by the National Strength and Conditioning Association (Baechle & Earle, 2008).

#### *Dietary adherence*

To avoid potential dietary confounding of results, subjects were advised to maintain their customary nutritional regimen and avoid taking any supplements other than that provided in the course of the study. Dietary adherence was assessed by self-reported 5-day food records using MyFitnessPal.com (<http://www.myfitnesspal.com>), which were collected twice during the study: 1 week before the first training session (i.e. baseline) and during the final week of the training protocol. Subjects were instructed on how to properly record all food items and their respective portion sizes consumed for the designated period of interest. Each item of food

was individually entered into the programme, and the programme provided relevant information as to total energy consumption, as well as the amount of energy derived from proteins, fats, and carbohydrates for each time period analysed. To help ensure that protein needs were met for anabolism, subjects were supplied with a supplement on training days containing 25 g protein and 1 g carbohydrate (Iso100 Hydrolyzed Whey Protein Isolate, Dymatize Nutrition, Dallas, TX) immediately following the RT session (Aragon & Schoenfeld, 2013).

#### *Measurements*

*Body composition and anthropometry.* Participants' height was measured using a Detecto Physicians Scale (Cardinal Scale Manufacturing Company, Webb City, MO). Assessment of fat mass, fat-free mass, and skeletal muscle mass was carried out using an InBody 770 multi-frequency bioelectrical impedance device (Biospace Co. Ltd., Seoul, Korea) according to the manufacturer's instructions. Subjects were told to refrain from eating for 12 h prior to testing, eliminate alcohol consumption for 24 h, abstain from strenuous exercise for 24 h, and void immediately before the test. Prior to each measurement, the subject's palms and soles were cleaned with an electrolyte tissue. Subjects then stood on the InBody 770, placing the soles of their feet on the electrodes. The instrument derived the subject's body mass, and their age and sex subject were manually entered into the display by the researcher. Subjects then grasped the handles of the unit ensuring that the palm and fingers of each hand made direct contact with the electrodes. Arms were fully extended and abducted approximately 20°. Analysis of body composition was determined by the unit with subjects remaining as motionless as possible.

*Muscle thickness.* Ultrasound imaging was used to obtain measurements of MT. A trained technician performed all testing using a B-mode ultrasound imaging unit (ECO3, Chison Medical Imaging, Ltd, Jiang Su Province, China). The technician applied a water-soluble transmission gel (Aquasonic 100 Ultrasound Transmission gel, Parker Laboratories Inc., Fairfield, NJ) to each measurement site, and a 5 MHz ultrasound probe was placed parallel

to the tissue interface without depressing the skin. When the quality of the image was deemed to be satisfactory, the technician saved the image to a hard drive and obtained MT dimensions by measuring the distance from the subcutaneous adipose tissue-muscle interface to the muscle-bone interface, as described previously (Abe, DeHoyos, Pollock, & Garzarella, 2000). Measurements were taken on the right side of the body at three sites: (1) elbow flexors, (2) mid-thigh (a composite of the rectus femoris and vastus intermedius), and (3) lateral thigh (a composite of the vastus lateralis and vastus intermedius). For the anterior upper arm, measurements were taken 60% distal between the lateral epicondyle of the humerus and the acromion process of the scapula; for the mid- and lateral thigh, measurements were taken 50% between the lateral condyle of the femur and greater trochanter for the quadriceps femoris. In an effort to ensure that swelling in the muscles from training did not obscure results, images were obtained 48–72 h before commencement of the study, as well as after the final training session. This is consistent with research showing that acute increases in MT return to baseline within 48 h following a RT session (Ogasawara, Thiebaud, Loenneke, Loftin, & Abe, 2012). To further ensure the accuracy of measurements, three images were obtained for each site and then averaged to obtain a final value.

*Isometric muscle strength.* Strength assessments were carried out using isometric dynamometry testing (Biodex System 4; Biodex Medical Systems, Inc. Shirley, NY, USA). After familiarization with the dynamometer and protocol, subjects were seated in the chair and performed isometric actions of the knee extensors and elbow flexors. All isometric testing was carried out on the subjects' dominant limbs.

During knee extension trials, subjects sat with their backs flush against the seat back pad and maintained hip joint angles of 85° with the centre of their lateral femoral condyles aligned with the axis of rotation of the dynamometer. The dynamometer arm length was adjusted for each subject to allow the shin pad to be secured with straps proximal to the medial malleoli. Subjects were instructed to hold onto handles for stability and were also strapped in across the ipsilateral thigh, hips, and torso to help prevent extraneous movement during performance. Testing was carried out at a knee joint angle of 70° (Knapik, Wright, Mawdsley, & Braun, 1983).

During elbow flexion trials, subjects were seated with the dominant arm flexed to 30° and supported in the sagittal plane to eliminate the effects of gravity. The dominant forearm was strapped into

the upper extremity attachment, and the wrist was placed in a supinated position. The hip and knee joint angles were maintained at 85° and 90°, respectively. The non-dominant arm was kept pinned to the left side of the trunk with the forearm on the abdomen. Subjects were strapped in by crossover shoulder harnesses and an abdominal belt to help prevent extraneous movement during performance. Testing was carried out at an elbow joint angle of 90° (Knapik et al., 1983).

Each maximum voluntary contraction trial lasted 5 s, followed by 30 s rest, for a total of three to four trials in each position (if a participant's net joint moment continued to increase in the third trial, then a fourth trial was performed). Participants were verbally encouraged to produce maximal force throughout each bout. The highest peak net extension moment from each of the three trials for each maximum voluntary contraction position was used for analysis.

### *Statistical analyses*

Data were imported into Jamovi (version 0.7.7.3, Jamovi team) for statistical analysis. Before carrying out analyses, equality of variances (homogeneity) was ensured using Levene's test. Rather than comparing baseline values statistically, using independent *t*-tests, baseline values were used as covariates in analyses of covariance (ANCOVA), from which the differences in the magnitude of changes from baseline were compared (de Boer, Waterlander, Kuijper, Steenhuis, & Twisk, 2015; Vickers & Altman, 2001). No within-group comparisons from baseline were made (Bland & Altman, 2011, 2015). Effect sizes were calculated using partial eta squared ( $\eta_p^2$ ), which represents the variance in the model accounted for by the difference between groups. Because this model is analogous to a multiple regression or partial correlation (Vickers & Altman, 2001),  $\eta_p^2$  can be interpreted as the square of a Pearson's *r* effect size. As such, the correlation coefficient interpretations as defined by Hopkins (Hopkins, 2002) were adapted (squared) for qualitative interpretation:  $0 \leq \eta_p^2 < 0.01$  is trivial;  $0.01 \leq \eta_p^2 < 0.09$  is small;  $0.09 \leq \eta_p^2 < 0.25$  is moderate;  $0.25 \leq \eta_p^2 < 0.49$  is large;  $0.49 \leq \eta_p^2 < 0.81$  is very large;  $0.81 \leq \eta_p^2 < 1$  is nearly perfect; and  $\eta_p^2 = 1$  is perfect. Alpha was set *a priori* to 0.05 for determining statistical differences between groups.

### **Results**

Of the 30 initial participants, 27 ultimately completed the study; 2 subjects dropped out for personal reasons and data for another subject were discarded due to lack of compliance. Demographics of the included

participants can be found in Table I. Adherence to the protocol was good for both INTERNAL and EXTERNAL groups, with a mean attendance of 93% and 92% of sessions, respectively.

### Hypertrophy

Of the three muscles that were measured, only elbow flexor hypertrophy differed statistically between groups, with a large effect size favouring the internal focus condition ( $F_{1,24} = 10.64$ ;  $\eta_p^2 = 0.307$ ;  $p = 0.003$ ). Small and trivial effect sizes favouring external and internal focus were observed for rectus femoris and vastus lateralis, respectively ( $F_{1,22} = 0.68$ ;  $\eta_p^2 = 0.030$ ;  $p = 0.418$  and  $F_{1,24} \approx 0$ ;  $\eta_p^2 \approx 0$ ;  $p = 0.999$ ) (Table II).

### Strength

No statistical differences between groups were found for any of the strength measures. Small effect sizes favouring the external focus condition were observed for isometric knee extension strength ( $F_{1,22} = 1.50$ ;  $\eta_p^2 = 0.064$ ;  $p = 0.234$ ), while a moderate effect size favouring internal focus was observed for isometric elbow flexion strength ( $F_{1,22} = 2.82$ ;  $\eta_p^2 = 0.114$ ;  $p = 0.107$ ) (Table II).

### Body composition

No statistical differences between groups were found for any body composition measures. Small and trivial effect sizes favouring internal focus were noted for increases in body fat and body weight, respectively ( $F_{1,24} = 0.618$ ;  $\eta_p^2 = 0.025$ ;  $p = 0.439$  and  $F_{1,24} = 0.179$ ;  $\eta_p^2 = 0.007$ ;  $p = 0.676$ ). A small effect size favouring external focus was noted for increases in skeletal muscle mass ( $F_{1,24} = 0.288$ ;  $\eta_p^2 = 0.012$ ;  $p = 0.596$ ) (Table II).

### Nutritional intake

Despite attempts to counsel subjects on how to properly log nutritional information, analysis of the food diaries indicated gross misreporting of data. We thus were unable to determine if/how changes in dietary practices may have impacted results.

## Discussion

This is the first study to investigate the effects of different attentional focus strategies on long-term muscular adaptations. The study produced several novel and notable findings. First, an internal focus elicited

superior hypertrophic increases in the elbow flexors compared to an external focus, but MT in the quadriceps was unaffected by attentional focus strategy. The differences in changes in elbow flexor size between INTERNAL and EXTERNAL (12.4% vs. 6.9%, respectively) translated into a large magnitude of effect favouring the INTERNAL condition ( $\eta_p^2 = 0.307$ ). These findings partially support the common bodybuilding claim that a mind-muscle connection enhances muscle growth. Although we did not attempt to determine mechanistic reasons for discrepant findings between the upper and lower limbs, it can be speculated that subjects found it easier to focus on the elbow flexor muscles compared to the thighs – a sentiment that was anecdotally expressed by several participants in the INTERNAL group. Postulations regarding the mechanisms of this phenomenon can be deduced from motor control and neuroplasticity perspectives. First, neuromuscular reeducation, at least following tendon transfer, appears to be more prevalent in upper compared to lower extremities (Sperry, 1945), suggesting that the nervous system is better able to alter muscle recruitment patterns of the upper extremity. Second, individuals have greater force control of their elbow flexors than their knee extensors (Tracy, Mehoudar, & Ortega, 2007). Indeed, this may relate to why individuals have better control of and coordination with their upper extremities when compared to their lower extremities (Kauranen & Vanharanta, 1996). Practically speaking, Gordon and Ferris (Gordon & Ferris, 2004) speculated,

If there are inherent differences in efferent control between any muscle groups, it would seem likely that lower limb muscles might be the least accurate. Humans rarely perform fine motor tasks with their lower limbs, instead relying on them for gross power output during locomotion.

Such sentiments do not preclude one from being able to learn how to effectively utilize an internal focus of attention. That is, such a phenomenon may be related to the subjects' untrained statuses, as individuals with RT experience have been shown to be able to increase quadriceps EMG amplitude when directed to focus on the thigh musculature during knee extension exercise (Marchant & Greig, 2017), and recent evidence suggests that training status-dependent control may indeed be muscle-specific (Calatayud et al., 2016). If true, this would suggest that trained individuals may be able to enhance quadriceps hypertrophy by adopting an internal focus during lower body RT. Perhaps differences in this regard would have been borne out with a longer intervention period. Further investigation is needed to test the validity of this hypothesis.

Table II. Within- and between-group changes following 8 weeks of strength training with either internal or external focus of attention.

	Internal focus			External focus			Between-group difference			
	Pre	Post	Change	Pre	Post	Change	Absolute	Effect size ( $\eta_p^2$ )	Interpretation	<i>p</i> -value
Elbow flexor thickness (mm)	39.62 ± 8.07	44.55 ± 8.15	4.93 ± 1.73	40.22 ± 6.53	42.98 ± 6.40	2.77 ± 1.63	2.14 (0.85–3.43)	0.307	Large	0.003
Rectus femoris thickness (mm)	55.10 ± 11.57	57.82 ± 10.99	2.72 ± 2.62	55.09 ± 5.90	58.69 ± 5.74	3.60 ± 2.87	−0.88 (−2.98–1.22)	0.030	Small	0.418
Vastus lateralis thickness (mm)	51.81 ± 11.03	55.10 ± 10.80	3.29 ± 2.94	53.82 ± 5.47	56.99 ± 6.09	3.17 ± 3.37	0.00 (−2.41–2.41)	0.000	Trivial	0.999
Isometric elbow flexion (N m)	57.46 ± 12.96	66.78 ± 17.87	9.32 ± 10.88	62.45 ± 14.56	64.06 ± 11.55	1.61 ± 9.21	6.90 (−1.16–14.96)	0.114	Moderate	0.107
Isometric knee extension (N m)	286.99 ± 70.04	316.08 ± 68.82	29.09 ± 55.04	280.99 ± 60.90	338.33 ± 55.38	57.34 ± 52.66	−12.80 (−33.38–7.78)	0.064	Small	0.234
Body mass (kg)	76.46 ± 20.60	77.90 ± 20.58	1.44 ± 1.24	80.89 ± 16.60	81.85 ± 15.18	0.95 ± 2.64	0.16 ± (−0.58–0.90)	0.007	Trivial	0.676
Skeletal muscle mass (kg)	33.66 ± 6.90	34.26 ± 6.78	0.60 ± 0.63	34.55 ± 4.42	35.25 ± 4.33	0.71 ± 0.58	−0.06 (−0.29–0.17)	0.012	Small	0.596
Body fat (%)	20.02 ± 10.54	20.36 ± 10.01	0.34 ± 1.46	23.17 ± 8.88	22.82 ± 8.64	−0.35 ± 2.01	0.52 (−0.77–1.81)	0.025	Small	0.439

Notes: Pre, post, and change scores are presented as mean ± SD. Between-group, absolute differences are presented as mean (95% CI), with a positive value being in favour of (i.e. a greater or more positive change score) internal focus, and are corrected for baseline values.

Attentional focus had markedly different effects specific to the upper versus lower limbs. With respect to peak isometric elbow flexion strength, INTERNAL resulted in a 16.2% increase versus a 2.6% in EXTERNAL, translating into an ES of a moderate magnitude of effect ( $\eta_p^2 = 0.114$ ). These potential findings are in contrast to acute studies, wherein an external focus of attention is often found to result in greater strength performance than an internal focus of attention (Marchant et al., 2009); therefore, it is important to note that participants were not encouraged to utilize specific attentional foci during strength testing. Although potential mechanisms for these non-statistical differences in isometric elbow flexion strength were not studied, two often-proposed mechanisms of strength gain include peripheral (i.e. muscle hypertrophy and normalized muscle force) and neural (i.e. neural drive and excitation) changes (Erskine, Jones, Williams, Stewart, & Degens, 2010). To explore muscle size as a potential contributor, an additional ANCOVA was carried out *post hoc*, using the change in elbow flexor thickness as a covariate. After accounting for the change in elbow flexor thickness, the magnitude of the group effect decreased substantially, from moderate ( $\eta_p^2 = 0.114$ ) to trivial ( $\eta_p^2 = 0.006$ ). In contrast to recent criticisms of the theory that hypertrophy is related to changes in strength (Buckner et al., 2016), it appears that, in this study, differences in hypertrophy accounted for potential differences in strength between groups.

As opposed to isometric elbow flexion strength, peak isometric knee extension strength favoured EXTERNAL versus INTERNAL (20.4% vs. 10.1%, respectively), with the ES indicating a small magnitude of effect ( $\eta_p^2 = 0.064$ ). Although the observed effect size was small and did not reach the *a priori* alpha, in the interest of consistency, another *post hoc* ANCOVA was carried out, utilizing both changes in vastus lateralis and rectus femoris thickness as covariates, but unlike elbow flexion strength, the change in magnitude of the effect size was minuscule ( $\eta_p^2 = 0.052$ ).

The study had several notable limitations. First, the exercise protocol employed a moderate repetition range and thus the results cannot necessarily be extrapolated to training with heavier or lighter loads, especially because the acute effects of internal cueing are load-dependent (Calatayud et al., 2016). Second, although we provided explicit instructions on the focus of attention and supplemented the instructions with cueing throughout each set, there is no way to be sure that subjects were actually focusing as directed. It remains possible that some subjects did not adhere to the proper focus in at least some of the sets, which in turn may have altered results. That

said, the marked between-group differences in elbow flexor muscle growth favouring the internal focus condition provides strong evidence that cueing strategies affect hypertrophic outcomes. Third, MT was measured only at the mid-portion of the muscles. Although this region is widely considered to be indicative of overall muscle growth, some studies report that hypertrophy manifests in a regional-specific manner, with greater adaptations seen proximally and/or distally (Wakahara et al., 2012; Wakahara, Fukutani, Kawakami, & Yanai, 2013). Thus, we cannot discount the prospect that greater proximal or distal increases in MT occurred in one protocol versus the other. Fourth, we were not able to obtain accurate reporting on dietary practices throughout the study and thus cannot rule out the possibility that differences in nutritional intake unduly confounded results. Finally, the findings are specific to untrained subjects; future research is needed to determine the strength- and hypertrophy-related effects of different attentional focus strategies on those with previous RT experience.

## Conclusion

Our findings indicate that an internal focus of attention is superior to an external focus of attention when the goal is to maximize hypertrophy of the elbow flexors. Attentional focus does not seem to affect lower extremity hypertrophy, which may be due to the difficulty for untrained individuals to establish a “mind-muscle connection” in the thigh musculature during resistive exercise.

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No potential conflict of interest was reported by the authors.



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