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Attentional Focus and Grip Width Influences on Bench Press Resistance Training

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Abstract

This study evaluated the influence of different attentional foci for varied grip widths in the bench press. Eighteen resistance-trained men were familiarized with the procedure and performed a one-repetition maximum (1RM) test during Session 1. In Session 2, they used three different standardized grip widths (100%, 150%, and 200% of biacromial width distance) in random order at 50% of 1RM while also engaged in three different attention focus conditions (external focus on the bench press, internal focus on pectoralis major muscles, and internal focus on triceps brachii muscles). Surface electromyography (EMG) signals were recorded from the triceps brachii and pectoralis major, and peak EMG of the filtered signals were normalized to maximum EMG of each muscle. Both grip width and focus influenced the muscle activity level, but there were no significant interactions between these variables. Exploratory analyses suggested that an internal focus may slightly (4%–6%) increase pectoralis major activity at wider grip widths and triceps brachii activity at narrower grip widths, but this should be confirmed or rejected in a study with a larger sample size or through a meta-analysis of research to date.

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Introduction

The effectiveness of a given exercise for inducing muscle strength depends on numerous variables such as load variation (Sakamoto & Sinclair, 2012), exercise positions (Barnett, Kippers, & Turner, 1995), velocity (Sakamoto & Sinclair, 2012), and number of repetitions (Sundstrup et al., 2012). In addition, for bench press exercises, muscle activity can be modified by using (a) different bench press grip widths (Barnett et al., 1995; Clemons & Aaron, 1997; Lehman, 2005) or (b) different attentional foci (Calatayud et al., 2016). Variations of grip width during typical upper-body exercises such as the lat pull-down (Andersen, Fimland, Wiik, Skoglund, & Saeterbakken, 2014), push-ups (Youdas et al., 2010), or bench press (Barnett et al., 1995; Clemons & Aaron, 1997; Lehman, 2005) result in different muscle activity patterns. The few studies that have evaluated the use of different grip widths during the bench press have shown contradictory results. Clemons and Aaron (1997) found that a narrow grip of 100% biacromial distance (i.e., distance between acromioms) provided lower activity in the prime movers, while Barnett et al. (1995) found that the narrow grip width provided higher triceps brachii (triceps) and clavicular pectoralis activity than did the wide grip (200% of biacromial distance), and the sternocostal head of the pectoralis was unaffected by grip variation. More recently, Lehman (2005) found that the narrow grip provided higher triceps brachii activity, whereas sternocostal pectoralis major activity was enhanced during the wide grip width variation. Lehman's (2005) results could be due to the use of different types of contractions (dynamic and isometric) or different intensities. Because all the aforementioned studies were performed using a regular attention focus on lifting the weight, there have been no tests of how different attentional foci might interact with grip width effects in influencing exercise effectiveness. Understanding how attention focus interacts with grip width effects is important because exercise participants may vary their attention focus from an external focus on the outcome to various internal foci on specific muscle groups with each grip width position; participants may then experience varied exercise benefit (Greig & Marchant, 2014). For example, if the pectoralis muscle is of primary interest, combining an internal focus with a wide grip width may provide superior activity of this muscle. Conversely, if the triceps brachii is of primary interest, combining an internal focus with a narrow grip width may be superior.

In general, an internal attention focus has been shown to enhance conscious control of movement inducing "noise" in the motor system (Zachry, Wulf, Mercer, & Bezodis, 2005), reducing the coherence between sensory input and motor output (McNevin & Wulf, 2002), and thereby increasing muscle activity. For instance, an internal focus on using the pectoralis major or the triceps brachii was shown to increase muscle activity during the bench press performed at loads between 20% and 60% of one-repetition maximum (1RM; Calatayud et al., 2016; Snyder & Fry, 2012). An internal attention focus in other typical resistance training exercises increased activity in the abdominal muscles compared with no attention focus instruction during a squat exercise at 50% of 1RM (Bressel, Willardson, Thompson, & Fontana, 2009), a regular trunk curl (Karst & Willett, 2004) and in latissimus dorsi activity during the pull-down exercise performed at 30% of maximal force (Snyder & Leech, 2009). However, using an internal focus does not always result in greater muscle activity. Recent research confirmed that several variables can interact with attentional foci during pushing actions, including training experience (Calatayud et al., 2017b) and the use of different movement velocities (Calatayud et al., 2017a) to determine electromyography (EMG) amplitude. In the same vein, certain grip widths during the bench press may interact with different attentional foci in their effects on muscle activity. Additional studies evaluating variables interacting with attentional foci are needed to optimize its applicability during training. On the basis of prior literature, we hypothesized that for the pectoralis muscle, combining an internal focus with a wide grip width would increase activity of this muscle, and for the triceps brachii, combining an internal focus with a narrow grip would increase activity of this muscle. These hypotheses were tested for each respective muscle through statistical interaction analyses of grip width with attentional focus. In case of no interaction, we performed exploratory post hoc analyses to allow for the estimates to be used in future meta-analyses.

Method

Participants

A sample of 18 young males voluntarily participated in the study (Table 1). Participants' weight training status was considered to be advanced according to the National Strength and Conditioning Association (NSCA) classification, as they all reported a minimum of one year of resistance training experience, performing at least three sessions per week at moderate to high intensity (Baechle & Earle, 2008). In addition, they were familiarized with the bench press exercise. Exclusion criteria were blood pressure above 160/100 measured on the day of testing and self-reported disc prolapse or other serious chronic disease that may be aggravated by heavy-load strength training. All participants gave written informed consent to participate, and all study procedures conformed to The Declaration of Helsinki and were approved by the Local Ethical Committee (H-3-2010-062).

Table 1. Demographics and Resistance Training Variables ($n = 18$, All Men).

	Mean (*SD*)
Age (years)	31 (8)
Height (cm)	179 (8)
Body weight (kg)	82 (10)
Body fat percentage	15 (5)
BMI ($kg \cdot m^{-2}$)	26 (3)
Resistance training experience (years)	8 (6)
1RM bench press (kg)	103 (25)
100% biacromial distance (cm)	44.2 (2.1)
150% biacromial distance (cm)	66.3 (3.2)
200% biacromial distance (cm)	88.4 (4.3)

Note. BMI = body mass index; 1RM = one-repetition maximum.

Procedures

Each participant took part in one familiarization session with a 1RM bench press determination and a second experimental session, with the two sessions separated by at least two days. Participants received instructions to avoid physical activity that was more intense than normal daily activities for 24 hours before the sessions. All measurements were made by the same two investigators and were conducted in the same facility with no one present but the investigators and the particular participant. Data collection took place during April to May 2014 as part of another research project investigating the effects of using different attentional focuses during resistance training. Previous data from this project have already been published and referenced in the introduction of this article (Calatayud et al., 2016, 2017a, 2017b). The present study uses the same data collected from the same participants as the previously published articles. The data for 100% and 200% of grip width are previously unpublished, while data for 150% grip width have been included in two previous studies and are included in the present article as well, now for the purpose of comparing the effects of different grip widths.

1RM determination and familiarization. Height (Seca model 217, Hamburg, Germany), body mass, body fat percentages (Tanita model MC-180MA, Tokyo, Japan), and biacromial width were obtained before the 1RM determination, and the participants performed mobility drills without ballistic movements as warm up. The 1RM test was performed with the same technique and body position that would later be used during data collection. The measurement of the 1RM for the bench press was performed according to the protocol described by the NSCA (Baechle & Earle, 2008). Assessment of 1RM enabled calculation of the precise training load used in the bench press during the following experimental session (50% of 1RM). After the 1RM determination, the participants were familiarized with the different conditions, exercise technique and velocity of movement that would later be used during data collection. Participants practiced the exercise at 50% of 1RM, at least three times for each condition, until the participant felt confident and the researchers were satisfied that the correct technique had been achieved.

Experimental session. The protocol started with the preparation of participants' skin, followed by electrode placement and exercise performance. Hair was removed from the area overlying muscles of interest with a razor, and the skin was then cleaned by rubbing with cotton wool dipped in scrubbing gel (Acqua gel, Meditec, Parma, Italy) to reduce EMG electrode impedance (Jakobsen, Sundstrup, Andersen, Aagaard, & Andersen, 2013). Afterwards, electrodes were placed according to recommendations of Criswell and Cram (2011) on the following muscles: the lateral head of the triceps, long head of the triceps, clavicular portion of the pectoralis major, and sternocostal portion of the pectoralis major. Additional electrodes were placed two centimeters apart from the sternum in the clavicular portion of the pectoralis major and two centimeters apart from the sternum in the sternocostal portion of the pectoralis major. In addition, electrodes were placed on the muscle belly of the medial triceps brachii portion. Pre-gelled bipolar silver/silver chloride surface electrodes (Blue Sensor M-00-S, Medicotest, Olstykke, Denmark) were placed with an interelectrode distance of two centimeters. The reference electrode was placed approximately 10 centimeters away from each muscle, according to the manufacturer's specifications. Once the electrodes were placed, participants performed one standard push-up on the floor in order to check signal saturation and quality. All signals were acquired at a sampling frequency of 1500 Hz, amplified and converted from analog to digital. All records of myoelectrical activity (in microvolts) were stored on a hard drive for later analysis.

The participants started all the bench press trials in an extended arm position with forearms and wrists pronate and feet at biacromial (shoulder) width. In the flexed position, the forearm and wrists were kept pronated, whereas the elbow was flexed until the bar touched the chest and the shoulder abducted approximately 45°. The hips and spine were maintained neutral during all repetitions. Elbow joint angle was continuously measured using an electronic inclinometer (2D DTS inclination sensor, Noraxon, Scottsdale, AZ) placed at the lateral side of the humerus. The inclinometer data were synchronously sampled with the EMG data, using a 16-channel 16-bit PC-interface receiver (TeleMyo DTS Telemetry, Noraxon). The dimension of the probes was 3.4 centimeters × 2.4 centimeters × 3.5 centimeters.

Using tape as a marker on the barbell, three different standardized grip widths (distance in centimeters between the tips of right and left third digits) of biacromial width distance (100%, 150%, and 200%) were randomly performed during the bench press at 50% of 1RM. Furthermore, participants performed three different conditions in a randomized order with each of the aforementioned grip widths: externally focused bench press and bench press with two different internal foci, using the pectoralis major and triceps brachii, respectively. The internally focused instruction for the pectoralis was as follows: "During this set, try to focus on only using your chest muscles." The internally focused instruction for the triceps was as follows: "During this set, try to focus on only using your triceps muscles." The researcher showed each participant where these muscles were located to avoid misunderstandings. In the externally focused condition, the instruction was as follows: "During this set, just lift the barbell in a regular way." A 1-minute rest interval was given between all the conditions. Each participant performed only three consecutive repetitions in all conditions to avoid the influence of fatigue on the subsequent condition. Participants were instructed to maintain a 2-second rate for descent and 2-second rate for ascent. The speed of movement was monitored, providing verbal feedback if any variance was noted. A trial was discarded and repeated if participants were unable to perform the exercise with the correct technique or if a subject stated that he had forgotten the instruction.

Data analysis

During later data analysis, all raw EMG signals obtained during the exercises were digitally filtered, consisting of (a) high-pass filtering at 10 Hz, and (b) a moving root mean square (RMS) filter of 500 milliseconds. The RMS routine was performed using a 500 milliseconds smoothing filter/window across the entire signal (i.e. across all contractions). The RMS filter was centered by performing an RMS routine 250 milliseconds backward and 250 milliseconds forward from each data point. For each individual muscle, peak RMS EMG of the three repetitions performed at each level was determined, and the average value of these three repetitions was then normalized (expressed as a percentage) to the maximal RMS EMG obtained during the experimental session (maximum maximorum EMG of each muscle; Calatayud et al., 2016). Normalized values for each muscle were averaged for the four different portions at the pectoralis muscle (pectoralis) and the three different portions at the triceps brachii muscle (triceps). The inclinometer signals were digitally low-pass filtered using a fourth-order zero-lag Butterworth filter (3 Hz cutoff frequency) and used to identify movement of the elbow joint. Accordingly, only peak muscle activation from prober repetitions using elbow joint movements with at least 70° range of motion was used in the analysis.

Statistical Analyses

A linear mixed model (Proc Mixed, SAS version 9.4, SAS Institute, Cary, NC) was used to determine whether differences existed between attentional foci (external, internal pectoralis, and internal triceps) and grip widths (100%, 150%, and 200%) for the pectoralis and triceps muscles performed in two separate analyses (one for triceps and one for pectoralis). Instruction and grip width as well as the interaction between these were entered as independent variables. Normalized EMG was the dependent variable. Participant was entered in the model as a random factor. Values are reported as least square means (95% *CI*) and differences of least square means between conditions (95% *CI*) unless otherwise stated, and p values $< .05$ were considered statistically significant.

Results

For the pectoralis muscle, there was a main effect for both grip width, $F(4, 12) = 16.4$, $p < .01$, and attentional focus, $F(4, 12) = 9.7$, $p < .01$, but there was no significant interaction. For the triceps muscle, there was a main effect of both grip width, $F(4, 12) = 74.3$, $p < .01$, and attentional focus, $F(4, 12) = 12.0$, $p < .01$, but no significant interaction. The post hoc comparisons for each combination of grip width and attentional focus should be considered exploratory and were based on differences of least square means provided by the linear mixed model. For the post hoc comparisons, Table 2 shows complete normalized EMG values of the pectoralis and triceps muscles, respectively, during the different conditions. Focusing on using the pectoralis increased activity of this muscle during grip widths at 150% and 200%. Focusing on using the triceps increased activity of this muscle during grip widths at 100% and 150% and reached borderline statistical significance at 200% ($p = .057$). Focusing on the triceps during the grip at 150% also increased pectoralis activity.

Secondary results showed that during bench press with external focus, the grip width at 100% provided greater pectoralis activity than the grip at 200%, but no difference was found when compared with the grip width at 150%. When focusing internally on a muscle, grip widths at both 100% and 150% provided greater pectoralis activity than the wider 200% grip. Internal focus on the triceps showed greater activity with narrow grip width at 100% than at grip widths of 150% and 200%.

Discussion

The purpose of the present study was to evaluate the influence on muscle activity of different attentional foci while using different grip widths in the bench press exercise. The main finding of this study is that both grip width and attentional foci affected muscle activity level among these participants, but, in contrast to

Table 2. Normalized RMS EMG (Expressed as Percentage) of the Pectoralis and Triceps Muscles During Externally Focused Bench Press and With Focus on the Pectoralis and Triceps Muscles at Different Grip Widths.

Muscle	Grip width	External focus	Focus pectoralis	Focus triceps	Δ Focus pectoralis − external focus	*p*	Δ Focus triceps − external focus	*p*
Pectoralis EMG	100%	54 (50–59)[a]	57 (53–61)[a]	55 (51–60)[a]	3 (−1 to 6)	.1124	1 (−2 to 4)	.5852
	150%	52 (47–56)	57 (53–62)[a]	55 (51–60)[a]	6 (2 to 9)	.0006	4 (1 to 7)	.0203
	200%	49 (45–53)	53 (49–58)	49 (45–54)	4 (1 to 7)	.0099	1 (−3 to 4)	.7488
Triceps EMG	100%	63 (59–68)[a,b]	62 (58–67)[a,b]	68 (63–72)[a,b]	−1 (−5 to 3)	.5818	4 (0 to 8)	.0267
	150%	55 (51–59)[a]	54 (50–58)[a]	59 (54–63)[a]	−1 (−5 to 3)	.6199	4 (0 to 8)	.0393
	200%	51 (46–55)	49 (45–53)	54 (50–59)	−2 (−5 to 2)	.3781	4 (0 to 7)	.0574

Note. EMG = electromyography; RMS = root mean square. Values are least square means and 95% confidence intervals. *p* values are from the post hoc test of the differences between focus conditions.

[a]Significant difference compared with 200%.

[b]Significant difference compared with 150%.

our hypothesis, there were no significant interactions between these variables. To our knowledge, no studies have investigated the effect of manipulating both attentional foci and grip widths during the bench press exercise. Yet, past research has shown increased pectoralis and triceps activity with internal attentional focus during the bench press performed at 50% of 1RM and pectoralis and anterior deltoid activity when the exercise was performed at 80% of 1RM (Snyder & Fry, 2012). More recently, our research group also showed an extended range of intensities with selective activation during the bench press, as we reported that participants can increase pectoralis and triceps activity at loads between 20% and 60% of the 1RM when focusing on these specific muscles (Calatayud et al., 2016). Greater muscle activity is expected when a subject is internally focused on the muscle, possibly because of a lower coherence between sensory input and motor output (McNevin & Wulf, 2002). For instance, in our study, participants could use the minimum muscle recruitment needed to lift during the regular condition, but needed extra voluntary activity when they attempted to selectively use specific muscles, leading to increased muscle tension. Concurrent activation (i.e., increased activation in the nonfocused muscle) was found in the present study. Concretely, focusing on the triceps during the 150% grip width increased activity in both the triceps and pectoralis muscles. In the other conditions, where concurrent activation was not visible, the nonfocused muscle remained unchanged. This absence of concurrent relaxation has also been reported in other studies using the bench press exercise with lower and higher intensities (Calatayud et al., 2016; Snyder & Fry, 2012). Previous works support the possibility of increasing muscle activity by using an internal focus during other typical resistance training exercises. For example, greater muscle activity after specific internally focused instructions, compared with no instructions, has been reported in rectus abdominis, external oblique, transverses abdominis, and internal oblique muscles during a squat at 50% of the 1RM (Bressel et al., 2009), greater internal oblique and rectus abdominis activity during a trunk curl (Karst & Willett, 2004), and higher latissimus dorsi activity during the pull-down exercise performed at 30% of maximal force (Snyder & Leech, 2009).

Despite the lack of significant interaction between grip width and focus conditions, we offer below further exploratory analyses that should be tested in larger studies or through meta-analysis of existing studies before valid conclusions can be drawn. We found no significant pectoralis activity differences between the grip widths of 150% and 200% during the external focus. In regard to the triceps muscle, activation increases as the grip width decreases (i.e., 100% > 150% > 200%). In addition, internally focusing on using the triceps tended to provide even higher activity in this muscle during grip widths of 100% and 150%. Partially in accordance with our results, Barnett et al. (1995) found that grip width at 100% produced higher triceps and clavicular pectoralis activity than a grip width of 200% of the biacromial distance during the bench press, while grip width variation had no effect on the sternocostal head muscle. In contrast, Clemons and Aaron (1997) found that a wider grip (190% biacromial distance) provided greater activity in the prime movers than grip widths at 100% and 130%, but no difference was observed when compared with grip width at 165%. More recently, Lehman (2005) found that the narrow grip (one hand width distance between the two hands) during an isometric bench press produced the greatest triceps activity, whereas the sternocostal head was more activated during the wide variation (200% of biacromial distance) than during the middle grip (100% of biacromial distance). Nevertheless, this author found comparable clavicular pectoralis activity during the different grip widths. The results of these studies might be merged in a meta-analysis to provide further interpretive meaning.

Most of the aforementioned studies seemed to conclude that greater triceps activation is associated with a narrower (vs. wider) grip width during the bench press. In the same vein, greater triceps activity (Youdas et al., 2010) and greater external elbow flexion torques across the elbow joint (Donkers, An, Chao, & Morrey, 1993) have been shown with a narrower grip during push-ups. It is plausible that these results were produced due to the greater elbow range of motion during a narrow grip (Barnett et al., 1995) and thus greater external demand created across the elbow joint (Youdas et al., 2010), emphasizing the role of the triceps as an extensor of the elbow and shoulder joints (Kendall, McCreary, Provance, Rodgers, & Romani, 2005). These speculations may also apply during an internal focus when the grip width is reduced, possibly explaining our results. Interestingly, the study conducted by Youdas (2010) found no pectoralis activity differences between push-ups performed with grips at 100% and 150%, which is in agreement with our findings. Contrasting results about the optimal grip to enhance pectoralis activity could be due to different factors such as the use of different intensities. For example, while Barnett et al. (1995) used 80% of the 1RM, Clemons and Aaron (1997) used 1RM. In addition, Lehman (2005) used isometric contractions, which makes it difficult to extrapolate his results to typical dynamic conditions.

Our study has both strengths and weaknesses. By averaging different portions of the pectoralis major and triceps brachii, we failed to provide detailed data on how these portions were affected by the different grip widths. However, as participants were asked to focus on the entire muscle in their internal focus, the use of an averaged value for the different portions of the pectoralis major and triceps brachii may provide more representative data (Calatayud et al., 2016). We found strong main effects for both grip width and attentional foci, meaning that both of these affect muscle activity levels. However, the absence of any significant interaction between these variables means that our exploratory comparisons regarding effects of combining these variables must be validated by subsequent research before it can be accepted as helpful to resistance training.

Declaration of Conflicting Interests

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