The Effect of Priming With Questionnaire Content on Grip Strength in Patients With Hand and Upper Extremity Illness

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Abstract

Background: Grip strength is a performance-based measure of upper extremity function that might be influenced by priming (the influence of a response to a stimulus by exposure to another stimulus). This study addressed the influence of questionnaire content on performance measurements such as grip strength between patients who complete the standard Pain Catastrophizing Scale (PCS) compared with patients who complete a positively adjusted PCS. **Methods:** Between June 2015 and August 2015, we enrolled 122 patients who presented to 3 hand surgeons at 3 outpatient offices. They were randomized to 2 groups: the control group, which completed the PCS, and the intervention group, which completed a positively phrased version of the PCS. Before and after completion of the questionnaire, we measured each patient's grip strength 3 times by alternating between hands. Two patients were excluded after participation. We calculated both the preintervention and postintervention mean and maximum grip strengths. **Results:** There was no significant difference between groups on mean or maximum grip strength before completion of the questionnaires. There was a greater improvement in mean grip strength of both hands in the intervention group compared with the PCS group. This improvement was statistically significant in the affected hand. The maximum grip strength showed a statistically significant greater improvement in both hands in the positive PCS group compared with the control group. **Conclusions:** Positive priming through a questionnaire leads to an increase in mean and maximum grip strength when compared with the standard questionnaire that uses negative terms rather than positive.

Keywords: grip strength, priming, dynamometer

Introduction

Strong grip is not an objective measure of upper limb function. Grip requires effort, motivation, and belief in the ability to perform the task safely. Although young men are generally stronger,^{7,12} grip measurement at all 5 stations on a grip dynamometer and rapid alternating grip strength is used to identify incomplete effort (which may be associated with pain avoidance or secondary gain). Grip strength correlates with measures of the subjective aspects of illness such as the Disabilities of the Arm, Shoulder and Hand (DASH),³ and with discharge disposition, depressive or anxiety disorders, and mortality.^{9,13,17} A previous study by our group demonstrated no correlation between the Pain Catastrophizing Scale (PCS) score and grip strength.¹⁹

Priming, the influence of a response to a stimulus by exposure to another stimulus, affects responses on subjective measures of upper extremity function. A study by our group recently found that patients primed with a positively phrased

version of the PCS presented less disability on the Patient-Reported Outcomes Measurement Information System (PROMIS) Upper Extremity when compared with patients primed with a negatively phrased PCS.⁵ However, it is not known whether priming also affects performance measurements of hand function. This study addressed the influence of questionnaire content on partially subjective, partially objective performance measurements such as grip strength.

This study tested the primary null hypothesis that there is no difference in mean grip strength (based on 3 attempts) between patients who complete the standard PCS compared

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Table 1. PCS Versus the Positively Primed Version of the PCS.

PCS	Positively primed version of the PCS
When I'm in pain . . .	When I'm in pain . . .
I worry all the time about whether the pain will end.	I go about my business, without concern about whether the pain will end.
I feel I can't go on.	I feel I can carry on.
It's terrible and I think it's never going to get any better.	It's manageable and I think it will get better.
It's awful and I feel that it overwhelms me.	It's tolerable and I can push it to the background.
I feel I can't stand it anymore.	I feel I'll be OK.
I become afraid that the pain may get worse.	I am confident that the pain will diminish.
I think of other painful experiences.	I think about how things have worked out in the past and I move on.
I anxiously want the pain to go away.	I realize it may take some time for the pain to go away.
I can't seem to keep it out of my mind.	I have learned how to take my mind off of the pain.
I keep thinking about how much it hurts.	I am able to stay focused on daily tasks regardless of pain.
I keep thinking about how badly I want the pain to stop.	I have a sense that I'll be OK with or without pain.
There is nothing I can do to reduce the intensity of the pain.	There are some things I can do to reduce the intensity of the pain.
I wonder whether something serious may happen.	I trust everything will be all right.

Note. PCS = Pain Catastrophizing Scale.

with patients who complete the positively adjusted PCS. The secondary null hypothesis was that there is no difference in maximum grip strength (based on 3 attempts) between patients who complete the standard PCS compared with patients who complete the positively adjusted PCS.

Methods

Design

This study was an institutional review board–approved, double-blinded randomized controlled study, performed at 3 outpatient offices of a level 1 trauma center in Boston, Massachusetts. The trial was registered on www.clinicaltrials.gov under identifier NCT 02493127.

Subjects

Between June 2015 and August 2015, new and follow-up patients presenting to 3 hand surgeons at 3 outpatient offices were invited to participate in this study. Inclusion criteria were patients aged 18 years or greater with English fluency and literacy and able to provide informed consent. Patients who were physically unable to use a dynamometer were excluded. Written informed consent of each patient was obtained after providing information about the study orally and in writing.

Randomization, Intervention, and Blinding

The patients were randomized in a 1:1 ratio through permuted block randomization (Microsoft Excel, Redmond, Washington) to either the intervention group (positively worded PCS) or the control group (standard PCS).

The patients in the control group were asked to complete the PCS. This is a 13-item scale to measure catastrophic

thinking in response to nociception.¹⁵ Patients answer items on a response scale from 0 to 4. Scores range from 0 to 52: A lower score indicates less catastrophic thinking about pain. The patients in the intervention group received a validated positively phrased version of the PCS, for example, “I go about my business, without concern about whether the pain will end” or “I feel I can carry on”⁵ (Table 1). Here too, patients answer items on a response scale from 0 to 4. Scores range from 0 to 52: A higher score indicates less catastrophic thinking about pain.

Prior to questionnaire completion, for each patient, we measured each hand's grip strength 3 times by alternating between hands. We standardized our measurements by performing all measurements according to the recommendations of the American Society of Hand Therapists (ASHT): We used a Jamar dynamometer with its handle position set at the second position and had the subjects seated with their shoulders adducted, their elbows flexed in 90°, and their forearms in neutral.⁸ We repeated the grip strength measurements after completing the questionnaires. The same examiner completed all measurements for study participants.

All patients were blinded to the study hypothesis. The examiner completing the measurements was also blinded to the intervention or control group, and so were the 3 referring surgeons. All questionnaires were filled out on a computer by using REDCap data management software (REDCap; Vanderbilt University, Nashville, Tennessee) before or after the consultation with the hand surgeon. No further evaluation was performed.

Outcome Measures

Our primary outcome was mean grip strength, which was calculated by calculating the mean of the grip strength measurements. We calculated both the preintervention and

postintervention mean grip strengths. Our secondary outcome was maximum grip strength, which was determined by selecting the largest of the observations. We determined both the preintervention and postintervention maximum grip strengths.

Interventions to Prevent Bias

Participants were informed about the study purpose but blinded to our specific study hypotheses. They were told that we were interested in their grip strength before and after completing a questionnaire regarding their responses to pain. The informed consent letter specified the protocol title, number of necessary participants, possible risks and discomforts, and statements regarding protection of privacy. The investigator was unaware of which group the participant was assigned to and ensured that the grip strength measurements were performed correctly. There was no significant difference between the number of new and follow-up patients in both groups (Table 2). If necessary, the medical record was reviewed for additional information.

Power Analysis

Based on drafts of the protocol, we planned to use a 1-way analysis of variance (ANOVA) leading to an analysis indicating the need for 120 patients. We realized after completing the study that the 2-sample *t* test was the more appropriate test for the final version of our protocol. A post hoc power analysis demonstrated that a sample size of 60 patients in each group gave us 80% statistical power to detect a difference between the grip strength of the 2 groups with an effect size of 0.52.

Statistical Analysis

The demographic and clinical characteristics of patients were reported with frequencies and percentages for dichotomous or categorical data and as mean $\pm$ standard deviation for continuous data. The associations between priming and the primary and secondary outcomes were analyzed using the 2-sample *t* test.

Results

Participants

One hundred twenty-five patients were asked to participate in this study, 3 patients (2.4%) declined participation. A total of 122 patients were enrolled. Two patients were excluded after participation in our study: One patient was excluded because she could not finish the study due to inadequate time, and 1 patient had a grip strength that was too low to measure. Our final cohort included 120 patients. The

intervention and control groups were well balanced, with no significant differences in terms of demographic and other patient-specific characteristics (Table 2).

Mean Grip Strength

There was no significant difference in preintervention mean grip strengths between the intervention and control group ($P > .05$; Table 3). Bivariate analysis identified significantly greater improvement ($P < .05$) in mean grip strength including all measurements of both hands in the positively adjusted PCS intervention group compared with the PCS control group (3.1 vs 0.71). The improvement in mean grip was statistically significant in the affected hand (3.9 vs 1.3; $P < .05$), and not significant for the unaffected hand (2.2 vs. 0.31; $P = .056$; Table 4), which we used as a control for the affected hand.

Maximum Grip Strength

There was no significant difference in preinterventional maximum grip strengths between the intervention and control groups ($P > .05$). Bivariate analysis identified a significant difference ($P < .05$) in improvement of maximum grip strength including all measurements of both hands in the positively adjusted PCS intervention group compared with the PCS control group (2.7 vs -1.2). The improvement was statistically significant in both the affected (4.0 vs -0.17 ; $P < .05$) and unaffected hands (1.8 vs -0.77 ; $P < .05$; Table 4).

Discussion

Priming influences perceptions,¹⁰ behavior,² performance on cognitive tasks,⁶ and a person's attitudes and values.¹¹ We found that positive priming leads to an improvement in the mean grip strength of the affected hand and the mean grip strength of both hands together. In the unaffected hand, the *P* value was .056, and the upper value of the confidence interval (CI; 95% CI, -3.78 to 0.051) was very close to being below zero. Taken together, these findings suggest that future research should reexamine the relationship between positive priming and the unaffected hand. In addition, our results showed that positive priming leads to an increase in maximum grip strength in both the affected and unaffected hands.

Our study should be interpreted in light of its strengths and limitations. This is a double-blinded randomized controlled study that was performed at 3 different outpatient clinics. Furthermore, we used the ASHT recommendations for measuring grip strength, allowing for standardization of our measurements.⁸ However, our study results may not extrapolate to patients who do not fit our inclusion criteria. Also, some patients were enrolled directly before their visit to the hand surgeon, whereas other patients were enrolled

Table 2. Patient Characteristics.

	All patients (n = 120)	PCS (n = 60)	PPCS (n = 60)	P value
Age, mean (SD), y	53 (16)	55 (16)	51 (16)	.25
Sex, n (%)				.14
Men	59 (49)	25 (41)	34 (56)	
Women	61 (50)	35 (58)	26 (43)	
Race, n (%)				.71
White	111 (92)	56 (93)	55 (91)	
Black or African American	3 (2.5)	1 (1.6)	2 (3.3)	
Asian	1 (0.83)	0 (0.0)	1 (1.6)	
Native Hawaiian or Other Pacific Island	1 (0.83)	0 (0.0)	1 (1.6)	
Other	4 (3.3)	3 (5.0)	1 (1.6)	
Ethnicity, n (%)				.61
Hispanic or Latino	4 (3.3)	1 (1.6)	3 (5.0)	
Not Hispanic or Latino	116 (96)	59 (98)	57 (95)	
Marital status, n (%)				.34
Single	33 (27)	17 (28)	16 (26)	
Living with partner	7 (5.8)	1 (1.6)	6 (10)	
Married	71 (59)	36 (60)	35 (58)	
Separated/divorced	3 (2.5)	2 (3.3)	1 (1.6)	
Widowed	6 (5.0)	4 (6.6)	2 (3.3)	
Education in years, mean (SD), y	15 (2.6)	16 (2.3)	14 (2.8)	.25
Insurance status, n (%)				.075
Workman's compensation	13 (10)	57 (95)	50 (83)	
No workman's compensation	107 (89)	3 (5.0)	10 (16)	
Smoker, n (%)				.36
Smoker	108 (90)	56 (93)	52 (86)	
Nonsmoker	12 (10)	4 (6.6)	8 (13)	
Diagnosis, n (%)				.46
Nontraumatic	89 (74)	43 (71)	46 (76)	
Traumatic	31 (25)	17 (28)	14 (23)	
Visit type, n (%)				.67
New patient	46 (38)	25 (41)	21 (35)	
Follow-up patient	74 (61)	35 (58)	39 (65)	
Hand dominance, n (%)				.72
Left	20 (16)	12 (20)	8 (13)	
Right	98 (81)	47 (78)	51 (85)	
Both	2 (1.6)	1 (1.6)	1 (1.6)	
Injured hand(s), n (%)				.15
Left	58 (48)	32 (53)	26 (43)	
Right	57 (47)	24 (40)	33 (55)	
Both	5 (4.1)	4 (6.6)	1 (1.6)	
PCS score, mean (SD), score from 0 to 52	—	8.2 (8.7)	—	—
PPCS score, mean (SD), score from 0 to 52	—	—	36.4 (9.8)	—

Note. PCS = Pain Catastrophizing Scale; PPCS = Positive Pain Catastrophizing Scale.

right after their visit. Even though our permuted block randomization will most likely negate any effect this may have had, this could be a potential confounder.

Our results showed that—among patients with hand and upper extremity illness—positive priming leads to an increase in both mean and maximum grip strength when

compared with patients that were primed negatively. Prior studies confirm the influence of priming and speculate on mechanisms of action. In a study on 42 healthy participants, Aarts et al¹ reported that reaction time, force exertion, mean force, and maximal force were increased by subliminal priming combined with observable positive stimuli. In a

Table 3. Grip Strength Before Intervention.

	Intervention		Intervention		P value
	Original PCS	Range	Positive PCS	Range	
Both hands					
Mean (SD), pounds force	59 (23)	14-128	68 (30)	23-129	.066
Maximum (SD), pounds force	73 (28)	16-140	81 (33)	28-164	.14
Affected hand					
Mean (SD), pounds force	52 (24)	10-120	62 (32)	10-122	.055
Maximum (SD), pounds force	56 (25)	11-121	66 (32)	11-126	.070
Nonaffected hand					
Mean (SD), pounds force	67 (28)	14-137	75 (32)	25-155	.18
Maximum (SD), pounds force	72 (30)	16-140	79 (33)	28-164	.22

Note. PCS = Pain Catastrophizing Scale.

Table 4. Difference in Grip Strength After Intervention.

	Intervention		P value
	Original PCS	Positive PCS	
Both hands			
Mean (SD), pounds force	0.71 (4.1)	3.1 (4.5)	.0033
Maximum (SD), pounds force	-1.2 (6.9)	2.7 (6.5)	.0019
Affected hand			
Mean (SD), pounds force	1.3 (4.3)	3.9 (6.2)	.0070
Maximum (SD), pounds force	-0.17 (5.4)	4.0 (7.3)	<.001
Nonaffected hand			
Mean (SD), pounds force	0.31 (5.3)	2.2 (5.1)	.056
Maximum (SD), pounds force	-0.77 (7.2)	1.8 (6.6)	.049

Note. PCS = Pain Catastrophizing Scale. Values in bold indicate statistical significance.

study on 19 healthy volunteers, Takarada and Nozaki¹⁶ used transcranial magnetic stimulation to show that this priming effect may be due to enhanced corticospinal excitability. Both studies only included healthy volunteers, as opposed to our study in which we only enrolled patients with a hand and upper extremity condition. Despite their small sample sizes, these studies may provide additional insights on the effects of priming on the neuronal circuits of the motor system. The observation that nonconscious affective cues influence measures of maximum performance is supported by another study on healthy individuals.⁴

Grip strength is associated with upper extremity-specific symptoms and disability. Both grip and disability are subject to priming. We interpret this to indicate that positive priming of patients might affect symptom intensity and magnitude of limitations. Research has identified the emotional impact of the words orthopedic surgeons use when communicating diagnoses, symptoms, etiology, treatment, and prognoses.¹⁸ These words, concepts, and behaviors of hand surgery may risk negative priming. Words such as “tear,” “overuse,” “compensation”; concepts such as cortisone injection for puzzling pains or

disease for which there is no or uncertain efficacy; and the use of diagnostic tests of limited yield; and the potential to mislead might all contribute to negative priming.^{14,18} The weight of this evidence suggests that priming by word choice might facilitate recovery. Future studies might measure symptoms and disability prior to and after different word choices optimized to account for the concept of psychological priming.

Ethical Approval

This study was approved by our institutional review board (IRB Approval No, 2015P000879/MGH).

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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