

Influence of general self-efficacy as a mediator in Taiji-induced stress reduction – Results from a randomized controlled trial

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Abstract

Aim of the study: In this study we examined the effects of Taiji on perceived stress and general self-efficacy (GSE), and investigated the mediating role of a Taiji-induced GSE increase on Taiji-related reduction of perceived stress.

Materials and methods: 70 healthy participants were randomly allocated either to the Taiji intervention group or the waiting list control group. The intervention lasted for 12 weeks comprising two Taiji classes per week. Before, shortly after, and two months after the intervention, we assessed the degree of perceived stress and GSE in all participants by employing the Perceived Stress Scale (PSS) and the GSE-Scale.

Results: Compared to controls, participants of the Taiji group showed a significantly stronger decrease of perceived stress and a higher increase in GSE from pre- to post-intervention assessment (PSS: $p=0.009$; GSE: $p=0.006$), as well as from pre-intervention to follow-up assessment (PSS: $p=0.018$; GSE: $p=0.033$). A mediator analysis based on a multiple regression approach revealed that a Taiji-related increase in GSE statistically mediated the reduction in perceived stress after Taiji as compared to baseline. Post hoc testing showed that the mediating effect of GSE was significant ($p=0.043$).

Conclusions: Our findings confirm previously reported Taiji-related stress reducing and GSE enhancing effects with GSE increase mediating Taiji related reduction of perceived stress.

Keywords: Taiji; General self-efficacy; Perceived stress; Randomized controlled trial; Mediator analysis

Introduction

Chronic stressful experiences predispose to the development of maladaptive changes in physiological stress responsive systems and health behavior known for their harmful impact on health and longevity [1–3]. Longitudinal and experimental studies have shown that perceived chronic stress plays an important role in pathogenesis of various physical diseases such as acute respiratory infection [4], cardiovascular disease [5], and delayed wound healing [6], as well as of mental disorders

including depression, alcoholism, generalized anxiety disorder or phobia [7–9]. Hence, the investigation of stress protective interventions is of high relevance for health maintenance or promotion.

Taiji is a mind-body practice that has received increased attention in western societies [10] as well as in the research community as a potential intervention for stress management [11]. Taiji is rooted in Chinese martial arts and is characterized by the flow of gentle and mindfully performed body movements. Taiji practice aims to strengthen and relax both body and mind, as well as to enhance personal development and self-defence [12]. Despite some non-significant findings [13–16] the current state of research generally supports stress-reducing effects of Taiji such as decreasing perceived stress [11,17–26], and attenuating psychophysiological stress reactivity [27,28]. However, investigations related to the underlying stress protective mechanisms of Taiji are still scarce [26].

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Self-efficacy is defined as the confidence in one's capability to master a demanding situation [29]. Perceived self-efficacy influences behavior as well as cognitive, motivational, and emotional processes in subjectively difficult events [30]. The concept of confidence in one's coping abilities can be related to a specific domain (specific self-efficacy) as well as more generally to a variety of stressful situations (general self-efficacy – GSE) [31]. Positive effects of Taiji on domain-specific self-efficacy have been repeatedly observed, namely on self-efficacy related to exercise behavior [19,32–35], pain management [36], physical capability [37] and fall prevention [34,38]. A significant increase in GSE following Taiji has been reported in three randomized controlled trials [39–41]. The notion that GSE is likely to mediate stress reducing treatment effects is supported by the cognitive transactional stress theory [42,43]. According to this theoretical approach GSE plays a key role in the appraisal process in potentially stressful situations. The greater self-efficacy, the more likely a stressful encounter is interpreted as a challenge and less likely as a threat [44]. In line with this reasoning the association of higher levels of GSE with a lower degree of perceived stress has been repeatedly found in prior research [44–49]. Moreover, a mediating effect of GSE on the perception of psychological stress has been previously reported [45,50]. However, a mediating effect of a GSE increase on the reduction of perceived stress in response to regular Taiji practise has not yet been examined. We therefore set out to investigate in a first step whether Taiji increases general self-efficacy (GSE) and reduces perceived stress. In a second step, we assessed whether a Taiji-related increase in GSE potentially mediates stress reduction following Taiji.

Methods and materials

Participants and design

This study was part of a trial investigating psychobiological effects of Taiji on psychosocial stress reactivity in healthy participants [27]. Formal approval was obtained from the ethics committee of the Canton Bern, Switzerland. Recruitment of study participants was carried out through advertisement of the study on pin boards and on the homepage at the University of Bern, and at the University Hospital in Bern. Through telephone screening, healthy applicants aged from 18 to 50 years were included and, if the exclusion criteria did not apply, randomly allocated either to the Taiji intervention group or to the waiting list control group. Detailed information about exclusion criteria and the randomized group allocation are reported elsewhere [27].

Taiji intervention

The Taiji course started in September 2010 and lasted for 12 weeks. Training sessions of 60 min took place twice a week. A certified Taiji teacher, awarded by the Swiss Society for Qigong and Taijiquan (Schweizerische Gesellschaft für Qigong und Taijiquan – SGQT), was in charge of all Taiji classes

and recorded participants' course attendance. Participants in the Taiji group were taught the first 18 sequences of the 37 Chen Man-Ch'ing Yang-Style Taiji short form [10] by emphasizing basic Taiji principles such as extension, relaxation and alignment of the body, as well as holistic and mindful body movements [51]. Each training session started with warm-up exercises (15 min), followed by practicing Taiji movements and reviewing the above mentioned basic principles (35 min) and ended with Taiji related breathing and relaxation exercises (10 min). Participants of both study groups were asked not to take part in any new mind-body or physical exercise program during their study participation. After completion of the study, an equivalent Taiji course was offered to participants in the control group.

Measures

Psychological stress was measured by the Perceived Stress Scale (PSS) [7]. This 10-item self-report questionnaire assesses participants' cognitive evaluation of stressfulness of the situations experienced in the past month of their life. Items were designed to estimate on a five point Likert scale ranging from "never" to "very often" how unpredictable, uncontrollable, and overloaded participants perceive their lives. Good internal consistency is reported (Cronbach's $\alpha = 0.78$) [7].

GSE was measured by the General Self-Efficacy Scale [31]. This 10-item scale assesses a general sense of perceived self-efficacy with the aim to predict coping with daily hassles as well as adaptation after experiencing stressful life events in general. Each item refers to successful coping and has to be rated regarding its accuracy on a four point Likert scale ranging from "not at all true" to "exactly true". Internal consistency is considered to be high with Cronbach's α values ranging from 0.86 to 0.94 [52].

Procedure

Complete oral and written description of the study was provided to all included participants and informed written consent was obtained prior to participation. At pre-intervention assessment prior to group allocation, participants completed an online survey comprising the PSS and the GSE questionnaires, alongside other questionnaires not relevant to the present study. All study participants were asked to complete post intervention assessment shortly after the Taiji course (week 12) and follow-up assessment two months after the intervention (week 20). Participants not responding within 5 days were reminded by phone call and email.

Statistical analyses

Data analysis was conducted by using the statistical software package SPSS (version 18) for Macintosh (IBM SPSS Statistics, Somers, NY, USA). All analyses were two-tailed, with the level of significance set at $p < 0.05$. Unless indicated, all results are presented as mean \pm standard deviation (SD). Prior

Table 1
Group characteristics and baseline values.

Group characteristics ^a	Taiji group (<i>n</i> = 28)	Control group (<i>n</i> = 31)	<i>p</i> ^b
Age (years)	35.86 ± 8.64	35.13 ± 6.53	0.74
Gender (male/female)	10/18	10/21	0.79
Body mass index (kg/m ²)	23.38 ± 3.31	23.11 ± 3.57	0.79
Education (with/without high school degree)	21/7	25/6	0.76
Occupational status (full or part time workers/students)	25/3	30/1	0.34
Smoking (non-smokers/light smokers i.e. <5 cigarettes per day)	23/5	24/7	0.75
Previous experience with mind-body practices (months of regular practice)	15.79 ± 29.98	30.04 ± 45.10	0.21
Taiji classes attended (incl. %-value)	20.8 ± 2.97 (86.8%)	–	–
Baseline values			
PSS score	17.07 ± 5.30	17.61 ± 5.83	0.77
GSE score	29.18 ± 3.19	27.97 ± 4.02	0.21

^a Continuous data are expressed as mean ± SD

^b *p*-Values refer to χ^2 tests for categorical data, and independent samples *t*-tests for continuous data PSS, Perceived Stress Scale; GSE, general self-efficacy scale.

to statistical analyses all data were tested for normal distribution and homogeneity of variance using the Kolmogorov–Smirnov and Levene test. Group characteristics were analyzed by χ^2 -test for categorical data, and independent samples *t*-test for continuous data. Group differences in baseline values were also tested using *t*-tests.

To examine the impact of Taiji on perceived stress and GSE we calculated repeated measures ANOVAs with group (Taiji vs. control) as the independent variable and repeated measures of perceived stress and GSE respectively as dependent variables. Post hoc analyses were conducted to test whether the study groups significantly differed in their mean change values from pre to post intervention assessment, as well as from pre intervention to follow-up assessment by conducting independent samples *t*-tests. For *F*-tests, the effect size parameter Cohen's *f* was calculated from partial η^2 -values (effect size conventions: *f*: 0.10 = small, 0.25 = medium, 0.40 = large) and for *t*-tests Cohen's *d* was computed (effect size conventions: *d*: 0.20 = small, 0.50 = medium, 0.80 = large) [53].

To test whether GSE increases following Taiji mediate reductions in perceived stress, a mediator analysis based on a multiple regression approach [54] was conducted. A variable is regarded to mediate the relationship between an intervention and an outcome if the following three conditions are confirmed: (1) the predictor variable (Taiji vs. control group) predicts the outcome variable (i.e. PSS change from pre- to post-intervention/waiting), (2) the predictor variable predicts the mediator variable (i.e. GSE change from pre- to post-intervention/waiting), and (3) both, the predictor and the mediator variable predict the outcome variable with the effect of the predictor variable on the outcome variable being lower than in condition 2 [54,55]. PSS and/or GSE baseline values were included in regression analyses with the respective change scores (i.e. PSS change (condition 1), GSE change (condition 2), as well as PSS and GSE change (condition 3)) to control for their influence on the outcome variable and on the mediator variable, respectively. The level of significance of the mediation effect was assessed post hoc by using the Sobel test [56].

Results

Of the 112 applicants, 70 fulfilled inclusion criteria and completed pre-intervention assessment. They were randomly assigned to either the Taiji group (*n* = 35) or the waiting list control group (*n* = 35). As 11 participants discontinued (Taiji group *n* = 7/control group *n* = 4), post-intervention measures were obtained from 28 participants of the Taiji group and 31 participants of the control group. One participant in the Taiji group and one in the control group did not attend follow-up assessment. Their last value was carried forward.

Group characteristics

No significant group differences were found with respect to age, gender, body mass index, education, occupational status, smoking, or previous experience with self-applicable mind-body practices. Neither did the baseline values for perceived stress and GSE significantly differ between both study groups (see Table 1).

Taiji effects on perceived stress and general self-efficacy

Taiji training significantly lowered perceived stress scores [main effect Taiji: $F(1/309.62) = 3.88$, $p = 0.054$, partial $\eta^2 = 0.064$, $f = 0.26$; interaction Taiji by time: $F(2/49.11) = 4.67$, $p = 0.011$, partial $\eta^2 = 0.076$, $f = 0.28$] and significantly enhanced GSE scores [main effect Taiji: $F(1/241.80) = 5.82$, $p = 0.019$, $\eta^2 = 0.093$, $f = 0.32$; interaction Taiji by time: $F(2/15.36) = 4.82$, $p = 0.010$, partial $\eta^2 = 0.078$, $f = 0.29$] as compared to the control condition.

Post hoc testing revealed a significantly stronger decrease of perceived stress scores from pre- to post-intervention assessment ($t = -2.69$, $df = 57$, $p = 0.009$) as well as from pre- to follow-up assessment ($t = -2.43$, $df = 57$, $p = 0.018$) in the Taiji group compared to controls. Post hoc testing of GSE showed a significantly higher increase from pre- to post-intervention assessment in the Taiji group compared to controls ($t = 2.83$, $df = 57$, $p = 0.006$) which persisted in the follow-up assessment ($t = 2.19$, $df = 57$, $p = 0.033$). Raw data, *p*-values and effect sizes are listed in Table 2.

Table 2
Changes in perceived stress scores and general self-efficacy scores.

Variable	Mean change from baseline (\pm SD)		p^a	d
	Taiji group ($n = 28$)	Control group ($n = 31$)		
PSS score				
- Week 12 (post intervention)	-2.75 ± 3.53	$+0.32 \pm 5.02$	0.009	0.71
- Week 20 (follow-up)	-4.57 ± 5.12	-1.32 ± 5.15	0.018	0.64
GSE score				
- Week 12	$+1.89 \pm 2.88$	-0.10 ± 2.52	0.006	0.75
- Week 20	$+2.46 \pm 2.30$	$+1.06 \pm 2.58$	0.033	0.58

PSS, Perceived Stress Scale; GSE, general self-efficacy scale; and d , effect size parameter Cohen's d .

^a p -Values refer to independent samples t -tests.

Mediation effects of general self-efficacy on perceived stress

Fig. 1 depicts the mediational model for GSE. In accordance with the above reported findings, regression analyses showed significant effects of Taiji practice (predictor) on mean change values of perceived stress from pre- to post-intervention assessment (outcome) ($B = -3.25$; s (= standard error) = 1.05; $\beta = -0.36$; $p = 0.003$) (condition 1), and on mean change values of GSE from pre- to post-intervention assessment (mediator) ($B = 2.11$, $s = 0.71$; $\beta = 0.37$; $p = 0.004$) (condition 2). The effect of pre-post changes in GSE (mediator) on pre-post changes in perceived stress (outcome) was significant ($B = -0.66$, $s = 0.18$; $\beta = -0.41$; $p < 0.001$) and persisted when additionally controlling for Taiji practice ($B = -0.53$, $s = 0.19$; $\beta = -0.33$; $p = 0.007$) (condition 3). Notably, the effect of Taiji practice on pre-post changes in perceived stress was no longer significant, when pre-post changes in GSE were controlled ($B = -1.92$, $s = 1.08$; $\beta = -0.21$; $p = 0.08$). Post hoc testing revealed that the reduction of perceived stress following Taiji was significantly mediated by Taiji-induced GSE increase ($z = -2.06$; $p = 0.043$).

Discussion

In the present randomized controlled trial we investigated the impact of Taiji practice on perceived stress and GSE, and explored a mediating role of GSE in Taiji-induced reduction of perceived stress. To the best of our knowledge, this is the first study examining GSE as an underlying stress protective mechanism of Taiji. We found that three months of regular Taiji practice led both to a significant decrease of perceived stress and an increase of GSE in healthy Taiji novices compared to the

waiting list control group. Notably, these effects were of medium effect sizes and persisted at least two months after the intervention. Our regression analyses confirmed the assumption that an increase in GSE following the Taiji intervention significantly mediates the observed reduction in perceived stress.

The observed significant attenuation of perceived stress in response to Taiji is in line with emerging reports on stress reducing effects induced by regular Taiji practice [11]. Since our trial was nested within a larger research project investigating effects of Taiji practice on psychobiological stress reactivity, participants might have fostered high expectations regarding Taiji induced stress reduction. Due to the waiting list control design we cannot rule out a confounding influence of a potential expectancy effect. Future studies may incorporate an additional active control intervention that is likely to evoke similar stress reducing expectations. It might be speculated that participants' positive expectations and/or breathing exercises might have added to the stress-reducing effects observed in our Taiji group. However, Taiji is characterized by unique principles emphasizing the development of a mindful embodiment of effortless stability and calmness in motion. These principles might have effectively been transferred to coping with potentially stressful encounters in daily life. [27] To elucidate whether the stress reducing effects observed in our Taiji group differ from other activities that also include breathing exercises and/or positive expectations, comparative effectiveness research is needed.

The observed enhancement of GSE through Taiji practice is in accordance with prior research [39–41]. Considering all four sources of self-efficacy, i.e. performance accomplishment, vicarious experience, verbal persuasion and emotional arousal [29], we assume that positive experiences of successfully

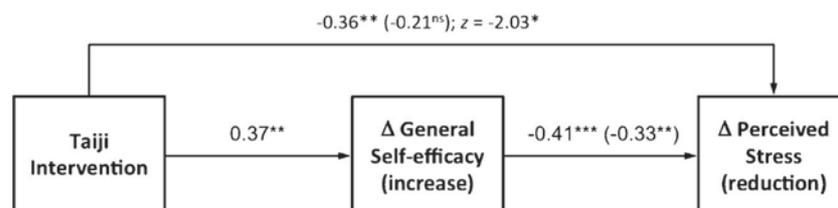


Fig. 1. Mediational model for general self-efficacy. Values on paths are path coefficient scores (standardized β). Path coefficients outside parentheses are zero-order regression coefficient scores. Path coefficients in parentheses are standardized partial regression coefficient scores from the equation that includes the other variable with a direct effect on the outcome (condition 3). PSS and/or GSE baseline values were controlled for in regression analyses including the respective change scores. ns, not significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; z , z -value derived from Sobel test.

accomplished learning objectives are very likely to occur during Taiji classes and probably contribute the most to an increase in self-efficacy. However, as other sources of self-efficacy may also be present in Taiji interventions, their specific contribution to a Taiji-induced increase in self-efficacy remains to be elucidated. Moreover, transferability and usefulness of the Taiji course contents into participants daily lives needs to be addressed in future research, as these aspects are likely to shed light on the process of how self-efficacy experience during Taiji classes is transferred and generalized into participants' daily lives.

The perception of stress and the use of coping strategies to deal with stressful encounters depend on situational and personal resource factors [42]. The significant association between GSE and perceived stress found in the present study supports the idea that GSE functions as a personal resource factor influencing the appraisal process and therefore exerting an impact on perceived stress. Our mediational model suggests that the impact of Taiji on perceived stress may have been due to its effect on GSE, which in turn affected perceived stress. As indicated by regression analyses, a GSE increase may act as a mediator between Taiji and perceived stress reduction. This mediation effect might have been even stronger, if a more stress management specific aspect of self-efficacy such as coping-self-efficacy would have been tested [57,58]. It needs to be kept in mind that, since GSE and perceived stress have been measured at the same time points, it could be that individuals with a higher reduction in perceived stress are more likely to develop a higher level of GSE. However, this alternative mediational model lacks theoretical foundation. Based on the definition of Taiji as a multicomponent intervention, future studies should also consider to examine other potential Taiji components (e.g. musculo-skeletal fitness, mindfulness, social interactions, imagery and breathing) [12], as well as other personal resource factors (e.g. commitments, beliefs, optimism, and sense of control) [42] related to stress reduction that may function as underlying mechanisms of Taiji. In addition to the above-mentioned considerations, the following limitations need to be taken into account. First, we did only control for baseline values of GSE and PSS scores but not for potentially confounding factors such as social support that may cause both elevation of GSE and reduction of perceived stress [47,58]. Second, our data is exclusively based on self-report, which raises the issue of potential biases caused by socially desirable response patterns and/or other systematic response tendencies. To improve the validity of our self-report data in future research multiple instruments and approaches for data assessment such as physiological tests and third party ratings should be used. Third, as absolute reliability of the employed questionnaires is not warranted, random misclassification may cause the observed associations to appear not as strong as they actually are [55]. Furthermore, as the effects of Taiji practice on stress reduction and resource activation may be substantially different in at risk populations, future research on ill and/or stressed population need to be undertaken.

The main strength of this study is its randomized controlled design with a two months follow-up period. Moreover, baseline characteristics of the two study groups were comparable. Finally, our results were obtained among a sample of healthy young to

middle aged adults and thus are more broadly generalizable than clinical research restricted to selected patient populations and older age groups.

Conclusions

Our results confirm Taiji-related stress reducing and GSE enhancing effects. By highlighting the role of GSE as a mediator of Taiji induced stress reduction, our findings provide preliminary insight into one mechanism of how Taiji may contribute to mental health promotion.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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