JOURNAL OF BEHAVIORAL HEALTH, 2018
VOL 7, NO. 4, PAGE 185–192
10.5455/jbh.20180727033842

ORIGINAL RESEARCH

Open Access

Mindfulness-based walking vs. seated meditation on anxiety, affect, fatigue, and cognition

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ABSTRACT

We conducted a side-to-side comparison of mindfulness meditation versus mindfulness-based walking on psychological functioning. Participants (23 young adults; M_{age} = 21 years) completed three laboratory visits (1-week apart). Session 1 included a familiarization trial. Sessions 2 and 3 (counterbalanced) included either a 10-minute guided mindfulness session or a 10-minute mindfulness-based treadmill walk (employing mindfulness meditation techniques while walking). The psychological outcomes, assessed before and after each visit, included various cognitive (e.g., executive function), affect (e.g., perceived valence, distinct emotions, and arousal), and psychological (e.g., anxiety and fatigue) outcomes. Mindfulness meditation was effective in enhancing cognition ($p = 0.005$); improving affective valence ($p = 0.01$); reducing arousal ($p = 0.001$); and decreasing sadness ($p = 0.04$), anxiety ($p = 0.001$), and tension ($p = 0.01$). Similarly, mindfulness-based walking was effective in enhancing cognition ($p = 0.05$); improving affective valence ($p = 0.001$) and excitement ($p = 0.03$); reducing sadness ($p = 0.04$); and decreasing anxiety ($p = 0.001$), tension ($p = 0.006$), and fatigue ($p = 0.04$). However, one intervention was not superior than the other. Both mindfulness meditation and mindfulness-based walking had similar effects on improving various cognitive, affect, and psychological parameters. Such findings demonstrate the health-enhancing effects of these brief interventions and provide individuals and health professionals with various options (based on preference) to choose from to facilitate improved psychological well-being.

ARTICLE HISTORY

Received July 27, 2018
Accepted October 10, 2018
Published October 27, 2018

KEYWORDS

Exercise; health; mental health; physical activity; yoga

Introduction

There is strong evidence supporting the benefits of exercise for a wide variety of health-related outcomes [1]. The ability for exercise to enhance the various aspects of cognition [2,3], as well as one's psychological well-being (e.g., mood and anxiety) [4,5] is an important area to focus research efforts, as these are foundational constructs to living a healthy, high-quality life [6,7]. The recent work has evaluated the effects of meditation and mindfulness on affective and cognitive outcomes [8,9]. Regarding cognition, for example, both meditation/mindfulness training and exercise may alter the levels of vigilance and arousal [10,11], which may improve one's level of attention. This is important, as attention while resisting distraction is critical for adaptive, goal-directed behaviors [11]. Meditation has also been shown to improve mood regulation [12], immune function [13], and to reduce chronic pain [14].

As both meditation and mindfulness may benefit affect and cognition, numerous mindfulness meditation techniques are observed in the western hemisphere, with common practices including principles of choiceless awareness, concentration, focus attention, and loving-kindness meditations. The choiceless awareness allows the participants to become fully aware of the scope of each thought that surfaces during practice, and to learn how to identify the thought rather than identify with the thought. This allows individuals to perhaps notice that the thought of stress is extant, but not identifying with stress by adopting this mood as an identifier (e.g., "I am stressed.") while choosing to

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remain focused on the present moment [15]. The concentration mindfulness encourages individuals to avoid ruminating on past or future thoughts and to center their focus upon awareness within the present moment [15]. The focused attention meditation is a concentrated practice where practitioners guide individuals to direct their thoughts to one selected stimulus [16]. The loving-kindness mindfulness is intended to facilitate other and self-love, acceptance, and non-judgment by concentrating on the repetition of brief and guided "well-wishing" phrases [15].

While there are a variety of meditation types, meditation practiced widely in the western hemisphere often includes some derivation of present-moment awareness and non-judgment [17]. Given the variety of meditation techniques, intervention duration, and studied outcomes, the mechanisms of meditation training are still being heavily investigated [18]. While some studies [19] have begun to evaluate exercise and mindfulness techniques (e.g., mindfulness-based stress reduction) [14] on psychological/cognitive outcomes, more research is needed within this domain. An emerging movement-based mindfulness practice known as dancing mindfulness integrates principles of loving-kindness and concentration on the present moment but utilizes the physical motion and rhythm of dance to engage this experience of focus and acceptance [20]. Dancing mindfulness encourages engagement in spontaneous movements to express oneself creatively and become more aware of attention and energy. In fact, the term "bodyfulness" has been proposed as a novel paradigm to highlight the mindfulness as an inclusive platform for self-expression and includes yoga, dance, and any physical movement that promotes heightened, attentive awareness of the body within the present moment [20].

While there is ample evidence for evaluating chronic and acute exercise interventions [21], there is a paucity of work that has examined the effects of an isolated bout of meditation (i.e., most interventions span multiple weeks) [22]. One recent study [23], however, examined the effects of a single bout of meditation (among those who had no meditation experience) on stress-induced changes in cognitive function. Stress and performance are believed to follow an "inverted U shape," and the relaxation experienced by those in this study is thought to confine stress levels within an optimal range for the cognitive function task. Ultimately, it seems that meditation and exercise may confer some similar effects on psychological/cognitive outcomes. As such, future research would benefit from continuing to explore the interrelations between these practices.

The current study applied concepts of mindfulness that would be practiced during meditation to an aerobic bout of exercise (i.e., walking). This is not dissimilar to what is done within a yoga practice; yoga practitioners move through sequences of poses and are encouraged to remain deeply connected to what they feel during each pose, each transition, and each breath (while minimizing mind-wandering and rumination) [24]. The purpose of this study was to evaluate the effects of this "mindfulness-based aerobic activity" on affect, state anxiety, fatigue, and cognition, in comparison with a traditional, guided meditation. Our initial hypothesis was that there would be significant differences in the amount of change in the aforementioned-outcome variables following the two different interventions (i.e., 10-minute meditation or 10-minute mindfulness-based walk). This is an extension of our recent experimental work demonstrating that engaging in a brief walk immediately before or after a mindfulness meditation session may help to reduce anxiety [8]. Our previous findings led us to hypothesize that engaging in mindfulness meditation while walking would be superior to mindfulness meditation alone.

Methods

Design

A non-probability, convenience-based sampling approach was utilized. Twenty-three participants were recruited via word-of-mouth (e.g., from academic classes). All participants signed the informed consent document (indicating approval of the corresponding author's Institutional Review Board), which was verbally explained to them. Prior to completing any surveys, participants were read a script intended to reduce the potential responder bias (e.g., social desirability bias). The script reads as follows: "Any time that you are working on surveys, I will leave the room so that you are able to complete them in a quiet and controlled environment. When you complete your surveys, I ask that you flip them over before knocking for me to come back into the room. I will not be reading your survey results, and when your data is entered into a spreadsheet it will be de-identified, meaning your name will not be associated with it. That being said, I encourage you to please respond to all questions as accurately and honestly as possible. There are no "good" or "bad" answers. If a survey question seems unclear, feel free to leave your response to that question blank and ask me for clarification or an explanation when I re-enter the room."

Sample

The sample consisted of 23 young adults (college students). This sample size was based on an *a priori* power analysis of a related project employing anxiety as the outcome measure [8], yielding a statistical power of 0.80. During the initial visit (Visit 1), participants completed several baseline assessments (detailed herein to follow). During Visit 1, the participants also completed a 5-minute familiarization with the meditation protocol (detailed herein to follow). Participants were excluded if they were not within the target age range (18–35 years), self-reported a strong aversion to meditation or treadmill-based exercise, or were currently regularly (i.e., more than once/week) practicing meditation. To assess aversion to meditation and treadmill-based exercise, participants rated the statements "I dislike the idea of meditating" and "I dislike treadmill-based exercise" on 1–10 rating scales; scores of 8 or higher on either question resulted in exclusion from the study. Participants were also asked to self-report the number of hours that had elapsed since their previous meal and how long they slept (in hours) the night before, as well as their present desire to eat and current degree of hunger (using Likert-type scales).

During Visit 2 and Visit 3, participants completed either a 10-minute meditation or a 10-minute mindfulness-based walk. The order of intervention (i.e., meditate alone or mindfulness-based walk alone) was counterbalanced (i.e., half of the participants did meditation at Visit 2 and a half did the mindfulness-based walk at Visit 2). All participants were instructed to refrain from exercise and caffeine within 6 hours, and food consumption within 1 hour, of coming into the laboratory (all participants were compliant with these instructions). Additionally, during the meditation and mindfulness-based walk visits, participants completed pre-and post-surveys to assess dimension (i.e., valence and arousal) and distinct affect, state anxiety, mental fatigue, as well as a test of cognitive function (Trail Making A & B). Additionally, a manipulation check including six questions about the meditation and exercise experience was included at the end of the visit to confirm whether or not the walking and meditation bouts exerted the hypothesized effects (e.g., that meditation had a relaxing effect).

Meditation protocol

Participants listened to a pre-recorded, 10-minute, guided mindfulness meditation. The implemented guided meditation cues focused on breath/body present-moment awareness (through deep breathing exercises and a full-body scan), limiting mind-wandering/letting go of distractions or worries (i.e., enhanced attentional control), and cultivating relaxation [25]. Participants either reclined in a seated computer chair with both feet propped up on a bench or were asked to lie down on a provided yoga mat. It was important to give participants this option (sit *vs.* lie down), as we wanted them to feel as comfortable as possible during the meditation. All participants closed their eyes during the meditation.

Mindfulness-based walk protocol

Participants engaged in a 10-minute treadmill walk while listening to a 10-minute mindfulness audio file. Similar to the seated meditation audio, the mindfulness-based walking audio focused on breath/body, present-moment awareness (e.g., paying careful attention to gait and foot striking patterns while walking), limiting mind-wandering, letting go of distractions or worries, and cultivating relaxation. Participants self-selected their walking speed and kept their eyes open during walking. Participants were simply instructed to select a speed they felt they would be able to maintain for the entire 10 minutes without having to adjust up or down.

Main outcome measures

State anxiety

State anxiety was assessed via the state-trait anxiety inventory-form Y (STAI) [26], which includes 20 items assessing feelings of apprehension, tension, nervousness, worry, and arousal of the autonomic nervous system. Participants are instructed to rate the extent to which each statement describes how they feel "right now, in the present moment" on a 1 (not at all) to 4 (very much so) Likert-type scale. Eleven items on this survey represent anxiety symptomology (e.g., "I am worried" or "I feel tense"); nine items do not represent anxiety symptomology (e.g., "I feel calm" or "I feel content").

The "non-anxiety symptomology" associated items were reverse coded, such that a higher composite score would indicate overall worse anxiety symptomology. Though not assessed in the present study, the STAI also includes 20 items to assess trait anxiety. During the initial development and validation, test–retest reliability coefficients were reported to range between 0.31 and 0.86 [26]. The state anxiety portion of the STAI often detects transient states, explaining why the test–retest reliability is not generally as high as the trait anxiety portion. During the initial development, STAI also demonstrated high internal consistency alpha coefficients between 0.86 and 0.95. The content validity for the STAI has been evidenced through concurrent validity (strong, significant, and positive correlations) with the Taylor manifest anxiety scale [27] (r = 0.73) and Cattell and Scheier's anxiety scale questionnaire (r = 0.85) [26,28].

Affect

As implemented elsewhere [29], the hedonic valence component of affect was assessed via an affective circumplex scale. Participants were asked to rate how much they feel each of nine emotions (e.g., content, sad, and angry) in the present moment, on a 1–100 rating scale. The feeling scale (FS) [30] is an 11-point bipolar scale of pleasure and displeasure that ranges from −5 to 5. Anchor values are presented at 0 = "neutral" as well as odd integers, ranging from −5 = "very bad" to 5 = "very good." The felt arousal scale (FAS), part of the telic state measure [31], is a six-point single-item rating scale ranging from 1 to 6, with anchors at 1 = "low arousal" and 6 = "high arousal." The aforementioned-affect measures were selected based on a proposed three-step process [32] for the selection of affect, mood, or emotion-related measures. Consistent with the aim of the present study, we identified affect as the core construct to be measured. Our measurement of affect was based on the circumplex model [33], which defines core affect by two dimensions, affective valence and perceived activation. The FS and FAS were selected due to their construct validity [30,31] and brief and straightforward assessment of these dimensions. The affective circumplex scale was selected to complement the FS and FAS (which offer more broad assessments of valence and arousal), enabling the assessment of distinct emotions. Thus, the inclusion of these three scales enabled the assessment of both core affect (valence and arousal) as well as distinct affect. This was important to the current study, given our interest in examining whether a mindfulness-based walk and meditation would elicit an overall valence and/or arousal effect.

Fatigue

The 10-item, present tense cognitive scale of the modified fatigue impact scale (MFIS) was used to assess cognitive fatigue. This survey contains statements such as "Because of fatigue, I am having difficulty paying attention." Participants were asked to rate each statement on a 1 (not at all) to 5 (to a great extent) scale, regarding the way that fatigue is impacting them in the present moment. The MFIS has been found to have strong convergent validity with the positive and negative affect schedule [34] and moderate correlations with the fatigue severity scale [35]. Cronbach's alpha for the cognitive sub-scale has been reported to be high (0.88) and reported intra-class correlation coefficients of the MFIS (e.g., 0.84) has suggested it offers good reproducibility [35].

Cognitive function

Trail Making A and B (pen-and-paper) were implemented to assess visual-perceptual abilities, working memory, and task-switching [36]. For trail making A, participants are instructed to connect a series of 25 dots in ascending numerical order. For trail making B, participants are instructed to connect a series of 24 dots in alternating ascending numerical order and alphabetical order (e.g., 1, A, 2, B, 3, C). Participants were told to "not worry about drawing neat lines," and that they would be judged based on their speed of completion.

Additional measures

The additional (i.e., non-main-outcome) assessed parameters included self-reported physical activity (via the physical activity vital sign [37], as well as the participants' aversion to treadmill-based exercise/meditation and their exercise/meditation experiences and attitudes). As aforementioned, aversion to treadmill-based exercise and meditation was evaluated on a 1–10 Likert scale, with higher scores indicating greater levels of disliking. Typical exercise enjoyment was measured on a 1–5 Likert scale, with higher scores indicating greater typical enjoyment levels for exercise. Height was assessed using a standard stadiometer and weight was assessed using a standard scale; height and weight were used to calculate body mass index (BMI).

Data analysis

Analyses were computed using Stata software (version 12.1). Mean values and relative proportions were evaluated for demographic variables. A series of paired *t*-tests were employed to assess the differences in baseline values (e.g., hours of sleep the night before) between Visit 2 and Visit 3. For all pre-to-post measures (e.g., STAI), change scores were calculated and were used within a series of paired *t*-tests. Further, to evaluate the interaction effects of the two interventions, the change score (for each outcome) from the mindfulness intervention was compared with the change score from the mindfulness-based walking intervention using a paired *t*-test. Traditional 2 (pre/post) × 2 (intervention type) repeated measures analysis of variance analyses yielded the same findings as the paired *t*-test change score analyses. Statistical significance was established as $p < 0.05$.

Results

The demographic information for the analyzed sample can be found in Table 1. The sample included 23 participants with a mean age of approximately 21 years. The sample was composed of non-Hispanic white (52%) and non-Hispanic black (48%) participants. The average BMI for the sample was within the overweight range, approximately 26 kg/m^2. On average, the sample reported engaging in moderate to strenuous physical activity nearly 4 days/week, with the average amount of time per session of physical activity reported to be 69 minutes. The average walking speed selected during the mindfulness-based walk was 2.5 miles/hour. Out of the entire sample, only two participants (9%) reported as not exercising regularly. Approximately 44% of the sample reported having at least some prior experience with the meditation.

Table 2 contains values for the main outcome variables both pre-and post-meditation or walk, for both the meditation visit and the mindfulness-based walk visit (as well as additional variables measured only at the pre-timepoint for each visit). As shown in the table, there were no significant differences between hours since the previous meal, desire to eat, hunger, or hours of sleep the night before, when comparing the values measured at the meditation visit and at the mindfulness-based walk visit (all *p*-values for the aforementioned variables were > 0.05). Though not shown in Table 2, there were no significant differences in pre-meditation versus pre-walk scores for affect, state anxiety, fatigue, or cognition ($p > 0.05$ for all circumplex, FS, FAS, STAI, MFIS, and trail-making scores, when comparing baseline values with the meditation and the mindfulness-based walk visits).

As shown in Table 2, the meditation intervention (change score of post-pre) was successful in improving cognition (trail-making B), improved affect, reduced arousal and decreased sadness, anxiety, and tension. The mindfulness-based walking intervention (change score of post-pre) was successful in improving cognition (trail-making B), improved affect, increased excitement and decreased sadness, tension, fatigue, and anxiety. However, when evaluating the interaction effects of these two interventions, these two interventions did not differ on their effectiveness in changing any of the outcomes, with the exception of fatigue (*p*-value interaction = 0.02). Specifically, fatigue decreased (on average) by 0.39-units following the seated/lying meditation, whereas it decreased by 8.30 units following the mindfulness-based walk.

Discussion

Previous research has demonstrated that both meditation and aerobic-based physical activity, in isolation, have considerable health benefits. However, it remains unclear whether an integrated approach (engaging in mindfulness-based awareness while walking) may influence additive, beneficial effects, and whether this integrated approach is superior to mindfulness meditation in isolation. Thus, the motivation for this study was to conduct a side-to-side comparison between mindfulness meditation and mindfulness-based walking on a variety of psychological-related health outcomes. Our findings

Table 1. Demographic characteristics of the analyzed sample ($N = 23$).

Variable	Point estimate (SD)
Age, mean years	21.09 (1.44)
Gender, % male	43.48
Race, %	52.17
Non-Hispanic white	47.83
Non-Hispanic black	
BMI, mean kg/m^2	26.07 (5.43)
PA level, mean days/week	3.83 (1.56)
PA duration, mean minutes	69.13 (51.18)
Treadmill disliking, mean	3.39 (1.88)
Meditation disliking, mean	2.65 (1.70)
Walking speed, mean mph	2.50 (0.74)
Exercise regularly, % yes	90.91
Exercise enjoyment, mean	4.35 (0.71)
Meditation experience, % yes	43.38

PA = physical activity.

Table 2. Meditation vs. mindfulness-based walk (*N* = 23).

Variable	Meditation			Mindfulness-Based Walk			Interaction *p*-value†
	Pre	Post	*p*-value	Pre	Post	*p*-value	
Food, mean hours	2.97 (1.43)	-		3.19 (2.06)	-	0.63	
Desire to eat, mean	2.04 (1.19)	-		2.09 (1.38)	-	0.55	
Hunger, mean	2.04 (1.19)	-		2.17 (1.40)	-	0.64	
Sleep, mean hours	7.28 (1.19)	-		7.35 (2.03)	-	0.57	
Resting HR, mean bpm	76.58 (13.03)	-		76.05 (12.75)	-	0.45	
End HR, mean bpm	77.69 (17.82)	-		77.84 (12.12)	-	0.15	
Resting BP, mean mmHg	111/73	-		113/73	-	-	-
End BP, mean mmHg	110/71	-		112/73	-	-	-
Mindfulness	16.29 (3.70)	-		16.78 (3.39)	-	0.73	
TM A, mean seconds	16.23 (4.06)	14.81 (3.35)	0.08	15.96 (5.33)	14.50 (5.06)	0.11	0.45
TM B, mean seconds	40.67 (18.74)	32.35 (10.21)	0.005	38.10 (17.65)	30.91 (13.73)	0.05	0.52
Feeling scale	3.15 (1.69)	3.74 (1.21)	0.01	3.14 (.96)	3.82 (.98)	0.001	0.65
Felt arousal scale	2.83 (1.15)	2.39 (1.31)	0.001	2.91 (1.12)	3.05 (1.46)	0.58	0.99
Circumplex happy	73.83 (17.71)	76.96 (18.74)	0.09	70.0 (21.38)	72.65 (22.92)	0.09	0.41
Circumplex excited	58.70 (18.43)	50.52 (32.86)	0.17	55.35 (21.98)	61.35 (25.65)	0.03	0.98
Circumplex content	75.96 (20.79)	72.74 (24.29)	0.40	76.04 (19.21)	77.83 (18.87)	0.58	0.97
Circumplex sad	7.70 (14.56)	6.13 (12.95)	0.04	6.26 (11.03)	4.13 (7.88)	0.04	0.34
Circumplex angry	5.39 (14.62)	2.87 (7.03)	0.24	4.22 (11.11)	2.91 (6.33)	0.40	0.67
Circumplex anxious	22.65 (27.88)	11.78 (17.40)	0.001	18.83 (24.50)	10.91 (17.53)	0.01	0.76
Circumplex tense	14.65 (21.42)	9.26 (16.14)	0.01	19.56 (24.29)	7.78 (12.67)	0.006	0.08
Circumplex fatigued	22.65 (27.47)	22.26 (27.20)	0.81	25.26 (24.61)	16.96 (24.31)	0.04	0.02
STAI composite	30.74 (9.42)	28.29 (7.94)	0.002	30.26 (8.37)	26.78 (5.63)	0.01	0.27
MFIS composite	21.09 (9.83)	19.30 (8.94)	0.25	19.18 (7.31)	19.22 (8.22)	0.70	0.78

BP = blood pressure; HR = heart rate; MFIS = modified fatigue impact scale; STAI = state trait anxiety inventory; TM A = trail-making A; TM B = trail-making B.

†Paired *t*-test comparing the change (post-pre) score for meditation *vs*. change (post–pre) score mindfulness-based walking.

demonstrate that both mindfulness meditation and mindfulness-based walking may be effective in enhancing various psychological outcomes among healthy college-student populations. Specifically, cognition and affect, anxiety reduction, tension, sadness, and fatigue were favorably influenced by both mindfulness-based protocols. Although both interventions were effective in influencing these parameters, one was not superior to the other. Fatigue was the only interaction effect observed, in that the mindfulness-based walking intervention decreased fatigue more so than the mindfulness meditation intervention. However, applying a correction for multiple comparisons caused this difference to disappear. Therefore, the main conclusion from this experiment is that both acute mindfulness meditation and acute mindfulness-based walking may have similar effects in influencing various psychological-related outcomes.

We intentionally selected a duration of 10-minutes for exercise, given that 10-minutes is what the United States Department of Health and Human Services recommends as the shortest duration of exercise to elicit health benefits [38]. An additional rationale for selecting a brief exercise bout is the fact that most adults do not adhere to minimum physical activity guidelines [39,40]. One strategy to increase activity levels may be to educate people on various potential benefits they may obtain from a single, brief exercise session. To this end, it is imperative that research studies evaluate shorter, acute bouts of exercise to better delineate these potential benefits. The mindfulness meditation session was matched in duration to the exercise session, which offers a relatively novel contribution to the acute meditation literature, given that a "short-duration," 10-minute meditation session is under-investigated when compared with the studies utilizing acute 5-minute meditation sessions [41–44].

Although we did not observe any differences in the psychological outcomes between the two acute interventions, the concept of mindfulness-based walking deserves further empirical attention. Of course, the promotion of mindfulness during arduous, fatigue-inducing exercise may be less favorable for performance outcomes, as focus on exercise-related discomfort may be minimized if individuals become distracted from the present moment, and less self-aware when engaging in high-intensity exercise. However, practicing mindfulness while engaging in comfortable walking may be advantageous, as it may facilitate a deeper connection with exercise. Exercisers may more wholly appreciate and recognize the pleasures of low- to moderate-intensity physical activity when observing the principles of mindfulness. Notably, the lower intensity physical activity is favorably associated with a multitude of health outcomes, even independent of higher intensity physical activity [45–48]. We did not observe differences in any of the psychological outcomes between the two interventions evaluated herein, but we encourage future work to more comprehensively investigate this paradigm while considering additional psychological outcomes or, perhaps, assessing them from a different methodology or context (e.g., modality of exercise, duration of intervention, and so on). Related to methodological refinements, a qualitative versus quantitative methodological approach may yield different findings. Related to future assessment considerations, although we assessed various distinct affective outcomes, subsequent work may wish to assess parameters such as pleasantness and relaxation. These constructs, in theory, may be more influenced by mindfulness-based walking.

In conclusion, our findings demonstrate that both mindfulness meditation and mindfulness-based walking may help to improve various psychological-related outcomes. These preliminary findings, however, do not suggest a differential effect of these two interventions on our evaluated outcomes. Further work is needed to re-evaluate this paradigm as well as assess individual differences in willingness and satisfaction with mindfulness-based walking.

Funding

No funding was used to prepare this manuscript.

Conflict of interests

We have no conflicts of interest.

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