

REVIEW

Set shifting reaction-time improves following meditation or simple breathcounting in meditators and meditation-naïve participants: Data from naturalistic, ecological momentary-assessment devices



Rachel Atchley*, Daniel Klee, Barry Oken

Department of Neurology, Oregon Health & Science University, United States

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KEYWORDS

Meditation;
Reaction time;
Naturalistic data

Abstract A comparison is made between the performance of meditators and controls in a letter-number task-switching test. Data were recorded over a five-day period using a previously developed ecological momentary assessment paradigm. Participants consisted of naïve, novice, and experienced meditators, who completed a task-switching reaction time (RT) task before and after 20-min breath-counting sessions. There was a decrease in reaction time over testing days, $p < .007$, as well as a separate decrease in reaction time pre- to post-meditation, $p < .001$. RTs decreased each day, as expected, and post-meditation/breath-counting RTs were consistently faster than pre-meditation/breath-counting RTs. These results suggest a meditation effect separate from a learning effect.

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PALABRAS CLAVE

Meditación;
Tiempo de reacción;
Datos naturalistas

El tiempo de reacción al cambio de set cognitivo mejora después de la meditación o tras contar respiraciones sencillamente en meditadores y neófitos en la meditación: datos de mecanismos de evaluación ecológica instantánea naturalista

Resumen Comparamos el rendimiento de meditadores y controles en una prueba de conmutación de tareas de letras y números. Se registraron los datos de un período de 5 días utilizando un paradigma de evaluación ecológica instantánea desarrollado anteriormente. Los participantes eran neófitos, principiantes y experimentados en la meditación, y realizaron una tarea de tiempo de reacción ante la conmutación de tareas antes y después de sesiones de contar respiraciones de 20 min. Hubo una disminución en el tiempo de reacción durante los

* Corresponding author.

E-mail address: rachel.atchley@gmail.com (R. Atchley).

días de la prueba, $p < 0,007$, así como una disminución independiente en el tiempo de reacción antes y después de la meditación, $p < 0,001$. Los tiempos de reacción fueron disminuyendo cada día, como se esperaba, y los tiempos de reacción posteriores a la meditación/contar respiraciones fueron consecuentemente más rápidos que los tiempos de reacción anteriores a la meditación/contar respiraciones. Estos resultados sugieren un efecto de la meditación independiente del efecto del aprendizaje.

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Introduction

Studies on meditation and attention have found that experienced meditators have greater attentional control than inexperienced meditators (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Chan & Woollacott, 2007; Chiesa, Calati, & Serretti, 2011; Lutz, Slatger, Dunne, & Davidson, 2008). Moreover, attentional control has been shown to differ in meditators and people who do not meditate (Cahn & Polich, 2009; Delgado-Pastor, Perakakis, Subramanya, Telles, & Vila, 2013; Tang et al., 2009).

To further inform this line of research, a logical step is naturalistic data collection and assessment of cognitive changes in meditation interventions. To begin to address this need, we compared performance of meditators and controls on a letter-number task-switching test before and after at-home meditation. Data were recorded over five days using a previously developed ecological momentary assessment (EMA) paradigm (Oken, Miller, Goodrich, & Wahbeh, 2014; Wahbeh, Zwick, & Oken, 2011). We hypothesized that set-shifting reaction times (RTs) would decrease across days due to a learning effect; RTs were also expected to decrease after each meditation session due to increased attentional focus. In a sample of non-meditators and meditators, we predicted a greater reduction of reaction time in meditators following the meditation sessions compared to the reduction of reaction time in controls following simple untrained breath counting sessions.

Methods

RT study design

This cross-sectional study evaluated differences across three meditation groups: 1) naïve (no experience within 2 years); 2) novice (formal training and a minimum of 1000 h of practice); 3) experienced (≥ 5000 h of practice). Participants were recruited from the Portland, OR, USA metro area and meditator groups were pooled in these analyses using the same rationale as Atchley et al. (2016).

Participants were screened and consented when they came in for a single laboratory visit for EEG and physiological assessments, then took home pre-programmed handheld devices that sounded an alert once a day to signal participants to begin a cognitive assessment before and then

after a 20-min experimental condition. The experimental conditions were breath counting and meditation for the controls and meditators, respectively. Meditators potentially engaged in breath-counting if they chose that practice. The ecological momentary assessment (EMA) software was implemented on a repurposed smartphone and required no cellular or internet connectivity. Individual testing times were chosen in advance by the participants. The devices sounded a signal to begin the EMA session. Participants could opt to delay the session by 30 min up to three times. At the end of five days, the device was mailed back to the laboratory by the participant, or the research assistants would arrange to pick up the device from the participant's home. Devices recorded all participant inputs, times, completion statuses, and assessment data.

RT task procedure

The task-switching test, modeled after Rogers and Monsell (1995), took 10 min to complete and contained 160 trials (see Fig. 1 for visual). Consecutive congruent trials occurred randomly 1–4 times followed by a task-switching trial. The task-switching test was completed before and after either a 20-min meditation session (meditation group) or a 20-min breath counting session (control group). Median RTs for the

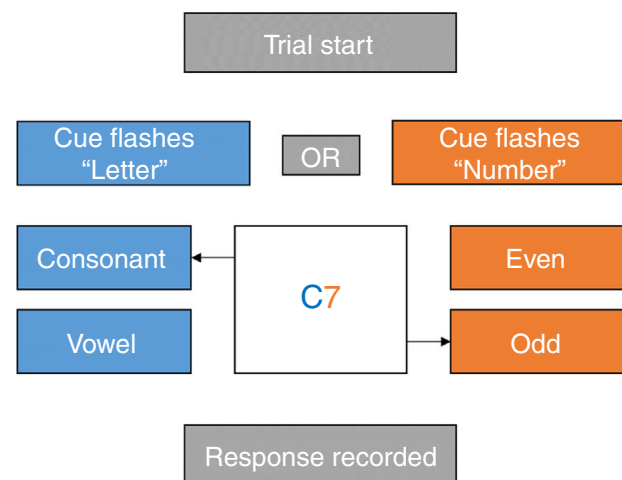


Figure 1 Task-switching test.

correct task-switching trials were calculated for each of the two sessions on all 5 days.

Statistical analysis

RTs were analyzed using a hierarchical mixed ANOVA comparing day (1–5, within subjects), meditation/breath-counting (pre- or post-, within subjects), and group (meditator or control, between subjects). All analyses were conducted in SPSS Version 22 (IBM).

Results

Participants

We recruited 42 participants (M age = 49, 62% female) who met the following criteria: (1) aged between 25 and 75 years; (2) good past and present medical health; (3) stable on all meditations for at least 2 months; (4) cognitively intact, as determined by a score of at least 31 on the Telephone Interview for Cognitive Status (TICS) (Welsh, Breitner, & Magruder-Habib, 1993). Exclusion criteria were: (1) significant medical or neurological disorder/disease; (2) significant visual or hearing impairment; (3) medications that would alter outcomes such as benzodiazepines or neuroleptics; and (4) significant untreated depression. See Table 1 for more details on the participant sample. Participants in the control group had no experience with any form of meditation, while participants in the meditation groups had formal training, practiced at least 3 times a week, and had a lifetime practice minimum of either 1000 h (novices) or 5000 h (experienced) using the same rationale reported in Atchley et al. (2016). Acceptable meditation practices for the study's purpose included any styles with an attentional focus, including mind-body practices such as yoga.

There was a decrease in task-switching trial reaction time across days, $p < .001$ (Fig. 2). There was a separate decrease in reaction time pre- to post-meditation or breath-counting for controls, $p < .001$, but not meditators (Fig. 3). Interestingly, there were no group effects on task-switching RTs, although there was a day by pre-/post-breath counting or meditation interaction, $p = .012$ (Fig. 3).

Discussion

Most of our hypotheses were confirmed. The results indicate improved ability to switch attentional set following either the meditation or breath counting experimental condition. The interaction suggests that task switching RTs decreased each day; however, post-meditation RTs were consistently faster than pre-meditation RTs, which suggests a meditation effect separate from a learning effect. However, there was no difference in improvements between the meditation-naïve participants and the meditators. This post-experimental condition (meditation or breath counting) change is in addition to the learning effect in RT seen over the five days. The fact that simple breath counting in meditation-naïve people improved RT shows that it is critical to pay careful attention to the design of control conditions for mechanistic studies of meditation on cognition. Since

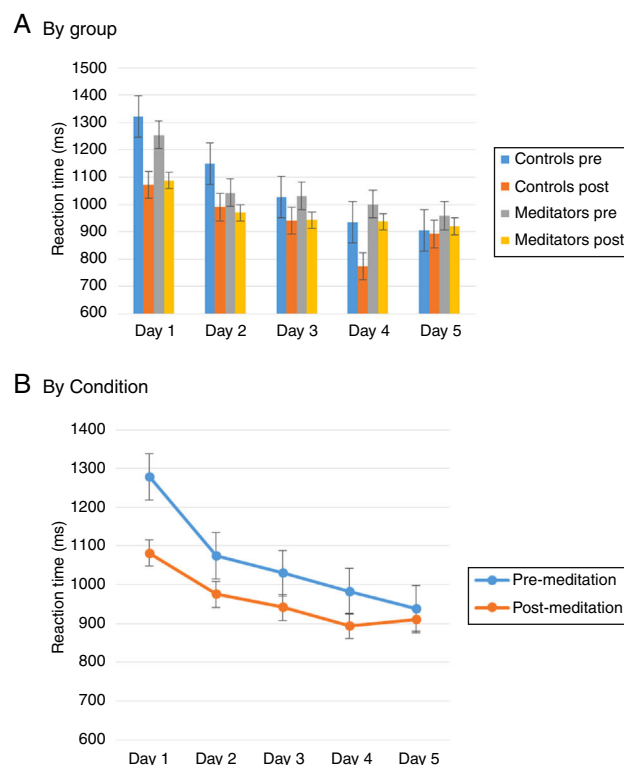


Figure 2 Task-switching reaction times.

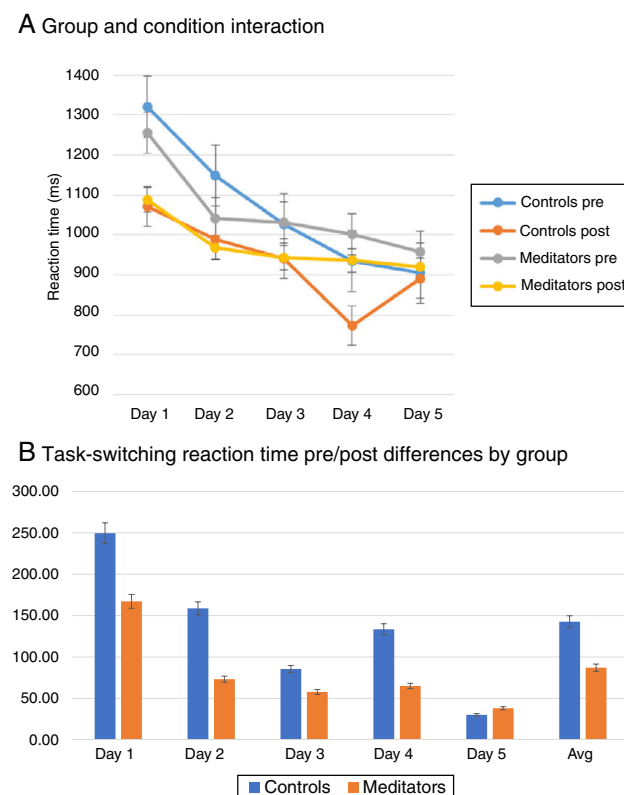


Figure 3 Task-switching reaction time group comparisons.

Table 1 Participant characteristics.

	All participants (SD)	Non-meditators (SD)	Novice meditators (SD)	Experienced meditators (SD)
N	42	13	15	14
Age (M)	49 (13)	48 (11)	50 (13)	49 (15)
Female	62%	69%	73%	43%
Minority	24%	23%	27%	21%
Practice in Years (M)	–	–	2.4 years (2.5)	22.6 years (13.2)

some degree of same-day learning may even be occurring pre- to post-experimental condition, it may well be necessary to utilize two control conditions.

Conclusions

RTs decreased each day, as expected, and post-meditation/breath-counting RTs were consistently faster than pre-meditation/breath-counting RTs. This effect was more pronounced early on and present in both controls and meditators.

While highly interesting in terms of changing cognition in relation to meditative practice, these findings are still preliminary. These results draw strength from the naturalistic setting for data collection in addition to in-laboratory assessments, but replication studies are needed.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

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

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