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The relaxation response: Reducing stress and improving cognition in healthy aging adults[☆]

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KEYWORDS

Relaxation response
training;
Memory;
Anxiety;
Cortisol;
Aging

Summary Aging adults are vulnerable to the effects of a negative emotional state. The relaxation response (RR) is a mind–body intervention that counteracts the harmful effects of stress. Previous studies with relaxation techniques have shown the non-pharmacological benefit of reducing stress and improving the memory of healthy older adults. Our pilot study evaluated whether a RR training program would decrease anxiety levels, improve attention, declarative memory performance and/or decrease salivary cortisol levels in healthy older adults. Fifteen adults participated and were randomly assigned to a RR training or control groups. Mean age was 71.3 years and mean education level was 17.9 years. Reaction time on a simple attention/psychomotor task was significantly improved ($p < 0.0025$) with RR training, whereas there was no significant improvement on complex tasks of attention, verbal, or visual declarative memory tests. Self-reported state anxiety levels showed a marginally significant reduction ($p < 0.066$). All subjects' salivary cortisol levels were within low-normal range and did not significantly change. Our 5-week program in highly educated, mobile, healthy, aging adults significantly improved performance on a simple attention task.

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Introduction

The interrelationship of stress, aging, and memory performance has shown that increased levels of anxiety can interfere with an older adult's learning and memory. Increased levels of glucocorticoids (GC), such as cortisol, suppress normal function of the hippocampus, which has a high concentration of Type II GC receptors in the CA1 and CA3 regions.¹ Lupien and associates² have shown a strong relationship between elevated GC levels and

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Table 1 Demographics characteristics of all subjects.

Measure	Control (<i>n</i> = 7)	M	SD	R	RR (<i>n</i> = 8)	M	SD	R
Gender								
Females	3				5			
Males	4				3			
MMSE*		28.6	(1.6)			28.7	(1.6)	
Vocabulary**		63.7	(7.5)			60.6	(16.6)	
Education (yr)		18.6	(2.9)	(14–22)		17.4	(4.3)	(8–22)
Age (yr)		69.4	(3.4)	(66–76)		73.0	(3.7)	(68–80)

M, mean; SD, standard deviation; R, range.

*Maximum score = 30.

**Maximum score = 70.

decreased memory task performance in older adults. GC exposure acts as a pacemaker of aging in an area of the brain known to support declarative memory performance.¹

In 1974, Dr. Herbert Benson first described a coordinated physiological response that is characterized by decreased arousal, diminished heart rate, respiratory rate, and blood pressure, in association with a state of “well-being”.^{3,4} This physiologic state was subsequently defined as the “relaxation response”^{3,5} and hypothesized to oppose the physiological changes caused by stress, such as the “fight or flight” response described by Cannon⁶ and the “general adaptation response” to stress described by Selye.⁷

Numerous techniques, including progressive muscle relaxation, meditation, guided imagery, biofeedback, the pre-suggestion phase of hypnosis, deep breathing exercises, autogenic training, tai chi, Qi gong and yoga can elicit the relaxation response (RR). Researchers have demonstrated the benefit of such non-pharmacological techniques to reduce stress and improve the intellectual performance of healthy older adults.^{8–10} At the same time, the RR has shown to be an effective therapeutic measure as it is a counterbalancing mechanism to the stress response.^{5,11}

In the present study, we examined whether a 5-week RR-training program at the Mind/Body Medical Institute (M/BMI) would decrease self-reported state anxiety levels, and whether that reduction in anxiety would be associated with improvements in attention, and/or improvements in declarative memory performance or decreases in salivary cortisol levels.

Subjects and methods

Informed consent was obtained from all study subjects in accordance with the Declaration of Helsinki.

Table 2 Sequence of neuropsychological testing session.

1. Salivary Cortisol Reading 1
2. Rey's Auditory Verbal Learning Test (RAVLT)
3. Trail Making Test A¹³
4. Trail Making Test B¹³
5. Verbal Paired Associates¹⁴
6. Visual Reproduction¹⁴
7. Digit Symbol Test¹⁵
8. RAVLT Recall Delay
9. RAVLT Recognition Delay
10. Verbal Paired Associates Delay
11. Visual Reproduction Delay
12. Digit Symbol Test Delay
13. Beck's Depression Inventory-II (BDI-II)¹⁶
14. State-Trait Anxiety Inventory (State, Form Y-1)¹⁷
15. State-Trait Anxiety Inventory (Trait, Form Y-2)¹⁷
16. Salivary Cortisol Reading 2

This project was approved by the Institutional Review Board at the Beth Israel Deaconess Medical Center. Adults from 65 to 80 y were recruited from local senior community centers, university/continuing education newspapers, and the local Council on Aging. All subjects were screened for a previous psychiatric or neurological condition and were required to score above 26 on the Mini-Mental State Exam (MMSE).¹² Fifteen subjects of 21 respondents met these criteria. Fifteen subjects were randomly assigned to the control (*n* = 7) or the RR-trained (*n* = 8) group and the examiner (JAG) was unaware of all subjects' group assignment. Table 1 represents the demographics for all subjects.

Table 2 shows the testing session sequence. All subjects abstained from eating, drinking, and smoking 1 h prior to collecting saliva. All subjects chewed a sterile non-covered cotton roll (Salivette[®] kit, Sarstedt Corporation, Newton, NC) for 60 s.

All subjects' salivary cortisol levels were collected at the same time of day, both before (9:30 am) and after (12:30 pm) the neuropsychological and memory tests. The samples were kept at -20°C until assayed by the ImmuChemTM Cortisol 125-I RIA kit (ICN Biomedicals, Inc., Diagnostics Division, Costa Mesa, CA) and read by a gamma counter.

In between testing the salivary cortisol levels, the sequence of the 14 neuropsychological and memory tests included: Rey's Auditory Verbal Learning Test (RAVLT), Trail Making Test A, Trail Making Test B, Verbal Paired Associates, Visual Reproduction, Digit Symbol Test, RAVLT Recall Delay, RAVLT Recognition Delay, Verbal Paired Associates Delay, Visual Reproduction Delay, Digit Symbol Test Delay, Beck's Depression Inventory-II (BDI-II), State-Trait Anxiety Inventory (Form Y-1), State-Trait Anxiety Inventory (Form Y-2).

Over 5 successive weeks, subjects participated in a 1.5h RR training, which was led by an experienced teacher of meditation, imagery and relaxation techniques (GRD) at the M/BMI. In addition, the RR-trained subjects listened to an RR audiotape for 20min per day at home and completed daily log sheets. This regime is in keeping with the typical RR curriculum.^{3,5} The daily logs were collected and assessed each week, with 100% subject compliance. In comparison, the control group subjects did not receive any RR training or additional instruction regarding improved well-being over the 5-week period.

For data analysis, repeated-measures and factorial ANOVAs were used to evaluate the significant differences among the control and RR-trained groups. A p -value of <0.05 was considered to be statistically significant.

Results

Fifteen adults, eight women (53.3%) and seven men (46.7%) from the Greater Boston area, partici-

pated. Mean age was 71.3 years (ranged from 66 to 80 years) and mean education level was 17.9 years (ranged from 8 to 22 years). All subjects' vocabulary performance was $>90\%$ when compared with normative data.¹⁵ All subjects rated themselves in good health. The 15 subjects were randomly assigned to the control ($n=7$) or RR-trained ($n=8$) groups. There was no significant demographic differences ($\alpha=0.05$) between the two groups. However, there was a greater range in years of education in the RR-trained group (8 to 22 years) compared to the control group (14 to 22 years), as reflected in the larger standard deviation for the vocabulary mean prior to RR-training.

Reaction time on a simple attention and psychomotor task (Trail Making Test A) was significantly improved in RR-trained subjects compared with control subjects ($p<0.0025$) (Table 3). A factorial ANOVA indicated a trend toward the control group performing better than the RR-trained group at pre-assessment ($p<0.090$). There were no significant group differences pre- and post-training in complex attention tasks (Trail Making Test B and Digit Symbol Test), verbal (RAVLT and Verbal Paired Associates Test), and visual (Visual Reproduction Test) memory tasks.

State anxiety levels showed a marginally significant reduction ($p<0.066$) in the RR-trained group as compared to the control group. A factorial ANOVA showed that the RR-trained group was significantly more anxious at pre-assessment as compared to the control group ($p<0.046$). Tables 4 and 5 indicate that there was no significant group difference on the depression scale nor was there a difference between the two groups for salivary cortisol levels before and after the memory tests at pre- and post-assessment of 5-week period.

Table 5 shows the four time points between the two groups: pre-A is before the memory tests at the initial session, post-A is after the memory tests at the initial session, pre-B is before the memory tests after 5 weeks, post-B is after the memory tests

Table 3 Trail making: control vs. RR.

	Pre-test		Post-test		p -value $\alpha = 0.05$
	M	SD	M	SD	
<i>Trail A</i>					
Control	34.5	(8.5)	34.5	(5.5)	0.0025
RR	43.4	(10.2)	33.5	(8.3)	
<i>Trail B</i>					
Control	87.6	(32.4)	70.3	(27.9)	0.73
RR	111.4	(44.4)	103.6	(77.2)	

M, mean; SD, standard deviation; RR, relaxation response.

Table 4 BDI-II, State & trait anxiety: control vs. RR.

	Pre-test		Post-test		<i>p</i> -value $\alpha = 0.05$
	M	SD	M	SD	
<i>BDI-II</i>					
Control	2.7	(2.8)	3.7	(4.5)	0.14
RR	4.0	(3.2)	2.3	(2.2)	
<i>State anxiety</i>					
Control	24.7	(4.6)	33.1	(14.5)	0.066
RR	35.1	(11.7)	29.4	(8.5)	
<i>Trait anxiety</i>					
Control	28.1	(7.4)	—	—	
RR	36.4	(10.2)	—	—	

M, mean; SD, standard deviation; RR, relaxation response.

Table 5 Salivary cortisol secretion levels: control vs. RR (nmol/l).

	Pre-A		Post-A		<i>p</i> -value $\alpha = 0.05$	Pre-B		Post-B		<i>p</i> -value $\alpha = 0.05$
	M	SD	M	SD		M	SD	M	SD	
Control	8.4	(2.1)	6.7	(4.2)	0.79	7.2	(3.9)	6.1	(4.2)	0.65
RR	10.0	(10.5)	9.9	(5.5)		9.9	(14.3)	6.3	(6.5)	

M, mean; SD, standard deviation; RR, relaxation response.

after 5 weeks. One RR-trained subject had undetectable salivary cortisol levels at pre-A, post-A, pre-B, post-B time points and the data analysis reflects this.

Discussion

Our findings indicate that the facilitation of the 5-week RR training program benefited aging subjects in only one aspect of memory improvement. When compared to the control group, the RR-trained group reported significantly improved simple attention performances while salivary cortisol levels remained at low-normal levels and state anxiety levels were only marginally reduced. In contrast to previous research, the RR-trained subjects' self-reported decrease in state anxiety was not paralleled by a reduction in salivary cortisol levels.^{18–20} It should be noted that all our subjects' salivary cortisol levels are within the low-normal range for healthy older adults. As such, it appears that there was little opportunity for salivary cortisol values to be influenced by RR training over a 5-week period.

In our small sample size, there were significant pre-assessment group differences. At baseline, the control group reported to have lower state and trait anxiety levels, lower levels of depression index, lower salivary cortisol, and faster trail making A and B attentional memory tasks. However, at post-assessment, the control group remained at their baseline after the 5-week period, whereas the RR-trained group improved, while not always significantly, in all tested areas. This emphasizes that while the two groups were not equivalent at baseline, it cannot be assumed with such a small total sample size ($n = 15$) that the two groups would be equivalent in either state anxiety or neuropsychological functioning. At the same time, would the control group's lower stress levels also benefited from the RR-training program? We definitely believe so; in fact, after our initial 5-week pilot study, 6 of the 7 control group subjects participated in a subsequent 5-week RR-training course. Findings comparing the six subjects of the control group to themselves with 5-weeks of RR-training showed significantly improved attentional memory and a significant reduction in self-reported state anxiety levels with no significant changes in salivary cortisol levels.²¹

While previous studies of the HPA adaptation process indicate that increased stress is associated with the rate of cortisol secretion,²² there is considerable variation among the cortisol levels of aged human adults.²³ Further evidence for subgroupings comes from a longitudinal study of basal cortisol levels of healthy, older adults: cortisol levels increased in one subgroup, decreased in another, and remained stable in a third.²⁴ Similarly, Preville et al.²⁵ reported that healthy older adults did not have a consistent pattern of salivary cortisol measurement over time. It may be that our subjects represent an older adult sub-grouping that has maintained stable salivary cortisol levels over the years. However, as consistent with previous research,^{9,26,27} our findings show that healthy, non-depressed older adults improve their performance on an attention task and self-reported anxiety decreases levels with relaxation training.

Concerning the lack of declarative memory improvement with the RR-trained group, it is important to note that 7 of the 8 subjects had more than 16 years of formal education. Over a dozen previous studies using relaxation training with healthy older adults reported a mean level of education from 8 to 15 years, whereas only one other known study had a comparable level of education at 17.8 years.²⁵ Formal intellectual training in this small sample size may have limited our ability to detect any RR related benefits on declarative memory performance. Specifically, Compton et al.²⁸ suggest that relaxation methods may not improve highly educated subjects' retrieval process through the hippocampal system because the years of educational training have facilitated a higher level of memory organization and consolidation at baseline. In this way, more highly educated older adults may exhibit increased compensation against the effects of aging as compared to less educated older adults. Future studies of RR training should be conducted in more subjects with less education.

The methodological limitations of our 5-week pilot study include a small sample size, as well as the highly mobile, healthy and motivated subjects, as the study took place in a medical university setting. Further studies should include a larger sample size, subjects without previous exposure to relaxation training, subjects with non-normal salivary cortisol levels, and that training could be conducted in a community dwelling/senior center setting. A large sample size would also help with a baseline assessment of more equivalent levels in stress and memory performance. We believe that these changes may provide a suitable setting in which to evaluate the effects of RR-training

program upon salivary cortisol levels and declarative memory performance in healthy, older adults.

References

1. McEwen BS, Sapolsky RM. Stress and cognitive function. *Curr Opin Neurobiol* 1995;5(2):205–16.
2. Lupien SJ, de Leon M, de Santi S, Convit A, Tarshish C, Nair NPV, et al. Cortisol levels during human aging predict hippocampal atrophy and memory deficits. *Nature Neurosci* 1998;1(1):69–73.
3. Benson H, Beary JF, Carol MP. The relaxation response. *Psychiatry* 1974;37(1):37–45.
4. Wallace RK, Benson H, Wilson AF. A wakeful hypometabolic physiologic state. *Am J Physiol* 1971;221(3):795–9.
5. Benson H. The relaxation response: therapeutic effects. *Science* 1997;278(5344):1694–5.
6. Cannon W. Emergency function of the adrenal medulla in pain and the major emotions. *Am J Physiol* 1914;33:356.
7. Selye H. *The stress of life*. New York: McGraw-Hill; 1956.
8. Yesavage JA. Relaxation and memory training in 39 elderly patients. *Amer J Psychiatry* 1984;141(6):778–81.
9. Yesavage JA, Jacob R. Effects of relaxation and mnemonics on memory, attention and anxiety in the elderly. *Exp Aging Res* 1984;10(4):211–4.
10. Yesavage JA, Rose TL, Spiegel D. Relaxation training and memory improvement in elderly normals: correlation of anxiety ratings and recall improvement. *Exp Aging Res* 1982;8(4):195–8.
11. Jasnosi ML, Kugler L. Relaxation, imagery, and neuroimmunomodulation. *Ann NY Acad Sci* 1987;496:722–30.
12. Folstein MF, Folstein SE, McHugh PR. Mini-mental state: a practical method of grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975;12:189–98.
13. Reitan RM. *Clinical neuropsychology: current status and application*. Washington: Hemisphere Press; 1974.
14. Wechsler D. *WMS-R: Wechsler memory scale-revised manual*. New York: The Psychological Corporation; 1987.
15. Wechsler D. *WAIS-R: Wechsler adult intelligence scale-revised manual*. New York: The Psychological Corporation; 1981.
16. Beck AT, Steer RA, Brown GK. *Beck depression inventory*. New York: Harcourt Brace; 1996.
17. Spielberger CD, editor. *The state-trait anxiety inventory: a comprehensive bibliography*, 2nd ed. New York: Mind Garden; 1989.
18. Lupien SJ, Gaudreau S, Tchiteya BM, Maheu F, Sharma S, Nair NPV, et al. Stress-induced declarative memory impairment in healthy elderly subjects: relationship to cortisol reactivity. *J Clin Endocrinol Metab* 1997;82:2070–5.
19. Nicolson N, Storms C, Ponds R, Sulon J. Salivary cortisol levels and stress reactivity in human aging. *J Gerontol A Biol Sci Med Sci* 1997;52(2):68–75.
20. Aardal E, Holm AC. Cortisol in saliva—reference ranges and relation to cortisol in serum. *Eur J Clin Chem Clin Biochem* 1995;33(12):927–32.
21. Galvin JA. *A pilot study: the relaxation response: reducing stress and improving memory in healthy, normal aging adults*. Thesis, Harvard University, 2000 [chapter 3], p. 39–46.
22. Porter NM, Landfield PW. Stress hormones and brain aging: adding injury to insult? *Nature Neurosci* 1998;1(1):3–4.

23. Meaney MJ, O'Donnell D, Rowe W, Tannenbaum B, Steverman A, Walker M, et al. Individual differences in hypothalamic-pituitary-adrenal activity in later life and hippocampal aging. *Exp Gerontol* 1995;**30**(3/4):229–51.
24. Lupien S, Lecours AR, Schwartz G, Sharma S, Hauger RL, Meaney MJ, et al. Longitudinal study of basal cortisol levels in healthy elderly subjects: evidence for subgroups. *Neurobiol Aging* 1996;**17**(1):95–105.
25. Preville M, Susman E, Zarit SH, Smyer M, Bosworth HB, Reid JD. A measurement model of cortisol reactivity of healthy older adults. *J Gerontol Psychol Sci* 1996;**51B**(2):P64–9.
26. Alexander CN, Chandler HM, Langer EJ, Newman RI, Davies JL. Transcendental meditation, mindfulness, and longevity: an experimental study with the elderly. *J Pers Soc Psychol* 1989;**57**(6):950–64.
27. DeBerry S, Davis S, Reinhard KE. A comparison of meditation-relaxation and cognitive/behavioral techniques for reducing anxiety and depression in a geriatric population. *J Geriatr Psychiatry* 1989;**22**:231–47.
28. Compton DM, Bachman LD, Brand D, Avet TL. Age-associated changes in cognitive function in highly educated adults: emerging myths and realities. *Int J Geriatr Psychol* 2000;**1**(15):75–85.

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