Research Article

Staged Present: Attending to the Mystical on the Stage of Working Memory

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Summary: *An experiment (N = 48) was conducted to investigate the effect of focused attention on working memory. Two experimental groups, meditators (n = 12) and contemporary actors (n = 12), were matched on age, gender and level of education and measured on working memory and attention tests from the CANTAB battery. The practice of meditation and contemporary theatre training satisfied the criteria of maintaining focused attention necessary for this study. Through the performance of these groups the possible effect of focused attention induced by different training procedures could be compared and explored.*
Although on most measures the experimental groups did not differ significantly, a significant difference was found between meditators and their controls on one test (Paired Associates Learning) measuring working memory capacity. Since these two groups differed from actors and their controls in age (Mean age of meditators and actors = 37.00, 23.75 respectively), it was suggested this might account for the apparent non-significant difference between the two experimental groups. CANTAB norms establish different thresholds for age. The results also suggest that exercises of focused attention might contribute in delaying the normal degeneration of higher cognitive functions in old age.

Keywords: Working memory, attention, consciousness, actors, meditators, CANTAB

Introduction

In recent years, psychological research has advanced in a field where previously it feared to tread - consciousness. Research into the structural basis and process nature of consciousness has generated an impressive amount of literature and yet the nature of consciousness continues to elude and intrigue.

In this research, consciousness is examined from the perspective of working memory and attention. This relationship hinges upon Baars' (1988) Global Workspace (GW) theory of consciousness, in which Baars compares everyday human consciousness to a theatre. Baars describes the theatre of consciousness as having a stage of working memory over which a spotlight of attention roams.

Attention and the periphery of awareness are the two salient points in Baars' theory of consciousness (Baars, 1988). In Baars' model, focal consciousness acts as a 'bright spot' on the stage, directed by the selective 'spotlight' of attention. The bright spot is surrounded by a 'fringe' of vital but vaguely conscious events on a 'stage' of working memory. Information from the bright spot is globally distributed through the theatre to two classes of complex unconscious processors: those in the darkened theatre 'audience,' who receive information from the bright spot; and the 'behind the scenes', unconscious contextual systems, which shape events in the bright spot (Baars, 1997b).

The stage of working memory (WM)
Although WM can store up to seven plus or minus two elements, we are only conscious of a single element at any point in time. WM contents are mostly in the dark, but its active elements can come into awareness (Baars, 1997b). This core aspect of Baars' (1988) theory has been echoed by other theorists who view consciousness as the awareness of what is in WM (LeDoux, 1998). Kosslyn and Koenig (1992) argue that to be aware of something, it must be in WM, and Johnson-Laird (1988) notes that the contents of WM are what we can be conscious of at any moment. WM stores relevant information only temporarily, and its main feature is its ever-changing content. Thus the object in awareness can similarly change continuously.

The spotlight of attention
Only events in the bright spotlight are strictly conscious at any point in time. However the contents of WM can become conscious as the attention spotlight roams onto them.

The actors trying to get in the bright spot
Elements in WM compete to gain the spotlight of attention. The more an 'actor' requires being conscious, the more it will compete against the others. For example, our daily worries come into consciousness even when we are trying to concentrate on the task at hand.

Context is set behind the scenes
Often enough attentional selection is spontaneous and unconscious, as if commands from behind the scenes influence the direction of the spotlight. For instance, all perceptual systems are shaped by unconscious factors: for example, our visual perception of depth is shaped by the unconscious assumption that light comes from above. Similarly, conceptual assumptions can act as unconscious contexts.

The director
Working memory is guided by an executive system that

makes decisions guided by goals. But the goals themselves may not be entirely conscious. The intention of automatic actions is often beyond awareness. Thus it seems that the theatre director works invisibly behind the scenes. Such executive functions are located in the prefrontal cortex (Baars, 1997c).

The audience
This consists of diverse specialized unconscious capacities, like long-term memory, and operators that induce implicit learning or procedural knowledge. Consciousness can be the gateway to vast unconscious knowledge (Baars, 1997b).

The strength of the GW theory lies in its ability to describe what we know intuitively. In normal everyday consciousness the complex network system in our brains generates thousands of bits of information per second. However, WM enables us to focus and attend to a limited amount of information relevant for that task at hand. This produces a stream of consciousness, which contains the most relevant pieces of information from one moment to the next and enables the mind to continuously change the contents of working memory producing a myriad of thoughts, emotions and perceptions. Our normal everyday consciousness can be likened to a continuous divided attention task: we drive, whilst listening to the radio; listen to a lecture, whilst thinking about yesterday's party. We seldom focus on the same object in the environment for more than a few minutes.

This is contrary to the issue raised by Crook (1980) where he showed that when subjectively aware a person is completely focused on the environment or the task at hand. This implies that the object of attention remains fixed for a lengthy period of time. Forman (1998) showed that this is precisely the technique used by mystics to empty their mind and reach altered states. Through disciplines like meditation, where there is a focusing of attention on a single repetitive stimulus like breathing, the stream of consciousness is reduced to a single element over time. Forman (1998) raises the issue that the mystical experience is the simplest possible consciousness, and consequently should be studied to enlighten us on the more complex forms of everyday consciousness.

The central role of attentional processes in working memory (WM) has been further explored by Engle, Kane and Tuholski (in press) who have described WM as a system consisting of:

- a store in the form of long-term memory traces active above threshold;
- processes for achieving and maintaining that activation;
- controlled attention.

In this regard, WM capacity, refers to the capacity of just one element of the system: controlled attention. Therefore Engle, Kane and Tuholski (in press) do not focus on the entire WM system, but rather on the capabilities of the limited-capacity attention mechanism described by Baddeley and Hitch (1974) as the central executive. Thus, WM capacity is not really about storage or memory per se, but about the capacity for controlled, sustained attention in the face of interference or distraction (Engle, Kane & Tuholski, in press).

Engle, Kane and Tuholski (in press) argue that this attention capability is domain free and therefore individual differences in this capability reveal themselves in a wide variety of tasks. Indeed, Conway and Engle (1996) emphasize that the correlation between measures of WM capacity and higher-order cognitive tasks is not a result of skill in the specific tasks - as Ericsson and Kintsch (1995) propose with their studies on expertise - but rather of the underlying critical feature of controlled attention which is inherently different in each individual.

Consequently, the study of attention and working memory provides a singular means of understanding consciousness. Moreover, questions are raised as to whether engaging in activities which require maintaining focused attention over long periods of time will produce measurable differences in the cognitive elements of Baars' model of consciousness. More specifically, could the attention spotlight be undergoing particular changes that might affect the working memory stage or any other cognitive processes in Baars' Global Workspace theory of consciousness?

Methodology

Subjects
Four paired samples (N = 48) participated in the experiment. Two experimental groups, actors and meditators and their matched controls were identified for this study. The variables of age, gender and level of education were taken as matching criteria.
From a total sample of 48 participants (Mean age = 30.3; range 19.0 to 45.0), 50% of the participants were male and 50% female. 12.5% of the total sample had a secondary level of education, and 8.33% had a post-secondary level of education (all were employed in skilled labour.) 37.5% of the sample were students at a tertiary level, and 45.83% were graduates in professional employment.

The actors were selected for their specific training techniques. The training which these actors engage in entails intense physical exercise whilst being fully attentive to their creative process, thus satisfying the criteria for attention exercises which was adopted for this research.

Within the actors group (n = 12), 50% were male and 50% were female. Their mean age was 23.7 and ranged from 19.0 to 30.0. 8.33% had a post-secondary education, 25.0% were graduate professionals and 66.67% were University students.

Matching of the actors to controls resulted in the following characteristics: Mean age was 24.0 and ranged from 20.0 to 30.0. 8.33% had a post-secondary education, whilst 25.0% were graduate professionals and 66.67% were University students.

The meditators were selected from the Ananda Marga (AM) yoga and meditation school. Selection criteria for the meditators involved the ability to be fully concentrated on a single object or thought whilst the body is not engaged in movement.

In the meditators group (n = 12), 50% were males and 50% females. Their mean age was 37.0 and ranged from 20.0 to 45.0. 25.0% of the meditators group had a secondary level of education, 8.33% had a post-secondary level of education, 8.33% were enrolled in a university degree and 58.33% were graduates in professional employment.

The same characteristics were evident in the meditators control group except for a mean age of 36.33.

Both the actors and meditators had to have a minimum of one year regular training in their respective domains to be selected for the study. One year of training for the actors group was equivalent to 312 hours, or three weekly 2-hour sessions (six hours per week). For the meditators the minimum requirement was of 365 hours, or a twice daily 30-minute meditation session (seven hours per week).

In addition to matching criteria, naivete to the experimental conditions was a necessary prerequisite for the two control groups. The upper and lower age limits were set at 49 and 18 years respectively and all participants had to have a secondary level of education. Equal numbers of males and females were selected. Exclusion of participants who did not meet these inclusion criteria resulted in a total sample of 48 participants.

Measurement

The Cambridge Neuropsychological Test Automated Battery (CANTAB), developed by CeNeS Cognition (1987), is a computerised battery of neuropsychological tests. Twelve tests form its 'Attention Battery', 'Visual Memory Battery' and 'Working Memory and Planning Battery.' It provides for the assessment of a variety of cognitive functions, including working memory, attention, learning and problem solving, as well as tests of executive function and vigilance.

Specific tests were selected from this battery for this study: Intra/Extra-Dimensional Shift (IED), and Rapid Visual Information Processing (RVP) from the Attention Battery; Paired-Associates Learning (PAL) from the Visual Memory Battery; and Spatial Working Memory (SWM) from the Working Memory and Planning Battery.

Each of the following tests was selected for their accuracy in measuring the particular cognitive functions relevant to this research.

Intra/Extra-Dimensional Shift

This test measures the subject's ability to attend to the specific attributes of compound stimuli, and to shift that attention when required. The actors' and meditators' training in attention was expected to differentiate their performance from that of their respective controls. Moreover, performance on this test was expected to differentiate actors and meditators since actor training entails a multi-tasking component which necessitates a shifting of attention absent in meditator's training.

Rapid Visual Information Processing

The RVP is a test of sustained attention with a small working memory component. The actors and meditators' performance was expected to be significantly better than that of their controls as a result of their training.

Paired Associates Learning

The test is a form of delayed response procedure, which tests two different aspects of the ability to form visuo-spatial associations. First, the number of patterns placed correctly on the first presentation of each trial gives an index of 'list memory', which can also be described as WM capacity. Second, the number repeat-reminder presentations needed for the subject to learn all the associations provides a measure of list learning. This measure explores the relationship between focusing of attention and WM capacity. It was expected that the actors and meditators groups perform significantly better on this test than their control groups.

Spatial Working Memory

This test of spatial working memory, includes a planning and attention component. The actors, as a result of their training using the body as a medium in space, were expected to do overall significantly better in this test. Nevertheless, with their training in attention, the meditators were also expected to do significantly better than their controls.

In summary, a positive effect on all tasks was predicted as a result of training.

Procedure

Prior to the experimental phase, checklists were distributed amongst the actors and meditators populations. Information about gender, age, level of education, occupation, length of training in the respective disciplines and the frequency and duration of each training session was gathered. Similar checklists were distributed amongst prospective control participants. The two control groups were matched according to the demographic information gathered. Any prospective participant who had any experience of the experimental conditions was excluded.

A pilot test was conducted prior to the experimental phase. Completion time for the test was determined to be between 30 to 40 minutes. The participants, who still conformed to the inclusion criteria, experienced no difficulties in performing the test.

The experiment was conducted in a constant environment, and any extraneous variables were accounted for. Testing was carried out on an individual basis with a random allocation of participants to time of testing. The tests were administered in the following order; with tests from the Attention battery being administered first, followed by a test each from the Visual Memory Battery and Working Memory and Planning Battery:

1 Intra/Extra-Dimensional Shift
2 Rapid Visual Information Processing - Training
3 Rapid Visual Information Processing - Test
4 Paired Associates Learning,
5 Spatial Working Memory.

Standardized instructions were followed in accordance to the CANTAB manuals (CeNeS, 1998a, 1998b).

In the CANTAB battery, data is automatically scored and analyzed according to the variables of gender and age for each individual test. This data, together with information collected from the checklists which included age, gender, level of education, training history and total amount of training was explored to investigate the research hypothesis.

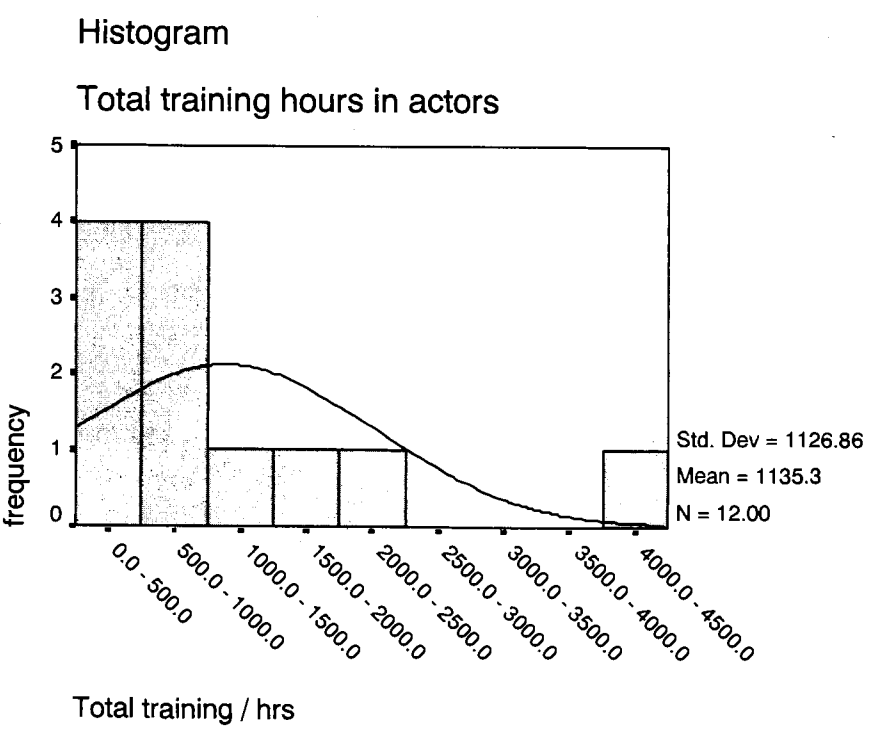

Figure 1. Histogram showing the frequency distribution of total training hours in actors.

Analysis

Multivariate Analysis of variance (MANCOVA) was performed to analyze main and interaction effects in a between-subjects design. Age was selected as a covariate. T-tests explored differences as a result of training, type of training and age.

Results

Descriptive statistics

Gender and age characteristics of the sample are illustrated in Table 1.

	Gender		Age		
	Males	**Females**	**M**	**SD**	**Range**
Actors	50%	50%	23.75	4.04	11.00
Actors - Controls	50%	50%	24.00	3.43	10.00
Meditators	50%	50%	37.00	7.37	25.00
Meditators - Controls	50%	50%	36.33	7.27	25.00

Table 1. Gender and age characteristics of sample

Amount of training in hours

The mean total hours of training in the actors and meditators population (n = 24) was 3605.531 hours (SD = 4035.78). The mean total training hours for the sample of actors (n = 12) was 1135.33 hours (SD = 1126.86). The range of total training hours in actors varied from a minimum of 312 hours to a maximum of 4160 hours.

A frequency distribution of the total training hours shows that 66.7% of the actors trained between 312 and 1000 hours. 16.6% trained between 1000 and 2000 hours, whilst 16.6% trained between 2000 and 4160 hours.

The mean total training hours for the meditators group (n = 12) was 6075.72 hours (SD = 4412.79). The range of meditation hours varied between a minimum of 730 hours and a maximum of 16060 hours. A frequency distribution of the total meditation hours shows that 66.7% of the meditators practised meditation between 730 and 6000 hours. 16.6% practised between 6000 and 10500 hours, whilst 16.6% have meditated between 10500 and 16500 hours.

Comparisons between Samples

Multivariate analysis of variance exploring main and interaction effects of training and type of training yielded the following results. Age was selected as a covariate as a result of the difference in mean age between actors and controls (M = 23.75, 24.00) and meditators and controls (M = 37.00, 36.33).

Intra/Extra-Dimensional Shift (IED)

The mean stage reached by the total population (n = 48) was 7.79 (SD = 1.93), with a minimum score of 1 and a maximum of 9. Table 2 illustrates a comparison of the mean stage reached by the four groups.

Group	**n**	**M**	**SD**
Actors	12	7.91	2.31
Actors Controls	12	7.83	1.03
Meditators	12	8.00	1.53
Meditators Controls	12	7.41	2.64

Table 2. Comparison among groups on stage reached in IED.

No significant main or interaction effects were obtained $F(5, 43)=0.72$, $p>0.05$. Age did not covary significantly.

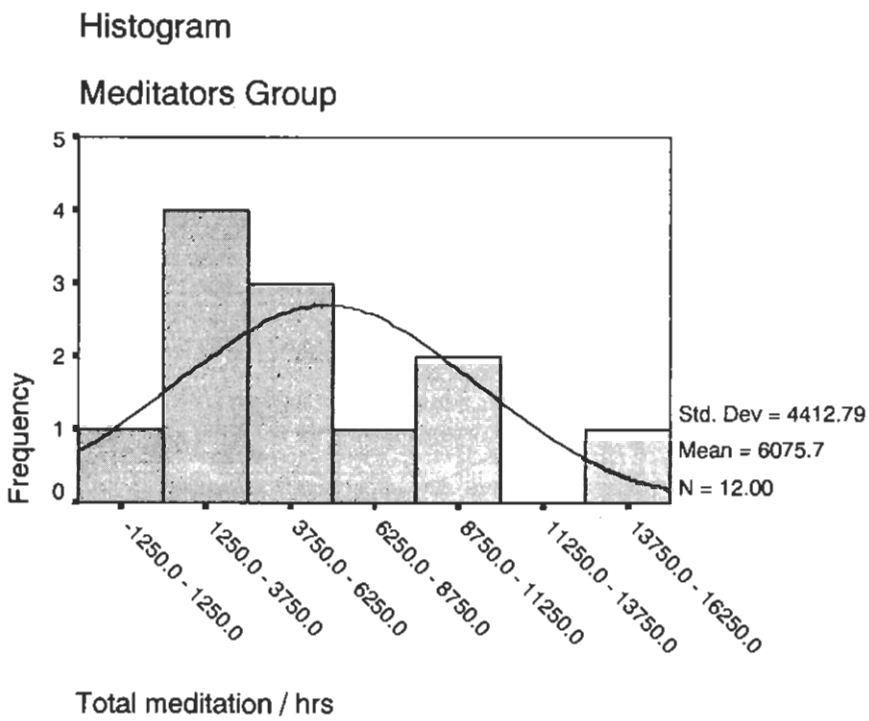

Figure 2. Histogram showing the frequency distribution of total meditation hours in meditators.

The population (n = 48) had a mean of 24.98 (SD = 11.63) on total errors made in the IED, with a minimum of 7 errors and a maximum of 54. Table 3 illustrates a comparison of the mean total errors among the four groups.

Group	n	M	SD
Actors	12	23.58	14.89
Actors Controls	12	25.25	10.63
Meditators	12	25.91	12.64
Meditators Controls	12	25.16	8.97

Table 3. Comparison among groups on total errors in IED

A MANCOVA showed no significant differences (F (5, 43) = .056, $p > .05$) among the four groups on the total errors in the IED.

Table 4 illustrates a comparison among groups on ID-ED errors at ED shift.

Group	n	M	SD
Actors	12	11.83	9.67
Actors Controls	12	16.83	12.86
Meditators	12	11.58	9.99
Meditators Controls	12	10.25	11.33

Table 4. Comparison of groups on ID-ED errors at ED shift

A MANCOVA yielded no significant main and interaction effects (F (5, 43) = 1.66, $p > 0.05$) on errors at ED shift.

Table 5 compares the groups on the ID-ED errors up to ED shift.

Group	n	M	SD
Actors	12	5.00	2.41
Actors Controls	12	7.75	4.52
Meditators	12	9.33	7.24
Meditators Controls	12	7.83	6.39

Table 5. Comparison of groups on ID-ED errors up to ED shift

A MANCOVA yielded a significant main effect, F (5, 43) = 8.48, $p = 0.01$. Age covaried significantly, (F (43, 1) = 13.50, p = 0.001).

Rapid Visual Information Processing (RVP)

The most significant data items for the RVP were the probability of hit, and the probability of false alarm.

The mean probability of hit of the total population (n = 48) was .687 (SD = .187), with a minimum score of .3 and a maximum of 1. Table 6.0. illustrates a comparison of the probability of hit of the four groups.

Table 6. Comparison among groups on probability of hit in RVP.

Group	n	M	SD
Actors	12	.67	.19
Actors Controls	12	.72	.13
Meditators	12	.69	.19
Meditators Controls	12	.65	.22

A MANCOVA showed no significant differences (F (5, 43) = .75, $p > .05$) among the four groups on probability of hit in the RVP.

The mean of the whole population (n = 48) on probability of false alarm in RVP was 3.333E-03 (SD = 5.19E-03), ranging from a minimum of .00 to a maximum of .02.

Table 7. illustrates a comparison of the probability of false alarm among the four groups.

Group	n	M	SD
Actors	12	8.33E-04	2.88E-03
Actors Controls	12	3.33E-03	4.92E-03
Meditators	12	5.00E-03	5.22E-03
Meditators Controls	12	4.16E-03	6.68E-03

Table 7. Comparison among groups on probability of false alarm in RVP.

A MANCOVA showed no significant main and interaction effects (F (5, 43) = .807, $p > .05$) among the four groups on probability of false alarm in RVP. However age covaried significantly F (1, 45) = 5.64, p = 0.02.

Paired Associates Learning (PAL)
The most significant data items for the PAL were the total trials and mean errors made.

The total sample (n = 48) had a mean of 10.93 (SD = 2.51), which ranged from a minimum score of 8 and a maximum of 20, on total trials in the PAL. Table 8 illustrates a comparison of total trials amongst the four groups.

Group	n	M	SD
Actors	12	10.58	2.87
Actors Controls	12	10.16	2.08
Meditators	12	10.50	1.38
Meditators Controls	12	12.50	2.97

Table 8. Comparison among groups on total trials in PAL.

A MANCOVA showed no significant differences (F (5, 43) = 1.67, $p > .05$) among the four groups on total trials in the PAL.

The mean of the whole population (n = 48) on mean errors in the PAL was 1.03 (SD = 1.04), ranging from a minimum of .00 to a maximum of 5.40. Table 9 compares the scores obtained on mean errors in PAL.

Group	**n**	**M**	**SD**
Actors	12	.85	1.10
Actors Controls	12	.68	.71
Meditators	12	.80	.57
Meditators Controls	12	1.80	1.32

Table 9. Comparison among groups on mean errors in PAL.

A MANCOVA yielded no significant results on mean errors in PAL (F (5,43) = 2.57, $p > 0.05$).

Spatial Working Memory (SWM)
The most significant data items for the SWM test were the between errors, and the strategy score.

The mean between errors in SWM of the total population (n = 48) was 17.58 (SD = 18.21), with a minimum score of 0 and a maximum of 68. Table 10 illustrates a comparison among the four groups on between errors in SWM.

Group	**n**	**M**	**SD**
Actors	12	14.33	19.82
Actors Controls	12	15.58	18.50
Meditators	12	22.08	18.09
Meditators Controls	12	18.33	17.75

Table 10. Comparison among groups on between errors in SWM.

A MANCOVA showed no significant differences (F (5, 43) = .09, $p > .05$) among the four groups on between errors in SWM.

The mean of the whole population (n = 48) on strategy score in SWM was 32.18 (SD = 4.42), ranging from a minimum of 21 to a maximum of 39.

A MANCOVA showed no significant differences (F (5, 43) = 0.39, $p > .05$) among the four groups on strategy score in SWM.

Effect of Training
Independent-samples t-tests explored differences in performance on the CANTAB sub-tests as a result of training. Interestingly, a training effect was found only on the ID-ED errors at the ED shift (t (46) = -.57, p = .007).

Type of Training
T-tests for independent samples (two-tailed) compared performance on the CANTAB tests of actors and meditators to establish differences as a result of the type of training undergone. A significant difference was found between actors and meditators on the probability of false alarms in RVP (t (22) = -2.42, $p = 0.0001$).
However, as Figures 1.0 and 2.0 illustrate, the range and total amount of training of actors and meditators vary considerably. Independent-samples t-test was performed between actors and meditators with comparable training experience (< 4000 hours). This also yielded a significant result for the ID-ED score up to ED shift (t (14) = 2.25, p = 0.001).

The effects of meditation and actor training were further explored using paired - samples t-test. Actors and meditators were compared to their respective controls. Surprisingly, actors did not differ significantly from their controls on all measures of the CANTAB.

Meditators differed from their controls on total trials in PAL (t (11) = -2.23, $p < .05$) and mean errors in PAL (t (11) = -2.70, $p < .05$).
Therefore, meditators and their matched controls differed significantly on both measures of the Paired Associates Learning test.

Amount of training
An analysis of the relationship between the total amount of practice for actors and meditators, and the performance on the CANTAB tests was performed. Surprisingly, no relationship was found between the total amount of training in actors and their performance on the IED, PAL and SWM. However, there was a strong positive correlation between the total hours training in actors and their probability of false alarms in the RVP (r = .833, $p < .01$). No significant correlations were found between the total hours practising meditation and the meditators' performance on the IED, RVP, PAL and SWM tests. Tables 11 and 12 illustrate the results obtained using Pearson's two-tailed correlations for actors and meditators.

Test	Data Items	*n*	*r*	sig (2-tailed)
IED	Stage reached	12	.15	.62
	Total errors	12	.04	.90
	Errors at ED-shift	12	.20	.52
	Errors up to ED-shift	12	.05	.87
RVP	Probability of hit	12	.07	.81
	Probability of false alarm	12	.83**	.001
PAL	Total trials	12	-.029	.93
	Mean errors	12	-.10	.73
SWM	Between errors	12	.02	.93
	Strategy score	12	.18	.56

** $p < .01$

Table 11. Pearson's correlations between total hours training in actors and performance on CANTAB tests.

Test	Data Items	*n*	*r*	sig (2-tailed)
IED	Stage reached	12	-.17	.58
	Total errors	12	-.02	.95
	Errors at ED-shift	12	.25	.42
	Errors up to ED-shift	12	-.16	.59
RVP	Probability of hit	12	.04	.88
	Probability of false alarm	12	-.03	.91
PAL	Total trials	12	.18	.56
	Mean errors	12	.16	.59
SWM	Between errors	12	.38	.21
	Strategy score	12	.20	.52

Table 12. Pearson's correlations between total hours training in meditators and performance on CANTAB tests.

Age Differences

Performance on the CANTAB tests varies significantly with age. In view of the mean age difference between actors and controls compared to meditators and controls, independent samples t-tests were performed to determine whether performance varied as a function of age. It was expected that actors perform better than meditator controls both as a function of training and age. The two groups differed significantly on the RVP probability of false alarm (t (22) = -1.58, p = 0.03) and SWM strategy score (t (22) = .78, p = 0.02.

Meditators were compared to actor controls using an independent - samples t-test (two-tailed). Although meditators are older than the actor controls, their performance on the CANTAB measures is better with the differences being significant for the ID-ED errors at ED shift (t (20) = 1.16, p = 0.02) and RVP probability of hit (t (19) = .51, p = 0.04).

The actor controls and meditator controls differ only as a function of age. Independent-samples t-test yielded a significant difference on the SWM strategy score (t (18) = .21, p = .03).

Discussion

This study has focused on the relationship between attention, working memory and consciousness by studying focused attention from the perspective of two disciplines, meditation and contemporary theatre. The effect of training in meditation and contemporary theatre was then explored through standardised tests that measure higher cognitive functions, notably working memory.

There were few significant differences on the performance of specific CANTAB tests among the actors, meditators and their controls.

In the Intra/Extra - Dimensional Shift (IED) test, which is a measure of shifting of attention no significant differences were obtained on stage reached in IED, total errors in IED and ID-ED errors at ED shift. However, a significant main effect was obtained on errors up to ED shift. Age covaried significantly. This implies that any differences between the groups are not necessarily a result of training but may be a result of an interaction with age. This is interesting in view of the fact that although, not statistically significant, meditators reached a higher stage on the IED than their controls and performed better than actors who did not differ from their matched controls. This result is surprising in view of the age difference between the meditators and actors. Meditators and their controls had a mean age approximately ten years older than that of the actors and control, therefore it is interesting that meditators performed better in this test than the actors and controls, especially when their age counterparts performed worse than the younger groups as expected.

Consequently, it might be suggested that whilst meditators' controls scored lower than the younger groups because of the normal weakening of cognitive functions due to older age, in meditators, this cognitive deterioration seems to be less marked. This claim is supported by the fact that when meditators were compared to the actors controls they differed significantly on the RVP probability of false alarm and SWM strategy score. Stoltzfus, Hasher and Zacks' (1996) findings that older adults find it more difficult to inhibit irrelevant thoughts and distractions could also support this pattern. In the IED, which is an exercise of attention and disattention, meditators' controls were probably more distracted as predicted by Stoltzfus, Hasher and Zacks (1996).

Actors made fewer errors in the ED shift, when the task was to shift their attention between two similar stimuli. Interestingly the meditators made most errors in these preliminary stages of the test. Perhaps the meditators' training in keeping fixed attention on a single object hindered them from shifting their attention at first, but gradually they learnt to attend and disattend according to the task at hand, improving their performance, ultimately reaching the highest stages in the IED.

It is interesting to note that all participants irrespective of condition performed lower than that expected from the CANTAB norms. This finding is interesting because the CANTAB is supposedly culture-fair, however, there are some indications that this might not be so. (Fray, 1999, personal communication).

Once again there were no significant differences amongst the groups' performances on RVP and the same pattern of results was obtained as in the ID/ED shift. Moreover, age covaried significantly on probability of false alarm. The suggestion regarding the possible beneficial effects of meditation in old age remains pertinent in this case.

Actors also train in attentional exercises. However, they did not perform any better than their controls. It is suggested that contemporary theatre training does not produce cognitive effects as marked as meditation. Moreover, the essence of theatre training is its motoric component, an aspect which is not captured by the CANTAB tests. It may be the case that these tests are not sufficiently sensitive or they do not tap the relevant cognitive functions, thus masking any differences between the two experimental groups.

The Paired Associates Learning (PAL) Test explores the cognitive functions of attention and working memory capacity. A significant difference between the performance of meditators and their controls was shown. Whilst actors and their controls scored within the average norm for their age, meditators scored significantly higher than their controls and higher than the average norm for their age. This finding strengthens the suggestion that attention exercises like meditation produce beneficial effects on higher cognitive functions, which become more labile due to old age.
Similairly, meditators and their controls differed significantly in the amount of errors made. The fact that significant results were found on the PAL, rather than the other tests is also highly interesting, since the PAL tests for working memory capacity. Consequently, it is suggested that attention exercises like meditation have an effect specifically on working memory capacity. This is significant in view of Baars' Global Workspace theory of consciousness. Indeed from this finding it is hypothesised that training this attention mechanism, should strengthen working memory capacity especially in old age, when it would otherwise deteriorate.
The Spatial Working Memory (SWM) test explores the capacity of spatial working memory and planning. No significant results were obtained from this test.
When the two control groups were compared, a significant age difference was obtained on the SWM strategy score. This fits in with Stoltzfus, Hasher and Zacks' (1996) suggestion that older adults compensate for their lowered working memory capacity by planning their actions more accurately. This is a rational, and consequently, a left-brain task. The practice of meditation, however, has been shown to sharpen more intuition (Wulff, 1997). Perhaps, meditators were relying more on their intuitive functions during this task, thus failing to create an adequate strategy leading to a lot of errors.

Actors however, who also had a poor strategy, still managed to make few errors. This might arise as a result of their training, which is focused on the movements which the body creates in space, which sharpens their

capacity to note spatial relations, which is another right-brain function (Cytowic, 1995).

It is surprising that no interaction effects were exhibited. However, as has been discussed age may have had a masking effect on any relationships between training and type of training.

Consequently, the results from this study can be summarised accordingly;
Attention exercises appear to produce a positive effect on working memory capacity and its attention mechanism as hypothesised by Engle, Kane and Tuholski (in press), possibly by limiting the deterioration of cognitive functions in old age. This effect was shown by meditators, but it is not clear whether contemporary theatre could have produced a similar effect had the actors been older and more experienced.

Amount and Quality of Training

Although no correlations were found between the total amount of hours of actors' training and meditation with the performance on any of the CANTAB tests, it is important to highlight particular differences between the two forms of attention exercises:

The actors' training is mostly physical and consequently the form of attention employed involves being completely involved with the task at hand. Since the task is continuously changing, attention is consequently continually changing, although the change is limited to the particular task. In meditation, however the object of attention is fixed throughout, since all stimuli, including movement and sensations are excluded from consciousness.

Mean total training hours in meditators was 6075.729, whilst that of the actors was just 1135.333. This wide difference is due to the fact that meditators, on average, had been practising for more than eight years, whilst most of the actors had only trained for two years. Moreover, meditators practice for seven hours weekly, whilst most of the actors only train six hours a week. However, meditators have a more consistent pattern of meditation with two daily thirty minute slots, whilst actors train three times weekly for two hours each time. This quantitative difference could have produced the patterns described above. Interestingly, when actors and meditators with similair amounts of training were compared, a significant effect of RVP probability of false alarm and ID-ED score up to ED shift resulted.

It could be argued that meditators tended to do better than actors because they have been in training for a number of years and their training is more consistent. Ericsson, Krampe and Tesch-Romer (1993) suggest that the most effective activity for skill acquisition is consistent and sustained training. It could also be argued that, since meditators have been in training for a longer duration than the actors, they have had more opportunity to experience mystical states of consciousness, which could produce the positive effects on the cognitive functions of the meditators.
Nevertheless, as has been already noted, meditators were, on average, ten years older than the actor cohort. This fact should have contributed to the actors performing better than the meditators on most tests. Therefore, it does seem important that, although the results were not significant, meditators still managed to perform as well - and sometimes even better - than the actors and their controls. This pattern may be worth pursuing in view of its potential practical implications in old people who experience a decreased efficiency in working memory. Regular meditation from early adulthood could perhaps prove beneficial in slowing down this cognitive deficit. Since meditation is practised sitting down, it can be maintained even if the elderly become less physically mobile.
In conclusion it appears that although there were no consistent significant results on a number of the CANTAB tests, meditation seems to be a better attention exercise than contemporary theatre that can effect higher cognitive functions, especially working memory.

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