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Participation in a 10-week course of yoga improves behavioural control and decreases psychological distress in a prison population☆

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ABSTRACT

Background: Yoga and meditation have been shown to be effective in alleviating symptoms of depression and anxiety in healthy volunteers and psychiatric populations. Recent work has also indicated that yoga can improve cognitive-behavioural performance and control. Although there have been no controlled studies of the effects of yoga in a prison population, we reasoned that yoga could have beneficial effects in a setting where psychosocial functioning is often low, and the frequency of impulsive behaviours is high.

Methods: Participants were recruited from 7 British prisons and randomly allocated to either a 10-week yoga programme (yoga group; 1 class per week; $N = 45$) or a control group ($N = 55$). Self-report measures of mood, stress, and psychological distress were collected before and after the intervention period. Participants completed a cognitive-behavioural task (Go/No-Go) at the end of the study, which assessed behavioural response inhibition and sustained attention.

Results: Participants in the yoga group showed increased self-reported positive affect, and reduced stress and psychological distress, compared to participants in the control group. Participants who completed the yoga course also showed better performance in the cognitive-behavioural task, making significantly fewer errors of omission in Go trials and fewer errors of commission on No-Go trials, compared to control participants.

Conclusions: Yoga may be effective in improving subjective wellbeing, mental health, and executive functioning within prison populations. This is an important consideration given the consistently high rates of psychological morbidity in this group and the need for effective and economical intervention programmes.

1. Introduction

Being in prison is a form of punishment with far reaching implications for one's physical and psychological functioning. Heightened levels of personal distress, aggression, antisocial behaviour, and substance abuse are commonly reported amongst incarcerated prisoners (Haney, 2002; Hawkins, 2003). Within the United Kingdom, there is an increasing recognition of the need for interventions that address the high rates of psychological problems and reduced wellbeing experienced by prisoners (Department of Health, 2001).

With the growing popularity of practises like meditation and yoga, policy makers, prison governors, and scientists have considered the effectiveness of applying these techniques to prisons. Thus far, the studies that have focused on meditation with this population have shown encouraging results, including reports of improved psychosocial function (Chandiramani et al., 1998;

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Samuelson et al., 2007), reduced rates of recidivism (Alexander et al., 2003; Bleick and Abrams, 1987; Rainforth et al., 2003), and reduction in substance use (Bowen et al., 2006). Together, these findings suggest that transposing these techniques, which were originally devised as ascetic-spiritual practices, into prisons might help in the management of disinhibited and criminal behaviours (Walton and Levitsky, 2003).

Research on the benefits of yoga, on the other hand, is considerably thinner. That yoga has overall received less scientific attention is probably in part because it is a multifaceted and complex intervention, involving poses (*asanas*; physical movement and postures), breathing techniques, as well as relaxation and meditation. Such complexity makes it challenging when attempting to pin or break down the specific components of this practice which effect the individual's wellbeing. Nevertheless, there has recently been significant growth in the study of yoga in healthy populations. This body of research suggests that yoga is associated with improvements in mood (Shapiro and Cline, 2008), emotional function and life satisfaction (Hartfiel et al., 2011), reductions in anxiety, anger and aggression (Nagendra et al., 2008; Yoshihara et al., 2011), as well as significant reductions in perceived stress (Granath et al., 2006; Kirkwood et al., 2005; Rocha et al., 2012; Smith et al., 2007). In vulnerable and clinical samples, yoga has proved to be an effective method of reducing negative affect, depression, and anxiety (Banerjee et al., 2007; Michalsen et al., 2005; Vadiraja and Raghavendra, 2009; Woolery et al., 2004), and of improving emotional wellbeing (Moadel et al., 2007).

Yoga's potential application to a prison population is more specifically demonstrated by a number of studies showing that its practice is associated with reduced levels of state anxiety (for a review, see Sharma and Haider; Streeter et al., 2010; Vadiraja and Raghavendra, 2009) which, in turn, has been suggested to be linked to lower levels of aggression (Bekiari et al., 2006). Although most of the research thus far has focused on the health benefits of yoga, rather than the psychological processes that it stimulates, there is some indication of its underlying effects on cognition, including improved spatial recall (Manjunath and Telles, 2004), memory (Rocha et al. 2012) and sustained attention (Rangan et al., 2009), enhanced selective attention (Velikonja et al., 2010) and various improvements in cognitive functioning in patients with major depression (Sharma et al., 2006). Furthermore, a recent exploration of the neural underpinnings of the effects of yoga on cognition and emotion reported that yoga practitioners exhibited less reactivity in the right dorsolateral prefrontal cortex when presented with negative affective stimuli, compared to a control group (Froeliger et al., 2012). This last study suggests that yoga, besides having a range of psychological benefits, may specifically recruit frontal executive strategies that are implicated in the regulation of behavioural control. If this is true, then yoga could have a privileged role in a prison setting by enhancing executive functioning skills, including impulsivity, inhibition and attentional capacity, amongst prisoners. This is especially important since previous research has highlighted that this population presents deficits in executive functioning (Syngelaki et al., 2009).

Here, we aimed to extend the current literature on the psychological benefits and processes underpinning yoga practice by investigating the effects of a 10-week course of yoga in a sample of prisoners. More specifically, we combined self-report measures and a cognitive-behavioural task in a population randomly allocated to a yoga or a control group. Self-report measures of mood, stress, and mental health were administered at two time-points, before and after the 10-week course period, and scores provided by participants in the yoga and control groups were compared. We hypothesized that, similar to previous observations in healthy volunteers and patient groups, yoga would be associated with improved mood and psychological wellbeing. Secondly, participants completed a computerized Go/No-Go task after the 10-week yoga period. In this task participants are asked to respond when presented with one cue (in a "Go" trial) but must withhold that response when presented with a second cue (in a "No-Go" trial). By requiring individuals to inhibit pre-potent responses, this task has been used to tap aspects of executive function, and in particular those related to impulsivity (Band and van Boxtel, 1999). There is evidence that deficits in performance are related to difficulties in controlling violent behaviour; for example, violent offenders have been shown to make more errors of commission on No-Go trials, i.e. making a motor response when signalled to inhibit that response (Munro et al., 2007). Although there is considerable evidence that some types of meditation may confer benefits in cognitive tasks that require response inhibition and sustained attention (for a review, see Chiesa et al., 2011), there is no research addressing how yoga might enhance cognitive-behavioural control in prisoners.

2. Methods

2.1. Participants

A total of 173 participants were recruited from prisons in the West Midlands. Of these, 4 participants were excluded as they had experience of practising yoga, and 2 withdrew consent after being informed more extensively. The final cohort therefore consisted of 167 prisoner participants (155 male, 12 female), with ages ranging from 21–68; mean 36.08; and standard deviation 12.14 years. Seven prisons took part in the study,[2] including a young offenders' institution (aged 21–25) and a women's prison. The imprisonment conditions, as well as the crimes committed by participants, varied considerably. For example, one of the prisons (HMP Hewell) functioned on an open regime, allowing participants to go out and take part in educational courses. Another institution (HMP Shrewsbury) had a very high proportion of sex offenders. The study was approved by ethics committees of the British National Health Services and the Ministry of Justice, and all participants provided written informed consent to take part. Individuals assigned to the control group were informed that they would be given priority places in future yoga courses to be run shortly after the completion of the study. Exclusion criteria were the presence of psychiatric illness or a major medical condition, and current alcohol or drug abuse.

Of the 167 participants, 30.5% (51 individuals) were not present at the post-intervention assessment session, and a further 9.5% (16 individuals) attended less than half of the yoga sessions (<5). All these participants were excluded from the analysis. The final sample included 100 participants, 45 of which were in the yoga group (95.5% male; mean age 37.38 years, standard error 1.77 years), and 55 in the control group (90.9% male; mean age 39.42 years, standard error 1.89 years). There was no significant difference between groups in the proportion of participants that were lost at the post-intervention follow-up visit, $\chi(1) = 0.037$, $p = 0.848$. There were also no significant differences in age or gender composition between groups ($t[98] = 1.95$, $p = 0.45$ and $\chi[1] = 0.82$, $p = 0.31$, respectively).

2.2. Procedure

The study was planned and conducted as an exploratory trial, without sample size calculation or a predefined primary endpoint. After consenting to taking part in the research, prisoners were

[2] Participating prisons were: HMP – YOI Drake Hall; HMP Dovegate; HMP Hewell; HMP Featherstone; HMP Stafford; HMP Shrewsbury; and HMP – YOI Swinfen Hall. HMP = Her Majesty's Prison. YOI = Young Offenders' Institution.

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randomly assigned to the yoga or control group using a Microsoft Excel randomization routine. On the first meeting, one week before the start of the 10-week intervention (henceforth, Time 1), participants were assessed with a battery of scales. This baseline assessment was conducted by two researchers and lasted, on average, 45 min. As rates of illiteracy in UK prison populations can be high (Social Exclusion Unit, 2002; The Prison Reform Trust, 2008), all instructions and questionnaire items were read to participants by one of the researchers. Rating scales, in a large coloured format, were placed in front of participants to aid responses to the questionnaires. Post-intervention assessments took place one week after completion of the 10-week course (henceforth, Time 2), at which point participants were assessed using the same measures, in addition to a cognitive-behavioural task.

2.3. Yoga course

Yoga classes were run by trained teachers. They were held once a week and had a two-hour duration. Classes were held in a quiet room and consisted of a standardised set of hatha yoga postures and stretches (see Fig. 1). To complement the poses, the final 10–20 min of each class were spent doing relaxation, e.g. breathing exercises.

Participants in the Control group were asked to not attend the yoga course, but to continue their usual social life and physical exercise activities. Participants in both groups were given practice/exercise diaries. Participants in the yoga group were asked to monitor the time spent practising yoga outside of class; participants in the control group were asked to monitor time spent working out in the prison gym or other exercise facilities. No adverse events associated with taking part in the study were reported by participants in either group.

3. Materials

We collected socio-demographic information from participants, including gender, age, level of education, ethnicity, and marital status. Participants also completed questionnaire scales measuring affect, stress, impulsivity and psychological distress. All psychological measures, except impulsiveness, were given at pre and post intervention. They included:

a) The Barratt Impulsiveness Scale (version 11) or BIS-11 (Patton et al., 1995), a 30-item instrument measuring trait impulsivity which is scored on a four-point scale (from 'rarely/never' to 'almost always/always'). Examples of items are: "I plan tasks carefully" and "I do things without thinking". We included this measure of impulsivity as scores in the BIS-11 have been shown to relate to performance in cognitive-behavioural tasks like the one employed here (Spinella, 2004).
b) The Positive and Negative Affect Scale (PANAS; Watson et al., 1988), which consists of two 10-item scales with mood descriptors (e.g. "interested" and "scared"), which are rated on a continuum from 1 ("very slightly or not at all") to 5 ("extremely"). Participants were asked to rate the extent to which they had experienced each particular feeling or emotion during the past 24 h.
c) The Perceived Stress Scale (PSS; Cohen and Williamson, 1988) is a 10-item instrument used for measuring the degree to which situations in one's life are appraised as stressful, and is rated on a 0 (never) to 4 (very often) scale. Participants were asked how often they had experienced each situation in the last month. Examples of items are: "How often have you felt that things were going your way?" and "How often have you been able to control irritations in your life?"
d) The Brief Symptom Inventory (the BSI; Derogatis, 1993) is a 53-item measure commonly used to assess psychological distress. Each item, describing a psychological symptom, is rated on a 0 (not at all) to 4 (extremely) scale. Examples of items are: "Nervousness or shakiness inside" and "Feeling no interest in things". Although it includes various subscales (e.g. depression, anxiety, hostility), it is most often scored as a global severity indicator of current distress.

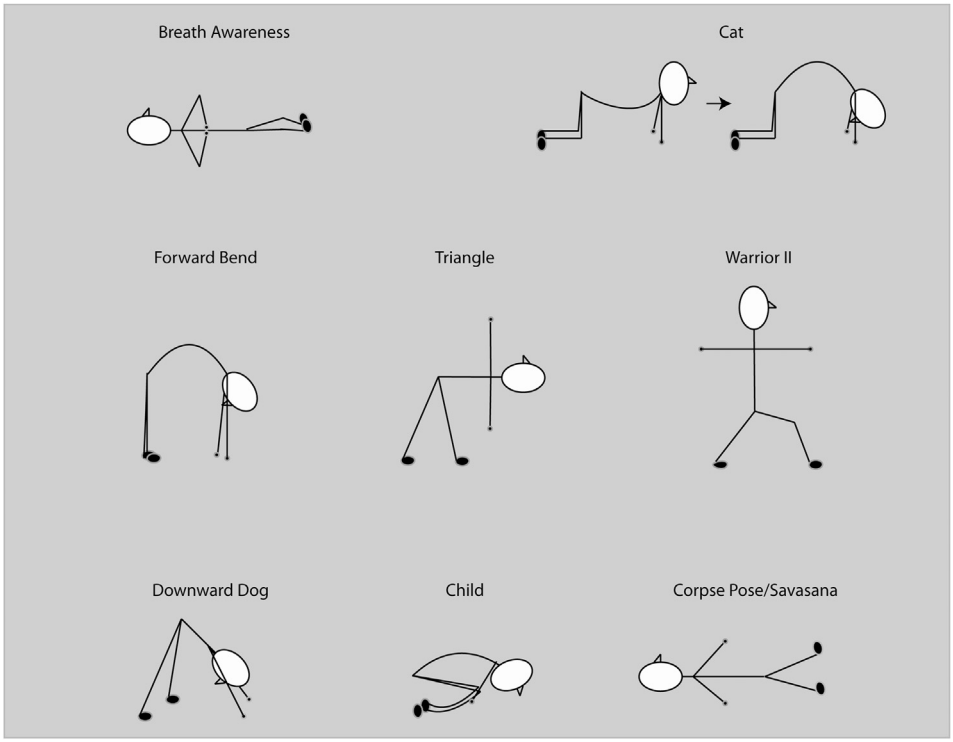

Fig. 1. Sketch diagrams of some of the asana poses practised in yoga classes by participants randomly allocated to the yoga group ($N = 45$).

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We selected these questionnaires because of their ease of use and comprehensibility; all have been used in forensic samples (Bowen et al., 2006; Haden and Shiva, 2009; Kramer et al., 2011; Muller et al., 2003; Patrick, 1994; Warren et al., 2004) and/or other vulnerable participant groups, such as those experiencing psychiatric illness (Boulet and Boss, 1991; Hewitt et al., 1992)

3.1. Cognitive-behavioural task

On the post-intervention assessment, prisoners started out by completing the 'Go/No-Go' task, which was presented on a laptop computer using *Presentation* software (version 16.0, www.neurobs.com). The Go/No-Go task was used to assess executive function, particularly attentional capacity and behavioural response inhibition (Band and van Boxtel, 1999). All stimuli, consisting of an "x" and an "o", were presented in the centre of the screen in white against a black background. Stimulus duration was fixed to 100 ms, with inter-trial intervals (during which an empty black screen was shown) of variable duration selected from a uniform distribution of 1–2 s. Participants had to respond by pressing the spacebar when the Go cue ("x") was presented, and withhold any response for the No-Go cue ("o"). Go stimuli were presented on 70% of trials, and No-go stimuli on 30% of trials. The presentation of a larger proportion of Go stimuli than No-Go stimuli establishes a dominant response tendency to the Go cue, such that the task would require more cognitive resources to withhold responses on No-Go trials. Accuracy (with a correct response defined as a button-press on a Go trial, or no button-press on a No-Go trial) and reaction time (where a response was made) were measured for each trial. Participants completed two blocks of 100 trials each, with a short break in between blocks.

3.2. Statistical analysis

Differences in age, trait impulsivity, and the time spent doing exercise for participants in the yoga and control groups were tested using an independent-samples *t*-test. Differences in categorical demographic data (e.g. gender) were tested using chi-squared tests. Unless otherwise stated, questionnaire data were analysed using a repeated-measures analysis of variance (ANOVA), with time (Time 1 and Time 2) as the within-subject factor and group (yoga or control) as the between subjects factors. Additionally, given the number of prisons included in the study, and their diverse environmental characteristics, we included prison as a between subjects factor.

Percentage of accuracy and reaction time data from the cognitive task (calculated separately for Go and No-Go trials) were analysed using a repeated-measures ANOVA with the trial-type (Go vs. No-Go) as a within-subjects factor, and Group (yoga or control) and prison as between-subjects factors. Post-error slowing (Rabbitt, 1966) was analysed by entering the average reaction time for correct 'Go' responses which followed (i) a *correct* 'No-Go' response (i.e. no button press) on the previous trial and (ii) an *incorrect* 'No-Go' response (i.e. button press, or error of commission) on the previous trial, into a repeated-measures ANOVA with the between-subject factors of Group (yoga or control) and prison.

4. Results

4.1. Demographics

Fig. 2 shows the recruitment, assignment, and subsequent follow-up of the study participants. Our final sample included 100

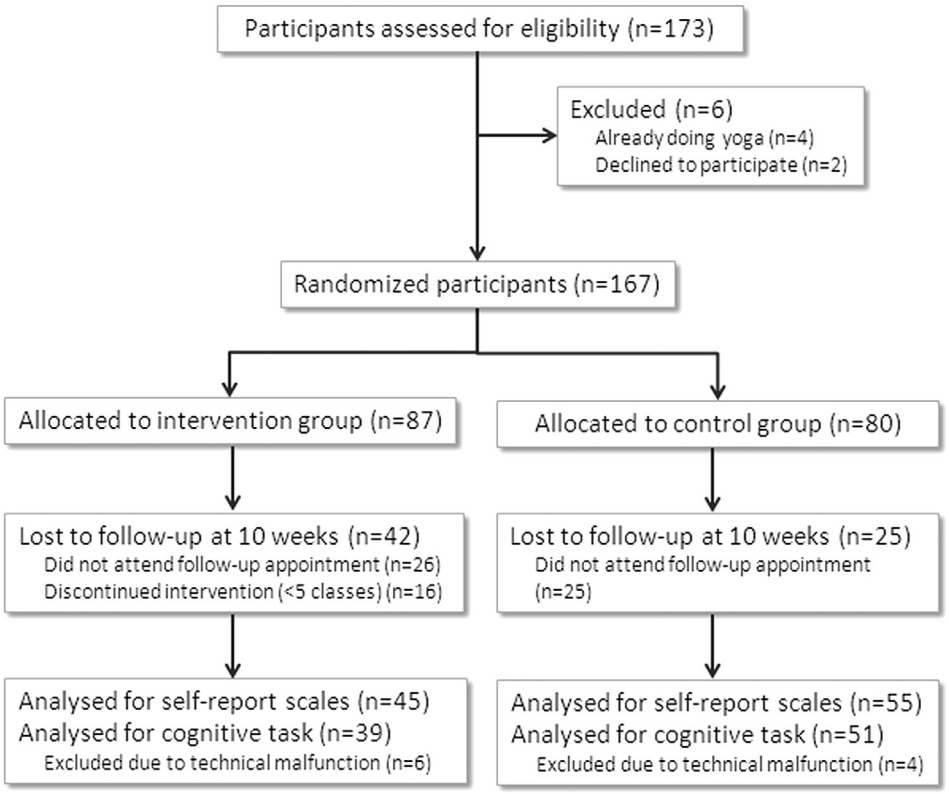

Fig. 2. Flow chart of the recruitment, inclusion, assignment, and subsequent follow-up of the study participants.

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Table 1
Participant demographics for 100 participants who either did (yoga group, $N = 45$) or did not (Control group, $N = 55$) participate in a 10-week yoga course.

	Yoga	Control
Gender (M/F)	43/2	50/5
Age (±S.E.)	37.38 (±1.77)	39.42 (±1.89)
Education: qualifications obtained		
None	10 (22.2%)	18 (32.7%)
O-levels/GCSEs	21 (46.6%)	13 (23.6%)
A levels and higher education	14 (31.1%)	24 (45.5%)
Ethnicity		
Caucasian	33 (73.3%)	47 (85.5%)
Black	7 (15.5%)	2 (36.4%)
Asian	2 (4.4%)	5 (9.1%)
Mixed	2 (4.4%)	1 (1.8%)
Relationship/marital status		
Single	24 (53.3%)	24 (43.6%)
Current partner	10 (22.2%)	12 (21.8%)
Married	3 (6.6%)	7 (12.7%)
Divorced	6 (13.3%)	10 (18.2%)
Separated	1 (2.2%)	2 (3.6%)
Widowed	1 (2.2%)	–

prisoners, 55 (50 men, 5 women) in the control group, and 45 (43 men, 2 women) in the yoga group.

Participants in the yoga and control groups were closely matched in age ($t[98] = -0.776$, $p = 0.44$). Chi-square testing showed that the groups contained similar proportions of individuals of who had had attained educational qualifications of at least GCSEs (General Certificate of Secondary Education) or O-Levels, the main qualifications taken by 14–16 year olds in the UK, $\chi s(1) < 1.35$. Participants in the yoga and control groups also contained similar proportions of Caucasian and non-Caucasian participants, $\chi s(1) < 1.73$ (one participant declined to provide information about ethnicity). The groups also had a similar proportion of smokers, $\chi(1) < 0.001$, $p = 0.984$. Finally, groups contained similar proportions of participants who were currently single, as opposed to those who were married or had a current partner, $\chi(1) < 1$. (See also Table 1).

A subset of 77 participants (26 in the yoga group, and 51 in the control group) provided records of the average time spent per week exercising. The average time that participants in the yoga group spent practising yoga (outside of class) did not differ significantly when compared to the time spent by the control group doing other forms of exercise (167.1 ± 48.4 min vs. 241.76 ± 27.0 min, respectively), $t(75) = -1.46$, $p = 0.15$.

4.2. Questionnaire measures

Participation in the yoga course significantly influenced positive affect as measured by the PANAS, $F(1,86) = 5.26$, $p = 0.024$. Exploration of simple effects demonstrated that participants did not differ in positive affect at baseline, $F(1,86) < 1$, but at Time 2 the yoga group reported significantly higher positive affect than the control group, $F(1,86) = 6.33$, $p = 0.014$. This difference was primarily driven by an increase in positive affect in the yoga group, which was marginally significant, $F(1,38) = 3.68$, $p = 0.062$. In contrast, positive affect did not change significantly for the Control group between these time points, $F(1,48) = 1.73$, $p = 0.20$ (see Fig. 3 and Supplementary Table S1). There were no significant changes in negative affect between Time 1 and Time 2 in the yoga group relative to the control group, $F(1,86) < 1$ (Supplementary Table S1).

The groups did not differ in terms of self-reported perceived stress or psychological distress at Time 1, $Fs(1,86) < 1$. Participation in the yoga course was, however, associated with improvements in both these measures from pre- to post-intervention, when compared to the control group, $F(1,86) = 4.31$, $p = 0.041$ and $F(1,86) = 4.48$, $p = 0.037$, respectively (see Fig. 3). The yoga group showed a significant decrease in perceived stress at Time 2 compared to Time 1, $F(1,38) = 18.02$, $p < 0.001$, and a similar decrease in psychological distress, $F(1,38) = 7.78$, $p = 0.008$. In contrast, the Control group reported similar levels of psychological distress at Time 1 and Time 2, $F(1,48) < 1$, although perceived stress decreased significantly between Time 1 and Time 2, $F(1,48) = 4.35$, $p = 0.042$.

4.3. Cognitive-behavioural task

A subset of 93 participants completed the Go/No-Go task (10 participants [6 yoga participants, 4 control participants] did not complete the cognitive task due to technical malfunctions). Of those remaining, 39 (37 male, 2 female) had participated in the yoga course and 51 (46 male, 5 female) were in the control group. Participants remained matched in terms of demographics and trait measures, including trait impulsivity as measured with the BIS-11, $t(88) = -1.21$, $p = 0.232$.

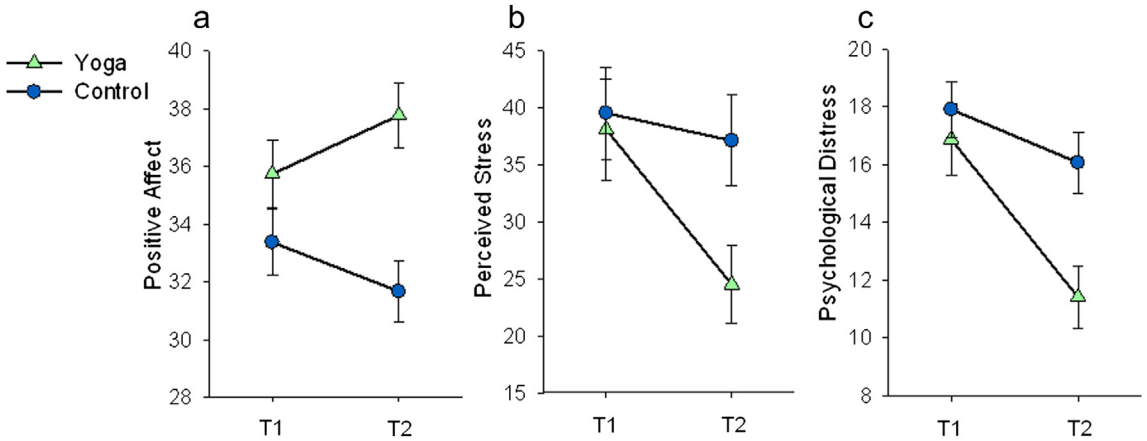

Fig. 3. Average ratings of Positive affect using the PANAS (a, left), perceived stress using the Perceived Stress Scale (b, centre) and psychological distress using the Brief Symptom Inventory (c, right), for 100 prisoner participants who either did (yoga group, green triangles, $N = 45$) or did not (control group, blue circles, $N = 55$) participate in a 10-week yoga course. Error bars: ±1 standard error of the mean. T1 = Time 1, or baseline. T2 = Time 2, or +10 weeks. The interaction between yoga and time (T1 vs. T2) was significant for each measure: (a) $F(1,86) = 5.26$, $p = 0.024$, (b) $F(1,86) = 4.31$, $p = 0.041$ and (c) $F(1,86) = 4.48$, $p = 0.037$.

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Participants who completed the yoga course showed a significantly higher proportion of correct responses, $F(1,76) = 5.43$, $p = 0.022$ (see Fig. 4). Simple univariate tests showed that participants in the yoga group were more likely to make correct button-responses in Go trials, $F(1,76) = 5.98$, $p = 0.017$, and more often correctly inhibited their responses in No-Go trials at a marginally significant level, $F(1,76) = 2.97$, $p = 0.089$. (see Supplementary Table S2).

Across all prisoners, and as expected from previous literature (de Bruijn et al., 2008) there was a strong main effect of trial type, $F(1,76) = 68.91$, $p < 0.001$, such that participants made more errors of commission (incorrectly pressing the spacebar) on No-Go trials than errors of omission (failing to press the spacebar) on Go trials (Fig. 4).

Reaction times for the yoga and control groups did not differ when either comparing speed to correct response on Go trials (in milliseconds: 379.90 ± 8.59 vs. 379.94 ± 7.99, respectively), $F(1,76) < 1$, or incorrect response on No-Go trials, (294.64 ± 6.48 vs. 303.00 ± 8.02, respectively) $F(1,70) = 1.90$, $p = 0.17$. (Six participants [4 control, 2 yoga] made no errors on any No-Go trials). As expected, and overall, incorrect responses in No-Go trials were made quicker than correct responses on Go trials (299.70 ± 5.07 vs. 379.85 ± 5.75), $F(1,70) = 121.79$, $p < 0.001$. Also as expected, reaction times for post-error trials (428.29 ± 9.64) were significantly slower than for post-correct trials (377.09 ± 5.40), $F(1,62) = 30.11$, $p < 0.001$. However, this effect of post-error slowing did not differ between participants who did or did not complete the yoga course, $F(1,62) < 1$.

5. Discussion

The results of this study are the first evidence for the benefits of yoga in a large, predominantly male, prison population using a randomised, between-groups design, and drawing on self-report as well as behavioural data. Overall, we found that prisoners who were randomly assigned to attend a ten-week yoga intervention reported improved mood, reduced stress, and reduced psychological distress, when compared with a control group of prisoners. Furthermore, participants in the yoga group demonstrated improved performance in a cognitive-behavioural task compared to the control group. Together, these results suggest that yoga has beneficial effects on subjective wellbeing and mental health, as well as enhancing cognitive-behavioural functioning.

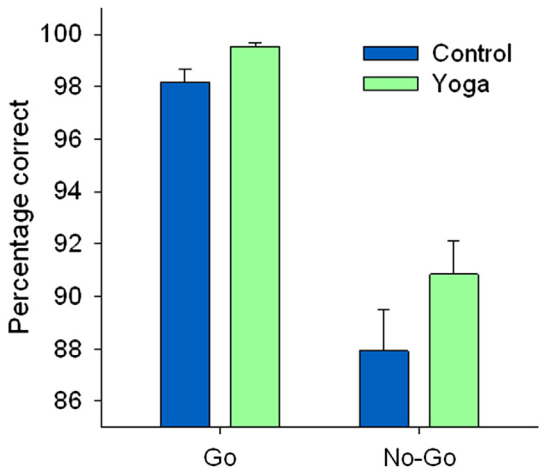

Fig. 4. Accuracy in the Go/No-Go task. Average percentage of correct responses for Go and No-Go trials for 90 prisoner participants who either did (yoga group, green bars, $N = 39$) or did not (control group, blue bars, $N = 51$) participate in a 10-week yoga course. Error bars: +1 standard error of the mean. Between-group differences for Go trials: $F(1,76) = 5.98$, $p = 0.017$, and for No-Go trials: $F(1,76) = 2.97$, $p = 0.089$.

The evidence is particularly compelling given the improved performance by the yoga group in a cognitive-behavioural task. Compared to the control group, prisoners who practised yoga demonstrated significantly greater accuracy during Go trials (i.e. correct button-presses to the 'x' stimulus). Go trials engage simple stimulus–response functions (requiring the participant to press a button when a stimulus is presented), and the improved performance on these trials suggests that yoga practice may enhance basic processes of sustained attention and concentration. Also, performance in the yoga group was enhanced on No-Go trials (i.e. correct inhibition of the button press response to the 'o' trials). The improved performance on No-Go trials suggests that practising yoga helps prisoners inhibit unhelpful responses and increases their capacity for cognitive control (Band and van Boxtel, 1999).

Importantly, differences in self-report scales and performance in the Go/No-Go task could not be accounted for by group differences in age or trait impulsivity as measured with the BIS-11. Both groups were also matched at baseline (T1) for levels of positive and negative affect, perceived stress, and psychological distress. This suggests that between-group changes in self-report and behavioural changes measured after the 10-week intervention period (T2) are specifically associated with participation in the yoga course.

The present results have particular relevance for prisons. If yoga practice is associated with behavioural inhibition, this is likely to have implications for the regulation of disinhibited and problematic behaviours, including reactive aggression and substance abuse. Indeed, previous literature has linked general antisociality with impairments in cognitive control (Morgan and Lilienfeld, 2000; Ogilvie et al., 2011) and altered – potentially less effective – patterns of neurocognitive recruitment in certain experimental tasks (Gao and Raine, 2009). Antisocial behaviour is common in incarcerated samples and it is therefore possible that, by facilitating cognitive-behavioural control, yoga practice may lead to improved deployment of neural processing and, eventually, reductions in the frequency or severity of antisocial acts. In sum, our results suggest that yoga may have benefits on multiple aspects of cognitive control, which are associated with indices of antisocial and criminogenic behaviour.

The findings also have implications for policy making. Thus far, research and policy surrounding mental health interventions in prisons has largely focused on psychological and psychosocial treatments. However, interventions provided by psychologists and psychiatrists are costly, and psychosocial treatments in prison are commonly found to be inaccessible, stigmatizing, and undesirable because of their time-consuming and emotionally demanding nature (Marlatt and Witkiewitz, 2002). It is possible that behavioural oriented interventions, like yoga, may offer a more socially acceptable and cost-effective alternative, or can be used as a complement to other rehabilitation programmes.

5.1. Strengths and limitations

Our findings are consistent with the past literature documenting the beneficial effects of yoga on emotional and psychological wellbeing in healthy volunteers (Granath et al., 2006; Hartfiel et al., 2011; Kirkwood et al., 2005; Rocha et al., 2012; Shapiro and Cline, 2008; Smith et al., 2007) and in clinical samples (Banerjee et al., 2007; Michalsen et al., 2005; Moadel et al., 2007; Sharma and Haider; Streeter et al., 2010; Vadiraja and Raghavendra, 2009; Woolery et al., 2004). Our results also corroborate the very few studies conducted in prisons, where yoga practice has been

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associated with improvements in psychological symptoms of depression and anxiety (Harner et al., 2010), as well as improved sleep, mood, and social behaviour (Bhusan, 1998). Given the methodological limitations of past research, including the lack of a control group, the non-randomization of participants, small sample sizes, and reliance on self-report data only (Birdee et al., 2009; Tsang et al., 2008), our study represents a significant step towards understanding the effects of yoga in a prison setting.

Other strengths of this study include the recruitment from a number of prisons, including category B and category C prisons, young offender institutions, and one female prison; correspondingly our sample of participants is diverse, and includes individuals with a range of backgrounds and convicted of a range of offences and of differing severity. Our results are therefore likely to be generalizable to the larger population of British prisoners. However, due to various legal limitations pertaining to this sample and the context in which the data was collected, it was not possible to gather individual information on the nature of offence or the length of sentence of participants, or to test stress levels using a biological indicator (salivary cortisol). We were also not allowed to recruit from, or test the effects of yoga in, category A prisons (with prisoners who are considered to be highly dangerous to the public or a threat to national security). These limitations should be addressed in future studies, potentially conducted in environments allowing easier access to prisoner data and the collection of biological samples.

Another important question, which remains unanswered, concerns the pinning down of the specific elements of yoga practice – asanas (or poses), breathing techniques, and meditation – that give rise to the particular benefits observed in studies such as this one. Although we showed that yoga is beneficial at a holistic level, we could not ascertain the individual contribution of each of these elements towards wellbeing and cognitive functioning. Future studies specifically designed to tease out the contributing effects of yoga's various elements should shed more light on this matter. There are other potential limitations in the study: firstly, there may have been nonspecific effects of the yoga intervention, such as receiving attention from teachers or the social effects of practicing yoga as part of a group, which potentially contributed towards the observed effects. As no data on the amount of non-yoga related exercise was collected for those in the yoga group, we cannot discount the possibility that participants in the experimental group overall spent more time doing a combination of yoga and other physical exercise than the control group. If this happened, there is a chance that changes in mood and cognitive performance may, in part, have been caused by increased levels of overall physical activity. Finally, we asked participants to complete the Go/No-Go task only at Time 2 (post-intervention) in order to avoid potentially large practice-effects; however, this means we were unable to test for changes in performance associated with participation in the yoga course.

In sum, we found evidence that yoga significantly improves measures of prisoners' mood and psychological wellbeing, as well as facilitating cognitive processes relating to sustained attention and behavioural inhibition. These changes are indicative of the potential for yoga to influence affect and behavioural regulation in a prison setting.

Contributors

AB and MF designed the study and wrote the protocol. SJ and CW conducted data collection. All authors contributed to the data analysis, which was managed by AB. AB and MF wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Role of funding source

The funders had no role in study design, data collection, data analysis, decision to publish, or preparation of the manuscript.

Conflict of interests

The authors have no competing interests to declare.

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Appendix A. Supplementary material

Supplementary material associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jpsychires.2013.06.014.

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