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Mood changes after cognitive testing in late middle-age: impacts of sex and habitual alcohol consumption

Sarah Elsabagh[a,b,*], David Hartley[a], Delia Randall[a,c], Pallab Seth[a], Sandra E. File[a]

[a]*Psychopharmacology Research Unit, Centre for Neuroscience, King's College London, Hodgkin Building, Guy's Campus, London SE1 1UL, UK*
[b]*Centre for Pharmacognosy and Phytotherapy, The School of Pharmacy, Brunswick Square,, London, UK*
[c]*Respiratory Support and Sleep Centre, Papworth Hospital, Cambridge, UK*

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Abstract

Men and women (50–67 years) completed drinking diaries and, on the basis of this, were divided into low (<2 units/day, 1 UK unit = 8 g alcohol) and moderate (2–5 units/day) alcohol groups. They completed analogue rating scales of mood and bodily symptoms before and after two extended computerised cognitive tests. After the tests, the women showed significantly greater increases in self-ratings on the factors of anxiety and discontentment and felt significantly less alert than did the men. They also showed significantly greater increases in bodily symptoms of somatic anxiety and ratings of aggressive mood than did the men. There were no significant effects of alcohol or Sex × Alcohol interactions on the self-ratings, but the men showed significant positive correlations of alcohol and negative mood. On both the cognitive tests, there were significant Sex × Alcohol interactions because the moderate-drinking men performed worse than the low-drinking men, whereas the moderate-drinking women performed better than the low-drinking women. Thus, the middle-aged women responded much more than did the men with negative mood changes to the psychological stress of cognitive testing, although their cognitive performance was not worse.

Keywords: Alcohol; Anxiety; Fatigue; Aggression; Sex differences; Memory; Mental flexibility

1. Introduction

It is well known that there is a much higher incidence of anxiety and depressive disorders in women than in men (Gater et al., 1998). An age of onset analysis showed that this sex difference begins in early adolescence and persists through to the mid-50s. However, over the age of 55, the prevalence of symptoms, apart from fatigue and sleep problems, was found to be equal in British men and women or higher in men (Bebbington et al., 1998). The change in sex ratio after age 55 is because of a reduction in female prevalence rather than an increase in male prevalence. These findings remained when social variables, such as employment, marital status and presence of children in the home, are controlled for. In a recent Australian survey, the prevalence of major depressive disorder declined sharply in men aged 55 and over and in women aged 65 and over (Wilhelm et al., 2003). Thus, in late middle-age there seems to be a decrease in the incidence of depression and a reduction in the sex differences in incidence.

However, there seems to be much less evidence concerning sex differences in mood in nonclinical populations. Previous studies have found cognitive testing to increase ratings of anxiety, discontentment and aggression in young men and women (File et al., 2001, 2002a; Randall et al., 2003), in middle-aged men and women (Randall et al., 2004a) and in postmenopausal women (File et al., 2002b; Hartley et al., 2003). However, it is not known whether there are sex differences in these mood changes in older men and women, who have lower levels of circulating sex steroids (Lamberts et al., 1997).

* Corresponding author. Psychopharmacology Research Unit, Centre for Neuroscience, King's College London, Hodgkin Building, Guy's Campus, London SE1 1UL, UK. Tel.: +44-20-7848-6663; fax: +44-20-7848-6660.
E-mail address: Sarah.M.Elsabagh@kcl.ac.uk (S. Elsabagh).

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There are reports in the literature that habitual moderate alcohol consumption is associated with psychological benefits, such as mood enhancement and stress reduction (for review, see Peele and Brodsky, 2000). Randall et al. (2004b) found that student teetotalers responded with more adverse mood changes than did light or moderate drinkers to the stress of cognitive testing. Hence, a second interest was to determine whether there was an impact of habitual alcohol consumption in response to stress in older adults. The purpose of the present study was, therefore, to explore whether there were sex differences in mood changes in response to the stress of exposure to cognitive testing in a group of late middle-aged healthy volunteers with differing levels of alcohol consumption.

There is considerable evidence for age-related deficits in cognition when the performance of young and middle-aged groups is compared (Raffaele et al., 1992; Craik et al., 1995; Salthouse et al., 1997; File et al., 1999). There is some evidence that in older populations, there is a greater decline in cognitive function with age in men than in women (Wiederholt et al., 1993; van Exel et al., 2001). In addition, in late middle-age there is some evidence that moderate habitual alcohol consumption has greater beneficial effects in women than in men on a wide range of cognitive tasks (Dufouil et al., 1997; Elias et al., 1999). As the main aim of the present study was to determine the mood changes in response to the stress of cognitive testing, we selected two lengthy and demanding computerised cognitive tasks. We also determined whether there were effects of alcohol consumption and sex on the performance on these two cognitive tasks.

2. Methods

2.1. Participants

Forty-five late middle-aged participants (aged 50–67 years, 20 men and 25 women) volunteered for studies of cognitive function. Participants were excluded if they were taking any form of psychoactive medication. They were recruited via circular email and press advertisement and were given up to £10 as reimbursement for their travel expenses. The studies were approved by King's College London ethics committee. Prior to the testing session, all participants were given a practice session to familiarise themselves with the computerised test battery. An estimate of verbal IQ was taken using the National Adult Reading Test-Revised version (NART-R, Nelson and Willison, 1991). The Hospital Anxiety and Depression Scale (HAD; Zigmond and Snaith, 1983) was used to determine habitual levels of anxiety and depression. The participants also completed a drinking diary of their daily alcohol consumption for the previous week and for a typical week. On this basis, they were divided into low (<2 units/day, 12 men, 17 women) and moderate drinkers (2–5 units/day, 8 men, 8 women), following the classification used in the Epidemiology of Vascular Aging Study (Dufouil et al., 1997). All of the women were postmenopausal, as defined by at least 1 year since their last period. None was taking any form of hormone replacement therapy.

2.2. Mood

Self-ratings of mood (Bond and Lader, 1974, 1986) and bodily symptoms of somatic anxiety (Tyrer, 1976) were taken prior to and straight after the cognitive testing session. The mood and aggression scales consisted of opposed adjectives denoting extremes of mood at opposite ends of a 100-mm horizontal line. For the bodily symptoms scale, each item went from *no symptoms* to *very severe symptoms*, separated by a 100-mm line. The participants were instructed to place a perpendicular mark at the appropriate place on each line to indicate how they were feeling at that time.

2.3. Tests of cognitive function

Two computerised tests were used from the Cambridge Neuropsychological Test Automated Battery (CANTAB; CeNeS, Cambridge). The delayed matching-to-sample (DMTS) task is a measure of nonverbal short-term memory. The participants are presented with a sample pattern to remember. They are then presented with a choice of four patterns, which appear either simultaneously on the screen with the sample pattern or after a delay of 0, 4 or 12 s. The participants are required to touch the pattern that matched the sample pattern. The latencies to make a

Table 1
Mean ± S.E.M. age (years), estimated IQ, caffeine intake (cups/day), anxiety and depression scores on the hospital anxiety and depression scale (HAD_A and HAD_D) and units of alcohol consumed in a typical week and last week by middle-aged men and women with low- and moderate-drinking habits

	Men		Women	
	Low alcohol	Moderate alcohol	Low alcohol	Moderate alcohol
Age	58.7 ± 1.2	59.1 ± 2.1	58.1 ± 0.9	58.3 ± 1.4
IQ	115.8 ± 2.2	119.9 ± 2.8	116.1 ± 1.8	115.3 ± 4.1
Caffeine intake (cups/day)	3.4 ± 0.7	4.4 ± 0.9	5.2 ± 0.6	5.1 ± 0.8
HAD_A	3.9 ± 0.7	3.3 ± 0.5	5.1 ± 1.1	6.0 ± 1.0
HAD_D	2.2 ± 0.4	1.7 ± 0.5	2.4 ± 0.4	3.1 ± 0.8
HAD_{Total}[a]	6.1 ± 0.9	5.0 ± 1.4	7.5 ± 2.5	9.1 ± 2.6
Alcohol typical (units/week)	6.9 ± 1.3	20.8 ± 2.6[†]	4.0 ± 1.3	22.8 ± 0.9[†]
Alcohol units last week	6.5 ± 1.3	18.6 ± 3.6[†]	3.4 ± 1.3	15.3 ± 3.7[†]

[a] Significant sex difference, see text for details.
[†] Significant difference between alcohol groups.

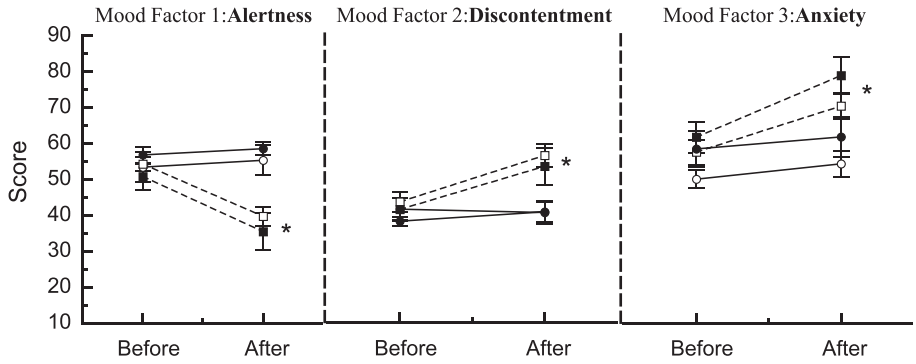

Fig. 1. Mean (± S.E.M.) self-ratings on mood factors extracted from the Bond and Lader Mood Scale by low and moderate-alcohol drinking men and women, before and after cognitive testing. * Significant Sex × Time interactions for all factors, see text for details. Men, low alcohol: -○-; men, moderate alcohol: -●-; women, low alcohol: –□–; and women, moderate alcohol: –■–.

correct response and the percent correct responses were recorded. The IDED task is a test of mental flexibility, in which the participant is required to learn rule reversals and an intra- or extradimensional shift. This test has been shown to activate the frontal cortex (Owen et al., 1991). The number of stages completed correctly, the number of errors made up to the extradimensional shift (EDS) stage and the number of errors made in the EDS stage were recorded.

2.4. Statistics

The three mood factors of 'alertness', 'anxiety' and 'discontentment' extracted from the mood rating scale (Bond and Lader, 1974), and the individual ratings of aggressive mood and bodily symptoms were analysed by three-way analyses of variance (ANOVAs), with sex and alcohol intake as the between-group factors and time being the repeated measures factor. The data for the cognitive tests were analysed by two-way ANOVAs, with sex as one factor and alcohol the second. As a subsidiary analysis, they were also analysed by analyses of covariance using IQ as a covariate. Both F values and probability levels are quoted where $P \geq .10$. Where results failed to reach this level of significance, only the F values are stated and nonsignificance is indicated (n.s.). To determine whether there was any relationship between typical weekly alcohol intake and mood, Pearson Product–Moment Correlation Coefficients were calculated. The statistical package used was SPSS version 10.1 for Windows.

3. Results

3.1. Demographic characteristics

Table 1 shows that the four groups did not differ significantly in age or estimated verbal IQ ($F < 1.0$ in all cases, n.s.). There was a tendency for the women to have a higher caffeine intake, but this did not reach significance [$F(1,41) = 2.7$, n.s.]. The women had higher habitual anxiety scores, as measured on the HAD scale, than the males did, although this just missed significance [$F(1,41) = 3.5$, $P = .07$]. There were no significant differences in the HAD depression scores ($F < 2.3$, n.s.). However, the women did have higher total scores on the HAD scale [$F(1,41) = 4.2$, $P < .05$].

3.2. Alcohol consumption

The groups were divided into low- and moderate-alcohol groups on the basis of average units per week. Not surpris-

Table 2
Mean (± S.E.M.) ratings of aggressive mood before and after cognitive testing

	Low alcohol				Moderate alcohol			
	Men		Women		Men		Women	
	Before testing	After testing	Before testing	After testing	Before testing	After testing	Before testing	After testing
Quarrelsome[a]	11.5 ± 3.1	14.3 ± 3.8	8.7 ± 2.6	23.4 ± 4.7	14.6 ± 5.9	24.2 ± 8.9	12.4 ± 4.8	22.5 ± 4.9
Furious[a]	13.0 ± 2.8	16.8 ± 4.0	21.1 ± 5.6	31.4 ± 3.8	16.1 ± 5.9	20.9 ± 6.4	13.2 ± 4.0	39.1 ± 9.1
Unsociable[a]	14.2 ± 3.8	15.5 ± 4.0	9.9 ± 2.8	21.4 ± 4.4	11.2 ± 2.7	15.7 ± 3.9	11.6 ± 4.0	13.0 ± 2.6
Aggressive[a]	12.2 ± 3.1	18.2 ± 4.9	22.0 ± 5.8	28.1 ± 3.9	18.0 ± 6.9	19.2 ± 3.9	14.2 ± 3.0	32.1 ± 6.1
Belligerent	17.9 ± 4.2	15.0 ± 3.6	24.9 ± 7.2	26.7 ± 3.4	24.7 ± 7.5	24.9 ± 6.7	24.7 ± 9.8	33.1 ± 9.0
Hostile	12.9 ± 3.5	13.2 ± 3.8	9.4 ± 1.6	15.7 ± 3.2	10.6 ± 2.3	11.4 ± 3.8	13.2 ± 4.5	16.6 ± 2.7
Spiteful	11.2 ± 3.3	12.0 ± 2.7	15.4 ± 3.6	21.1 ± 3.6	18.4 ± 6.3	14.0 ± 4.7	11.3 ± 3.0	15.2 ± 2.9

[a] Significant effect of time, see text for details.

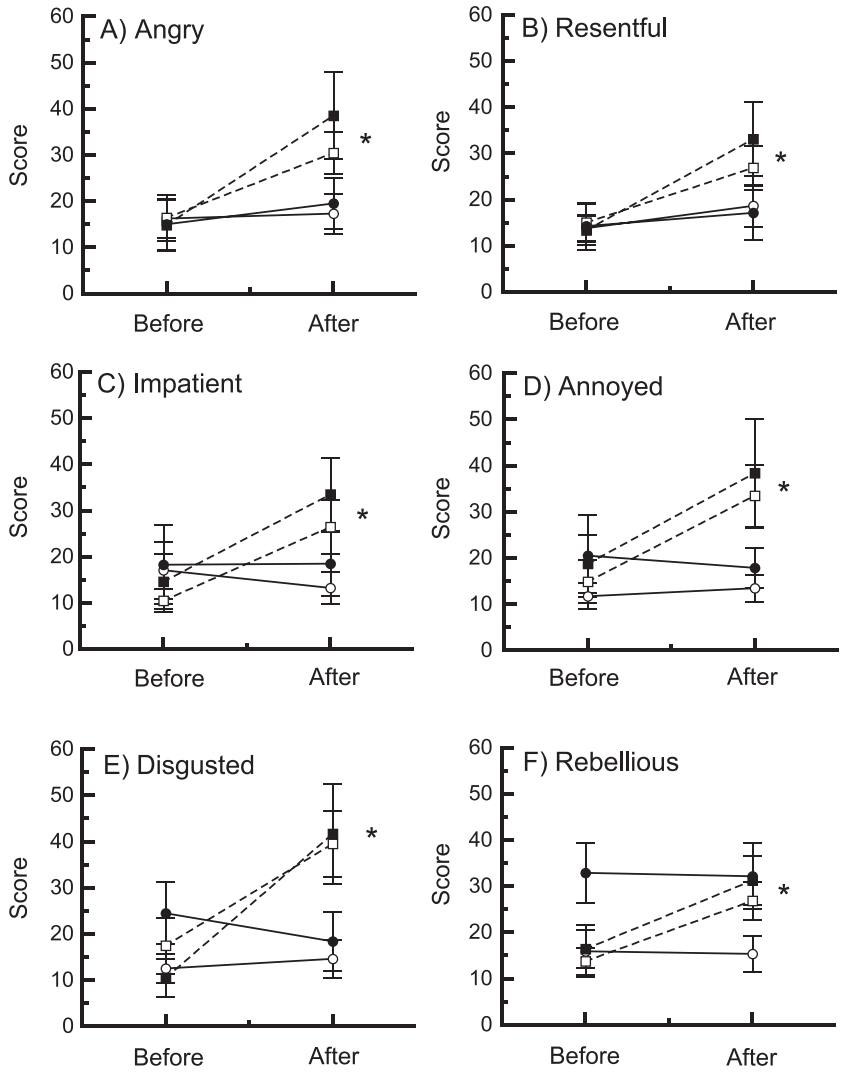

Fig. 2. Mean (± S.E.M.) self-ratings of aggressive mood by low and moderate-alcohol drinking men and women, before and after cognitive testing. * Significant Sex × Time interaction, see text for details. Men, low alcohol: -○-; men, moderate alcohol: -●-; women, low alcohol: –□–; and women, moderate alcohol –■–.

ingly, they also differed in their total alcohol consumption the previous week [$F(1,41)=28.5$, $P<.0001$] and their typical alcohol consumption [$F(1,41)=100.3$, $P<.0001$]. However, there were no sex differences or Sex × Alcohol interactions ($F<2.3$ in all cases, n.s.; see Table 1).

3.3. Mood ratings

3.3.1. Bond and Lader mood factors

Three independent factors can be extracted from the Bond and Lader (1974) mood rating scales. There were no significant differences between the groups in their scores before cognitive testing. However, overall, participants felt significantly less alert, more discontented and more anxious after the cognitive testing [$F(1,41)=12.6$, 12.3 and 18.2, respectively, $P<.001$ in all cases]. There were no Time × Alcohol or Time × Sex × Alcohol interactions ($F<1.0$ in all cases). However, there were significant Time × Sex interactions because the women became less alert, more discontented and more anxious than did the men as a result of the cognitive tests [$F(1,41)=20.9$, $P<.001$; 9.5, $P<.005$; 6.4, $P<.02$, respectively; see Fig. 1]. For the men, there were positive correlations between typical alcohol intake and negative mood states (anxiety: pretesting $r=.52$, $P<.02$ and posttesting $r=.66$, $P=.001$; discontentment: pretesting $r=.55$, $P<.02$ and posttesting $r=.53$, $P<.02$). A similar pattern was seen in the female moderate-alcohol group (anxiety: pretesting $r=.28$ and posttesting $r=.38$; discontentment: pretesting $r=.002$ and posttesting $r=.73$). However, the completely opposite pattern was seen in the low-alcohol females, with increased alcohol associated with decreases in anxiety and discontentment (anxiety: pretesting $r=-.42$ and posttesting $r=-.41$; discontentment: pretesting $r=-.23$ and posttesting $r=-.34$).

Table 3
Mean (± S.E.M.) ratings of bodily symptoms of somatic anxiety before and after cognitive testing

	Low alcohol				Moderate alcohol			
	Men		Women		Men		Women	
	Before testing	After testing	Before testing	After testing	Before testing	After testing	Before testing	After testing
Sweating	8.7 ± 1.7	15.0 ± 3.2	10.1 ± 3.2	19.1 ± 5.6	19.9 ± 8.7	19.3 ± 6.6	18.6 ± 6.9	20.5 ± 5.9
Palpitations	13.5 ± 3.5	14.9 ± 3.5	13.1 ± 4.4	21.5 ± 5.8	16.6 ± 6.3	15.5 ± 6.2	20.0 ± 6.3	25.2 ± 6.9
Nausea	11.3 ± 3.0	12.6 ± 3.3	5.3 ± 1.3	8.0 ± 3.0	6.8 ± 2.3	6.5 ± 2.1	9.1 ± 2.5	8.3 ± 1.5
Loss of appetite	9.9 ± 2.9	12.9 ± 3.5	9.7 ± 3.1	16.7 ± 6.3	13.1 ± 7.5	10.9 ± 4.0	8.5 ± 2.6	8.9 ± 1.4
Restlessness[a]	11.2 ± 2.9	14.1 ± 3.8	12.4 ± 4.1	22.6 ± 5.8	18.0 ± 7.7	17.0 ± 5.7	16.3 ± 5.8	14.5 ± 3.3
Dryness of mouth	13.5 ± 3.3	15.9 ± 4.4	8.8 ± 1.7	20.3 ± 5.9	17.0 ± 7.2	16.1 ± 7.7	19.1 ± 8.4	18.5 ± 5.2
Muscular tension[b]	12.6 ± 2.8	19.3 ± 4.4	17.5 ± 4.2	26.9 ± 6.9	13.0 ± 5.6	23.1 ± 7.6	13.1 ± 3.2	19.1 ± 6.6
Headache	21.3 ± 5.3	22.6 ± 6.0	11.1 ± 4.4	18.9 ± 6.6	7.1 ± 1.7	6.4 ± 2.1	13.6 ± 5.4	16.7 ± 9.3
Dizziness	10.1 ± 2.3	14.8 ± 4.2	5.6 ± 2.2	12.5 ± 5.0	7.0 ± 2.3	6.8 ± 1.9	8.9 ± 2.1	8.8 ± 1.5
Stomach trouble	12.0 ± 2.8	13.5 ± 3.7	4.7 ± 1.3	9.1 ± 3.0	7.9 ± 2.2	6.1 ± 2.2	9.2 ± 2.4	8.9 ± 1.5

[a] Significant Time × Alcohol interaction, see text for details.
[b] Significant effect of time, see text for details.

3.3.2. Aggressive mood

There were no significant group differences in the scores before cognitive testing. After cognitive testing, there were significant increases in ratings of feeling quarrelsome, furious, unsociable and aggressive [$F(1,41) = 16.4$, $P < .001$; 9.4, $P < .005$; 4.1, $P < .05$; 6.2, $P < .02$, respectively]. There were no significant Time × Alcohol, Sex × Alcohol or Time × Sex × Alcohol interactions in these ratings ($F < 2.1$; n.s. in all cases; see Table 2).

After cognitive testing, people felt more angry, resentful, impatient, annoyed, disgusted and rebellious [$F(1,41) = 13.8$, $P < .001$; 16.7, $P < .001$; 6.2, $P < .02$; 5.0, $P < .04$; 6.4, $P < .02$, respectively]. However, there were also significant Sex × Time interactions for these six ratings because in all cases, the increases were more marked in the women than in the men [$F(1,41) = 7.6$, $P < .009$; 6.2, $P < .02$; 9.3, $P < .005$; 5.5, $P < .0.03$; 11.5, $P < .005$; 7.7, $P < .01$, respectively; see Fig. 2]. There were no Alcohol × Time or Alcohol × Sex × Time interactions for these ratings ($F < 1.2$; n.s. in all cases).

3.3.3. Bodily symptoms of somatic anxiety

There were no significant group differences in bodily symptoms before cognitive testing, except for the rating of sweating, for which the moderate-alcohol groups had higher ratings than did the low-alcohol groups [$F(1,41) = 4.0$, $P = .05$;

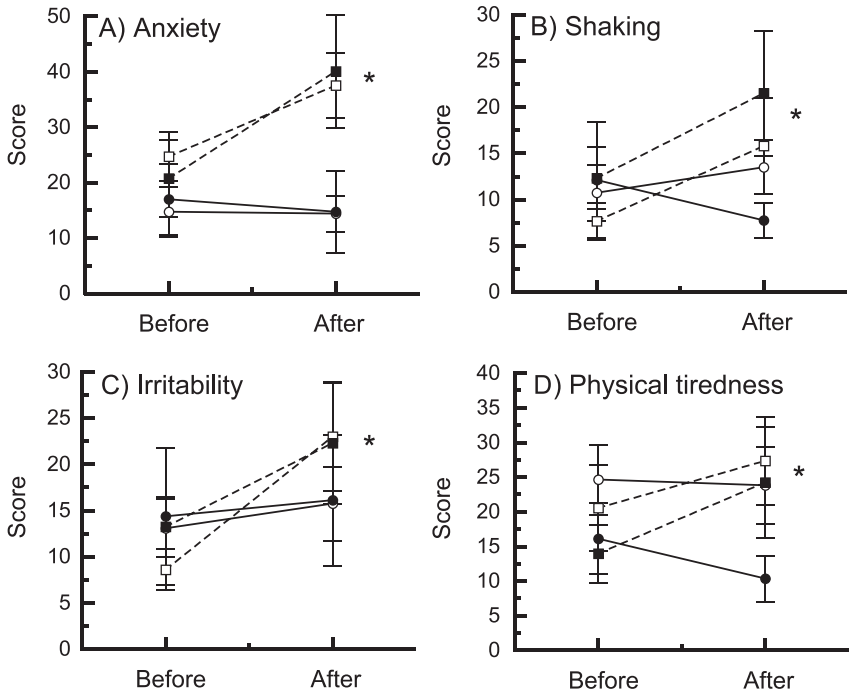

Fig. 3. Mean (± S.E.M.) self-ratings of bodily symptoms of somatic anxiety by low and moderate-alcohol drinking men and women, before and after cognitive testing. * Significant Sex × Time interaction, see text for details. Men, low alcohol: -○-; men, moderate alcohol: -●-; women, low alcohol: –□–; and women, moderate alcohol: –■–.

Table 4
Mean ± S.E.M. percent correct responses and latency (ms) to make correct responses in the DMTS task and number of stages completed, errors up to the final, extradimensional shift (pre-EDS errors) stage and errors in the EDS stage in the test of mental flexibility (IDED)

	Men		Women	
	Low alcohol	Moderate alcohol	Low alcohol	Moderate alcohol
DMTS				
% Correct *	86.0 ± 2.4	79.3 ± 2.6	80.0 ± 4.3	86.0 ± 3.2
Latency to make correct responses	4209.0 ± 354.3	3978.0 ± 460.5	3633.9 ± 315.5	3597.4 ± 265.8
IDED				
Stages completed	8.7 ± 0.2	8.8 ± 0.3	8.1 ± 0.3	8.3 ± 0.8
Pre-EDS errors *	6.3 ± 0.6	13.4 ± 2.4	12.5 ± 3.1	9.1 ± 2.8
EDS errors	11.3 ± 3.3	8.9 ± 3.8	11.2 ± 2.8	6.1 ± 2.3

* $P < .05$ Sex × Alcohol interaction, see text for details.

see Table 3]. After cognitive testing, all the participants had higher ratings of muscular tension [$F(1,41) = 7.9$, $P < .01$], but there were no significant interactions for this measure (see Table 3). After cognitive testing, the participants also had higher ratings of anxiety and irritability [$F(1,41) = 7.5$ and 8.1, respectively, $P < .01$ in both cases]. However, these increases were greater in the women than in the men [Time × Sex $F(1,41) = 10.3$, $P < .005$; 3.8, $P < .06$, respectively; see Fig. 3]. The women also showed significantly greater increases in ratings of shaking and physical tiredness after testing than did the men [Time×Sex $F(1,41)=5.1$, $P<.03$; $F(1,41)=4.6$, $P<.04$, respectively; see Fig. 3]. There was a significant Time × Alcohol interaction for feeling restless, with greater increases after testing in the low-alcohol groups, compared with the moderate-alcohol groups [$F(1,41) = 5.3$, $P < .03$; see Table 3]. There were no other significant effects in the bodily symptoms (see Table 3).

3.4. Cognitive tests

There was a significant Sex × Alcohol interaction on the percentage of correct responses in the DMTS task [$F(1,41) = 4.0$, $P = .05$], with the group of moderate-drinking females and low-drinking males showing better performance than the other two groups (see Table 4). There were no significant effects on the latency to respond in this task (for sex, alcohol and Sex × Alcohol interaction, $F < 1.6$, n.s. in all cases).

There were no significant effects on the number of stages completed in the IDED task (for sex, alcohol and Sex × Alcohol interaction, $F < 1.6$, n.s. in all cases). However, there was a significant Alcohol × Sex interaction for the number of errors made up to the EDS stage, the pre-EDS errors [$F(1,41) = 4.4$, $P < .05$]. Again, this was because the moderate-drinking females and low-drinking males performed better than the other two groups did (see Table 4). There were no significant effects on the errors made in the EDS (for sex, alcohol and Sex × Alcohol interaction, $F < 1.2$, n.s. in all cases; see Table 4).

Analyses of covariance using IQ as the covariate confirmed Alcohol × Sex interactions [DMTS, $F(1,40) = 5.1$, $P < .03$; IDED $F(1,40) = 3.7$, $P=.06$]. This shows that the differences seen in the cognitive tests between the low- and moderate-alcohol groups are independent of IQ.

4. Discussion

In late middle-age, both male and female sex hormones have declined to low levels; yet, despite this, striking sex differences in self-ratings of mood and bodily symptoms were found. These self-ratings were of the current mood state; that is, they measured feelings at the particular time that they were made. There were no evident sex differences in these ratings prior to the cognitive testing. However, it was clear that women responded with far greater mood changes to the cognitive tests than did the men. They felt more anxious on the Bond and Lader Mood Scale and on bodily symptoms relating to somatic anxiety. However, the mood changes were not restricted to anxiety, and they also felt more discontented and aggressive and less alert than did the men. Indeed, the men showed no decrease in feeling alert after the testing, and in a previous study, a group of middle-aged men actually felt more alert after a battery of noncomputerised cognitive tests than they did before (File et al., 1999). This suggests that following cognitive stress, middle-aged women feel worse than do men. We cannot say whether this is also the case following less psychological stressors, but it may be a quite general phenomenon because the women also had higher scores on the HAD scales, which measure ‘how you usually feel’. It has been suggested that although men and women may experience a similar proportion of stressful life events, women seem to be more vulnerable in response to the impact of stress (Sherrill et al., 1997). Certainly, the greater negative mood changes in the women were not the result of poorer performance on the cognitive tests because there were no overall sex effects in these tasks. Interestingly, these very striking sex differences in mood change after cognitive testing were not found in similar studies on young volunteers (File et al., 2001; Randall et al., 2004b). Randall et al. (2004b) found no sex differences on the Bond and Lader mood scales or on the bodily symptoms of somatic anxiety. This suggests that the increased response to psychological stress in women is a

particular feature of this older group, although we cannot say whether it is the result of age, postmenopausal status, or both. There is some evidence that mood disturbances occur in women during the perimenopause due to fluctuating levels of circulating oestrogen (see review by Steiner et al., 2003). Whether this persists after the menopause, when levels of hormones are still declining (Soules et al., 2001; Lamberts et al., 1997), is not well documented. Furthermore, although a decline in sex steroids occurs during middle-age in both sexes, male hormones decline less rapidly than do female hormones (Lamberts et al., 1997), thus, it is possible that the sex differences that we noted in response to stress could have been influenced by differences in hormonal state.

Roberts et al. (1995) found that light drinkers (1–10 units/week) exhibited more psychological well-being than did heavy drinkers (>30 units/week) or abstainers. Although we found no significant differences in mood ratings between our four groups, there were positive correlations between alcohol intake and negative mood states (anxiety and discontentment) for all but the low female drinkers. This adds further evidence to the findings of Roberts et al. (1995) that increasing alcohol consumption is associated with worse mood.

Interestingly, on both the cognitive tests, we found a Sex × Alcohol interaction. Thus, the low-drinking men performed better than the moderate-drinking men did, whereas the reverse was true for the women. Women (mean age 65 years) drinking 2–5 units/day have been found to perform better on a variety of cognitive tests than do nondrinkers (Dufouil et al., 1997), and our findings suggest that this level of alcohol consumption may be associated with better performance than that in very light drinkers. From a review of the literature, Peele and Brodsky (2000) concluded that drinking in moderation (as opposed to either abstaining or drinking heavily) might be beneficial to cognitive functioning. Our results also support the previous findings that moderate alcohol consumption may be of greater benefit in older women than in men (Dufouil et al., 1997; Elias et al., 1999). These results are perhaps surprising in that the levels of drinking in the moderate group were the same for men and women, whereas the UK government recommends a lower intake for women. The same pattern, i.e., similar levels of alcohol consumption in men and women, was also reported in a recent U.S. study (Elias et al., 1999).

Although we only used two tests, we found no evidence within the age range of 50–67 that there was any worse performance in men compared with women. In a study with a much larger age range (55–94 years), there was a significantly greater age-related decline in men than in women on a selective reminding test, the delayed recall part of the visual reproduction test and on the blessed information memory concentration scale (Wiederholt et al., 1993). However, the decline was more apparent within the more advanced age groups and not within the 55–64 age range. Kaufman et al. (1991) reported no sex differences in the decline in performance on the Wechsler Adult Intelligence Scale across the age range of 20–74 years, but another study found performance in males to decline more rapidly than in females on measures of cognitive speed and memory in a group of 85-year-olds (van Exel et al., 2001). Therefore, it is possible that sex differences in cognitive decline emerge only in old age. Furthermore, it is possible that the tests of nonverbal memory and mental flexibility that were used in the present study are not sensitive to sex differences. It is well documented that females outperform males on tests of verbal episodic memory (Lewin et al., 2001; Yonker et al., 2003), but the evidence for sex differences on nonverbal episodic memory tasks is less robust (Lewin et al., 2001). In the case of tasks that measure mental flexibility, sex differences in performance are inconsistent. Women were found to perform better than men on the Wisconsin Card Sorting Test, which is similar with the IDED task, in a group of 45- to 83-year-olds (Boone et al., 1993). However, the reverse was found for performance on the Iowa Card Task, where a male superiority persisted until late middle-age (Reavis and Overman, 2001).

In summary, the women in this study had higher total HAD scores and responded with more adverse mood changes to the stress of cognitive testing than age- and IQ-matched men. There was some evidence that increased habitual alcohol consumption was associated with negative mood state for men, and for women in the moderate alcohol group. However, moderate, as opposed to low, alcohol consumption was associated with better cognitive performance in women, whereas the reverse was true for men.

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References

Bebbington PE, Dunn G, Jenkins R, Lewis G, Brugha T, Farrell M, et al. The influence of age and sex on the prevalence of depressive conditions: report from the National Survey of Psychiatric Morbidity. Psychol Med 1998;28:9–19.

Bond A, Lader M. The use of analogue scales in rating subjective feelings. Br J Med Psychol 1974;47:211–8.

Bond A, Lader M. A method to elicit aggressive feelings and behaviour via provocation. Biol Psychol 1986;22:69–79.

Boone KB, Ghaffarian S, Lesser IM, Hill-Gutierrez E, Berman NG. Wisconsin Card Sorting Test performance in healthy, older adults: relationship to age, sex, education, and IQ. J Clin Psychol 1993;49:54–60.

Craik FIM, Anderson ND, Kerr SA. Memory changes in normal ageing. In: Baddeley AD, Watts FN, editors. Handbook of memory disorders. London: Wiley; 1995. p. 211–41.

Dufouil C, Ducimetiere P, Alperovitch A. Sex differences in the association between alcohol consumption and cognitive performance. Am J Epidemiol 1997;146:405–12.

Elias PK, Elias MF, D'Agostino RB, Silbershatz H, Wolf PA. Alcohol consumption and cognitive performance in the Framingham Heart Study. Am J Epidemiol 1999;150:580–9.

File SE, Fluck E, Fernandes C. Beneficial effects of glycine (bioglycine) on memory and attention in young and middle-aged adults. J Clin Psychopharmacol 1999;19:506–12.

File SE, Fluck E, Leahy A. Nicotine has calming effects on stress-induced mood changes in females, but enhances aggressive mood in males. Int J Neuropsychopharmacol 2001;4371–6.

File SE, Dinnis AK, Heard JE, Irvine EE. Mood differences between male and female light smokers and nonsmokers. Pharmacol Biochem Behav 2002a;72:681–9.

File SE, Heard JE, Rymer J. Trough oestradiol levels associated with cognitive impairment in post-menopausal women after 10 years of oestradiol implants. Psychopharmacology 2002b;161:107–12.

Gater R, Tansella M, Korten A, Tiemens BG, Mavreas VG, Olatawura MO. Sex differences in the prevalence and detection of depressive and anxiety disorders in general health care settings: report from the World Health Organization Collaborative Study on Psychological Problems in General Health Care. Arch Gen Psychiatry 1998;55:405–13.

Hartley DE, Heinze L, Elsabagh S, File SE. Effects on cognition and mood in postmenopausal women of 1-week treatment with *Ginkgo biloba*. Pharmacol Biochem Behav 2003;75:711–20.

Kaufman AS, Kaufman-Packer JL, McLean JE, Reynolds CR. Is the pattern of intellectual growth and decline across the adult life span different for men and women? J Clin Psychol 1991;47:801–12.

Lamberts SW, van den Beld AW, van der Lely A-J. The endocrinology of aging. Science 1997;278:419–24.

Lewin C, Wolgers G, Herlitz A. Sex differences favoring women in verbal but not in visuospatial episodic memory. Neuropsychology 2001;15: 165–73.

Nelson HE, Willison JR. National Adult Reading Test (NART): test manual. Second edition. Windsor: NEFR-Nelson; 1991.

Owen AM, Roberts AC, Polkey CE, Sahakian BJ, Robbins TW. Extra-dimensional versus intra-dimensional shift set shifting performance following frontal lobe excisions, temporal lobe excisions or amygdalo–hippocampectomy in man. Neuropsychologia 1991;29:993–1006.

Peele S, Brodsky A. Exploring psychological benefits associated with moderate alcohol use: a necessary corrective to assessments of drinking outcomes? Drug Alcohol Depend 2000;60:221–47.

Raffaele KC, Haxby JV, Schapiro MB. Age-associated memory impairment. In: Racagni G, Mendlewicz J, editors. Treatment of age-related cognitive dysfunction: pharmacological and clinical evaluation. International Academy of Biomedical and Drug Research. Basel, Switzerland: Karger; 1992. p. 69–79.

Randall DC, Shneerson JM, Plaha KK, File SE. Modafinil affects mood, but not cognitive function, in healthy young volunteers. Hum Psychopharmacol 2003;18:163–73.

Randall DC, Fleck NL, Shneerson JM, File SE. Modafinil affects mood, but not cognitive function, in healthy young volunteers. Hum Psychopharamcol 2004a;77:547–555.

Randall DC, Elsabagh S, Hartley DE, File SE. Does drinking have effects on mood and cognition in male and female students? Pharmacol Biochem Behav 2004b;78:629–38.

Reavis R, Overman WH. Adult sex differences on a decision-making task previously shown to depend on the orbital prefrontal cortex. Behav Neurosci 2001;115:196–206.

Roberts R, Brunner E, Marmot M. Psychological factors in the relationship between alcohol and cardiovascular morbidity. Soc Sci Med 1995; 41(11):1513–6.

Salthouse TA, Toth JP, Hancock HE, Woodard JL. Controlled and automatic forms of memory and attention: process purity and the uniqueness of age-related influences. J Gerontol B Psychol Sci Soc Sci 1997; 52:216–28.

Sherrill JT, Anderson B, Frank E, Reynolds III CF, Tu XM, Patterson D, et al. Is life stress more likely to provoke depressive episodes in women than in men? Depress Anxiety 1997;6:95–105.

Soules MR, Sherman S, Parrott E, Rebar R, Santoro N, Utian W, et al. Stages of reproductive aging workshop (STRAW). J Women's Health Gend.-Based Med 2001;10:843–8.

Steiner M, Dunn E, Born L. Hormones and mood: from menarche to menopause and beyond. J Affect Disord 2003;74:67–83.

Tyrer P. The role of bodily feelings in anxiety. London: Oxford Univ. Press; 1976.

van Exel E, Gussekloo J, de Craen AJ, Bootsma-van der Wiel A, Houx P, Knook DL, et al. Cognitive function in the oldest old: women perform better than men. J Neurol Neurosurg Psychiatry 2001;71:29–32.

Wiederholt WC, Cahn D, Butters NM, Salmon DP, Kritz-Silverstein D, Barrett-Connor E. Effects of age, gender and education on selected neuropsychological tests in an elderly community cohort. J Am Geriatr Soc 1993;41:639–47.

Wilhelm K, Mitchell P, Slade T, Brownhill S, Andrews G. Prevalence and correlates of DSM-IV major depression in an Australian national survey. J Affect Disord 2003;75:155–62.

Yonker JE, Eriksson E, Nilsson L-G, Herlitz A. Sex differences in episodic memory: minimal influence of estradiol. Brain Cogn 2003;2:231–8.

Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361–70.