Benevolent sexism alters executive brain responses

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Benevolence is widespread in our societies. It is defined as considering a subordinate group nicely but condescendingly, that is, with charity. Deleterious consequences for the target have been reported in the literature. In this experiment, we used functional MRI (fMRI) to identify whether being the target of (sexist) benevolence induces changes in brain activity associated with a working memory task. Participants were confronted by benevolent, hostile, or neutral comments before and while performing a reading span test in an fMRI environment. fMRI data showed that brain regions associated previously with intrusive thought suppression (bilateral, dorsolateral, prefrontal, and anterior cingulate cortex) reacted specifically to benevolent sexism compared with hostile sexism and neutral conditions during the performance of the task. These findings indicate that, despite being subjectively positive, benevolence modifies task-related brain networks by recruiting supplementary areas likely to impede optimal cognitive performance. *NeuroReport* **24:572–577 © 2013 Wolters Kluwer Health | Lippincott Williams & Wilkins.**

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Introduction

At first glance, benevolence appears to be a positive and laudable attitude: one tends to help children, elderly, or disabled individuals. Benevolence is not necessarily targeted at minorities. Women, who represent roughly 52% of human beings, are daily targets of benevolence. Many individuals find it commendable to pay for women at restaurants, help them solve math problems, or orient them during a walk. However, it has been shown that benevolence paradoxically decreases women's cognitive performance [1] even if benevolence is sometimes prescribed by women to men [2]. Being the target of benevolent sexism impairs performance on working memory tasks, such as the reading span test (RST), not only compared with a neutral condition in which no sexism is expressed but also relative to a hostile sexism condition in which obviously sexist comments are uttered (the last two conditions do not differ). Self-reports indicate that female participants are preoccupied and anxious about performing poorly. Women report more intrusive thoughts related to self-doubt and to their own incompetence. They also self-report trying to spontaneously suppress intrusive thoughts more than women exposed to hostile sexism or no sexism [1,3].

Thought suppression has been studied in a number of brain imaging investigations. In one study [4], participants were asked to try to suppress a specific thought, to try to suppress all conscious thoughts, or to think freely about anything while they were imaged. The results indicated that neural activity was modulated by the nature of the suppression task. The anterior cingulate cortex (ACC) was activated when the instructions required suppression of a specific thought (compared with the free-thought condition). However, when participants attempted to banish all thoughts from consciousness (compared with free thought), a more distributed network of brain regions, including parietal areas and the insular cortex, was engaged. In addition, consistent with recent neural models of cognitive control, another study reported [5] that the prefrontal cortex and the ACC underlie specific and distinctive suppression activities, although both are related to mental control. Specifically, participants were scanned while alternatively trying to suppress thoughts about a specific target (a white bear) and thinking freely about any topic. In addition, they were instructed to press a response button whenever they thought of a white bear, whether this specific thought was allowed or not. Whereas the overall activity of suppressing thoughts elicited a sustained increase in control associated with an increase in the dorsolateral prefrontal cortex (DLPFC), the specific occurrence of the forbidden thought elicited a transient increase in control, associated with increases in ACC activation.

In this study, we used functional MRI (fMRI) to characterize the neural correlates of spontaneous thought suppression by women confronted by benevolent sexist comments. Our predictions were that female participants confronted by benevolent sexist comments while

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performing a reading working memory task should show relatively greater activity in brain regions that are specifically associated with intrusive thought suppression (i.e. bilateral DLPFC and ACC [6]).

Methods

Participants and ethics statement

The participants were 42 female (mean age = 23.4, SD = 3.8) right-handed, native French speakers with no history of neurological problems. The study was approved by the ethics committee of the Faculty of Medicine of the University of Liège and was carried out in accordance with the ethical standards described in the Declaration of Helsinki (1964). All participants provided their written informed consent before their inclusion in the study.

Independent variables

Female participants were assigned randomly to one of three experimental conditions (benevolent sexism vs. hostile sexism vs. no sexism) before performing a RST inside the scanner. All participants were provided the cover story and instructions twice: before entering the scanner and inside the scanner just before they performed the task. Instructions and manipulation comments were similar to those used by Dumont *et al.* [3]. Under all conditions, the study was represented as investigating whether men and women use different brain processes when facing job contexts where a cognitive task is to be performed. Participants were told that a chemical factory was offering new jobs. Under all conditions, participants were informed that the job required communication and social skills as well as work-team orientation. For all participants, the abilities mentioned as required for the job were 'sensitivity to clients' needs', 'cooperative orientation', 'good social abilities', and 'attentiveness to clients'. The recruiting procedure was also said to include performing a test (i.e. RST), which was alleged to be well known and frequently used in job recruitment procedures.

The hostile and benevolent sexist comments included as manipulation conveyed explicit expressions of the corresponding attitudes measured by the Ambivalent Sexism Inventory [7]. We manipulated benevolence through its complementary sex differentiation component. Under all conditions, it was explained that hiring women would be a good thing for the organization. In the hostile sexism condition, additional comments that were central to the manipulation were as follows: 'Women who are hired would work as much with men as women and this should not be a problem because everybody is well aware of the importance of hiring women in our organization, even though women always look for special favors and get easily offended by trivial remarks. It is true that women often exaggerate the problems they face in organizations simply to get power and control over men'. In the benevolence condition, additional comments evoking feminine niceness that were central to the manipulation were as follows: 'Women who are hired would work as much with men as women and this should not be a problem because everybody is well aware of the importance of hiring women in our organization. Indeed, everyone thinks that the presence of women, who are more cultured and better-groomed than men, would allow the organization to benefit from their morality and good taste, whereas these aspects are usually lacking in environments where only men work'. In the no-sexism condition, the comments contained nothing more than the job description and the introductory comment: 'Women who are hired would work as much with men as women and this should not be a problem because everybody is well aware of the importance of hiring women in our organization'.

Behavioral measures

The original RST [8] was adapted to the specific requirements of fMRI scanning. The task was composed of 15 blocks of trials. Within each block, participants were presented with five sentences; they had to read each sentence silently, decide whether the sentence was grammatically correct or not, and remember the last word of each sentence. To ascertain that all participants used the same strategy to perform the task, the instructions mentioned that making the grammatical decision first and then memorizing the last word of the sentence has been shown to be the most efficient strategy. Each block of five sentences was always followed by a recognition screen providing the first two or last two letters of the word that was to be remembered as memory cues. Half of the trials were grammatically correct, whereas the other half were not. Similarly, half of the recognition screens corresponded to the words that had been presented immediately before, whereas the other half did not. Under all conditions, participants made a keyboard response whenever providing an answer (grammatical decision or recognition answer). Each sentence and recognition screen was presented for 10 s, whether or not an answer was provided. Each block was separated by pseudorandom baseline intervals during which a black screen with a central cross was presented for 12–20 s. The reaction times and accuracy of the responses were recorded.

Participants then completed, outside the scanner, a series of nine-point scales focused on evaluation of intrusive thoughts related to sexism (five items; e.g. 'I disagree with these considerations about women'; $\alpha = 0.81$) and perception of sexism (three items; e.g. 'I think that the recruiters mentioned in the instructions are rather sexist'; $\alpha = 0.86$). Participants finally completed a series of nine-point scales to evaluate difficulties concentrating (two items; e.g. 'During the task, I felt 'anesthetized', as if my brain did not want to work'; $r = 0.78$, $P < 0.001$), motivation to provide a positive impression of women (two items; e.g.

'During the task, I wanted to show that women were able to perform well'; $r = 0.93$, $P < 0.001$), and intrusive thoughts about performing badly (two items; e.g. 'Damn, I've forgotten the words'; $r = 0.34$, $P < 0.03$) while they were scanned and performing the task.

Magnetic resonance imaging acquisition

Data were acquired on a 3-T scanner (Allegra; Siemens, Erlangen, Germany) using a T2* sensitive gradient-echo EPI sequence (TR = 2130 ms, TE = 40 ms, FA = 90°, matrix size = 64 × 64 × 32, voxel size = 3.4 × 3.4 × 3.4 mm^3). Thirty-two 3-mm-thick transverse slices (FOV = 22 × 22 cm^2) were acquired, with a distance factor of 30%, covering the entire brain. Structural images were obtained using a T1-weighted three-dimensional MP-RAGE sequence (TR = 1960 ms, TE = 4.4 ms, FOV = 23 × 23 cm^2, matrix size = 256 × 256 × 176, voxel size = 0.9 × 0.9 × 0.9 mm). In each session, between 530 and 560 functional volumes were obtained. The first three volumes were discarded to account for T1 saturation. Head movement was minimized by restraining the participant's head with a vacuum cushion. Stimuli were displayed on a screen positioned at the rear of the scanner, which the participant could see comfortably through a mirror mounted on the standard head coil.

Functional magnetic resonance imaging preprocessing and data analysis

Data were preprocessed and analyzed using SPM5 software (Wellcome Department of Imaging Neuroscience, *http://www.fil.ion.ucl.ac.uk/spm*) implemented in MATLAB (Mathworks Inc., Sherborn, Massachusetts, USA). Functional scans were realigned using iterative rigid body transformations that minimize the residual sum of squares between the first and subsequent images. They were normalized to the MNI EPI template (voxel size = 2 × 2 × 2 mm) and spatially smoothed with a Gaussian kernel with full-width at half-maximum of 8 mm.

For each participant, brain responses were estimated at each voxel using a general linear model with epoch regressors. For each condition (benevolence, hostility, and neutral), epoch duration was defined as covering the presentation of the five sentences and the recognition phase. For each condition, blocks pertained to the period from the appearance of the first item to the disappearance of the recall screen; the duration of each epoch was 20 s. Boxcar functions representative of these epoch conditions were convolved with the canonical hemodynamic response. The contrast of interest was the main effect of working memory by comparison with an implicit baseline (cross fixation). The design matrix also included the realignment parameters to account for any residual movement-related effect. A high-pass filter was implemented using a cut-off period of 128 s to remove the low-frequency drifts from the time series. Serial autocorrelations were estimated using a restricted maximum likelihood algorithm with an autoregressive model of order 1 (+ white noise). Linear contrasts estimated the simple main effect of each trial type. The resulting set of voxel values constituted a map of t statistics SPM[T].

The contrast images were further smoothed (6-mm full-width at half-maximum Gaussian kernel). They were then entered in a second-level analysis, corresponding to a random-effects model, to account for interparticipant variance in each contrast of interest. An analysis of variance controlling for nonsphericity of the variances [9] assessed the significance of the between-groups effects. The following effects were assessed: main effect of working memory across group; benevolence > hostility and neutral conditions; and hostility > neutral condition. As a rule, statistical inferences were performed at the voxel level at P value less than 0.005 uncorrected for multiple comparisons across the entire brain volume. When *a priori* knowledge about the potential response of a given area was available from the literature, a small volume correction was computed on a 10-mm radius sphere around the coordinates published for the corresponding location of interest (see below).

A priori locations of interest

The following *a priori* locations of interest were used for small volume corrections on the basis of published coordinates in the literature on thought suppression [4,5]. All stereotactic coordinates refer to the MNI space and are related to the comparison of thought suppression and free thought processing: right DLPFC [33 12 36] [4] and bilateral ACC [–12 48 12 and 15 45 6 [4], –3 11 44 and 6 0 55 [5]].

Results and discussion

Behavioral data: accuracy and response latencies

Regression analyses were used to analyze the level of accuracy of the grammatical decisions and cued recall and response latencies. With the first contrast, we compared benevolence (coded 2) with the two other conditions (hostility and no sexism were coded –1). In the second contrast, hostility (coded 1) was compared with no sexism (coded –1).

Overall, there was a good percentage of correct answers in the grammatical decisions (91%). Benevolence led to a similar level of accuracy in grammatical decisions as the two other conditions ($B = 0.69$, SE = 0.47, $P > 0.15$). Hostility also resulted in a similar performance as in the condition in which no sexism was expressed ($B = 0.15$, SE = 0.79, $P > 0.85$). Overall correct cued recall was moderate (66%). The accuracy of cued recall was similar when participants were confronted by benevolence and in the other two conditions ($B = –1.71$, SE = 1.58, $P > 0.28$). Hostility also led to similar performance as in the condition in which no sexism was expressed ($B = –3.25$,

SE = 2.64, $P > 0.22$). Analyses of the d' discrimination index on cued recall showed the exact same pattern.

To deal with outliers, we used the median reaction times to correct decisions in all the analyses. Analysis of the response latencies of grammatical decisions indicated no significant effect of sexism. Participants confronted by benevolent sexist comments manifested decision latencies similar to those confronted by hostility or no sexism (B = –45.00, SE = 102.78, $P > 0.66$). Hostility also led to similar grammatical response latencies as the condition in which no sexism was expressed ($B = 43.86$, SE = 173.62, $P > 0.80$). Analysis of the response latencies of cued recall items indicated no significant effect of sexism. Participants confronted by benevolent sexist comments manifested decision latencies similar to those confronted by hostility or no sexism (B = –92.10, SE = 127.42, $P > 0.47$). Hostility also led to similar recall response latencies as in the condition in which no sexism was expressed ($B = 239.86$, SE = 215.24, $P > 0.27$). Analyses of these behavioral data provide preliminary evidence that the imaging findings related to benevolence cannot be explained by better or worse performance on the grammatical decisions and cued recall or at the level of response latencies.

Regression analyses were used to analyze thoughts related to sexism that came to mind during the task as well as perception of sexism as a function of our *a priori* hypotheses. With a first contrast, we compared hostility (coded 2) with the two other conditions (benevolence and no sexism were coded –1). In the second contrast, benevolence (coded 1) was compared with no sexism (coded –1). Consistent with our manipulation, thoughts related to sexism that came to mind during the task were affected by the sexism manipulation. As expected, women confronted by hostility reported more thoughts about sexism than women confronted by benevolence or no sexism ($B = 0.59$, SE = 0.15, $P < 0.001$). Participants confronted by benevolence, however, had no more thoughts about sexism than participants confronted by no sexism ($B = 0.14$, SE = 0.26, $P > 0.59$). The perception of sexism in the recruiters' discourse showed a similar pattern. Women confronted by hostility reported a stronger perception of sexism than women confronted by benevolence or no sexism ($B = 1.15$, SE = 0.20, $P < 0.001$). Participants confronted by benevolence, however, did not perceive more sexism than participants confronted by no sexism ($B = 0.08$, SE = 0.34, $P > 0.81$).

For the next comparisons, we used the same contrast analyses as for the data on accuracy and response latencies. Participants' difficulties concentrating were the same when confronted by benevolence as by hostility or no sexism ($B = 0.27$, SE = 0.21, $P > 0.20$). The expression of hostility or no sexism led to similar difficulties concentrating on the task ($B = 0.28$, SE = 0.35, $P > 0.42$). The motivation to give a positive impression of women was not affected by the type of sexism expressed. Benevolence led to a similar motivation to give a positive impression of women as hostility or no sexism (B = –0.14, SE = –0.08, $P > 0.62$), and hostility and no sexism did not differ from each other ($B = 0.14$, SE = 0.46, $P > 0.29$). Analyses also showed that benevolence led to as many intrusive thoughts about performing badly as the other two conditions ($B = 0.13$, SE = 0.20, $P > 0.52$). Thoughts about performing badly were also similar after being confronted by hostility and when no sexism was expressed ($B = 0.34$, SE = 0.34, $P > 0.33$).

Functional magnetic resonance imaging data

Activation in a large bilateral anteroposterior cerebral network was observed during the performance of the working memory task ($P < 0.005$, corrected for multiple comparisons). Peaks of activity are specifically observed in the right and left precentral gyrus, in the left inferior frontal gyrus and right insula, in the right middle frontal and superior orbital gyri, in parietal areas (left superior parietal and right angular gyrus), and in the right hippocampus region and caudate nucleus (Table 1).

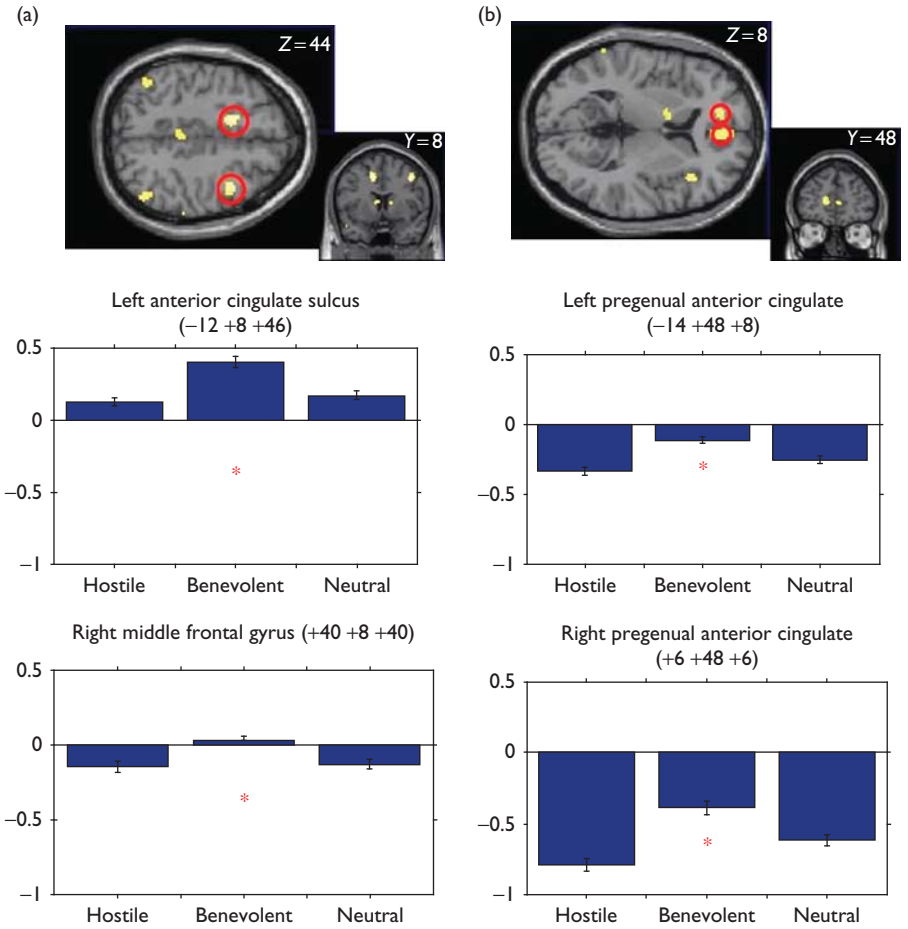
Next, we were interested in determining whether facing benevolent or hostile sexism induces changes in cerebral activity in some specific brain areas. The comparison of the benevolence condition with the hostile and neutral conditions shows significant changes in cerebral activity in the left DLPFC, near the anterior cingulate sulcus ($x = -12$, $y = 8$, $z = 46$; Z score = 3.19, $P_{corrected} = 0.028$), very close to the area referred to previously by Wyland *et al.* [4], and in the posterior part of the right middle frontal gyrus ($x = 40$, $y = 8$, $z = 40$; Z score = 2.77,

Table 1 Significant bold signal changes in the main effect of working memory (working memory condition – baseline fixation in the three groups)

	Stereotactic coordinates			
Brain areas	*x*	*y*	*z*	*Z* score
L and R precentral gyrus	–52	–2	48	>8
	–2	6	60	>8
	64	10	20	6.56
	58	–4	48	–
R postcentral gyrus	64	–8	40	4.95
L inferior frontal gyrus	–54	14	18	>8
	–18	24	–14	4.61
R insula	32	22	8	5.16
	44	0	18	4.80
	34	2	20	4.68
R middle frontal gyrus	40	44	30	6.04
R superior orbital gyrus	16	24	–14	4.63
L superior parietal	–26	–52	48	6.31
R angular gyrus	30	–58	52	4.76
R hippocampus	–26	–26	–6	6.72
	34	–34	0	6.61
R caudate nucleus	16	–4	–4	4.94
	14	–53	–14	5.28
L and R inferior occipital gyrus	–14	–98	–10	>8
	20	–98	–2	>8

Results are reported at a voxel $P<0.05$, corrected for multiple comparisons. L/R, left or right; *x*, *y*, *z*, coordinates (mm) in the stereotactic space defined by the Montreal Neurological Institute.

Fig. 1



Cerebral areas associated with the benevolent sexism condition (benevolent>hostile and neutral) during a working memory task. (a) Larger increase in brain activity (*) for the benevolent group in the left anterior cingulate sulcus and the right middle frontal gyrus (posterior part). (b) Smaller decrease (*) in brain activity for the benevolent group in the left and right pregenual anterior cingulate sulci. Functional statistical results ($P_{uncorrected}<0.005$) are overlaid on a canonical structural image. Activity estimates (arbitrary units) are shown for the different conditions (hostile, benevolent, and neutral).

$P_{uncorrected} = 0.003$) described by Mitchell *et al.* [5]. This comparison also showed a significant change of cerebral activity in the left and right pregenual anterior cingulate sulcus ($x = -14$, $y = 48$, $z = 8$; Z score = 2.97, $P_{corrected} = 0.048$; $x = 6$, $y = 48$, $z = 6$; Z score = 2.91, $P_{uncorrected} = 0.045$), described previously by Mitchell *et al.* [5]. No significant changes in activity were observed in the hostile versus neutral contrast according to our *a priori* hypotheses.

As reported previously [10], the performance on the working memory task was associated with a large bilateral frontoparietal network. Regional brain activity was never more extensive in the hostile than in the benevolent condition. By contrast, the comparison of the benevolent condition with the hostile and neutral conditions showed significant changes in cerebral activity in the left and right DLPFC and in the pregenual ACC, also bilaterally. The activity in the DLPFC increased more in the benevolence than in the hostility and neutral groups (Fig. 1a). Responses in the ACC, a region in the default mode network [11], decreased less when participants were confronted by benevolent sexism than in the other conditions (Fig. 1b). These changes in brain activity were not because of task performance as, in contrast to earlier behavioral studies, the scanning conditions were not associated with any significant difference in reaction times or response accuracy between benevolence and the other two conditions. Additional subjective data collected outside the scanner also showed that the benevolent condition did not elicit more difficulties concentrating, motivation to give a positive impression, and self-reported intrusive thoughts about performing badly than the other two conditions.

Consequently, our results suggest that performance is maintained in the benevolent condition at the cost of

increased activity in regions involved with maintaining cognitive control over thought suppression (DLPFC) and reduced deactivation in the ACC, a critical area of the default mode network, suggesting self-referential mental activity related to intrusive thoughts [11] or monitoring for errors and conflicts [6]. Collectively, these data suggest that benevolent sexism is able to significantly modify the brain activity recruited during a working memory task. These changes potentially provide the neural basis for the poor cognitive control and intrusion of self-related thoughts that make benevolent sexism likely to alter executive performance in numerous real-life activities.

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Conflicts of interest

There are no conflicts of interest.

References

1 Dardenne B, Dumont M, Bollier T. Insidious dangers of benevolent sexism: consequences for women's performance. *J Pers Soc Psychol* 2007; **93**:764–779.
2 Sarlet M, Dumont M, Delacollette N, Dardenne B. Prescription of protective paternalism for men in romantic and work contexts. *Psychol Women Q* 2012; **36**:444–457.
3 Dumont M, Sarlet M, Dardenne B. Be too kind to a woman, she'll feel incompetent: benevolent sexism shifts self-construal and autobiographical memories toward incompetence. *Sex Roles* 2010; **62**:545–553.
4 Wyland CL, Kelley WM, Macrae CN, Gordon HL, Heatherton TF. Neural correlates of thought suppression. *Neuropsychologia* 2003; **4**:1863–1867.
5 Mitchell JP, Heatherton TF, Kelley WM, Wyland CL, Wegner DM, Macrae CN. Transient and sustained cognitive control during the suppression of unwanted thoughts. *Psychological Sci* 2007; **18**:292–296.
6 Heatherton TF. Neuroscience of self and self-regulation. *Ann Rev Psychol* 2011; **62**:363–390.
7 Glick P, Fiske ST. The Ambivalent Sexism Inventory: differentiating hostile and benevolent sexism. *J Pers Soc Psychol* 1996; **70**:491–512.
8 Daneman M, Carpenter PA. Individual differences in working memory and reading. *J Verb Learn Verb Be* 1980; **19**:450–466.
9 Friston KJ, Glaser DE, Henson RNA, Kiebel S, Phillips C, Ashburner J. Classical and Bayesian inference in neuroimaging: applications. *NeuroImage* 2002; **16**:484–512.
10 Wager TD, Smith EE. Neuroimaging studies of working memory: a meta-analysis. *Cogn Affect Behav Neurosci* 2003; **3**:255–274.
11 Buckner R, Andrews-Hanna J, Schacter D. The brain's default network: anatomy, function and relevance to disease. *Ann NY Acad Sci* 2008; **1124**:1–38.