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The power of charisma—perceived charisma inhibits the frontal executive network of believers in intercessory prayer

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This study used functional magnetic resonance imaging to investigate how assumptions about speakers' abilities changed the evoked BOLD response in secular and Christian participants who received intercessory prayer. We find that recipients' assumptions about senders' charismatic abilities have important effects on their executive network. Most notably, the Christian participants deactivated the frontal network consisting of the medial and the dorsolateral prefrontal cortex bilaterally in response to speakers who they believed had healing abilities. An independent analysis across subjects revealed that this deactivation predicted the Christian participants' subsequent ratings of the speakers' charisma and experience of God's presence during prayer. These observations point to an important mechanism of authority that may facilitate charismatic influence, a mechanism which is likely to be present in other interpersonal interactions as well.

Keywords: fMRI; executive network; trust; authority; charisma; prayer

INTRODUCTION

In the classic study of charismatic authority, sociologist Max Weber stressed the importance of followers recognising the charismatic healer or leader as endowed with special powers (Weber, 1922). Even though most scholars of religion consider this recognition of powers to be a central aspect in the social and psychological dynamics of charismatic authority (Dow, 1969; Willner, 1984; Barker, 1993; Turner, 2003), cognitive mechanisms of this are rarely discussed. In this study, we investigate how recognition of sender's charismatic abilities affects recipients' neural response and subjective experience in interpersonal interaction. We find that recipients' assumptions about senders' charismatic abilities have important effects on their executive network.

It is a general finding that attentional processing and executive function recruit the same frontal regions and therefore compete for resources in critical situations (Engle *et al.*, 1995; Richeson *et al.*, 2003; Fuentes, 2004). Cognitive load on the attentional system therefore influences negatively on executive function, e.g. performance in Stroop tasks (Engle *et al.*, 1995; Garavan *et al.*, 1999). Interestingly, this effect has been demonstrated in Implicit Association Tests (IAT) in which incongruency between object and valence (e.g. insect + pleasant) impair task performance and significantly increase activation of the frontal executive network (Chee *et al.*, 2000; Fuentes, 2004).

Similar effects have been demonstrated in the social domain where negative social categories have been reported to increase cognitive load on the executive system, whereas positive social categories seem to have the opposite effect. In one study, Richeson *et al.* (2003) showed that white individuals activate the executive network in response to pictures of black faces according to their level of racial bias (Richeson and Shelton, 2003). Bartels and Zeki, on the other hand, have demonstrated that watching pictures of loved ones cause subjects to deactivate the executive and social cognitive networks (Bartels and Zeki, 2000; 2004). Wraga *et al.* have further shown that women improve task performance in an Imagined Rotation-task when primed with positive stereotypes (Wraga *et al.*, 2006).

We argue that such effects may have direct consequences on social interaction, especially because the valence of social categories depends on cultural framing and individual experience. Establishing negative assumptions about a person or group seems to impair communication even at the level of executive processing (Richeson *et al.*, 2003), whereas positive assumptions by contrast may facilitate communication. Insights from hypnosis research expand on this idea by proposing a causal mechanism for such facilitation. In this line of research, it is generally argued that during hypnosis subjects inhibit their executive system as they 'hand over' the executive control to the hypnotist (Kaiser *et al.*, 1997; Egner and Raz, 2007). Indeed, it has been demonstrated that

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hypnotic susceptibility is associated with frontal inhibition (Gruzelier *et al.*, 2002; Jamieson and Sheehan, 2004; Gruzelier, 2006; Egner and Raz, 2007) and that instructions received during hypnotically induced inhibition influence how subjects subsequently perceive and relate to stimuli (MacLeod and Sheehan, 2003; Raz, 2004).

We hypothesize that a mechanism similar to that of hypnosis may facilitate charismatic influence. More specifically, we hypothesize that subjects' recognition of the charismatic authority enhances their susceptibility to charismatic influence by down-regulating their executive system. In order to test this hypothesis, we used functional magnetic resonance imaging (fMRI) to investigate how assumptions about speakers' healing abilities changed the evoked BOLD response in 18 secular and 18 Christian participants who received intercessory prayer. Briefly, the participants were led to believe that they received intercessory prayers by speakers with different religious status; a non-Christian, a Christian and a Christian know for his healing powers.

METHODS

Participants

Thirty-seven young males ($n = 15$) and females ($n = 22$) participated in the study (one male participant was discarded in the analysis due to image acquisition errors). Eighteen participants were devoted Christians (mean age = 23 s.d. ± 2.6) and 18 were secular participants (mean age = 26.4 s.d. ± 4.9) with no prior experience of practicing prayer (see Results section). Participants were recruited via posters and announcements at various events and meetings, e.g. at prayer meetings. The Christian participants belonged to different charismatic denominations (mainly the Pentecostal Movement), which are jointly characterized by an extensive practice of intercessory prayer both collectively and in private. These participants demonstrated coherency in all important aspects in relation to this study, e.g. experience and frequency of prayer, and belief in healing through prayers, and belief in persons with special healing powers (see Results section, Figure 1). The secular participants were mostly BA students of the humanities with no experience of praying and no belief in the healing effects of prayer (see Results section). Based on the inconclusive evidence on the relation between charismatic believers and personality traits (Taylor and MacDonald, 1999) and hypnotic susceptibility (Groth-Marnat *et al.*, 1999), we decided not to obtain data on hypnotic susceptibility or personality traits.

Because our study investigated the effects of charismatic authority in the specific Christian context of intercessory prayer, we expected the concept of charisma to differ in Christian and secular participants. Nevertheless, we did not instruct participants to use a uniform definition of charisma in their post-scan evaluation of speakers (see Results section), because this would interfere with the central effect of having diverse cultural frameworks. The term 'charisma' was therefore not used during the experiment except for in the post-scan questionnaires. While charismatic Christians generally share the lay notions of charismatic persons, e.g. charming individuals with extraordinary persuasive powers, they also associate the term 'Charisma' with its original meaning, a Greek word used by Paul in the New Testament for 'divine gifts' to describe the powers of the early Christians which he understood as manifestations of the Holy Spirit (Corinth 1:12), e.g. wisdom, prophecy, speaking in tongues (glossolalia) and healing powers.

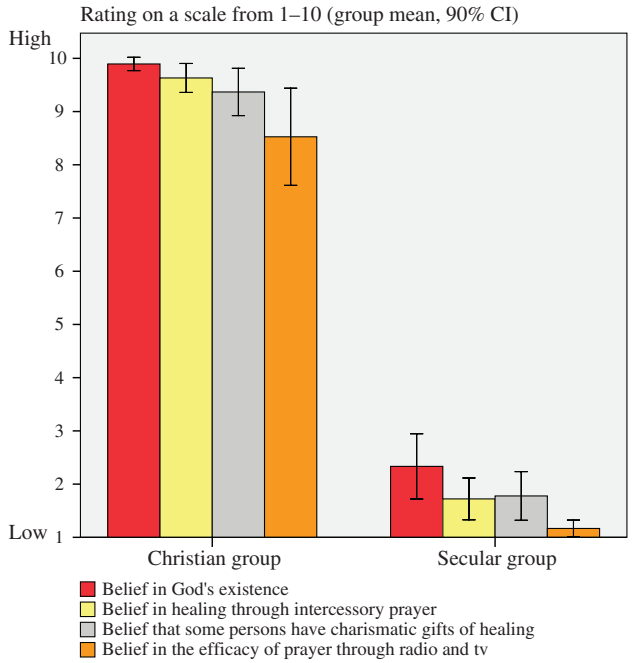

Fig. 1 Participants' ratings of beliefs on a scale from 1 to 10 (90% CI).

Conditions and procedures

All participants were told before the experiment that the study investigated the neural substrates of intercessory prayer but they received no mention of our particular interest in the effects of the speakers' religious status. The actual design and research interests were revealed to the participants after the experiment. The participants were instructed to listen to 18 different prayers performed by three different male speakers. Before each prayer, the participants were told through headphones which of the three categories the praying speaker belonged to: non-Christian, Christian, or Christian known for his healing powers (these cues were discarded in the analysis). In fact, the three speakers were all 'ordinary' Christians who had each recorded 18 prayers that were then randomly allocated into these three categories. Thus, the participants were led to believe that six prayers were performed by a non-Christian speaker, six prayers were performed by a Christian speaker and six prayers were performed by a Christian known for his healing powers. Each of the actual speakers were allocated an equal number of times to each of the three categories in order to filter out noise from the individual speech, e.g. prior

experience with praying, intonation, dialects and accents, etc. The participants were randomly divided into three groups that received the prayers in either of three different sets of stimulus, St1, St2 and St3 (Table 1).

After 10 min of structural scanning, which habituated the participants to the MR environment, they were presented with the auditory stimuli through headphones. The sound level was adjusted to individual preferences prior to the fMRI scan. Each condition lasted 30 s and was repeated six times. We contrasted the prayers with a secular counterpart, a speech with same structure as prayer, but without religious content (for further examples of prayers and secular counterparts, see Supplementary material). We then implemented the contrast images in a three-by-three full factorial design (Table 1). Prior to the four main conditions we further introduced two other tasks: a simple verbal condition (random read from telephone book) and rest. However, because these tasks had not been interspersed with the four main conditions we decided to discard these in the final data analysis. Prior to scanning, the participants were asked to read a brief statement from each of the three perceived speakers, which indicated their status as non-Christian, Christian and Christian known for his healing powers (See Supplementary data).

Questionnaires on the participants' confidence in God's existence, experience and frequency of praying, belief in healing through prayer, belief in persons with special healing powers, long distance healing, etc., were provided pre-scan (see Results section), while questionnaires about the perceived speakers and experience of God's presence were provided post-scan (see Results section). These data were analyzed in SPSS 16.

Image acquisition and data analysis

The fMRI was carried out by using echo planar imaging (EPI) and was performed on a 1.5 Tesla GE Signa using the standard head coil for radiofrequency transmission and signal reception. For whole-brain coverage, 30 axial slices (3 mm slice thickness, 1 mm spacing, in plane resolution 3.75 mm × 3.75 mm, matrix size 64 × 64) was used. Other acquisition parameters were: repetition time TR = 3000 ms, flip angle = 90°, echo time = 50.2 ms. Scout image and T1-weighted image of each participant were obtained before the fMRI sessions. Image processing and statistical analysis were done using SPM 5 (Statistical Parametric Mapping; Wellcome Department of Imaging Neuroscience) implemented in MATLAB 2006a. The image series was realigned and spatially normalized to the EPI template in SPM 5, which is in MNI space, and smoothed with a Gausian kernel of 8 mm × 8 mm × 8 mm at FWHM. For each of the four conditions a regressor was constructed by convolving the time series specifying each conditions by the SPM canonical hemodynamic response function. Serial correlations was modelled using AR (1). Low-frequency drift was removed by using a high pass filter. Because the actual and perceived speakers had to be randomized and because conditions lasted 30 s, a high pass cut-off at 256 s was used in order to retrieve the entire signal of the paradigm. This cut-off is longer than we would normally use, but additional analyses were made, to test the impact of this particular choice. The analysis using the standard cut-off point of 128 s confirmed the activations in the regions of interest, although as expected due to our model, at weaker signal intensities (see Supplementary Figure S1). Anatomical localizations of local maxima were assessed by reference to the WFU PickAtlas 2.3 (Maldjian *et al.*, 2003; 2004). The second-level analysis used to test the effects of the praying speakers' religious status was analyzed in a three-by-three full factorial design, where non-sphericity between conditions was modelled. Table 2 includes anatomical regions, cluster size of functional voxels, MNI coordinates and Z-value. The results of these contrasts are thresholded at $P < 0.05$ corrected for multiple comparisons (False Discovery Rate, Genovese *et al.*, 2002). As large areas of activated regions typically give rise to a large number of false discoveries the thresholding was further increased to $Z = 3.0$ and a cluster size threshold of 15 voxels.

Table 1 Speaker stimulus

	Actual Speaker		
Experimental Design	A	B	C
Perceived speaker			
Non-Christian	St3	St1	St2
Christian	St1	St2	St3
Christian known for his healing powers	St2	St3	St1

RESULTS

The Christian participants were all highly religious. On a scale from 1–10 where 1 is "I do not believe in God's existence" and 10 is "I am absolutely certain of God's existence", all Christian participants reported a strong confidence in God's existence (Figure 1). They demonstrated a strong belief in the possibility of healing through prayer, and they all agreed that some persons have special healing powers. Furthermore, they reported a high confidence that healing through intercessory prayer can happen over a distance, e.g. via television and radio (Figure 1). The secular participants, on the other hand, demonstrated a low confidence in God's existence, and they did not believe in the possibility of healing through prayer or in persons with special healing powers (Figure 1). The Christian participants had been practicing intercessory prayer for 12 years on average (s.d. ± 6.3) and practiced intercessory prayer 33 times a month on average (s.d. ± 19). None of the secular participants practiced prayer.

When asked post-scan to rate the praying speakers' charisma, the Christian participants rated the speaker whom they thought was known for his healing powers, as being more charismatic than the speaker whom they thought was Christian (paired t-test almost significant at $P = 0.0659$),

Table 2 Activations in the six contrasts of conditions in the Christian participants

Anatomical region (Brodmann areas)	Cluster size (functional voxels)	*x*	*y*	*z*	*Z*-value
Non-Christian *vs* Christian known for his healing powers					
Prefrontal/anterior cingulate cortex (Ba 8/9/10/32/46)	1 1169	−32	58	8	4.85
Temporoparietal junction (BA 39/40)	2962	44	−46	42	4.66
Inferior temporal cortex (BA20)	883	64	−18	−20	4.41
Temporopolar/ventrolateral Orbitofrontal region (BA 38/47)	346	−32	20	−20	4.09
Cerebellum	256	−24	−78	−28	3.97
Temporoparietal junction (BA 40/39)	1163	−42	−52	32	3.93
Cerebellum	157	12	−84	−24	3.71
Inferior temporal cortex (BA20)	336	−58	−24	−18	3.59
Amygdaloid region	233	36	−2	−18	3.56
Temporopolar region (BA 38)	224	−48	−2	−10	3.37
Precuneus (BA 7)	245	10	−54	48	3.36
LOPFC (BA 47)	110	−56	18	−2	3.25
Insula (BA 13)	47	−48	−24	18	3.21
Temporopolar region (BA 38)	23	48	20	−20	3.14
Inferior temporal cortex (BA 20)	65	44	−4	−34	3.03
LOPFC (BA 47)	64	32	22	−14	3.02
Medulla	23	−8	−32	−48	3.00
Non-Christian *vs* Christian			None		
Christian *vs* Christian known for his healing powers			None		
Christian *vs* non-Christian			None		
Christian known for his healing powers *vs* non-Christian			None		
Christian known for his healing powers *vs* Christian			None		

Region/cluster size/mni coordinates of local maxima (*x*, *y*, *z*)/*Z*-value. Results are thresholded at $P < 0.05$ FDR-corrected with *Z*-value >3.00.

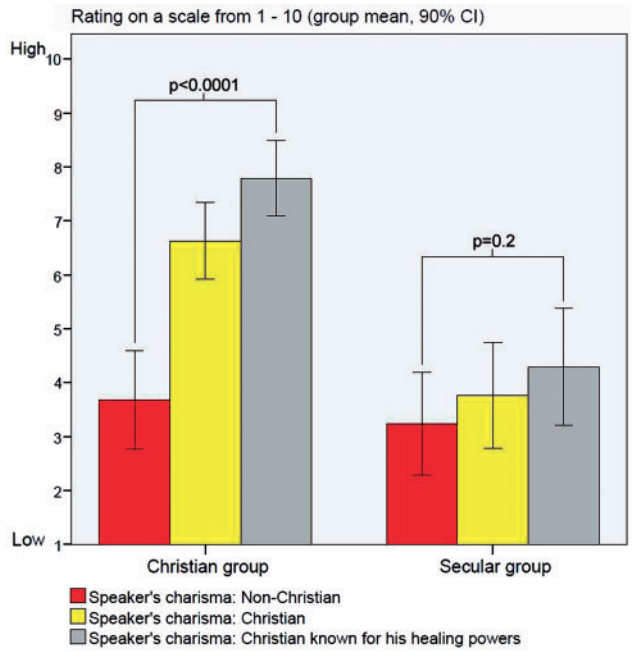

Fig. 2 Participants' ratings of speakers' charisma on a scale from 1 to 10 (90% CI).

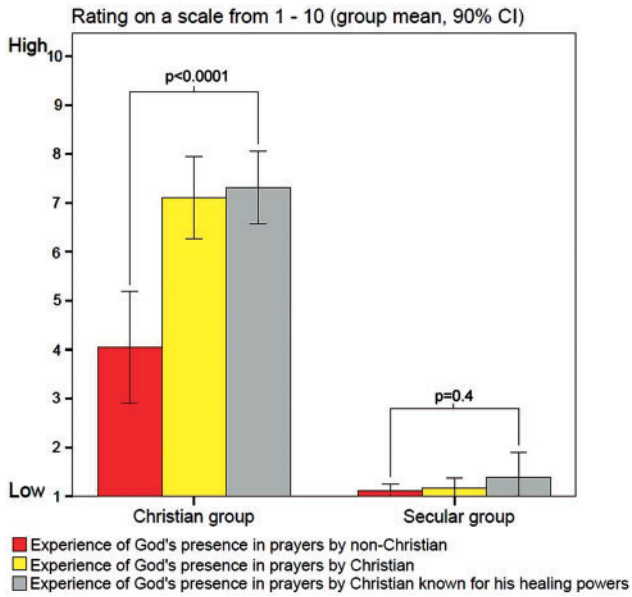

Fig. 3 Participants' ratings of the experience of God's presence on a scale from 1 to 10 (90% CI).

while the speaker whom they thought was non-Christian was rated significantly lower (Figure 2). A weak tendency for the same pattern was observed in the secular group (Figure 2). Similarly, the Christian participants reported that they felt God's presence in all prayers, but to a significantly less extent in prayers performed by the non-Christian. The secular participants did not feel God's presence in either of the prayers (Figure 3).

To test our hypothesis that participants' assumptions about the speaker would affect the evoked BOLD response,

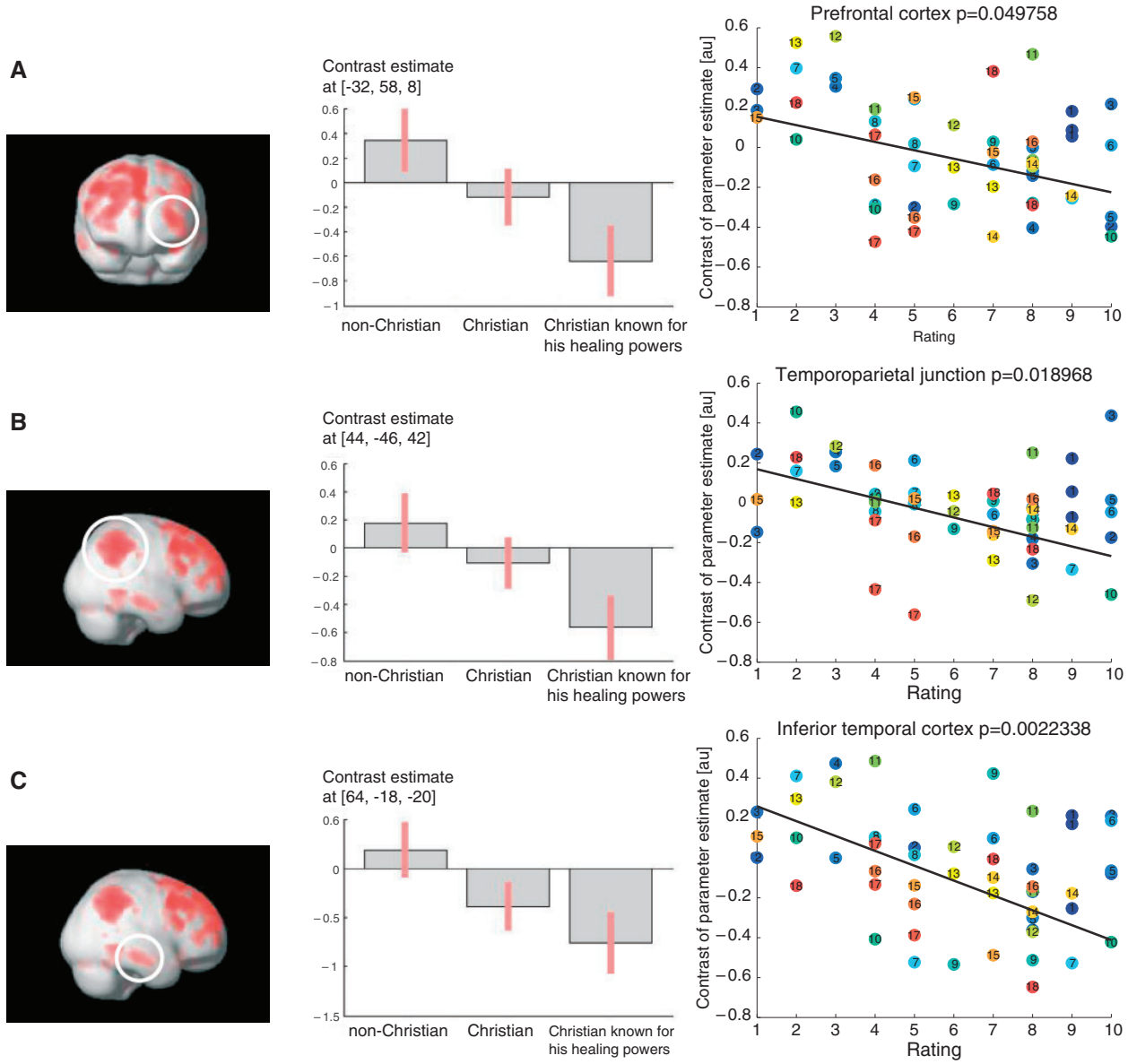

Fig. 4 Left: activations in 'non-Christian' relative to 'Christian known for his healing powers'. Results are thresholded at $P < 0.05$ corrected for multiple comparisons (FDR). The five global maxima are marked by white circles: (**A**) prefrontal cortex, (**B**) temporoparietal junction, (**C**) inferior temporal cortex, (**D**) temporopolar/orbitofrontal region and (**E**) cerebellum. Middle: effect size of the three conditions compared to baseline. Right: effect of listening to the praying speakers (*y*-axis) as a function of subsequent ratings of the speakers' charisma on a scale from 1–10 (*x*-axis). The black line corresponds to the average of fitted slopes from the individual participants (numbers encircled and coloured). A subject-specific fit was chosen to accommodate for large inter-subject variance in the ratings, e.g. some subjects consistently used high ratings, while others used only low ratings. A one-sample t-test across subject-specific slopes showed a significant effect for all regions except for the cerebellum ($P < 0.05$).

we analyzed the contrasts between the different 'speaker' conditions in both Christian and secular groups. In the secular group, we found no significant activations in these contrasts, which indicate that these participants did not modulate their neuronal response to the prayers according to the perceived speakers' religious status. In the Christian group, our results only revealed significant activations in one of the contrasts, namely, in the contrast 'non-Christian' relative to 'Christian known for his healing powers'. In this condition we observed frontal activations bilaterally in the anterior prefrontal cortex, the dorsolateral prefrontal cortex and the anterior cingulate/medial prefrontal cortex. We also found robust activations in the temporoparietal junction, the inferior temporal cortex, the temporopolar/ventrolateral orbitofrontal region and the cerebellum, and additionally in the precuneus, the amygdaloid region, the insula, and the medulla (Table 2 and Figure 4, left). To determine whether the BOLD response interacted with religious beliefs, we performed a direct between-groups comparison in a simple two-sample *t*-test. To limit the region in which

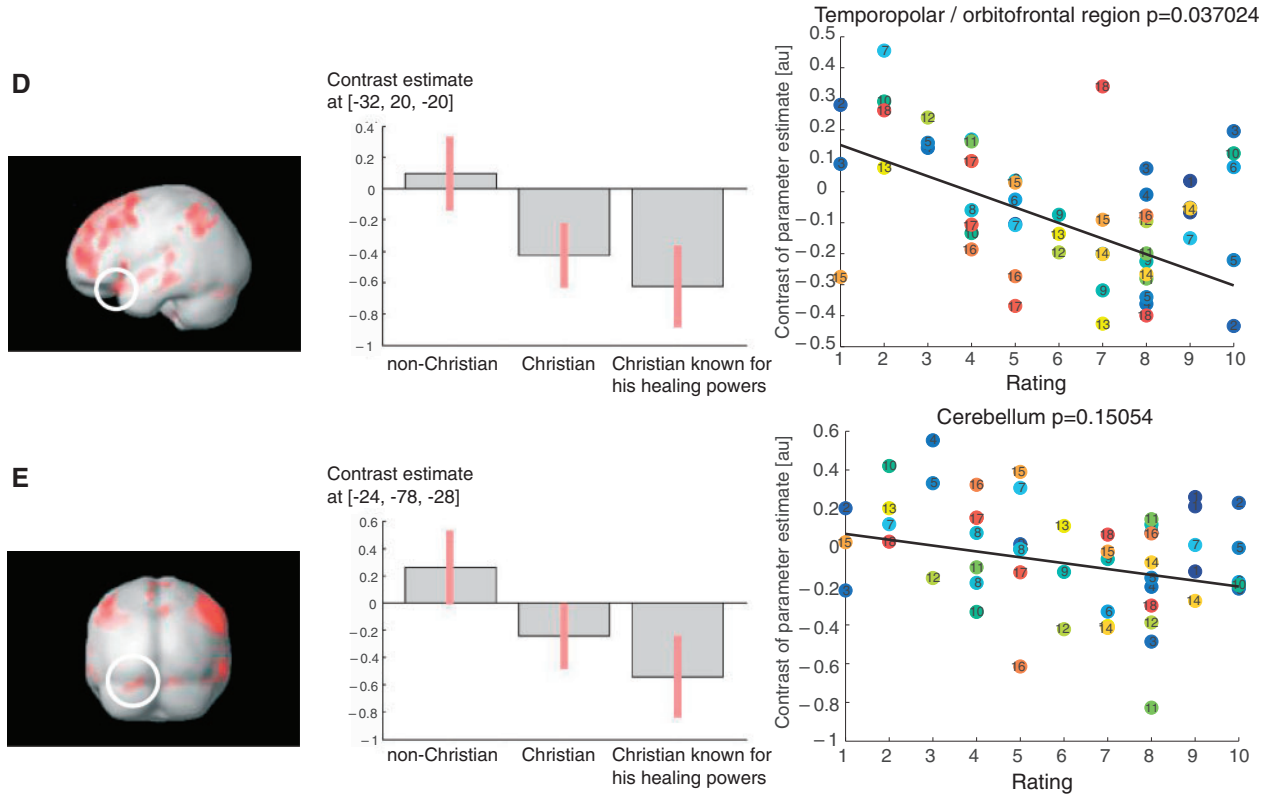

Fig. 4 Continued.

correction for multiple comparisons was performed, we masked the *t*-test with an *F*-test of any effect of speaker's religious status. As the *F*-test is non-directional no bias is introduced by this masking (Friston *et al.*, 2006). Results confirmed a significant difference between groups in the dorsolateral prefrontal cortex, the medial prefrontal cortex, the temporoparietal junction, the inferior temporal cortex and the lateral orbitofrontal region (Supplementary Figure S2 and Table S1).

In order to identify the relative effect of the activations in the Christian participants we compared the contrast estimates of each of the three 'speaker' categories to baseline by analyzing the peak activations of the five global maxima (Figure 4, middle). In these analyses, we observed less activation in response to the Christian known for his healing powers compared to baseline and more activation in response to the non-Christian speaker. These relative contrast estimates suggest an inverse correlation between the Christian participants' evoked BOLD response and their subsequent ratings of the speakers' charisma (Figure 2).

To show this relation between the Christian participants' neural activation and their subsequent ratings of the speakers' charisma we plotted the contrast estimates of the five global maxima (5 mm VOI around peak activation voxels) against subject ratings. A *post hoc* test was carried out to test for a significant negative slope across subjects. The results of this analysis confirmed a significant linear relationship between neural deactivation and higher ratings of speakers' charisma in all regions except for the cerebellum (Figure 4: right). We performed the same analysis on the relation between ratings of speaker's charisma and BOLD response in secular participants but found no significant activations (Supplementary Figure S3). Finally, we performed the same analysis on the five global maxima replacing the Christian participants' charisma ratings with their ratings of God's presence during prayer (Supplementary Figure S4). In this analysis, we found a significant relation in the temporopolar/orbitofrontal region ($P = 0.008$), the inferior temporal cortex ($P = 0.005$) and the cerebellum ($P = 0.039$). This means that the deactivations in these regions cannot be uniquely assigned to the subsequent rating of speaker's charisma as they also reflect participants' reported experience of God's presence during prayer. Note that the ratings of charisma and God's presence in the Christian group were strongly related (Supplementary Figure S5).

DISCUSSION

In this study, we find that young Danish charismatic Christians modulate their BOLD response to intercessory prayer according to their assumptions about the praying speaker. Most notably, we find differences in the executive and social cognitive networks. The contrast estimates reveal a significant increase of activity in response to the non-Christian speaker (compared to baseline) and a massive

deactivation in response to the Christian speaker known for his healing powers. These results support recent observations that social categories can modulate the frontal executive network in opposite directions corresponding to the cognitive load they impose on the executive system (Richeson *et al.*, 2003; Bartels and Zeki, 2004).

The observed activations cannot be attributed to simple congruency effects because the Christian participants mainly responded to the speaker known for his healing powers even though qualitative interviews revealed that they normally received intercessory prayer by their Christian peers. The fact that the secular group did not modulate their BOLD response further indicates that the effects observed in the Christian group are complex and depend on cultural framing and individual experience. Similar to the finding that successful hypnosis depends on subject's assumptions about the abilities of the hypnotist and the efficacy of the hypnotic procedures (Kirsch, 1999), our study suggests that the general deactivation in response to the known healer depends on the Christian participants' assumptions about the healing powers of the speaker and the efficacy of prayer.

Insights from hypnosis research may further explain how such effects become established in interpersonal interactions suggesting that frontal deactivation indicates a 'handing-over' of the executive function to the perceived charismatic speaker similar to a patient's 'handing-over' of executive function to the hypnotist. Studies on hypnosis have reported similar deactivations in subjects during hypnosis (Gruzelier *et al.*, 2002; Jamieson and Sheehan, 2004; Egner and Raz, 2007). Furthermore, hypnotically induced inhibition has been demonstrated to influence how subjects subsequently perceive and relate to stimuli (MacLeod and Sheehan, 2003). We find in an independent analysis across subjects that the more the Christian participants deactivate their executive and social cognitive networks the higher they rate the speaker's charisma post-scan. Note, however, that our study cannot determine whether participants' subjective experience was changed parallel to or as a result of the frontal deactivation. Integrating a behavioural measure of executive control in future studies will be necessary to determine the exact nature and causality of the observed mechanism.

At this point, we can only speculate to which extent this mechanism pervade normal interpersonal interaction. While our study informs us on the specific context of intercessory prayer in charismatic Christians we do not argue that this mechanism is exclusively related to hypnotic and charismatic interaction. Rather this relation may touch upon a central psychological mechanism of trust which is ubiquitously present in interpersonal interactions, e.g. in leader–follower, doctor–patient, teacher–student, producer–consumer and parent–child relations.

This notion, however, may seem challenged by previous studies on social interaction, e.g. in the context of fame (Leveroni *et al.*, 2000), social hierarchy (Zink *et al.*, 2008), expertise (Klucharev *et al.*, 2008) and friendship (Güroglu *et al.*, 2008), which have reported activations rather than deactivations in response to trusted persons in areas such as the dorsolateral and medial prefrontal cortex and the temporal cortex. Furthermore, recent studies on trust have linked learning and engaging in trust transactions to a neuronal response in the striatum (Delgado *et al.*, 2005; King-Casas *et al.*, 2005). Contrary to these findings, we find a general deactivation in the frontal executive network and in social cognitive regions including the medial prefrontal cortex, the temporoparietal junction, the temporopolar region (Gallagher and Frith, 2003) and the precuneus (Schilbach *et al.*, 2008).

These notable differences, we argue, may point to a dual-response model where trust in active paradigms increase cognitive load on executive and social cognitive processing because subjects are particularly motivated to pick up information associated with the trusted person, whereas trust in passive paradigms down-regulate executive and social cognitive processing, because subjects suspend or 'hand over' their critical faculty to the trusted person. In the above mentioned studies participants were instructed to actively relate to trusted persons, e.g. by participating in games (King-Casas *et al.*, 2005; Zink *et al.*, 2008), or making decisions by button press (Klucharev *et al.*, 2008). Conversely, the participants of our study were told to relax and listen to the prayers and they did not know that they were going to evaluate the speakers post-scan. The only other study to employ this kind of 'passive' paradigm is Bartels and Zeki's study (2004) in which participants were asked to relax and watch pictures of loved ones. To this condition they responded with deactivations in many of the same executive and social cognitive regions that we report in our study. This dual-response model of trust leads to an interesting hypothesis which we are currently testing at our lab that the same trust stimulus may have opposite effects on the executive network depending on the situation.

As an alternative interpretation of our results one might argue that prayer represents a very special category of social interaction subserved by unique neural mechanisms. However, in a previous study on personal prayer we found that praying to God activates the social cognitive network suggesting that praying is comparable to 'normal' interpersonal interaction (Schjoedt *et al.*, 2009). We also found that praying to God like other trust transactions recruits the reward system of the striatum (King-Casas *et al.*, 2005; Schjoedt *et al.*, 2008). These findings suggest that Christian prayer does not represent a special category of social cognition. Another interpretation might be that receiving prayer in fact involves actively praying. A recent study has reported medial prefrontal deactivation during sustained meditation (Brefczynski-Lewis *et al.*, 2007). However, the fact that receiving prayer deactivates regions found to be active in personal praying including the medial prefrontal cortex (Schjoedt *et al.*, 2009) suggests that the participants did not actively engage in prayer in response to the charismatic speaker.

Our findings support Weber's classic notion that followers recognizing the charismatic healer or leader as endowed with special powers is central to charismatic authority. While we agree with other researchers that communication style, ideology and personality as well as context may be important factors in facilitating charismatic influence (Conger and Kanungo, 1987; House and Howell, 1992; Barker, 1993; Kirkpatrick and Locke, 1996; Crant and Bateman, 2000; Gordijn and Stapel, 2008), we suggest that these aspects may primarily function as facilitators of the observed cognitive mechanism. Communication style, performance and personality, may enhance charismatic influence by boosting subjects' trust which in turn causes a down-regulation of the executive network maximizing subjects' susceptibility to charismatic vision and performance. Such behavioural and contextual components may be particularly important in the first stages of establishing charismatic authority and perhaps less important as the experience gets embedded in subjects' memory. Nevertheless, our study demonstrates that even without these components, without any prior interaction or any explicit techniques, subjects are readily capable of responding to a person of charismatic authority with, (i) a down-regulation of the evoked BOLD response, (ii) a more positive reported experience of that person's charisma and (iii) a stronger reported experience of God's presence during that person's prayer. We believe these early findings on Pentecostal interecessory prayer represent an important step toward an empirically based framework for understanding the cognitive mechanisms of charismatic authority.

SUPPLEMENTARY DATA

Supplementary data are available at *SCAN* online.

Conflict of Interest

None declared.

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