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Is it just a brick wall or a sign from the universe? An fMRI study of supernatural believers and skeptics

Marjaana Lindeman,[1] Annika M. Svedholm,[1] Tapani Riekki,[1] Tuukka Raij,[2,3] and Riitta Hari[2]
[1]Institute of Behavioural Sciences, Division of Cognitive Psychology and Neuropsychology, P.O. Box 9, 00014 University of Helsinki, Finland, [2]Brain Research Unit and AMI Centre, O.V. Lounasmaa Laboratory, School of Science, Aalto University, Puumiehenkuja 2, 00076 AALTO, Espoo, Finland and [3]Department of Psychiatry, Helsinki University Central Hospital, P.O. Box 590, 00029 HUS, Finland

We examined with functional magnetic resonance imaging the brain activity of 12 supernatural believers and 11 skeptics who first imagined themselves in critical life situations (e.g. problems in intimate relationships) and then watched emotionally charged pictures of lifeless objects and scenery (e.g. two red cherries bound together). Supernatural believers reported seeing signs of how the situations were going to turn out in the pictures more often than skeptics did. Viewing the pictures activated the same brain regions among all participants (e.g. the left inferior frontal gyrus, IFG). However, the right IFG, previously associated with cognitive inhibition, was activated more strongly in skeptics than in supernatural believers, and its activation was negatively correlated to sign seeing in both participant groups. We discuss the implications of these findings for research on the universal processes that may underlie supernatural beliefs and the role of cognitive inhibition in explaining individual differences in such beliefs.

Keywords: supernatural; fMRI; cognitive inhibition; sign

INTRODUCTION

Research on magical, paranormal, superstitious and other supernatural beliefs has for long been guided by the perspective that these beliefs are a departure from the norm and need to be explained. Although a host of cognitive, affective, motivational and social factors have been offered as tentative explanations (reviews: Vyse, 1997; Lindeman and Aarnio, 2006; Wiseman and Watt, 2006; Irwin, 2009), the explanations are fragmentary, and no consensus exists about the determinants of the beliefs.

Cognitive scientists of religion, in turn, have recently argued that belief in the supernatural, especially religiosity, is a cognitive default, a by-product of evolutionary adaptations present in all humans (Guthrie, 1993; Kelemen, 2004; Barrett, 2000; Boyer, 2001; Bering, 2006; Bloom, 2007). This so-called naturalness thesis can be summarized as follows: understanding intentional agents, the human manufacture of artifacts, and mental phenomena, which differ from physical entities, are evolved cognitive processes of the human mind. Supernatural beliefs are overgeneralizations in which this fundamental, universal and early-developing understanding is stretched onto inappropriate realms, both in children and adults. Thus, beliefs in supernatural agents and immortal souls are assumed to be 'natural' rather than anomalies requiring a more elaborate explanation. The thesis has been justified by the universality of religious beliefs and by the findings that both small children and adults are biased to believe in life after death, to see the world in terms of intentional design and to attribute intentions even to lifeless objects, such as moving geometric shapes (Heider and Simmel, 1944; Kelemen, 2004; Bering and Bjorklund, 2004).

The naturalness thesis does not, however, explain the individual differences in supernatural beliefs. If belief in the supernatural is a product of ordinary cognition, why do hundreds of millions of people not believe in the supernatural? This question is crucial because the origin, maintenance and the brain basis of such beliefs has remained poorly understood. Two possible explanations exist: either the skeptical individuals do not have a tendency toward supernatural beliefs in the first place, or—as we expect—they inhibit this tendency. Cognitive inhibition refers to conscious or unconscious stopping or overriding of a mental process; for example, suppressing unwanted or irrelevant thoughts, suppressing inappropriate meanings of ambiguous words and gating irrelevant information from working memory (Friedman and Miyake, 2004; MacLeod, 2007). As Hood (2009) has suggested, we might be overwhelmed by a sense of the supernatural if we did not have adequate inhibitory control. Several findings are in favor of the hypothesis that a skeptical attitude toward supernatural phenomena is associated with stronger cognitive inhibition.

First, decreased cognitive inhibition has strikingly similar correlates as supernatural beliefs. Decreased cognitive inhibition is associated with anxiety and neuroticism (a review: Nigg, 2000), feelings of threat and uncontrollability (Linville, 1996), altered states of consciousness (Dietrich, 2003), intuitive thinking and biases in logical reasoning (Moutier and Houdé, 2003; Cassotti and Moutier, 2010), spreading activations in semantic networks (White and Shah, 2006), and increased creative achievement (Carson *et al.*, 2003). More severe breakdowns in cognitive inhibition occur in several diseases, for example, in schizophrenia and obsessive-compulsive disorder (Nigg, 2000; Dewhurst and Beard, 2003; Friedman and Miyake, 2004). These are all qualities that are also associated with supernatural beliefs (for reviews, see Vyse, 1997; Lindeman and Aarnio, 2006; Wiseman and Watt, 2006; Brugger and Mohr, 2008; Irwin, 2009).

Second, cognitive inhibition develops gradually over childhood and declines with old age (Harnishfeger, 1995; De Neys and Van Gelder, 2009), whereas supernatural beliefs show a reverse developmental trend in that they decrease in school age (Rosengren *et al.*, 2000) and increase among older adults (Shermer, 2000; Zaitchik and Solomon, 2008).

Finally, people who believe in a variety of supernatural phenomena (e.g. telepathy, the afterlife, and amulets of luck) perform poorer than skeptics on each subscale of the Wisconsin Card Sorting Test, including perseverative errors (Lindeman *et al.*, 2011), the subscale most often connected to inhibitory problems (Demakis, 2003).

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Correspondence should be addressed to Marjaana Lindeman, Division of Cognitive Psychology and Neuropsychology, Institute of Behavioural Sciences, P.O. Box 9, 00014 University of Helsinki, Finland. E-mail: marjaana.lindeman@helsinki.fi

We thus hypothesized that a skeptical attitude toward supernatural phenomena is associated with a stronger cognitive inhibition, reflected as stronger activation of the right inferior frontal cortex, which has been associated with cognitive inhibition (Aron *et al.*, 2004; Volkow *et al.*, 2010; Munakata *et al.* 2011). The hypothesis was tested in an experiment that tempted participants to interpret ambiguous pictures as supernatural signs.

Signs come in manifold forms. For example, a heart-shaped box of chocolates can be a sign of romance and dark clouds signs of upcoming rain. In addition to these customary signs, individuals also construe ordinary objects and events as carrying idiosyncratic meanings and think of them as supernatural signs of how some situations are going to turn out. For example, Abraham Lincoln once told his wife that he had seen himself in a mirror at full length but with his face in two separate and distinct images. The wife considered this a sign that Abraham was to be elected to a second term of office (Brooks, 1958). Because threatening and emotionally arousing situations increase supernatural beliefs (Padgett and Jorgenson, 1982; Miner and McKnight, 1999; Keinan, 2002; Whitson and Galinsky, 2008), we hypothesize that when asked to imagine that they are about to experience critical life situations and then shown pictures of lifeless objects and scenery, supernatural believers will report seeing signs in the pictures more frequently than will skeptics.

METHOD

Pilot study

A pilot study on 119 volunteers (99 female, 20 male; mean age 27 years, range 19–48) was conducted to find appropriate pictures and to preliminarily test the hypothesis that seeing signs is typical for supernatural believers. The subjects filled in a web-based questionnaire where they read 24 short stories (one to two sentences long) describing critical life situations that were paired with pictures that were opened for viewing when clicked on with a mouse. The participants received the following instructions: 'In the next task it is important that you try to imagine yourself in various situations. You will be shown stories and a picture after each story. You should first read the story and then open the picture for viewing. Imagine you are walking down the street. You are deep in thought, thinking about the situation described in the story. Suddenly you see the picture on a large poster right in front of you. Try to think about what thoughts the picture might raise in you in that situation, and then answer the questions'.

Classic studies on life changes (Holmes and Rahe, 1967; Sarason *et al.*, 1978) were used as inspiration for the life situations depicted in the stories. The life situations related to six categories: intimate relationships, family, money and fortune, health, crimes and justice, and work. The pictures were sharp color photos of lifeless objects and sceneries containing no letters, numbers, animals or people, obtained from http://www.freedigitalphotos.net. An example item is the following: 'You have been unemployed and have now finally gotten a job interview. You are unsure about how it went and are anxiously awaiting the decision', followed by a picture of a business suit. After viewing each story–picture pair, the participants answered the following three questions. First, belief in signs was measured using the item 'If I saw that poster in that situation, I would think that the picture contained a sign or a message about how this situation was going to turn out', rated on a five-point scale (1 = Completely disagree, 2 = Somewhat disagree, 3 = In between, 4 = Somewhat agree, 5 = Completely agree). Second, emotional reactions were measured using the item 'Does the picture make you feel the following emotions in this context?', rated on a five-point scale (1 = Yes, very negative, 2 = Yes, quite negative, 3 = Does not raise emotions, 4 = Yes, quite positive, 5 = Yes, very positive). Because several participants commented in an open field for comments that they felt the pictures evoked contradictory feelings, the responses were recoded to form separate variables for positive and negative emotions. The positive emotion end of the five-point scale was recoded into a three-point scale for positive emotions, such that 'Yes, very positive' ratings were given the highest value, 'Yes, quite positive' the intermediate value and 'Does not raise emotions' the lowest value (recoding the values 5 into 3, 4 into 2 and 3 into 1). Correspondingly, the negative emotion end of the scale was reverse recoded into a three-point scale for negative emotions, such that 'Yes, very negative' ratings were given the highest value, 'Yes, quite negative' the intermediate value and the 'Does not raise emotions' the lowest value (recoding 1 into 3, 2 into 2, and 3 into 1). Third, ease of relating to the story–picture pairs was measured using the item 'How well were you able to imagine yourself in the situation that was described?', rated on a five-point scale (1 = Very badly, 5 = Very well).

Supernatural beliefs were measured using the Revised Paranormal Beliefs Scale (Tobacyk, 2004). The scale includes 26 five-point items (1 = Completely disagree, 5 = Completely agree) and seven subscales: witchcraft, psi, traditional religious beliefs, superstition, spiritualism, extraordinary life forms and precognition. Example items are 'Some psychics can accurately predict the future' and 'Some individuals are able to levitate (lift) objects through mental forces'. The reliability (Cronbach's α) was 0.92.

The mean rating of considering the pictures as signs of what was to come was 2.0 on the 1–5 scale. The distribution of ratings for most pictures was bimodal, with the highest peak at 1 (completely disagree) and another lower peak at 4 (somewhat agree). As expected, seeing pictures as signs correlated strongly with supernatural beliefs ($r = 0.50$, $P < 0.001$). The results also showed that seeing the pictures as signs was related to both positive ($r = 0.51$, $P < 0.001$) and negative ($r = 0.55$, $P < 0.001$) emotions. Ease of relating to the pictures correlated with negative emotions ($r = 0.24$, $P = 0.009$) but not with positive emotions ($r = 0.13$, $P = 0.172$). As ease of relating to the pictures did not correlate with belief in signs ($r = 0.09$, $P = 0.352$) or with supernatural beliefs ($r = 0.04$, $P = 0.638$), the variable was dropped from the main study.

Main study

Participants

Twenty-three volunteers, none of whom had participated in the pilot study, were recruited from a participant pool constituting a representative sample of 15- to 56-year-old Finnish people (for details, see Lindeman, 2011). To recruit supernatural believers and skeptics, we contacted subjects who were at the extreme ends (highest and lowest 10%) of the distribution of supernatural belief, as measured by the Revised Paranormal Beliefs Scale (Tobacyk, 2004) in a previous study (Lindeman, 2011). Out of the 23 participants, 12 were supernatural believers (six female, six male; mean age 38 years, range 23–53) and 11 were skeptics (six female, five male; mean age 34 years, range 21–49). Additional inclusion criteria were lack of psychiatric or neurological disorders and fulfillment of functional magnetic resonance imaging (fMRI) safety requirements. The study had prior approval from the ethics committee at the Hospital District of Helsinki and Uusimaa, and all subjects signed a written informed consent.

Stimuli and procedure

The stimuli were 30 story–picture pairs, developed and selected on the basis of the pilot study and balanced with respect to emotional valence. Figure 1 shows examples of stories and the pictures they were coupled with.

Before entering the scanner, the participants were informed about the task they would perform in the scanner, and they were given

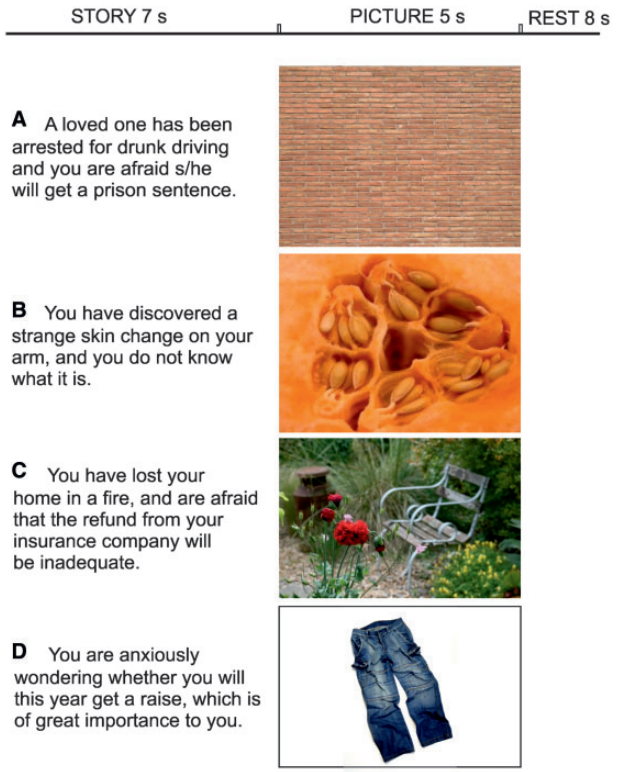

Fig. 1 Example story–picture pairs. Pictures from http://www.freedigitalphotos.net. Three of the pictures have a known image creator: m_bartosch (A), Simon Howden (C) and Suat Eman (D).

instructions on a computer screen followed by three practice story–picture pairs. The participants received the following instructions: 'In the next task it is important that you try to imagine yourself in various situations. You will be shown stories and a picture after each story. Imagine you are walking down the street. You are deep in thought, thinking about the situation described in the story. Suddenly you see the picture on a large poster right in front of you. Try to think about what thoughts the picture might raise in you in that situation'.

In the scanner, the instructions were shown again on a small projector screen 20 cm from the participant's face. The participants were shown each story for 7 s, then a picture for 5 s, followed by an 8 s pause showing a blank screen. The stimuli were presented using the Presentation® software (www.neurobs.com/presentation). T1-weighted structural images were acquired after the functional images.

After leaving the scanner, the participants received a questionnaire booklet containing the same stories and pictures that they had viewed during the scan. To obtain a self-report variable for seeing signs in the pictures, the participants were asked to rate their agreement on a five-point scale with the statement 'If I was in the situation described and saw that poster, I would think that the picture contained a sign or a message for me about how the situation was going to turn out' (1 = Completely disagree, 5 = Completely agree). The participants were also asked to indicate on three separate three-point scales to what extent each picture made them feel positive, negative and contradictory emotions in that context (1 = None, 2 = A little, 3 = A lot). Before leaving the Advanced Magnetic Imaging Centre of Aalto University, the participants were debriefed about the study.

Imaging was done using a Signa VH/i 3.0 T scanner (GE Healthcare, Chalfont St Giles, UK) with the following parameters for functional images: echo time 32 ms, repetition time 2.0 s, flip angle 75°, field of view 22 cm, 34 slices aligned with the line connecting the anterior and posterior commissures, slice thickness 4.0 mm and matrix size 64 × 64. To achieve equilibrium of the signal, the first four whole-head images were discarded.

fMRI analyses were conducted with SPM8 (http://www.fil.ion.ucl.ac.uk/spm/software/spm8/). The functional images of each subject were realigned to the same space by linear rotation and translation to correct for movement (Friston *et al.*, 1995). Then, images were normalized to a Montreal Neurological Institute (MNI) template for intersubject comparison (Friston, *et al.*, 1995) and smoothed with a Gaussian kernel (full width at half maximum = 8 mm) to compensate for individual variation in functional anatomy and to better fit the assumption of normal distribution in statistical testing.

Functional time series were analyzed with a general linear model. Box-car functions for story, picture and rest blocks were entered to model, and convolved with a hemodynamic response function. Movement parameters were entered as confounding covariates in case of movements larger than half a voxel during the scanning. The fMRI data were fitted to the model, and individual contrast images for each participant were calculated to show differences in parameter estimates between conditions in each voxel. These images were then used for group-level statistical tests.

To test the overall activation effects of the task (picture > rest), a one-sample *t*-test, with supernatural believers and skeptics pooled, was done on the entire brain with a familywise error (FWE) correction for multiple comparisons. Group differences were tested with a two-sample *t*-test on the whole brain and in an anatomical region of interest (ROI). The right inferior frontal gyrus (IFG) was chosen a priori as a ROI following the results of Aron *et al.* (2004) and located using the Wake Forest University School of Medicine PickAtlas (Maldjian *et al.*, 2003, 2004) and Talairach Atlas (Lancaster *et al.*, 2000). The right IFG was also the ROI of a multiple regression analysis with the picture > rest contrast in supernatural believers and skeptics pooled and the self-report variable of seeing signs as a covariate. Results were familywise error corrected for multiple comparisons in the volume of the ROI. In addition, we tested the difference between supernatural believers and skeptics in an a priori chosen ROI in the left IFG, because Tylén *et al.* (2009) found activation in these areas when participants viewed objects arranged to convey a message. No group differences in the left IFG were found.

RESULTS

Supernatural believers reported seeing signs in the pictures about twice as often as the skeptics ($M = 3.49$ and $M = 1.79$, respectively; one-way analysis of variance (ANOVA): $F(1,21) = 25.92$, $P < 0.001$, $\eta^2 = 0.564$). Seeing signs correlated with the positive emotions ($r = 0.56$, $P = 0.007$), the negative emotions ($r = 0.72$, $P < 0.001$) and the conflicting emotions ($r = 0.54$, $P = 0.009$) evoked by the pictures.

In the pooled data of supernatural believers and skeptics, viewing pictures when instructed to imagine seeing them in the context of the preceding story (picture > rest) activated the left inferior frontal gyrus, middle frontal gyrus, fusiform gyrus, middle occipital gyrus and hippocampus (see Figure 2 for visualization of activated areas and Table 1 for peak areas and activation clusters). The reverse contrast (rest > picture) revealed no statistically significant activity.

Figure 3 shows that, in group comparison, skeptics had a stronger activation than supernatural believers in the pars orbitalis and pars triangularis of the right IFG [Brodmann's area (BA) 45/47; $T = 5.34$; MNI coordinates $x = 52$, $y = 22$, $z = 0$; $P < 0.05$, FWE-corrected for multiple comparisons). No other group differences were found. Second, Figure 3 shows that, for the pooled group of paranormal believers and skeptics, the ratings of seeing signs covaried with the average contrast strength in the picture > rest contrast in these same areas

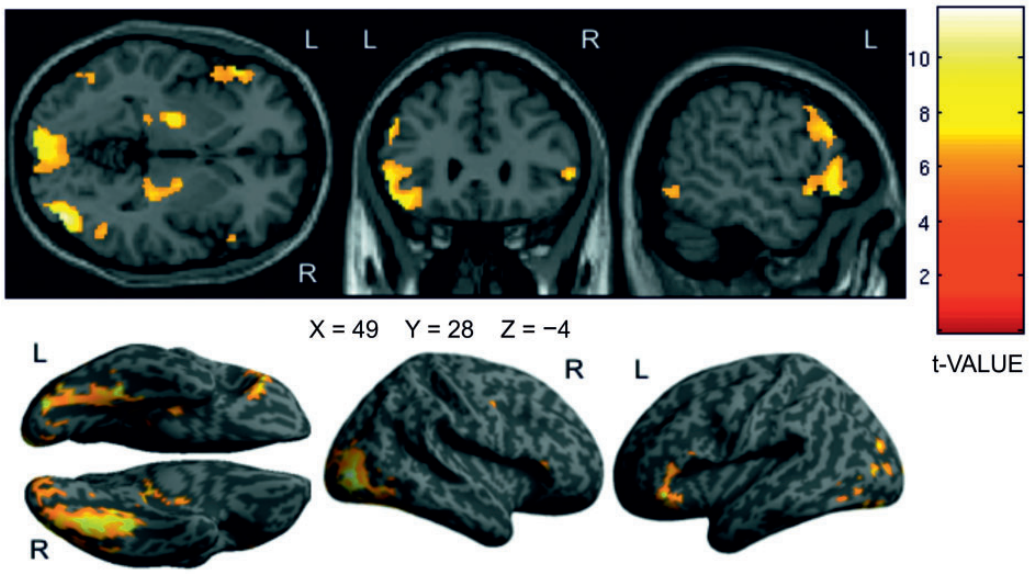

Fig. 2 Areas activated in the picture > rest contrast in the whole-brain analysis. Activations are thresholded at $P < 0.05$, FWE-corrected for multiple comparisons.

Table 1 Main brain regions showing stronger fMRI signals during picture viewing than rest; pooled data from both groups of participants

Area of activation	BA	Left hemisphere					Right hemisphere				
		T	Cluster size (voxels)	Coordinates			*T*	Cluster size (voxels)	Coordinates		
				x	*y*	*z*			*x*	*y*	*z*
Inferior frontal gyrus											
Pars orbitalis	47	8.86	644	−50	32	−10					
Pars triangularis/pars opercularis	9/45	8.72	237	−56	18	32	8.04	59	56	26	2
Middle frontal gyrus	8/6	7.80		−48	12	50	8.22	36	58	−2	48
Fusiform gyrus	20/37	9.55	1301	−28	−44	−24	9.98		32	−42	−24
	37/18	7.56		−30	−72	−16	11.81	4612	32	−64	−18
Middle occipital gyrus	19	8.42	294	−34	−92	18	11.12		40	−84	2
Hippocampus		7.52	229	−20	−10	0	8.85		26	−18	−10

Note. BA = Brodmann's area. The data were thresholded at $P < 0.05$ (FWE-corrected) for voxels and clusters. *T* scores are test statistics for the peak activations. Cluster size refers to the number of consecutively connected voxels (k_E) in an activation cluster.

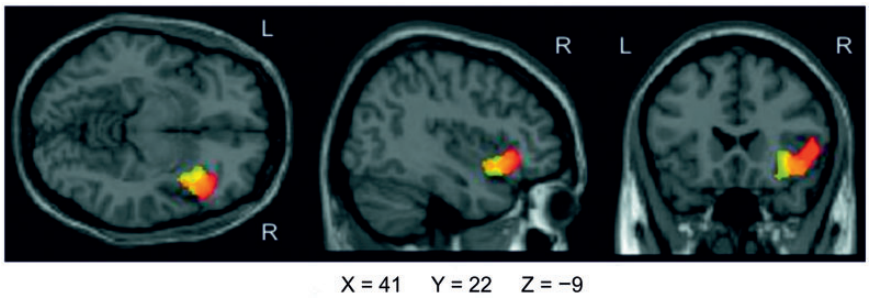

Fig. 3 Group differences between skeptics and paranormal believers. Red: the area more activated in skeptics than paranormal believers in the picture > rest contrast. Yellow: the deactivation area in a multiple regression analysis of the picture > rest contrast with seeing signs as a covariate. Thresholded at $P = 0.005$, uncorrected for visualizing purposes.

(BA 47; $T = 4.73$; MNI 36, 18, –10; $P < 0.05$, FWE-corrected for multiple comparisons). The stronger the activation was in these areas, the less the participants reported seeing signs, and vice versa.

Because the story and picture stimuli were presented sequentially and at relatively short time intervals, it was necessary to test the possibility that the activations in the picture condition were due to residual activations from the preceding story condition. To examine the activation of the left IFG in relation to the picture stimuli, we examined how the signal changed as a function of time. To obtain a measure of activation strength, we first scaled the global signal to the intracerebral mean in an anatomical ROI of BA 45 and BA 47 by collapsing the mean across multiple voxels, producing a signal-change

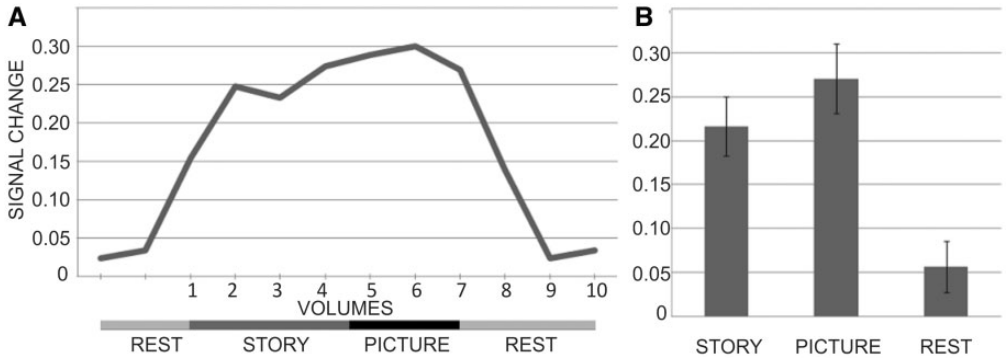

Fig. 4 (**A**) Average signal change in percent across participants during a trial (10 volumes, 2 s each) in the left IFG (BA 45/BA 47). (**B**) Average signal change in percent with standard errors of the mean in the story, picture and rest conditions.

value. We then extracted the time course of the signal in the ROI for each participant and calculated average signal changes for each time point across different trials. We next calculated the average signal changes during the story, picture and rest conditions for each participant. Finally, we followed the time course of the average signal change within trials and the average signal change in relation to story, picture and rest conditions across the subjects.

Figure 4 shows the average time course for a trial and the average signal changes in relation to story, picture and rest conditions. The activation of BA 45 and BA 47 is slightly stronger for pictures than stories, but the difference is not statistically significant, $t(22) = -1.25$, $P = 0.224$. Therefore, the activation of BA 45 and BA 47 during the picture condition is not due to residual activation from the story condition.

DISCUSSION

As expected, supernatural believers exhibited stronger belief in supernatural signs than skeptics did. In other words, participants who considered phenomena such as astrology, spirits and life after death as real reported that if they were to see the stimulus pictures (e.g. a brick wall) in critical life situations (e.g. risk for a prison sentence), they would think of the pictures as signs of how the situation was going to turn out. This result was found in the pilot study and replicated in the main study.

The causal processes underlying seeing these kinds of signs are not known. One possibility is that seeing supernatural signs is a pan-cultural human tendency and that people perceive random but emotionally salient and unexpected events as a mode of communication, similar to natural communication via language, eye gaze or pointing (Bering, 2006; Bering and Parker, 2006). This argument has received support, in that children who had been primed with a story about an invisible, magical 'princess Alice', interpreted an unexpected event (a painting falling off the wall) as a personal sign from the princess (Bering and Parker, 2006).

Other processes may also be involved in supernatural sign seeing. For example, belief in supernatural signs may reflect confusion between two types of signs, symbols and indexes. Symbolic meanings, such as the flag of a country or a photo of two red cherries bound together, are arbitrary and bear no realistic connection to their referents, the country and intimate relationships. An index (e.g. dark clouds), in turn, is a sign that has a physical and temporal causal connection to its existing or upcoming external referent (Peirce, 1955). Signs that are symbols for adults (e.g. names) are initially indexical for young children (Piaget, 1929/1951; Homer and Nelson, 2005; Iverson and Goldin-Meadow, 2005). Similarly, for adults with a tendency to hold supernatural beliefs, the symbolic content attached to a surprising scene or event may appear to be an index, i.e. causally connected to future events.

The present results cannot establish whether the participants coded the stimulus pictures as communication, indexes or something else. However, viewing the pictures activated the left IFG, including Broca's area, among both participant groups. The left IFG has an important role in processing various signs and their meaning (i.e. semantics), including spoken and written language (Poldrack *et al.*, 1999; Bookheimer, 2002; Price, 2010), sign languages (MacSweeney *et al.*, 2008), pantomimes and gestures (Willems and Hagoort, 2007; Xu *et al.*, 2009) and other communicative symbols (Tylén *et al.*, 2009). In our study, these language-related brain circuitries were activated both in skeptics and believers although the pictures included no objective signs. Because these activations may be related to task involvement or other verbal and semantic processes, future studies should use a control task (e.g. presenting a non-emotional narrative followed by a picture) that would allow to address the possibility that the left IFG activation reflects brain processing that supports supernatural beliefs. Nevertheless, the IFG activation strengths in the picture condition were equal to those in the story condition, supporting the argument that the activations were not just residuals from reading the preceding story, but related to interpretation of the pictures.

In addition, the results revealed important differences between supernatural believers and skeptics. In contrast to supernatural believers, skeptics did not interpret the pictures as signs in their verbal reports. This was probably more than a verbal smokescreen: When participants were viewing stimulus pictures, the right IFG was activated more strongly in skeptics than in supernatural believers. As the right IFG activation in a relevant context has been suggested to be an indicator of cognitive inhibition (Aron *et al.*, 2004; Volkow *et al.*, 2010), the results are consistent with the hypothesis that a skeptical attitude toward supernatural phenomena is associated with stronger cognitive inhibition. In particular, the negative correlation between the activation strength of the cognitive-inhibition-related right IFG and the extent to which the participants reported seeing signs in the pictures supports the argument that the skeptics suppressed the potential idea of a supernatural sign in the pictures as irrelevant, while believers did not. This interpretation is in line with previous findings showing that skeptics perform better on inhibitory tasks than supernatural believers do (Lindeman *et al.*, 2011).

The results have important implications, as individual and developmental differences in cognitive inhibition may provide a coherent framework for many fragmentary findings on supernatural beliefs. Although people's general inclination toward supernatural beliefs

may be understood as a form of natural information processing, weak cognitive inhibition may explain why supernatural beliefs are not typical of everybody but especially of, for example, children, old people, creative individuals, intuitive thinkers, people in distress and with mental disorders, as well as during decreased sense of control and altered states of consciousness (for reviews, see Vyse, 1997; Lindeman and Aarnio, 2006; Wiseman and Watt, 2006; Irwin, 2009). Similarly, it is possible that, besides an implicit inclination toward supernatural interpretations, skeptics may have endorsed explicit supernatural beliefs at some point in their lives. We suggest that developmental increases in cognitive inhibition may be among the factors that contribute to the decline of these beliefs.

Some limitations of the present study should be acknowledged. Although cognitive inhibition has a high heuristic value as a process that integrates findings on supernatural beliefs into a single framework, the topic requires further exploration. As has been noted (Aron *et al.*, 2004; Friedman and Miyake, 2004; Lustig *et al.*, 2007), cognitive inhibition includes a family of functions that are related but distinct, and the meanings of the term are inconsistent across authors, and some findings may be inconclusive because the reliabilities or validities of some commonly used inhibition tasks are not stable. Moreover, as described in the Introduction, believers and skeptics differ on many variables other than supernatural belief, which might have contributed to the observed differences in brain activation. One such variable is creativity. A crucial element in the creative process is the ability to produce a range of new associations (Schmajuk *et al.*, 2009), and creative achievement is associated with reduced latent inhibition (Carson *et al.*, 2003). It is thus possible that the tasks used in the present study activated semantic brain networks, and creative people showed less activation in areas associated with cognitive inhibition. Future studies should control for such confounding effects and replicate the present findings in larger samples.

Despite these limitations, the results were promising in that the converging findings from behavioral and fMRI results pinpoint cognitive inhibition as a strong candidate for explaining the tendency to abandon or suppress supernatural beliefs. If future research can replicate these findings, individual differences in supernatural beliefs should be approached from a new point of view: not as a question of why so many people believe in supernatural phenomena, but as a question of why some people do not. One of the basic tenets about human thinking is that when reasoning is powerful enough, people have the capacity to overcome the biases of automatic processing by inhibiting irrelevant or illogical information (Stanovich and West, 2000; Kahneman, 2003; Lustig *et al.*, 2007; Evans, 2008). Cognitive inhibition, that is, suppressing or overriding spontaneously occurring mental processes, may thus be the mechanism that, when working efficiently, controls our natural intuitions and explains why supernatural interpretations seem so natural for some people and yet others find them quite strange.

Conflict of Interest

None declared.

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