Neuroscience Letters 548 (2013) 239–243

Contents lists available at SciVerse ScienceDirect

Neuroscience Letters

journal homepage: www.elsevier.com/locate/neulet

Culture and its neurofunctional correlates when death is in mind

Verena Graupmann[a,*,1], Isabella Peres[b], Tonia Michaely[b], Thomas Meindl[b], Dieter Frey[b], Maximilian Reiser[b], Ernst Pöppel[b], Kai Fehse[b], Evgeny Gutyrchik[b,1]

[a] DePaul University, Chicago, United States
[b] Ludwig Maximilian University Munich, Germany

HIGHLIGHTS

- The interplay of death reminders and cultural coping is tested on a neural level.
- Death priming preceding the viewing of culture content was associated with specific brain activation patterns.
- Neither neutral nor meaning-threat priming preceding cultural content were associated with such activation.
- This supports the idea that notions of mortality evoke cultural worldview defense.

ARTICLE INFO

Article history:
Received 1 March 2013
Received in revised form 28 May 2013
Accepted 29 May 2013

Keywords:
Terror management theory
Culture
Functional magnetic resonance imaging
Meaning maintenance
Mortality salience
Self

ABSTRACT

The human fear of death is marked by specific psychological reactions that affirm cultural belonging. Terror management theory explains this phenomenon with the symbolic immortality provided by collective meaning in culture. This coping has also been explained with the motive of maintaining a meaningful representation of the world. Here we show that neural patterns of activations corresponding to cultural worldview defense processes differed when images that affirmed participants' cultural heritage were preceded by death-related verbal primes versus verbal primes threatening meaning. Cultural content was drawn upon distinctly on a neural basis when facing death-related cognitions. The neural representation of cultural coping sheds light on the immediate mechanisms in compensating the human fear of death.

Death gets to us. No other event has such undeniable implications for those affected by it. Awareness of own mortality leads to anxiety. When consciously aware of death, people employ proximal coping strategies reducing the anxiety by e.g. emphasizing physical health [20]. However, more often notions of death are not consciously worked through and people use more distal defenses to deal with the existential fear: By believing in an afterlife and thus literally insisting on immortality, or via symbolic immortality represented through lasting achievements, one's culture, or one's children [5]. Both defenses are based on the validity of a person's cultural worldview. Terror management theory (TMT) explains human investment in belief-systems that bolster cultural worldviews with the motivation to cope with death anxiety [24]. Research on TMT has consistently shown an association between death-related thoughts and subsequent reactions that defend, or affirm worldviews [5]. There is e.g. evidence for stronger identification with national symbols [14] and upvalueing one's ingroup [10] when mortality is salient. The association of death-related thoughts and subsequent defense reactions in TMT has been disputed by an alternative account, the Meaning Maintenance Model (MMM) [11]. The MMM holds that the superordinate motive to maintain meaning in one's representation of the world – i.e. to experience reality as coherent, consistent and continuous – can explain the effects. This suggests that not the unique psychological responses to the idea of death, but an overarching cultural coping-mechanism dealing with threats to meaning in general is responsible for the TMT-related outcomes. Various worldview defense effects have been shown to occur to the same degree under meaning threat, e.g. by exposure to surrealistic paintings or literature, as under mortality salience [5,19].

The common claim of the TMT and MMM approach consists of the assumption that worldview defense and -affirmation is a behavior triggered by a perceived threat to an important entity. The difference lies in the approaches' claims regarding the *specificity* of that threat (a threat to the continuity of life, or a any threat

* Corresponding author at: DePaul University, Department of Psychology, 2219 North Kenmore Avenue, Chicago, IL 60614-3504, United States.
Tel.: +1 773 325 8225; fax: +1 773 325 7888.
E-mail address: vgraupma@depaul.edu (V. Graupmann).
[1] These authors contributed equally to this work.

0304-3940/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.neulet.2013.05.062

directed at the general maintenance of a meaningful context). On a behavioral level cultural worldview defense can be observed under both conditions. In the current research we aim to examine neural activation during cultural worldview defense under both death and meaning threat, to determine whether also on this level of analysis a similar recruitment of resources is pursued.

On the neural level a specific activation pattern for the processing of death-related linguistic cues has been determined [9]. Although death-related words share activation patterns with negatively valenced words, in the precuneus and the posterior cingulate cortex (PCC) – areas of the brain that are associated with arousal and emotion regulation – death-related words are additionally correlated with decreased insular activity. This is indicative of less recruitment of self-processes that integrate emotional experiences, i.e. with the "sentient self" [6], when processing death-related content. Using manipulations similar to those used in TMT-research, Quirin et al. [21] give additional evidence for brain activation related to death-related thinking. They found differential brain activity that was related to mortality salience in the right amygdala, the left anterior cingulate cortex (ACC) and in the right caudate nucleus (CN). Finding differing areas for activation associated with death-related processing might be due to the different experimental paradigms used.

A neurocognitive validation of TMT as a theoretical approach does not require a specific activation pattern for death-related content – the predictions of the MMM are not in contrast to a specific emotional impact of death-related words. However, we argue that in order to establish the specific mechanisms proposed by TMT in distinction from a more general meaning threat approach, it is instrumental to examine on a neural level which areas of the brain are recruited *during the cultural worldview affirmation* when death- or meaning threat related content is accessible.

The specificity of mortality salience, that has both been the subject of philosophical debate [2] and an abundance of psychological study [5], informs our hypothesis, that on the neural level, there will be a distinct activation pattern during cultural worldview affirmation while the concept of death is activated, as compared to meaning threat and neutral priming.

Being interested in the interplay of the two psychological processes (mortality salience and processing of culture), we examined how death-related priming (death) compared to priming that threatened meaning (meaning-threat) interacted with the processing of content affirmative of own culture. We describe the underlying brain processing using functional magnetic resonance imaging (fMRI).

1. Method

1.1. Participants

Twelve right-handed native German speakers (5 female, 7 male; 33 ± 5 years) participated. The study was carried out in accordance with the Declaration of Helsinki and approved by the local ethics committee. Subjects provided informed consent and received payment for participation.

1.2. Stimuli

Based on our theoretical considerations we designed the experiment on the exploration of processes presumably involved in dealing with death or meaning threat. Here we expected specific neural patterns for each of these two conditions without having hypotheses about intensities. We additionally employed further experimental conditions to control for unspecific semantic, verbal or visual input.

Table 1
Overview over conditions.

Condition	Prime 200 ms	Image 3800 ms
dC	Death-related	Culture
mC	Meaning-threat	Culture
nC	Neutral (meaningful)	Culture
C	–	Culture
N	–	Neutral

1.2.1. Primes

Primes were word pairs composed of two German nouns [26,27]. The set of stimuli consisted 40 death-related, 40 meaning-threat, and 40 neutral primes. Death primes consisted of the word 'death' and a noun, e.g. "Todes-Gift" (death-poison). Meaning-threat primes were unsettling combinations of two nouns that are normally not associated [22], e.g. "Enten-Bumerang" (duck-boomerang). Neutral primes comprised two normally associated nouns, e.g. "Ziegen-Käse" (goat-cheese).

1.2.2. Culture affirmation

Images positively depicting participants' culture (Germany) served as worldview affirmation, neutral images served as a control. Eighty pictures had been pilot-tested as positively depicting Germany and used in four conditions (20 per condition). Control targets were 40 pictures with neutral valence (4.96 ± 0.24) from the International Affective Picture System [IAPS; 15].

1.3. Procedure

In an fMRI block design each block comprised four trials. In each trial a prime appeared on the screen for 200 ms, followed by an image for 3800 ms. There were three prime conditions (death prime/culture image: dC, meaning-threat prime/culture image: mC, neutral prime/culture image: nC) and two non-prime conditions comprising only pictorial stimuli (culture image: C or neutral image: N; see Table 1), where a black screen substituted word presentation. Participants judged whether they liked the images by pressing "yes" or "no" on a button box (LUMItouch, Photon Control Inc, Canada). A fixation cross was presented between blocks for 6000 ms. In two sessions participants completed 10 blocks per condition (10 blocks $\times$ 4 trials = 40 trials per condition) in a pseudo-randomized order.

Stimuli were presented computer controlled (Presentation, Neurobehavioral Systems, USA) onto a translucent screen viewed by subjects via a head coil-compatible mirror system.

Image acquisition was conducted at a 3 T whole body system (Magnetom VERIO, Siemens, Germany) with a standard A TIM head coil. For BOLD imaging T2*-weighted EPI sequence was used (TR = 2000 ms, TE = 30 ms, FA = 80°, 31 axial slices, slice thickness = 4 mm, gap = 0.4 mm, interleaved acquisition, FOV = 192 mm $\times$ 192 mm, matrix = 64 $\times$ 64). The total of 286 functional volumes were acquired per subject.

1.4. fMRI data processing

The functional images were realigned, spatially normalized into standard stereotaxic space (EPI template; Montreal Neurologic Institute, MNI), re-sliced to 2 mm $\times$ 2 mm $\times$ 2 mm voxels, and smoothed with an 8 mm full-width at half maximum (FWHM) Gaussian kernel using SPM8 software (Statistical Parametric Mapping; http://www.fil.ion.ucl.ac.uk/spm). To account for T1 saturation effects, the first five images in each series were removed from further analysis. At the first level, the five experimental conditions (with 16 s block duration) were modeled by a boxcar function convolved with the canonical hemodynamic response function.