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Research report

Hyperthymic temperament and rapid reaction time in brightness preference

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ABSTRACT

Background: It is well-known that Type A behavior pattern is characterized by hard-driving, competitive behavior and time urgency. Also, people with hyperthymic temperament are known to have high energy levels and are full of plans. It is therefore hypothesized that hyperthymic temperament is associated with rapid processing and fast reaction time in making decisions.
Methods: Using data from our previous experimental studies ($N=58$) examining brightness judgment and brightness preference, reaction time (RT) was investigated in relation to hyperthymic temperament scores and fMRI signal changes of the left inferior orbitofrontal cortex during brightness judgment.
Results: RT for brightness judgment was significantly shorter than RT for brightness preference. Significant associations were found between RT for brightness preference and hyperthymic temperament scores, and RT for brightness preference and fMRI signal changes of the left inferior orbitofrontal cortex whilst performing brightness preference task. Multiple regression analysis revealed that RT for brightness preference task was significantly and negatively associated with hyperthymic temperament scores, and significantly and positively associated with fMRI signal changes of the left inferior orbitofrontal cortex.
Limitations: It is uncertain whether the findings of RT (around 1 s) can be extrapolated to routine life (around 24 h) and whether RT for brightness preference can be generalized to a variety of daily activities.
Conclusions: The present findings suggest that hyperthymic temperament is associated with rapid processing. Further studies are required to overcome the above limitations.

1. Introduction

Type A behavior pattern (TABP) has been characterized in terms of *hard-driving*, *competitive behavior*, hostility, *time urgency* as well as vigorous speech stylistics (Gallacher et al., 2003; Rosenman et al., 1975). Similarly, people with hyperthymic temperament are described as cheerful and exuberant; articulate and jocular; over-optimistic and carefree; overconfident, boastful and grandiose; extroverted and people seeking. Furthermore, such people demonstrate *high energy levels*; are *full of plans* and improvident activities; are considered versatile with broad interests; over involved and meddlesome; uninhibited and stimulus seeking as well as being habitually short sleepers (Akiskal, 1996). As such, there appears to be many common elements between the two constructs and an association between hyperthymic temperament and TABP has been demonstrated (Wang et al. 2011). In view of these similarities, it is probable that hyperthymic temperament is also associated with rapid speed of processing but this has not been demonstrated experimentally.

Following from previous experimental studies examining brightness judgment (Harada et al., 2013a) and brightness preference (Harada et al., 2013b) in relation to hyperthymic temperament, we newly examined reaction time (RT) data generated from these experiments to investigate the hypothesis that hyperthymic temperament is associated with rapid processing in decisions of requiring subjects to judge and indicate preferences of illuminance. Moreover, the previous studies (Harada et al., 2013a, 2013b) suggest the left inferior orbitofrontal cortex as one of neural correlates of hyperthymic temperament and therefore percent signal changes of the region of interest (ROI) were measured and analyzed in relation to RT.

2. Methods

2.1. Subjects

The brightness judgment experiment consisted of 34 healthy subjects (13 women and 21 men, 27.0 ± 5.3 of a mean ± SD with

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range 21–41 years) whereas the brightness preference experiment had 34 healthy subjects (16 women and 18 men, 26.1 ± 4.7, 21–41 years). There were no significant differences in age or gender between the subjects in either experiment. There were 10 subjects who completed both experiments but duration between experiments was at least 3 months. All subjects were right-handed and had normal or corrected to normal vision. None of the subjects had any current or lifetime history of psychiatric disorder as determined by the Mini-International Neuropsychiatric Interview (MINI). All subjects gave written informed consent to participate in this study according to procedures approved by the ethical committee at Oita University Faculty of Medicine.

2.2. Hyperthymic temperament identification

As previously detailed (Harada et al., 2013a, 2013b), we used the Temperament Scale of Memphis, Pisa, Paris and San Diego-Autoquestionnaire (TEMPS-A) developed by Akiskal et al. (2005) to measure affective temperament. This scale has 110 questions that gauge 5 temperaments (depressive, hyperthymic, cyclothymic, irritable and anxious), has been verified in 32 languages, and has been widely used in a number of epidemiological and clinical studies with psychiatric patients and healthy subjects. Also in Japan, the scale has been validated and widely used to identify affective temperaments (Akiyama et al., 2005; Matsumoto et al., 2005).

2.3. Functional magnetic resonance imaging (fMRI) stimuli

Both the brightness judgment task (Harada et al., 2013a) and the brightness preference task (Harada et al., 2013b) used the same blocks consisting of a sequence of 11 blank screens (with 11 levels of indirect illuminance in the absence of any figure) adjusted by tristimulus value (Red, Green, and Blue: 0–250) with each blank screen gradating from white to black by 25 tristimulus value (Fig. 1). The gradated blank screens were randomly assigned in each block. From the white to black screen, the illuminance at the location of the subject's head was measured as 700, 589, 481, 396, 324, 263, 220, 185, 164, 152, and 146 lx (Fig. 1).

2.4. Experiment

In both the experiments, the same 3 experimental conditions/blocks were presented to the subjects in randomly allocated pattern of two balanced-order patterns which consisted of 9 blocks of “A” pattern or reverse “B” pattern. During the brightness judgment experiment, subjects were instructed as follows; “Please judge if the screen is bright or not bright by pressing the corresponding button” in the brightness judgment task, and; “Please judge if the screen is dark or not dark by pressing the corresponding button” in the darkness judgment task and; “Please press the button when the screen changes without making a judgment of brightness or darkness” in the control task.

During the brightness preference experiment, subjects were instructed as follows; “Please judge if the screen is preferable or not preferable by pressing the corresponding button” in the preference judgment task, and; “Please judge if the screen is unprefered or not unprefered by pressing the corresponding button” in the unprefered judgment task, and; “Please press the button when the screen changes without making a judgment of prefered or unprefered” in the control task.

2.5. Analysis of reaction time (RT)

The hypothesis of the current study was that hyperthymic temperament would be associated with rapid processing when making judgments and indications of preference of illuminance. To investigate this hypothesis, only 4 RT (i.e., RT for brightness judgment task, RT for brightness preference task, RT for control task of brightness judgment task, and RT for control of brightness preference task) were used because these comparisons seem to be most clearly interpretable. RT for other tasks was not used in the present study.

2.6. fMRI image acquisition

As previously mentioned (Harada et al., 2013a, 2013b), fMRI images were collected using Siemens magnetom verio 3 T MRI system. A time course series of 174 volumes was acquired with a T2-weighted single shot gradient echo planar imaging (EPI) sequence. Each volume consisted of 36 slices, with a slice thickness of 3 mm and a gap of 0.75 mm, and covered the almost the whole brain. Images were acquired in the axial plane (TR = 3000 ms; TE = 30 ms; FOV = 210 mm; voxel size = $3 \times 3 \times 3$ mm). The total acquisition time was 8 min 50 sec, including periods for signal equilibration. T1-weighted structural images were acquired with 3-D magnetization prepared rapid gradient echo (MPRAGE) in the sagittal plane (TR = 2040 ms; TE = 2.53 ms; TI = 900 ms; the flip angle was 9°; FOV = 192 mm; voxel size = $1 \times 1 \times 1$ mm^3).

2.7. fMRI image analysis

All fMRI analysis was performed in SPM8 (Statistical Parametric Mapping software, University College of London, London, UK; available at: http://www.fil.ion.ucl.ac.uk/spm/). Preprocessing (movement correction, normalization 6 to the MNI EPI template, smoothing with an isotropic 8 mm FWHM kernel, and resampling to 2 mm cubic voxels) were performed firstly. Each individual data set was carefully screened for data quality via inspection for image artifacts and excessive head motion (> 3 mm head motion or 2° head rotation).

2.8. Region of interest (ROI) analyses of BOLD signal change

We conducted region of interest (ROI) analyses using marsbar toolbox (marsbar.sourceforge.net). Before that, conventional individual analyses were performed on SPM8 to estimate the task-related activation for later use in ROI analyses. We defined 6 conditions: brightness judgment, darkness judgment, and their control (judgment control); brightness preference judgment, brightness un-preference judgment, and their control (preference control). Each condition was modeled with a boxcar function and convoluted with a canonical hemodynamic response function. Low frequency drifts were removed using a temporal high-pass filter with a cutoff of 128 s. Serial autocorrelation was also corrected using AR (1) model.

Following the previous studies (Harada et al., 2013a, 2013b) suggesting the left inferior orbitofrontal cortex as one of neural correlates of hyperthymic temperament, ROI was set at the left inferior orbitofrontal cortex using automated anatomical labeling, and percent signal change (relative to the low-level baseline activity observed during viewing of the fixation cross during the individual task) in the ROI was measured by marsbar toolbox.

2.9. Statistical analyses

First, RT for the brightness judgment task and RT for the brightness preference task were compared by unpaired *t*-test. Theoretically, it was expected that brightness preference requires brightness judgment which relies on brightness perception, and that the processing sequence may be (1) brightness perception, (2) brightness judgment and (3) brightness preference (Fig. 2).