Effects of arousing emotional scenes on the distribution of visuospatial attention: changes with aging and early subcortical vascular dementia


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Abstract

Background: The modulation of attention by emotionally arousing stimuli is highly important for each individual’s social function. Disturbances of emotional processing are a supportive feature for the diagnosis of subcortical vascular dementia (SVD). We address here whether these disturbances might be useful as an early disease marker.

Methods: In order to examine the modulation of visual attention by emotionally arousing stimuli of different valence, 12 elderly patients with early SVD, 12 age-comparable healthy adults and 12 young healthy subjects were studied while looking at pairs of pictures from the International Affective Picture Battery that were either neutral–neutral, neutral–positive or neutral–negative in terms of emotional content. Eye movements were recorded with an infrared eye-tracking system. The direction of the first saccade and the dwell time during the 10 s of presentation were measured and compared among groups with parametric tests.

Results: All subjects showed a modulation of initial attentional orienting as well as a higher percentage of dwell time towards the pictures containing emotional material. Patients with SVD and old controls did not differ in either experimental measure. Young patients showed a stronger bias towards emotionally negative material than both groups of older individuals.

Conclusions: Modulation of visuospatial attention is preserved in early SVD. This might have implications for therapeutic interventional approaches. A weakened sustained attention towards negative but not positive emotional pictures in the elderly is in accordance with the socioemotional selectivity theory, describing a relative selection of positive stimuli with aging.

Keywords: Dementia; Visuospatial attention; Emotion; Arousal; Aging; Eye tracking

1. Introduction

Pathogenetically, vascular dementia (VD) is not a distinct entity but heterogeneous. Among the subtypes that have been described [1], subcortical vascular dementia (SVD) comprises the entities of lacunar state and “Binswangers disease”, each of which consists of small vessel disease with possible lacunar infarcts and focal and diffuse white matter lesions without any territorial infarction [2].

Correspondingly, the clinical presentation is dominated by a so-called “subcortical syndrome” [3–5] where characteristic cognitive effects comprise deficits in executive functioning, general slowness of psychomotor processes and mood disorders. Emotional incontinence and liability are supportive features for the diagnosis of SVD [6]. However, little is known about the type of emotional disturbances in subcortical dementia. In comparison to patients with Alzheimer’s disease (AD), the involvement of subcortical structures in SVD [7] would make an impairment of emotional processing in these patients more likely than in AD patients [8]. This notion was confirmed in a study [9], including all types of VD. To date, there are no data describing aspects of emotional processing in a more
homogenous subgroup of VD, such as SVD. One possibility
to examine one aspect of the processing of emotional visual
material is to trace eye movements while attention is
modulated by emotional arousing pictures. Using this
approach and in line with the aforementioned negative
finding in Alzheimer’s disease, LaBar et al. [10] found a
preserved visual orienting to emotionally arousing pho-
tographs in patients with early Alzheimer’s disease. In the
present study, we examined the orienting of visual attention
to emotionally arousing photographs in 12 patients with
early SVD, 12 nondemented elderly subjects with normal
CCT or MRI scans of the brain, and 12 young and healthy
subjects. We tested the hypothesis that patients with early
SVD are impaired in the modulation of attentional orienting
and sustained attention to emotional arousing material. The
interest in performing this study was twofold. Firstly, early
clinical diagnostic markers are needed to establish early
treatment and prevention of VD and its preliminary stages
[11–13]. Secondly, emotionally modulated behavior is of
high importance in a social context for the patient and
caregivers, and the modulation of cognitive functions by
emotions might therefore be a promising line of therapeutic
compensation of cognitive decline.

2. Methods

2.1. Participants

A total of 36 subjects participated in the study. The 12
patients with SVD were patients admitted to the Clinic of
Neurology between 4/2002 and 4/2003 for evaluation of
dementia, gait abnormalities, a lacunar stroke syndrome or
transient ischemic attack. All fulfilled the recently formu-
lated criteria of subcortical vascular dementia, including
brain imaging studies with either a CT or MRI scan of the
brain [3,14]. All patients underwent a complete neurological
examination, including oculomotor testing. Spatial neglect
was excluded by clinical testing of visual, auditory and
sensory extinction. CT (in five patients) or MRI (in seven
patients) of the brain were obtained in each patient and rated
by a neuroradiologist blinded to diagnosis according to the
“age related white matter changes” (ARWMC) scale [15].
Criterion for inclusion in the SVD group was a score >8,

describing extensive white matter lesion load. Patients had
widespread white matter lesions. The distribution of lesion
sites is presented in Table 1.

Patients with territorial infarcts or lacunar infarcts of the
thalamus on MRI or CT of the brain were excluded as well
as patients with intracranial tumors or hemorrhages. Patients
did not suffer from any other psychiatric disease except
dementia. Thyroid dysfunction, vitamin B12 deficiency and
syphilis were excluded by standard laboratory tests. Neuro-
psychological testing of the SVD patients comprised the
CERAD Test Battery [16], the Test of Cognitive Estimation
(TCE) [17], the MMSE [18], a Verbal Fluency Test (FAS-
Test), the Digit Span from the Wechsler Memory Scale [19],
and the Geriatric Depression Scale [20].

Twelve elderly controls (OC) were recruited from the
patients submitted to the Clinic of Neurology in the same
time period as the SVD patients. They were required to have
no cerebrovascular disease, a normal MMSE (>26), a
normal TCE, no clinical signs of depression and an
ARWMC lesion score of <5 (based on CT for 3 patients
or on MRI for 9 patients). All OC underwent a neurological
and psychiatric examination. Diagnoses included migraine,
viral meningitis, vestibulopathy and isolated provoked
cerebral seizure. Young normal controls (YC) were recruited
from staff of the hospital, either nurses or doctors or
research staff without knowledge about the purpose of the
study. Young controls did not undergo imaging of the brain.
The distribution of age, gender, education and white matter
lesions is shown in Table 2.

In congruence with the study design, the YC group was
significantly younger than the SVD group (p<0.001) and
the OC group (p<0.001). SVD group and OC group did not
differ in age (p=0.101). Education level did not differ
between the SVD group and the OC group (p=0.520), but
the YC group was significantly higher educated than both
other groups (vs. OC p=0.002, vs. SVD p=0.015).

Neuropsychological test results of the SVD patients and
the OC subjects are given in Table 3.

<table>
<thead>
<tr>
<th>Lesion site</th>
<th>Averaged number of lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal left</td>
<td>2.17</td>
</tr>
<tr>
<td>Frontal right</td>
<td>2.08</td>
</tr>
<tr>
<td>Parieto-occipital left</td>
<td>2.00</td>
</tr>
<tr>
<td>Parieto-occipital right</td>
<td>2.00</td>
</tr>
<tr>
<td>Temporal left</td>
<td>0.75</td>
</tr>
<tr>
<td>Temporal right</td>
<td>0.67</td>
</tr>
<tr>
<td>Basal ganglia left</td>
<td>0.92</td>
</tr>
<tr>
<td>Basal ganglia right</td>
<td>1.00</td>
</tr>
<tr>
<td>Brain stem, cerebellum</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 1: Distribution of lesion sites in the SVD group

<table>
<thead>
<tr>
<th>Age in years</th>
<th>YC (N=12)</th>
<th>OC (N=12)</th>
<th>SVD (N=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (S.D.)a</td>
<td>26.5 (2.8)</td>
<td>64.4 (8.3)</td>
<td>71.3 (7.3)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 years</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10 years</td>
<td>0</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>13 years or more</td>
<td>12</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>ARWMC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (S.D.)a</td>
<td>NAb</td>
<td>1.8 (1.9)</td>
<td>12.8 (2.6)</td>
</tr>
</tbody>
</table>

| a S.D.: standard deviation. |
| b NA: not administered. |

Table 2: Sociodemographic description of the three groups
Among the SVD patients, the assessment of different cognitive functions and mood was carried out to provide an estimate of the cognitive impairment. Tests verified mild to moderate cognitive impairment in the SVD patients. There were no relevant depressive symptoms. The OC subjects showed significantly better results in the MMSE and the TCE than the SVD patients ($p < 0.001$ and $p = 0.002$, respectively). Their results fell into normal range.

All subjects gave written informed consent to participate in the present study. The study was approved by the Institutional Review Board of Frankfurt University Hospital (No. 149/01).

### 2.2. Experimental materials and procedure

Thirty-six photographs were taken from the International Affective Picture Battery (IAPS; Center for Research on Emotion and Attention, Gainesville, FL, 1995) and were paired to a left–right arrangement resulting in six neutral–neutral, three positive–neutral, three neutral–positive, three negative–neutral and three neutral–negative pairs of photographs. The emotional classification of the pictures was based on the standard scores for valence and arousal provided by the IAPS. Within the IAPS, the emotion evoked by a photograph was assessed by using a graphic figure (Self-Assessment Manikin) depicting nine values along the dimension of affective valence (ranging from pleasant to unpleasant) and nine values along the dimension of emotional arousal (ranging from calm to excited). Neutral pictures had valence scores between 4.3 and 5.7 ($\text{mean}=5.1$, S.D.=0.3) and an arousal scores between 1.8 and 4.1 (mean=3.0, S.D.=0.6). Negative photographs had valence scores between 1.3 and 2.3 (mean=1.6, S.D.=0.3) and arousal scores between 5.5 and 7.3 (mean=6.8, S.D.=0.7), whereas positive photographs had valence scores between 7.4 and 8.1 (mean=7.7, S.D.=0.2) and arousal scores between 6.3 and 7.3 (mean=6.6, S.D.=0.4). Neutral pictures were matched with the emotionally arousing pictures for the presence of human figures, global color content and complexity of visual scenes. Subjects were seated in 45-cm distance from a 53.3-cm, high-resolution display monitor. The distance to the medial border of each photograph was $3.8^\circ$ from midline. Each photograph ended at $19.9^\circ$ from midline. Each initial saccade to a target within this distance was counted. The same was true for computing the dwell time: eye movements of at least $3.8^\circ$ from midline and less than $19.9^\circ$ to either side were counted. The units of the experimental measures were “direction” for the initial saccade and “time” in seconds for dwell time. The 18 pairs of photographs were shown to the subjects for 10 s. An example is shown in Fig. 1.

Trials were presented in a pseudorandom order and were initiated after subjects fixated a central cross for 5 s. Subjects had been told that some of the photographs could contain emotionally arousing scenes. They were simply instructed to look at the photographs. No overt response was required. Eye movements were recorded using the Ober2 infrared eye-tracking system Version 1.35 (Permobil Medictech, Sweden). As experimental parameters we determined the direction of the initial saccade and the dwell time on each picture in percent. The direction of the initial saccade provided a behavioral index of the attentional orientation, whereas dwell times provided a behavioral index for

![Fig. 1. Example of a negative-neutral stimulus pair.](image)
sustained attention over time. Fig. 2 illustrates a typical recording of eye movements.

Before conducting the main experiment, we wanted to exclude the possibility of lower-level perceptual features being responsible for the recorded results. Therefore, 10 young healthy subjects (3 females, 7 males, mean age 29.4 years) were shown the same series of picture pairs but Gaussian-blurred as abstract pictures. They were not discernable, but color and other low-frequency visual information were relatively well preserved. This method was used the same way in the study of LaBar et al. [10]. For analyzing initial saccades and dwell time, ANOVAs for repeated measures were conducted. As in the study of LaBar, attentional orienting as well as sustained attentional measures were not significantly influenced by the emotional pairing condition. Therefore, the emotional modulation of visual attention as tested here did not seem to be confounded with low level visual properties.

2.3. Data analysis and statistical methods

All statistical analyses were carried out with the Statistical Package for the Social Sciences (SPSS), version 10.0 for Windows. Since Kolmogorov–Smirnov tests supported the normal distribution of the data, parametric methods were used. Demographical data and neuropsychological test results were compared among groups by univariate ANOVAs and post-hoc t-tests with correction for multiple comparisons (Bonferroni).

Because of a possible side bias towards the left hemisphere, the distribution of initial saccades and dwell time over the hemispheres were described as percentage of initial saccades and percentage of dwell time in both hemispheres in the neutral–neutral conditions. Results of the attentional orienting and the sustained attention measures were analyzed by two-factorial ANOVAs, using subject group (YC, OC, SVD) as a between-subjects variable and emotional pairing condition as a within-subjects variable. Analyses were calculated separately for positive and negative pairing conditions (positive–neutral, neutral–neutral, neutral–positive and negative–neutral, neutral–neutral). Significant effects were followed up by multiple post-hoc comparisons with appropriate correction of the significance level (Bonferroni). Only ANOVAs computed on data from the left hemispace are reported, because the attention measures are directly proportional in each hemispace. Significance level was set a priori at α=0.05.

3. Results

3.1. Side bias

Table 4 summarizes side biases for initial saccades and dwell time in the neutral–neutral condition. In the neutral–neutral pairs, the initial saccade showed the expected leftward bias towards the left photograph for all three groups. The dwell time over the 10-s period of presentation for each pair did not show a bias for either hemispace in the neutral–neutral conditions.

3.2. Positive pairing condition

Fig. 3 illustrates the group-averaged data for the initial saccades (left) and for dwell time (right) as a function of positive pairing condition (positive–neutral, neutral–neutral, neutral–positive).

Both dependent measures showed a significant main effect of the emotional condition [attentional orienting: F(2,66)=6.55, p=0.003; sustained attention: F(1.63, 53.73)=29.72, p<0.001]. Neither the main effect of subject group nor the emotional condition × group interaction reached the significance level, indicating that the emotional modulation of visual exploration was similar across all subject groups. Table 5 summarizes the statistical results of the ANOVAs for the positive pairing condition.

3.3. Post-hoc analyses of the main effect emotional condition

3.3.1. Attentional orienting (direction of initial saccade)

When the positive stimulus appeared on the left side, no difference in leftward orienting could be shown in comparison to the neutral–neutral conditions.

Table 4

<table>
<thead>
<tr>
<th>Initial saccade</th>
<th>YC (N=12), mean (S.D.)</th>
<th>OC (N=12), mean (S.D.)</th>
<th>SVD (N=12), mean (S.D.)</th>
<th>Group-averaged, mean (S.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral–neutral</td>
<td>66.7 (28.4)</td>
<td>68.1 (26.1)</td>
<td>62.5 (31.1)</td>
<td>65.7 (27.9)</td>
</tr>
<tr>
<td>Neutral–neutral</td>
<td>33.3 (28.4)</td>
<td>32.0 (28.4)</td>
<td>37.5 (31.1)</td>
<td>34.3 (27.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dwell time</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral–neutral</td>
<td>49.8 (5.5)</td>
<td>47.2 (5.8)</td>
<td>44.6 (6.3)</td>
<td>47.2 (6.1)</td>
</tr>
<tr>
<td>Neutral–neutral</td>
<td>50.2 (5.5)</td>
<td>52.8 (5.8)</td>
<td>55.5 (6.3)</td>
<td>52.8 (6.1)</td>
</tr>
</tbody>
</table>

* S.D.: standard deviation.
When the positive stimulus appeared on the right side, leftwards initial orienting was reduced significantly compared to the neutral–neutral pairing (MD=19.44, \( p=0.005 \)).

### 3.3.2. Sustained attention (dwell time)

When the positive stimuli appeared on the left side, leftward dwell time was significantly increased compared to the neutral–neutral condition (MD=11.81, \( p<0.001 \)).

When the positive stimuli appeared on the right side, leftward dwell time did not differ with respect to the neutral–neutral condition.

### 3.4. Negative pairing condition

Fig. 4 presents the group-averaged data for the direction of the initial saccade (top row) and for the dwell time (bottom row) as a function of negative pairing condition (negative–neutral, neutral–neutral, neutral–negative) dwell time as a function of emotional condition.

The direction of the initial saccade showed a significant main effect for the emotional condition \( [F(1.57,51.87)=14.63, \ p<0.001] \). Neither the main effect of subject group nor the emotional condition \( \times \) group interaction reached the significance level, indicating that again the emotional modulation of initial orienting was similar across all subject groups.

For the measure of sustained attention, analyses revealed a significant main effect of emotional condition \( [F(1.68,55.33)=54.96, \ p<0.001] \) and, different from the positive stimulus conditions, a significant main effect of group \( [F(2,33)=0.60, \ p=0.050] \) and emotional condition \( \times \) group interaction \( [F(3.35,55.33)=8.10, \ p<0.001] \). Table 6 summarizes the statistical results of the ANOVAs for the negative pairing condition.

### 3.5. Post-hoc analyses

#### 3.5.1. Attentional orienting (direction of initial saccade)

Post-hoc analyses of the main effect emotional condition.

When the negative stimulus appeared on the left side, no difference in leftwards dwell time could be shown in comparison to the neutral–neutral condition.

When the negative stimulus appeared on the right side, leftwards dwell time was reduced significantly compared to the neutral–neutral pairing (MD=19.44, \( p=0.001 \)).

#### 3.5.2. Sustained attention (dwell time)

Because of the significant emotional condition \( \times \) subject group interaction, post-hoc analyses should yield a specification.

Multiple \( t \)-tests within groups yield the following results:

- **Group YC.** When the negative stimulus appeared on the left side, leftward dwell time increased significantly in comparison to the neutral–neutral condition \( [t(11)=5.64, \ p<0.001] \).

  When the negative stimulus appeared on the right side, leftward dwell time was reduced significantly compared to the neutral–neutral pairing \( [t(11)=4.57, \ p=0.001] \).

- **Group OC.** When the negative stimulus appeared on the left side, leftward dwell time increased significantly in comparison to the neutral–neutral condition \( [t(11)=3.17, \ p=0.009] \).
When the negative stimulus appeared on the right side, no difference in leftward dwell time could be shown in comparison to the neutral–neutral condition.

3.5.2.3. Group SVD. When the negative stimulus appeared on the left side, leftward dwell time increased significantly in comparison to the neutral–neutral condition \( t(11)=4.16, p=0.002 \).

When the negative stimulus appeared on the right side, no difference in leftwards dwell time could be shown in comparison to the neutral–neutral condition.

One-way ANOVAs between groups yielded the following results.

For post-hoc analysis among groups, one-way ANOVAs were carried out for each pairing condition (negative–neutral, neutral–neutral, neutral–negative).

A significant result (Bonferroni-adjusted \( \alpha=0.017 \)) could be shown only for the negative–neutral condition \( F(2,35)=10.76, p<0.001 \). The result for the neutral–negative condition did not quite reach significance \( F(2,35)=3.95, p=0.029 \). Further comparisons concerning the negative–neutral condition revealed that there were significant differences between the groups YC and OC (MD=18.96, \( p=0.001 \)) and the groups YC and SVD (MD=17.42, \( p=0.002 \)). There was no difference between the groups OC and SVD.

4. Discussion

In summary, the main results of the current study are the following:

1. All three subject groups showed a leftward bias for the orienting saccade in the neutral–neutral condition.
2. Visuospatial attention, as measured by eye movements, could be modified by emotional photographs to the same extent in patients with early SVD and age-comparable elderly. This was true for the preattentive measure (direction of first saccade), as well as for the sustained attentional measures (dwell time). However, young controls showed a significantly stronger emotional bias for the sustained attentional measure in the negative–neutral condition.

The leftward bias of the initial saccades has been described previously in paper-and pencil cancellation tasks and a comparable study [10,21]. It can be explained by either a dominant role for the right hemisphere in spatial attention or habits of people reading from left to right. Therefore, a leftward bias was expected and confirmed in all three groups. All further evaluations had to be made in awareness of this bias with separate analyses of the experimental measures in both hemispheres.

The present finding of an unimpaired emotional modulation of visuospatial attention in SVD patients might seem surprising at first glance. However, up to now, there have been very few studies of emotional processing even in the more heterogeneous group of VD. The involvement of subcortical structures, especially fronto-subcortical circuits, in the processing of emotion is beyond doubt [22]. Cancelliere and Kertesz [8] provided evidence for the importance of subcortical lesions for emotional judgement; however, the patients examined in this work had additional cortical lesions. Shimokawa et al. found a significantly stronger impairment of patients with VD than in patients with AD in an emotional recognition task. In their VD
group, the score on the emotion recognition task correlated with the severity of the dementia [9]. The authors concluded that the differences between the two demented groups were due to involvement of subcortical structures in the VD group. However, in both papers, the emotional tasks were bound to cognitive tasks, and conclusions about isolated deficits of emotional processing should therefore be drawn with caution. In the present study, subjects were simply asked to look at the photographs. Therefore, our results seem to show an intact attentional-emotional network in SVD patients for orienting gaze to emotional stimuli and a preserved emotional curiosity.

A comparable study by LaBar et al. [10] has recently shown that in early-stage AD patients the distribution of attention to emotionally negative arousing scenes was also unimpaired. Mean MMSE scores of the AD group were comparable to the mean score of SVD in the present group (24 vs. 22). The latter and the present study are in contrast to studies examining novelty seeking behavior and visual search, which found robust deficits even in early-stage dementia patients [23,24]. The explanation might lie in different anatomical substrates of the arousing attention-orienting system on the one hand and the system recruited in the more complex and demanding visual search context where subjects have to attend to (and finally ignore) distractors and switch between local and global search strategies [25].

The neuroanatomical correlates of evoked pleasant and unpleasant emotion seem to be rather widespread: in negative/unpleasant emotions evoked with photographs from the IAPS system used in the present study, the amygdala, the hippocampus, the left parahippocampal gyrus, the cerebellum and the occipito-temporal cortex showed increased blood flow in a study using positron emission tomography, whereas positive/pleasant emotional stimuli provoked an increased blood flow in the vicinity of the medial prefrontal cortex, thalamus, midbrain and hypothalamus in 12 healthy women [26]. A recent study using functional magnetic resonance imaging examining activations of different regions of interest during a mixed attentional and emotional task revealed different subsystems for the attentional and the emotional part of the task [27]. While the attentional part of the task activated a previously described frontoparietal network, the emotional component activated the amygdala and the fusiform and inferior frontal gyrus. The anterior cingulate gyrus was activated by both components of the task. Summarizing these results, the prefrontal cortex and its interconnections with the amygdala, the anterior cingulate and the insula are crucial for the processing of emotional arousal. The patients with SVD in our study had widespread white matter lesions (see Table 1), with a pronounced lesion load in both frontal lobes, suggesting possible disturbances of the above-mentioned circuits. Therefore, it seems surprising that the SVD group showed no impairment in this task. However, the role of white matter lesions (WML) for cognition is still a matter of debate and there are no studies about the relation between WML and emotional processing. Clinical observations show that especially mood and affect, as clinical measures of the emotional self, are often abnormal in patients with SVD [6]. Furthermore there is an increasing evidence of a “vascular depression” model, stating that microvascular changes in the frontal deep white matter correlate with depression [28,29]. In the present study, patients with depression were excluded by clinical judgment and the Geriatric Depression Scale; therefore, the population in the current study was preselected.

One other possible explanation for the lack of significant impairment of patients with SVD in the current task is that the general impairment of the demented patients examined here was mild and visual orienting and sustained attention over a relatively short period of 10 s to emotionally arousing material therefore is not involved in the range of impairment in this early stage of dementia. Therefore, the results might not have been different from the ones obtained from elderly controls. This was true for emotionally negative and positive photographs.

Despite equal arousing scores for the negative and positive photographs used, the group comparison revealed a difference between young controls and both aged groups in the emotionally negative but not in the emotionally positive presentations. This is in accordance with recent results about changes in cognitive effects of emotional stimuli with aging. The “socioemotional selectivity theory” [30] describes a relative selection of positive stimuli for cognitive processing, so far shown for the recall of images and the identification of facial emotional expression with advancing age [31]. The preserved ability of emotional modification of attention, especially positive emotional stimuli, in patients with SVD in the present study might have implications for interventional approaches to overcome attentional difficulties in these patients.

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References


