PERGAMON

Neuropsychologia 38 (2000) 1734–1740

NEUROPSYCHOLOGIA

www.elsevier.com/locate/neuropsychologia

Emotional curiosity: modulation of visuospatial attention by arousal is preserved in aging and early-stage Alzheimer's disease

Kevin S. LaBar [a,*], M.-Marsel Mesulam [a,b], Darren R. Gitelman [a], Sandra Weintraub [b]

[a] *Department of Neurology, Cognitive Neurology and Alzheimer's Disease Center, Northwestern University Medical School, Chicago, IL, USA*
[b] *Department of Psychiatry and Behavioral Sciences, Cognitive Neurology and Alzheimer's Disease Center, Northwestern University Medical School, Chicago, IL, USA*

Received 10 September 1999; received in revised form 14 March 2000; accepted 14 June 2000

Abstract

Previous studies have shown that Alzheimer's disease, even in its early stages, decreases novelty-seeking behaviors (curiosity) and impairs the shifting of spatial attention to extrapersonal targets. In this study, early-stage probable Alzheimer's disease patients (PRAD) and young and aging controls were shown pairs of visual scenes, some of which contained emotionally-arousing material, while eye movements were recorded under free viewing conditions. In all three subject groups, emotionally-arousing scenes attracted more viewing time and also became the preferential target of the initial visual orientation. Our findings suggest that the arousing properties of sensory stimuli may overcome some of the AD-related impairments in the distribution of attention to extrapersonal targets. These results may have implications for interventions aimed at improving the cognitive symptoms of PRAD.

Keywords: Affect; Emotion; Arousal; Oculography; Eye tracking

1. Introduction

The neuropsychological hallmark of Alzheimer's disease (AD) is a severe impairment of memory function. However, the adaptive deployment of attention to extrapersonal events is also frequently disrupted early in the course of the disease and interferes with activities of daily living. These attentional deficits are multifaceted and include altered visual search strategies [8,22,24], an inability to disengage the focus of attention [20,23] and reduced orientation to novel and complex stimuli [4]. Furthermore, while AD patients may be able to focus attention globally or locally when each mode is tested in a separate experiment, they have difficulty when required to switch between these processing modes in the same block of experimental trials [7].

One possible strategy for improving attentional engagement in AD is to enhance the emotional impact of environmental stimuli. Several studies have argued for the preservation of emotional processing relative to the cognitive decline in mild AD [1,2,12,25]. Thus, it might be predicted that arousal provoked by emotionally-charged stimuli would deploy attentional resources toward the pertinent sectors of extrapersonal space. The influence of emotional arousal on the regulation of attention in AD has not been directly investigated and is the focus of the current study.

2. Experiment 1

2.1. Methods

2.1.1. Subjects

A total of 42 subjects participated in this study. Nine patients with mild probable Alzheimer's disease (PRAD) and nine nondemented aging controls (AC) were recruited from the Clinical Core subject registry of the Northwestern Alzheimer's Disease Center. Subjects

* Corresponding author. Present address: Center for Cognitive Neuroscience, Room B203, Levine Science Research Center, Duke University, Durham, NC 27708-0999, USA. Tel.: +1-919-6810664; fax: +1-919-6810815.

E-mail address: klabar@duke.edu (K.S. LaBar).

0028-3932/00/$ - see front matter
PII: S0028-3932(00)00077-4

had undergone neurological and neuropsychological examinations to establish the diagnosis of PRAD in the patient group [21] and the absence of cognitive deficits or alterations in daily living activities in the control group. In order to examine the effect of aging, 24 younger volunteer control subjects (YC), recruited through advertisements, also participated. All subjects gave informed consent and were paid for their participation. The experimental protocol was approved by the Institutional Review Board at Northwestern University.

Table 1 presents demographic information and test scores. PRAD and AC subjects did not differ significantly in education ($P > 0.05$) but the PRAD subjects were significantly older, $t(16) = 3.39$, $P < 0.004$. Scores on the Mini Mental State Examination (MMSE) [9] were normal for ACs and in the ‘mildly impaired’ range for the PRAD group. PRAD patients also had abnormal scores on the delayed recall condition of the Logical Memory subtest from the Wechsler Memory Scale-Revised (WMS-R) [28], consistent with the prominent amnesic disorder that characterizes this condition. ACs scored within the normal range for their age and education on all tests. There was no evidence of depression in either the AD or AC groups, as reflected in their total scores on the Geriatric Depression Scale [30].

Seven of the AD subjects in the present sample had also participated in a study of visual target detection reported by Rösler et al. [24]. In this study, subjects were required to detect a target number embedded in an irregular array of distractor letters. The AD subjects (eight in total) demonstrated reduced accuracy (54% correct on average versus 82%) and increased reaction time (almost 6 s per target on average versus 4 s) in comparison to controls. In addition, their search strategies for targets that they did find were distinctly different from those observed in the control subjects. They made more fixations en route to the target and fixation duration was longer on average than that for age-matched controls. These results provide evidence that most of the subjects in the present study were impaired on a visual attention task that involved emotionally-neutral stimuli.

2.1.2. Materials and procedure

Subjects were shown 30 pairs of color visual scenes that varied in emotional content while their eye movements were monitored under free viewing conditions. Subjects were told that some of the images would consist of emotionally-negative (graphic) scenes and they were simply instructed to look at the stimuli in any way they wished. No overt response was required. Emotionally-negative pictures were obtained from the International Affective Picture System (IAPS; Center for Research on Emotion and Attention, Gainesville, FL, 1995) and were chosen based on 9-point arousal and valence scales provided in the IAPS norms (arousal levels ranged between 4.5 and 9; valence levels ranged between 1 and 4). Emotionally-negative stimuli were chosen because they constitute a more homogeneous and reliable arousing category than positive stimuli and the neural systems mediating these stimuli have been investigated more thoroughly [11,15,17,18]. The neutral stimuli were matched for the presence of human figures, global color content and the complexity of the visual scene [15,17]. The 30 scene pairs were displayed on a computer screen for 10 s each and the trials were divided evenly into three left–right pairing conditions: neutral–neutral, negative–neutral and neutral–negative. The scenes subtended 6° of visual angle and the centers of the scene pairs were separated by 15° of visual angle. Each trial was initiated after subjects fixated on a central crosshair and the trials were presented in a pseudorandom order.

Eye movements were recorded using infrared oculography (ISCAN, Burlington, MA) as described previously [16,19,24]. Three regions of interest (ROIs) were drawn around the left, middle and right thirds of the screen. The left and right ROIs contained the two pictures in each trial pair and the middle ROI contained the fixation cross that initiated each trial. The entire vertical dimension of the computer screen was encompassed by the ROIs to compensate for vertical shifts in eye position, which typically occur when tracking eye movements in subjects with bifocal glasses (see the example of PRAD subject in Fig. 1). The ROIs were used to determine the lateral direction of the first saccade directed away from central fixation. In addition, the amount of time spent fixating in each ROI was calculated. The direction of the

Table 1
Mean ($\pm$S.D.) demographic and neuropsychological profiles of the subject populations[a]

Group	Age (years)	Gender	Education (years)	MMSE	GDS	WMS-R logical memory 1
YC ($n = 24$)	26 ± 4	11 M, 13 F	17 ± 2	n/a	n/a	n/a
AC ($n = 9$)	67 ± 5	2 M, 7 F	15 ± 3	29 ± 2	2 ± 4	30 ± 5
PRAD ($n = 9$)	76 ± 6	4 M, 5 F	14 ± 3	24 ± 4	7 ± 4	11 ± 6

[a] YC, young control; AC, aging control; PRAD, probable Alzheimer's disease; MMSE, Mini-Mental Status Examination (maximum score = 30); GDS, Geriatric Depression Scale (maximum score = 30; lower scores signify fewer symptoms); WMS-R, Wechsler Memory Scale-Revised (maximum score = 50); n/a, not tested.

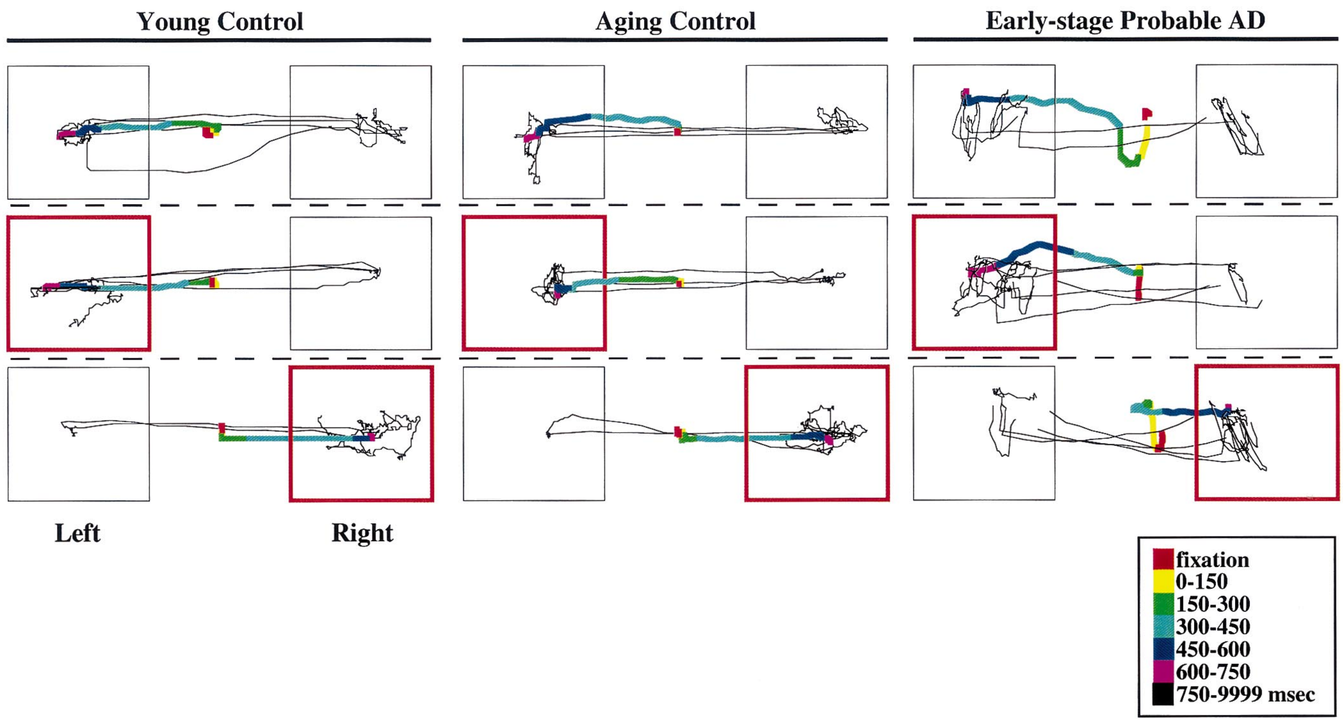

Fig. 1. Oculographic patterns on three trials from a representative young control (YC), aging control (AC), and probable Alzheimer's disease (PRAD) subject. Top row: neutral–neutral stimulus pair; middle row: negative–neutral stimulus pair; bottom row: neutral–negative stimulus pair. Red box = negative scene region of interest (ROI); black box = neutral scene ROI. Subjects began each trial by fixating on a central crosshair. Colored line segment indicates the initial saccade direction away from fixation in 150 ms time bins. Black line segment indicates the eye position for the remainder of the trial.

first glance provided a behavioral index of the initial direction of attentional orientation, whereas the fixation times provided a behavioral index of sustained attention over time (e.g. total dwell time). Eye movement data were analyzed using ILAB© software (D.R. Gitelman, Northwestern University Medical School, Chicago, IL) running under the MATLAB environment (Mathworks Inc., Sherborn, MA). Analyses of variance (ANOVAs) were calculated using experimental group (PRAD, AC, YC) as a between-subjects variable and emotional pairing condition (neutral–neutral, negative–neutral, neutral–negative) as a within-subjects variable. Significant main effects were followed up by appropriate post-hoc t-tests. The ANOVAs were computed separately for the attentional orienting and sustained attention measures. Because the attentional orienting responses are directly proportional in each hemispace, only the ANOVAs computed on data from the left ROI are reported. ANOVAs for the sustained attention measures are reported for the left and right ROIs separately, although similar results were obtained when the hemispaces were combined.

2.2. Results

Fig. 1 illustrates the eye movement patterns obtained on single trials from a representative YC, AC and PRAD subject. For neutral–neutral stimulus pairs (top row), subjects showed an initial gaze bias toward the stimulus on the left side (colored line segment), which equilibrated over the time course of picture viewing (black line segment). The leftward bias was more prevalent across trials and persistent in time if an emotional scene appeared in the left hemispace (negative–neutral trials, middle row) and it reversed to a rightward bias if an emotional scene appeared in the right hemispace (neutral–negative trials, bottom row).

Fig. 2 presents the group-averaged data for the initial saccade direction (attentional orienting, top panel) and total dwell time (sustained attention, bottom panel) as a function of emotional pairing condition (neutral–neutral, negative–neutral, neutral–negative). All dependent measures showed significant main effects of the emotional pairing variable (attentional orienting: $F(2,78) = 29.28$, $P < 0.001$; sustained attention to the leftward stimulus: $F(2,78) = 10.77$, $P < 0.001$; sustained attention to the rightward stimulus: $F(2,78) = 11.37$, $P < 0.001$). In comparison to the baseline condition (neutral–neutral pairs), inspection of the leftward stimulus was significantly increased when an emotionally-negative scene appeared on the left (attentional orienting: $t(41) = 3.39$, $P < 0.002$; sustained attention: $t(41) = 2.75$, $P < 0.01$). This effect reversed to a rightward bias when an emotionally-negative scene appeared on the right (attentional orienting: $t(41) = 6.20$, $P < 0.001$; sustained attention: $t(41) = 4.38$, $P < 0.001$). There were no significant group × emotional condition interactions, indicating that the arousal modulation of visual exploration was consistent across all subject groups. Latency to initiate the first saccade was also analyzed (data not shown) and yielded no significant main effects or interactions.

It is important to consider whether the failure to report significant differences in the AC and AD groups relative to the YC group was related to increased variability in the data. Several observations argue against this possibility. First, visual inspection of the error bars in Fig. 2 does not indicate a substantial increase in variability in these groups. Second, increased spread in the score distribution of these groups would be characterized by significant negative kurtosis, which was not found for any of the dependent measures in either group. Third, we performed an individual subject analysis to determine how many subjects in these groups scored > 2 S.D. below the YC mean in the degree of the emotional modulation effects. To derive an emotional impact index in the YC group, we converted each dependent measure into percent change scores relative to the neutral–neutral baseline (e.g. leftward dwell time [emotional–netural] minus leftward dwell time [neutral–neutral]/leftward dwell time [neutral–neutral] × 100). According to this index, only one AC and one AD subject showed impaired dwell times to emotional stimuli on the left and one AD subject showed impaired dwell times to emotional stimuli on the right. None of the other dependent measures showed any outliers relative to the YC group. Altogether, these considerations argue against increased variability in the AC or AD groups as a factor which may have obscured an underlying emotional impairment.

3. Experiment 2

The modulation of visuospatial attention in Experiment 1 is likely related to the arousal properties of the stimuli. It is possible, however, that lower-level perceptual features contributed to the observed oculographic patterns. For example, mere attention to stimulus color could account for the results if the subjects were differentially attending to color information across the stimulus categories. This is important to consider for negatively-valent scenes, as some of them contain images of blood. To address this issue, we conducted a

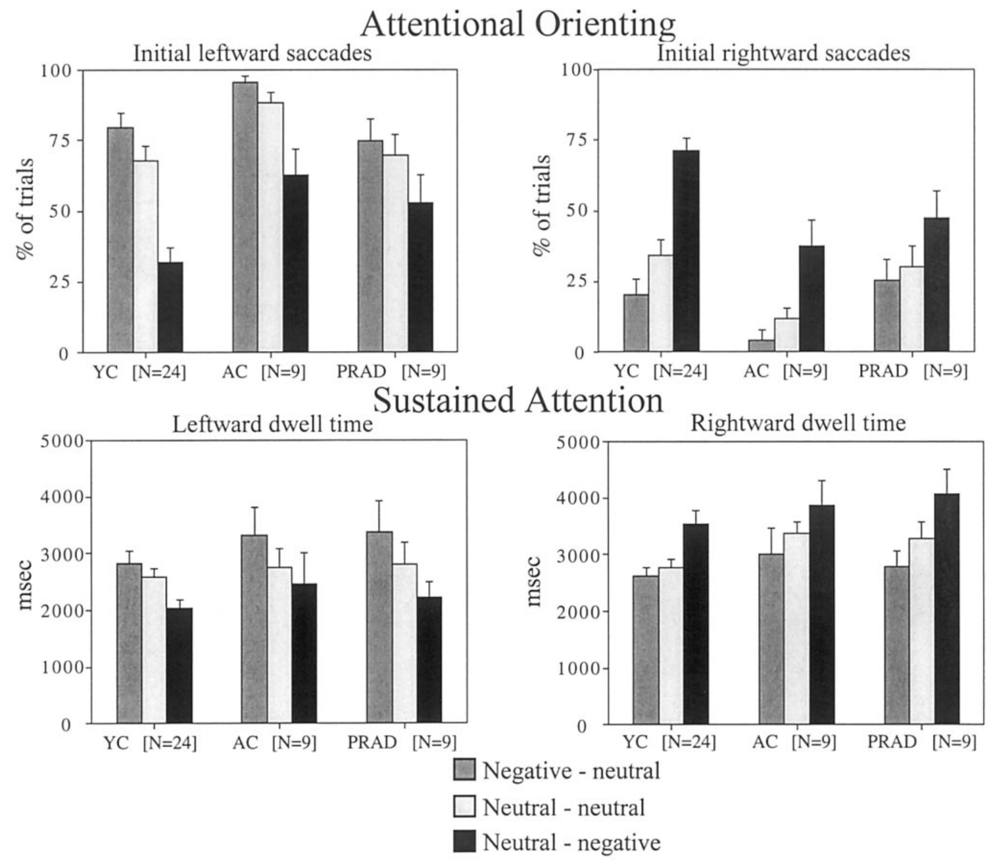

Fig. 2. Group-averaged oculographic patterns as a function of stimulus hemispace and trial type. Top panel: initial saccade direction (attentional orienting response); bottom panel: total fixation duration (sustained attention over time).

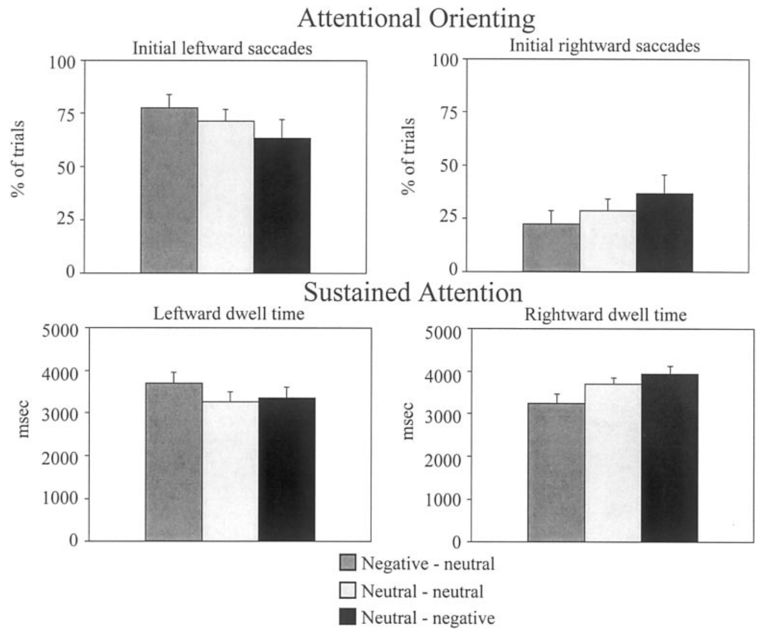

Fig. 3. Group-averaged oculographic patterns for the emotional curiosity task when the stimuli were Gaussian-blurred. All data are from young healthy subjects ($N = 10$). Top panel: initial saccade direction (attentional orienting response); bottom panel: total fixation duration (sustained attention over time).

follow-up study on young healthy subjects using the same stimuli as in Experiment 1, except that the scenes were Gaussian-blurred to appear as abstract images in which color (and other low-frequency visual information) was relatively preserved but object attributes (and other high-frequency visual information) were not discernable.

3.1. Method

3.1.1. Subjects

Ten healthy young adults participated (three male, seven female). The mean ($\pm$ S.D.) age of the subjects was 29 ± 5 years. All subjects gave informed consent and were paid for their participation. None of the subjects participated in Experiment 1.

3.1.2. Materials and procedure

The stimuli were identical to those in Experiment 1, except that the images were Gaussian-blurred using Adobe Photoshop 4.0 (Adobe Systems, San Jose, CA). The experimental design and analysis was similar to that in Experiment 1.

3.2. Results

The group-averaged data are depicted in Fig. 3. No significant main effects of trial type were found on the attentional orienting or sustained attention measures ($P > 0.05$), except in rightward dwell time, $F(2,78) = 9.71$, $P < 0.001$. Post-hoc t-tests, however, did not show a significant increase in dwell time to the rightward stimulus relative to the neutral–netural baseline condition ($P > 0.05$).

4. General discussion

The results of Experiment 1 demonstrate that, in the early stages of AD, patients can direct their attention to environmental stimuli in a normal manner when the stimuli contain negatively-valent emotional content. ‘Emotional curiosity’ as measured within our paradigm contains two components: an early attentional orienting component that directs the first saccade toward the emotionally-arousing cue in the pair and a sustained attention component that keeps the eyes focused on the emotional scene over the entire viewing period. Both of these mechanisms were preserved in the PRAD patients and there was no effect of normal aging on task performance.

The findings are in contrast to our previous report in which PRAD patients were impaired in modulating visual exploration according to variations in the novelty and complexity of emotionally-neutral stimuli using a task design similar to the one in the present study [4]. This dissociation probably reflects differences in the pathological vulnerability of the neural networks that subserve novelty-seeking behaviors versus those that subserve orientation to arousing stimuli. An alternative explanation may be based on differences in dementia severity. To address this possibility, we converted the MMSE scores from the sample in the present study to Blessed Dementia Scale (BDS) scores on the same scale as that used by Daffner et al. [4]. The MMSE and BDS are highly correlated scores of dementia severity and can be converted to one another [6,26,27]. The AD patients in the Daffner et al. sample had lower scores than the present sample, but the difference did not quite reach statistical significance, $t(8) = 2.21$, $P = 0.058$. Further exploration of the relationship between dementia severity and emotional curiosity will require a longitudinal study on the patients in the present sample, which is currently being pursued.

Experiment 2 ruled out the possibility that the modulation of curiosity in the primary experiment was simply related to differences in selective attention to color (or other low-frequency featural components) across the stimulus categories. Although attention to color may play a role in conveying the emotional impact of a scene (e.g. images containing blood), color information alone was insufficient to drive and sustain visual scanning patterns on the task when the stimuli were blurred. These findings support the idea that extraction of the emotional content of the scene, rather than mere attention to lower-level visual features, is of primary relevance to task performance.

There was a tendency for all subjects to initially look leftward when the stimulus pairs were emotionally neutral. This normal leftward orienting bias in initiating a visual search has been reported previously in the performance of subjects on paper-and-pencil visual target cancellation tasks [29]. The basis for the asymmetry may lie in right cerebral dominance for spatial attention or it may reflect reading-induced habits in English-speaking cultures. The strengthening of this bias when the emotional stimulus was on the left and its reversal when the emotional stimulus was on the right provide evidence that emotional content can modulate these habitual orienting tendencies. These observations highlight the importance of including neutral stimulus conditions when interpreting emotional asymmetry effects.

The attentional orienting results also imply that some covert (or pre-conscious) analysis of emotional content had taken place prior to the initiation of the first saccade (< 300 ms after stimulus onset; Fig. 1). The consequence of this processing was to immediately direct the subject's eye movements toward the emotional stimulus in the pair. This result supports previous behavioral studies that have emphasized the rapid coding of affective information outside of awareness or in the absence of eye movements [3,5,31].

The neural systems that mediate emotional interactions with attention are not well-understood. Given that the amygdala is implicated early in the course of AD [13] and is involved in the perception of negative emotionally-arousing scenes [11,15], it may seem surprising that the AD patients were not impaired on this task. However, it must be emphasized that the neuropathological changes in AD are heterogeneous within amygdala subnuclei [13] and that the amygdala is one node in a distributed network of brain regions sensitive to negative emotional arousal [17,18]. MRI volumetry of the entire amygdala has failed to differentiate early-stage AD patients from control subjects [14], underscoring the regional selectivity and progressive nature of the disease process. Animal studies have shown that motivationally-driven increments of attentional orienting are mediated by the central nucleus of the amygdala [10], which is relatively spared in the neuropathology of AD [13]. It is possible that involvement of other amygdala subnuclei, combined with the recruitment of additional brain regions and neurotransmitter systems, may impair emotional modulation of attention over the course of the disease. Longitudinal behavioral studies combined with in vivo imaging will be required to directly correlate changes in emotion-mediated attentional functions and pathological alterations within the relevant brain networks.

Patients with AD show multiple alterations in the spatial distribution of attention. As discussed above, they fail to show a preferential viewing of novel events [4]. Furthermore, they have difficulty covertly shifting attention to targets at different spatial locations, especially in the presence of distracters or when attention has first been cued to a location that is different from the one at which the target actually appears [23]. They are deficient at visual target search and detection, not only with respect to accuracy and response time, but also with respect to fixation parameters during search [24]. In contrast to these deficits, the present study suggests that visual orientation and sustained attention to emotionally-salient information may remain intact, at least in the early stages of the disease. Our findings may be limited by the small sample size studied. Provided that our findings extend to larger patient groups and other (including positively-valent) stimuli in real-life situations, the results may have potential implications for interventions to overcome the attentional deficits in AD.

Acknowledgements

The authors would like to thank Shelly Huddle for assistance with data collection and analysis. Supported in part by a NARSAD Young Investigator Award (KSL), NIH Grant NS30863-03 (MMM) and NIA Grant AG14068 (SW).

References

[1] Albert MS, Cohen C, Koff E. Perception of affect in patients with dementia of the Alzheimer type. Archives of Neurology 1991;48:791–5.

[2] Cadieux NL, Greve KW. Emotion processing in Alzheimer's disease. Journal of the International Neuropsychological Society 1997;3:411–9.

[3] Christianson S-Å, Loftus EF, Hoffman H, Loftus GR. Eye fixations and memory for emotional events. Journal of Experimental Psychology: Learning, Memory and Cognition 1991;17:693–701.

[4] Daffner KR, Scinto LFM, Weintraub S, Guinessey JE, Mesulam M-M. Diminished curiosity in patients with probable Alzheimer's disease as measured by exploratory eye movements. Neurology 1992;42:320–8.

[5] Esteves F, Dimberg U, Öhman A. Automatically elicited fear: Conditioned skin conductance responses to masked facial expressions. Cognition and Emotion 1994;9:99–108.

[6] Fillenbaum GG, Heyman A, Wilkinson WE, Haynes CS. Comparison of two screening tests in Alzheimer's disease: The correlation and reliability of the Mini-Mental State Examination and the Modified Blessed Test. Archives of Neurology 1987;44:924–7.

[7] Filoteo JV, Delis DC, Massman PJ, Demadura T, Butters N, Salmon DP. Directed and divided attention in Alzheimer's disease: Impairment in shifting of attention to global and local stimuli. Journal of Clinical and Experimental Neuropsychology 1992;14:871–83.

[8] Foldi NS, Jutagir R, Davidoff D, Gould T. Selective attention skills in Alzheimer's disease: Performance on graded cancellation tests varying in density and complexity. Journal of Gerontology 1992;47:146–53.

[9] Folstein MF, Folstein SE, McHugh PR. Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research 1975;12:189–98.

[10] Gallagher M, Schoenbaum G. Functions of the amygdala and related forebrain areas in attention and cognition. Annals of the New York Academy of Sciences USA 1999;877:397–411.

[11] Irwin W, Davidson RJ, Lowe MJ, Mock BJ, Sorenson JA, Turski PA. Human amygdala activation detected with echo-planar functional magnetic resonance imaging. NeuroReport 1996;7:1765–9.

[12] Koff E, Zaitchik D, Montepare J, Albert MS. Emotion processing in the visual and auditory domains by patients with Alzheimer's disease. Journal of the International Neuropsychological Society 1999;5:32–40.

[13] Kromer Vogt LJ, Hyman BT, Van Hoesen GW, Damasio AR. Pathological alterations in the amygdala in Alzheimer's disease. Neuroscience 1990;37:377–85.

[14] Laakso MP, Partanen K, Lehtovirta M, Hallikainen M, Hänninen T, Vainio P, Riekkinen P, Sr, Soininen H. MRI of amygdala fails to diagnose early Alzheimer's disease. NeuroReport 1995;6:2414–8.

[15] LaBar KS, Gatenby JC, Gore JC, Phelps EA. Role of the amygdala in emotional picture evaluation as revealed by functional MRI. Journal of Cognitive Neuroscience 1998;S.108.

[16] LaBar KS, Gitelman DR, Parrish TB, Mesulam M-M. Neuroanatomic overlap of working memory and spatial attention networks: A functional MRI comparison within subjects. NeuroImage 1999;10:695–704.

[17] LaBar KS, Rabinovici GD, Ranganath C, Gitelman DR, Parrish TB, Paller KA, Mesulam M-M. Spatiotemporal dynamics of a neural network for emotional picture encoding revealed by parallel evoked potential and fMRI measurements. Society for Neuroscience Abstracts 1999;25:2146.

[18] Lane RD, Reiman EM, Bradley MM, Lang PJ, Ahern GL, Davidson RJ, Schwartz GE. Neuroanatomical correlates of pleasant and unpleasant emotion. Neuropsychologia 1997;35:1437–44.

[19] Mapstone ME, Rösler A, Hays A, Gitelman DR, Weintraub S. Dynamic allocation of attention during simulated driving in aging and Alzheimer's disease: Uncoupling of the eye and the mind, Journal of the International Neuropsychology Society, 2000;6:169.

[20] Maruff P, Malone V, Currie J. Asymmetries in the covert orienting of visual spatial attention to spatial and non-spatial cues in Alzheimer's disease. Brain 1995;118:1421–35.

[21] McKhann G, Drachman D, Folstein M, Katzman R, Price D, Stadlan EM. Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's disease. Neurology 1984;34:939–44.

[22] Nebes RD, Brady CB. Focused and divided attention in Alzheimer's disease. Cortex 1989;25:305–15.

[23] Parasuraman L, Greenwood PM, Haxby JV, Grady CL. Visuospatial attention in dementia of the Alzheimer's type. Brain 1992;115:711–33.

[24] Rösler A, Mapstone M, Hays AK, Mesulam M-M, Rademaker A, Gitelman DR, Weintraub S. Alterations of visual search strategy in Alzheimer's disease and aging. Neuropsychology 2000;14:398–408.

[25] Roudier M, Marcie P, Grancher A-S, Tzortzis C, Starkstein S, Boller F. Discrimination of facial identity and of emotions in Alzheimer's disease. Journal of Neurological Sciences 1998;154:151–8.

[26] Salmon DP, Thal LJ, Butters N, Heindel WC. Longitudinal evaluation of dementia of the Alzheimer type: Comparison of 3 standardized mental status examinations. Neurology 1990;40:1225–30.

[27] Thal LJ, Grundman M, Golden R. Alzheimer's disease: A correlational analysis of the Blessed Information-Memory-Concentration Test and the Mini-Mental State Exam. Neurology 1986;35:262–4.

[28] Wechsler D. Wechsler Memory Scale-Revised. New York: Psychological Corporation, 1987.

[29] Weintraub S, Mesulam M-M. Visual hemispatial inattention: Stimulus parameters and exploratory strategies. Journal of Neurology, Neurosurgery and Psychiatry 1988;51:1481–8.

[30] Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, Leirer VO. Development and validation of a geriatric depression screening scale: A preliminary report. Journal of Psychiatric Research 1983;17:37–49.

[31] Zajonc RB. Feeling and thinking: Preferences need no inferences. American Psychologist 1980;35:151–75.