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Autobiographical memories of anger in violent and non-violent individuals: A script-driven imagery study

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ABSTRACT

Numerous studies have implicated frontal lobe dysfunction in anger-related impulsive violent behavior; however, few studies have looked at frontal activity during angry states in violent individuals. Using PET and a script-driven imagery paradigm, we report on autobiographical memories of angry vs. neutral memories in violent patients and psychiatric matched controls. Relative to recall of neutral memories, recall of anger-laden memories was associated with an activation of frontal regions among control subjects but not violent subjects. Violent subjects demonstrated relatively greater activations in the left amygdala, pontine, and cerebellar regions compared to control subjects.

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1. Introduction

A growing convergence of evidence has implicated frontal lobe dysfunction in impulsive and violent behavior. For example, some murderers have decreased prefrontal glucose metabolism during an attentional task (Raine et al., 1998), and decreased left orbital frontal gray matter volume has been associated with aggressive behavior among psychiatric patients (Gansler et al., 2009). Impaired functioning of the ventromedial and medial frontal cortices may contribute to the expression of violent behavior by either poor modulation of amygdala-related negative affective states (Coccaro et al., 2007; New et al., 2007, 2009; Silbersweig et al., 2007), and/or by alteration in ability to perform moral judgments and to select alternate behavioral responses (Lawrence et al., 2009; Young et al., 2010).

Although several studies have found altered frontal functioning in individuals who engage in impulsive violent behavior, few studies have examined frontal regions in people who commit affectively-driven violent acts during an affectively charged state. Dougherty et al., 2004, found that depressed patients who have anger attacks have reduced activation of ventromedial and medial frontal regions relative to healthy controls during a script-driven anger induction task. More recently, individuals with impulsive violent behavior have been shown to have reduced activations in orbital frontal regions relative to healthy controls during an anger-provoking decision making task (New et al., 2009) and when processing angry faces (Coccaro et al., 2007). In this study, we examined neural correlates of an angry mood by using a script-driven imagery paradigm of autobiographical memories of intense anger among subjects with histories of impulsive violent behavior compared to patients without violent histories who were matched with violent subjects on Axis I diagnoses and handedness. We were specifically interested in whether inferior frontal regions decreased in violent subjects during recall of anger-related autobiographical memories.

2. Methods

2.1. Subjects

Potential subjects were solicited by advertisement, screened by phone for appropriateness and given a description of the study. Those who were eligible and interested were seen for in-person administration of the Structured Clinical Interview for DSM-IV (parts I and II; First et al., 1996, 1997) and the Brown -Goodwin Life History of Aggression Scale (Brown et al., 1979). To be eligible, violent subjects had to have at least one physically violent act within the prior year, a history of repetitive violent behavior that began by early adolescence, experienced legal consequences due to violent behavior, and met criteria for either a Cluster B personality disorder or Intermittent Explosive Disorder (APA, 1994). Control subjects had no history of violent behavior and matched violent subjects on Axis I disorders, age, handedness and use of psychotropic medications. All subjects were males between 18-55 years old. Excluded were those with psychotic

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Table 1
Neutral autobiographical memory -Rest Condition comparisons between violent subjects and non-violent psychiatric controls.

Violent > Control Subjects						Control > Violent Subjects					
	X	Y	Z	Z-score (voxels)	BA		X	Y	Z	Z-score (voxels)	BA
M. Frontal G.	-45	34	34	4.72 (308)	**9/46/8**						
Inf. Frontal G.	-58	22	22	3.45 (29)	**45**	**Inf. Frontal G.**	-25	9	-14	4.81 (267)	**47**
	54	18	22	3.35 (98)	**9**						
Precentral G.	47	-14	43	3.71 (279)	**4/6**						
Cingulate G. /M. Frontal G.	7	-7	27	3.14 (235)	**24/6**	**Anterior Cingulate**	-2	16	-7	4.15 (226)	**25**
Insula	-36	4	11	3.90 (210)	**13**						
						M. Temporal G.	58	-25	-14	3.17 (80)	**21**
						Parahippocampal G. / Hippocampus	-25	-27	-4	3.67 (58)	**27**
Precuneus	-18	-68	27	3.34 (139)	**7**						
Cuneus	0	-81	32	3.05 (134)	**19**						
						Pons	-2	-18	-22	3.47 (147)	
						Cerebellum	20	-86	-27	3.73 (103)	
							43	-70	-29	3.24 (79)	

Notes:. Coordinates and Z-scores represent the maximum voxel values within the activated region.
X<0 is left of the midsagittal plane.

disorders, active substance abuse/dependence, seizure disorders, gross traumatic brain injury, or violent behavior only while intoxicated. The study was approved by the Minneapolis VAMC institutional review board and the Radioactive Drug Research Committee of the FDA. All subjects provided informed consent. A Certificate of Confidentiality (U.S. Department of Health and Human Services; MH-97-90) was acquired to ensure subjects' confidentiality about criminal activity.

2.2. Autobiographical Memories

In a separate appointment prior to imaging, subjects were interviewed about memories associated with intense anger and those that were affectively neutral. For each subject, two angry and two neutral memories were developed into brief scripts that were used in the mood-induction protocol using script-driven imagery. For violent subjects, angry memories were characterized by violent behavior (i.e., assault).

2.3. PET imaging

Subjects were scanned in a rest condition with their eyes closed, followed by presentation of previously prepared autobiographical scripts (i.e., script-driven memory conditions). Scripts of autobiographic memories associated with either intense anger (ANGER) or neutral affect (NEUTRAL) were read to the subject while in the scanner immediately before initiating measurement of brain blood flow. There were two scans of each condition per subject administered in a counterbalanced order. Imaging used a Siemens ECAT 953B camera in 3D mode. Image reconstruction used a filtered back-projection (0.5 cycles/pixel Hanning filter). A slow bolus infusion of $H_2^{15}O$ (average initial dose of 0.25 mCi/kg) was used, and rCBF was estimated from normalized tissue activity (measured attenuation corrected) and integrated over 90 s. Images were smoothed with a Gaussian filter, and final image resolution was 9 mm FWHM. Software by Minoshima et al., 1994, permitted image registration, ACPC determination, and nonlinear warping to Talairach space.

2.4. Analyses

Regional CBF was calculated by voxelwise subtraction of inter-subject averaged images from the contrasts between anger and neutral autobiographical memory conditions (ANGER - NEUTRAL). Violent subjects and controls were compared to ascertain significant group differences in the rest condition (RC), and for the ANGER - NEUTRAL subtraction. Foci were considered significant if the cluster contained at least 25 contiguous voxels, and the z-score of the peak voxel was at least 3.0 (p-value of ≤ 0.001) to account for multiple comparisons. The Talairach Daemon client (Lancaster et al., 1997, 2000) was used to identify anatomical labels (i.e., gyri and Brodmann areas) associated with coordinates of maximum and submaximum peak voxels.

3. Results

There were 8 subjects in each group. There were no significant differences between groups in age (violent = 44.25 ± 9.3 yo; control = 42.4 ± 9.2 yo), education (violent = 13.3 ± 1.5 yrs; control = 15 ± 1.8 yrs), or history of chemical dependency (all p's > 0.05). Three subjects from each group were on antidepressants. Two of the violent subjects on antidepressants were also prescribed mood stabilizers. Six of each group were right handed. Two violent subjects were left handed, and one control subject was left handed and one ambidextrous. Of the violent subjects, six met criteria for antisocial personality disorder, one for borderline personality disorder and one for intermittent explosive disorder. Of the four violent subjects who had major depression, two also had posttraumatic stress disorder. Among controls subjects, four had major depression, one had posttraumatic stress disorder, and one who had major depression also met criteria for anxiety disorder NOS with posttraumatic features.

Table 2
Anger-related autobiographical memory – Rest Condition comparisons between violent subjects and non-violent matched psychiatric controls.

Violent Subjects > Controls						Controls > Violent Subjects					
	X	Y	Z	Z-score (voxels)	BA		X	Y	Z	Z-score (voxels)	BA
						Inf. Frontal G. / M. Frontal G.	-36	20	-18	3.44 (405)	**47**
						Cingulate G.	25	-43	36	3.41 (39)	**31**
						S. Temporal G.	-63	-16	0	3.21 (36)	**22**
Inf. Parietal L.	61	-36	45	3.20 (49)	**40**	**Fusiform G.**	47	-20	-20	3.52 (125)	**20**

Notes:. Coordinates and Z-scores represent the maximum voxel values within the activated region.
X<0 is left of the midsagittal plane.