

# fMRI Measures of Hemispheric Asymmetry in Young Adults Verbally or Sexually

## Abused as Children: Implications for Dissociative States of Consciousness

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### INTRODUCTION:

Dissociative states of consciousness observed with multiple personality disorder (MPD), hypnosis or the American spiritual phenomena of channeling (Brown, 1997) represent an enigma for the modern sciences of mind. So much controversy surrounds these phenomena that a theoretical foundation for understanding their origin has been largely neglected.

Recent findings have indicated a strong connection between dissociative states and a history of childhood abuse or post traumatic stress disorder (PTSD). The present work demonstrating the existence of functional hemispheric asymmetries in association with early childhood abuse and scores on the dissociative experiences scale (DES) presents a new theoretical and clinical approach to studying the neuropsychological basis of dissociative states.

The findings reported in this poster represent "work in progress" and may change or be modified with further analysis.

### SUBJECTS:

Young adults between 18-22 years of age, unmedicated, and not using illicit substances, were recruited by advertisement.

**Exclusion factors:** History of DSM-IV axis I psychiatric disorder in first degree relative or history of known neurological disease or insult or history of maternal substance abuse or viral infection during pregnancy, and any of a series of complications during delivery or perinatal period (e.g., prematurity, eclampsia, fetal distress, high forceps delivery, labor greater than 24 hours, emergency Cesarean section, low birth weight, hyperbilirubinemia, respiratory distress, etc.). Also subjects with verified or suspected seizure disorders were excluded if the seizure disorder predated the abuse, or was related to known CNS disease or trauma. Subjects with head injuries were excluded if the injury resulted in loss of consciousness for more than 2 hours, or fractured the skull.

**Inclusion criterion:** Satisfactory completion of the following assessment tests:

Abuse Trauma Questionnaire (ATQ), Parental Bonding Instrument (PBI), Dissociative Experience Scale (DES), Limbic System Check List (LSCL-33), and Medical History-Birth Questionnaire.

**Subject procedures:** On the first visit, subjects received a brief screening interview to confirm the data collected to date, to explain the purpose and nature of the study, and to obtain informed consent. Eligible subjects underwent a EEG coherence assessment and a structured clinical interview (SCID) supplemented by clinical ratings of depression and anxiety, and a toxicological screen. During the second visit they underwent phlebotomy at 10:00 a.m.  $\pm$  30 min for  $\alpha$ 2 and glucocorticoid receptors, as well as neuropsychological tests, complete self-report ratings. They then underwent fMRI study and regional Cerebral Blood Volume determinations at the McLean Hospital's Brain Imaging Center. Patients received payment of \$15 for the assessment tests and \$250 after completing the study.

### fMRI METHODS:

Recently, magnetic resonance images with very high temporal resolution (e.g., Echo planar imaging) have facilitated the development of a family of related methods for functional imaging which are sensitive to changes in regional cerebral metabolism or blood flow (2). These methods, collectively referred to as fMRI, commonly detect acute signal intensity changes in cerebral activity rather than assessing steady state blood flow. The design of most blood oxygenation level dependent (BOLD) functional MRI brain imaging studies involves localizing brain activation that results from alternating periods of rest and stimulation. This is followed by some form of correlation or regression analysis of the data to locate voxels with signal intensity changes that covary with the stimulation pattern. The observed increased signal during activation reflects a decrease in deoxyhemoglobin content due to an increase in oxygenated blood flow to the region.

Blood flow and cerebral blood volume both increase with neuronal activation but blood flow exceeds blood volume changes by two to four times effectively diluting paramagnetic blood deoxyhemoglobin content within an observed voxel and thereby reducing the local magnetic susceptibility effect. While this technique works well for rapid hemodynamic shifts which might occur during testing or cognitive activation, it cannot be used to access flow under steady-state conditions where deoxyhemoglobin content is constant.

We used an echo-planar "T2 relaxometry" technique for mapping the brain water relaxation time T2 with a high degree of reliability in our abuse study subjects. During steady state conditions, deoxyhemoglobin content remains relatively constant as compared with content under activation procedures. Under these conditions greater blood flow is associated with greater oxyhemoglobin content. This method uses a TE (Time-to-Echo) stepping procedure to factor T2\* from the estimate of T2 decay.

We have found that T2 decay estimates derived from this measure appear proportional to local cerebral blood flow (3). One of the advantages of measuring T2 decay, as opposed to a change in image signal intensity during a single scanning session, is the higher signal to noise ratio. In pilot studies of adults with Seasonal Affective Disorder (SAD), we have recently demonstrated the usefulness of T2 relaxometry for investigating shifts in abnormal hemispheric asymmetry with light treatment in the same individual(4).

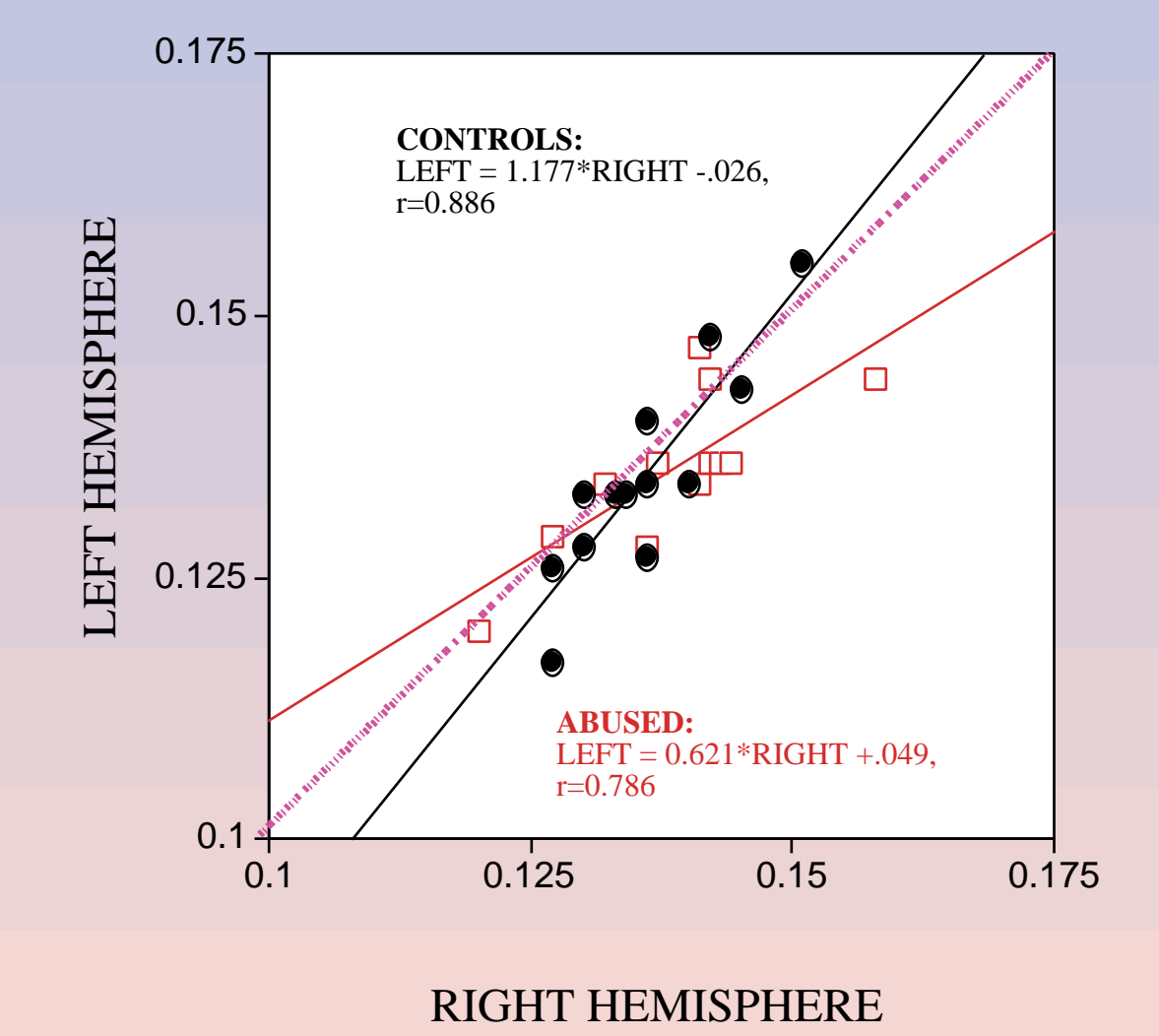
In this study, we compare differences in blood flow in the right and left hemispheres of abuse and control subjects (see figure 1). Images were acquired using a 1.5-T GE Signa system equipped with a whole-body echo planar gradient set and a quadrature head coil. Values of T2 were estimated from a series of 32 TE stepped echo planar imaging (EPI), spin echo images collected in 10 axial slices (TE = 32 msec, TR = 10 msec, Slice thickness = 7mm with a 3mm skip, in-plane resolution = 3.125 mm 3.125 mm, FOV = 200 mm). For temporal lobe regions, a median regional decay curve was generated by taking the median pixel intensity within the region of interest (ROI) at each value of TE examined. An estimate of T2 decay time was then computed by linear least square fitting of the log-transformed median time course. Use of median values provides greater immunity from partial volume contamination due to bordering regions, white matter and CSF. Images were corrected for frame-to-frame motion with the DART registration algorithm (5).

Conventional T1 images      T2 decay images



Figure 1. Left column: Conventional T1 weighted image slices from a control subject; Adjacent column T2 decay images with green lines defining the region of interest (ROI). The ROI's were selected to avoid interface hyperintensity artifacts and ventricular regions.

RIGHT VS LEFT HEMISPHERE T2



### RESULTS & CONCLUSIONS:

The most prominent finding to emerge from this preliminary analysis of the data is that in normal subjects there is a tight coupling between right and left hemisphere T2 measures ( $r = 0.886$ ) with a slope that is close to unity ( $b = 1.177$ ) and a near zero y intercept. In contrast, abused subjects had a lower correlation ( $r = 0.786$ ), a substantially greater y-intercept and flatter slope ( $b = 0.621$ ). The regression lines for normal and abused subjects were also found to be significantly different ( $F_{1,22} = 4.982, p < 0.05$ ). In addition, a striking correlation between right or left hemisphere T2 and the dissociative experiences scale (DES) was also observed ( $r = 0.800$  or  $0.800$ ).

These findings suggest that coupling between right and left hemisphere is diminished in abused patients and is concordant with previous findings from our laboratory (1,6). For example, Schiffer has recently reported in 70 psychotherapy patients, changes in anxiety levels induced by selective left or right lateral visual field stimulation(7). In psychiatric interviews 40 of the 70 patients manifested personality changes such that the lateral view induced a more mature world view and greater sense of security while the other view induced a more immature or more anxious perspective.

As part of the current study, Schiffer et al. found that left or right visual stimulation altered the affective theta EEG laterality of subjects and that Right-sided resting anterior temporal lobe (ATL) blood flow determined by baseline fMRI appeared to predict EEG and affect responses to lateral visual field stimulation. Functional hemispheric asymmetry associative with abuse during childhood may play role in altered emotional regulation.

The higher incidence of dissociative symptoms in women.

Work by Leonard et al. demonstrates that asymmetry in the auditory associative cortex is associated with early language proficiency in girls. In the case, young girls, due to the existence of a natural developmental asymmetry, may be particularly sensitive to the effects of early sexual abuse. This could explain the high incidence of dissociative symptoms found in female inpatients hospitalized for depression with a history of childhood sexual abuse (Chu and Dill, 1990).

Differential hemispheric coupling and creativity.

Tight coupling between hemispheres may restrict cognitive and emotional functioning to a smaller space of possible states. The wider range of states available to individuals with intrinsic asymmetries may promote enhancement of emotional and cognitive abilities. Natural or abuse-mediated asymmetry may also explain the high incidence of depression among creative individuals from many disciplines.

Bilateral limbic structures as emotional-cognitive broadband heterodynes.

Great bursts of creativity, self hypnosis during driving or daydreaming, or other variations in human conscious experience could also be explained within the broad framework of differential functional hemispheric coupling. If the two hemispheres function as independent processing systems, it could be made to phase array techniques used with radio telescopes in which receivers are aligned in parallel to increase signal-to-noise ratio. Differential coupling between hemispheres may enhance the detection of physical processes out of the normal range of conscious experience.

Limbic structures such as the amygdaloid complex would be ideally suited to act as emotional-cognitive receivers in such cases. The bilateral complex could then be conceptualized as a broadband heterodyning system which mixes broadband internal and external processing streams to generate control output for the basal forebrain and reticular activating system.

Consciousness as a continuum of selves.

What are the implications of these findings for the theoretical foundations of dissociative states of consciousness? These findings support Schiffer (8) and the pioneering work of Sperry that the traditional concept of the singular "self" is an illusion and could be more completely a plurality or continuum of selves. Although in normal individuals a tight functional coupling may exist between the hemispheres which experience of the unified self, abuse-mediated disruption of cortical developmental processes (Thatcher, 1997) may result in diminished functional coupling thus revealing the underlying continuum of selves.

### In Summary,

**These findings suggest that diminished right/left hemispheric integration could be more common in adults with a history of childhood abuse, and that decreased hemispheric activity may engender dissociated states of consciousness**

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