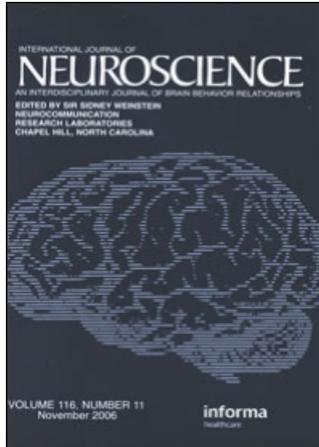


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Ronald A. Yeo ^a; Eric Turkheimer ^b; Erin D. Bigler ^c

^a Department of Psychology, The University of New Mexico, Albuquerque, NM

^b Department of Psychology, The University of Texas, Austin, TX

^c Department of Psychology, The University of Texas, Austin, Tx

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THE INFLUENCE OF SEX AND AGE ON UNILATERAL CEREBRAL LESION SEQUELAE

RONALD A. YEO

Department of Psychology, The University of New Mexico, Albuquerque, NM 87131

ERIC TURKHEIMER

Department of Psychology, The University of Texas, Austin, TX 78712

and

ERIN D. BIGLER

Department of Psychology, The University of Texas, Austin, Tx 78712

and Austin Neurological Clinic

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Group differences in unilateral lesion sequelae may suggest group differences in brain organization, but only if the two groups have equivalent lesions. In an analysis of sex and age on neuropsychological performance, we quantified lesion size and location, based on CT images. Significant sex by group (left, right, controls) interactions were found for variables most related to left hemisphere functions (verbal intellectual, right motor, right sensory), but not for variables most related to right hemisphere functions (nonverbal intellectual, left motor, left sensory). For each interaction, left males performed worse than left females, but right males were better than right females. Further, these sex differences were not due to sex differences in lesion parameters. Age was not a major determinant of lesion sequelae.

Individual differences in the physical asymmetries of the human brain have been frequently documented (e.g., McRae, Branch, & Milner, 1968; LeMay, 1977). More controversial are individual differences in the localization of functions. It has been suggested that some human brains have verbal and nonverbal processing systems in the left and right hemispheres, respectively, while others show bilateral distribution of one or both systems (Denenberg, 1980). Experimental investigation of such differences among normal subjects, with tachistoscopic or dichotic techniques, for examples, is complicated by interpretive difficulties (Bryden, 1978) and replication difficulties.

A more direct technique for investigation of individual differences lies in the analysis of unilateral cerebral lesion sequelae. A group difference in neuropsychological performance after brain damage, however, implies differences in brain organization only if it can be demonstrated that the groups have equivalent brain lesions (i.e., size and location). Previous investigations of individual differences in lesion effects have not been able to demonstrate directly that the groups had equivalent lesions. As both sex and age have been linked to systematic differences in lesion location (Sinderman *et al.*, 1970; Kaste & Waltimo, 1976), it is clearly premature to attribute differences in sequelae to differences between the brains rather than the lesions.

The current investigation quantified aspects of cerebral lesions, as revealed by CT scans (Yeo, Turkheimer, & Bigler, 1983; Turkheimer, Yeo, & Bigler, 1983). We also sought to extend the neuropsychological measures beyond ability tests to include sensory and motor functions.

METHODS

Unilateral brain-damaged subjects were selected from the patients of the Austin Neurological Clinic according to several criteria: 1). right-handedness, 2. age over 16, 3. CT scan performed, and 4. neuropsychological test results available. Of the 78 brain-damaged subjects selected, 63 (80%) had their CT scans quantified. The etiologies were infarcts ($N=48$, 62%), hemorrhage (7, 9%), extrinsic tumor (2, 3%), intrinsic tumor (11, 14%), focal trauma (8, 10%), and abscess (2, 3%). Control subjects ($N=76$) were also patients from the Austin Neurological Clinic, who, after extensive neurological work-up, were judged not to have cerebral dysfunction.

CT scans were traced then converted to digital data which was analyzed by means of an interactive program written in APL. CT-derived lesion measures were lesion size (a ratio of lesion volume to brain volume) and lesion location. Location was expressed as the centroid of the lesion in three dimensional space, yielding a left-right coordinate, an anterior-posterior coordinate, and a superior-inferior coordinate.

Neuropsychological variables from the Halstead-Reitan Battery (including the Wechsler Adult Intelligence Scale and Wechsler Memory Scale) were standardized and combined to form seven composite variables: verbal (verbal WAIS and WMS subtests, Halstead-Wepman Aphasia Screening Exam), nonverbal (WAIS Performance subtests, excluding Digit Symbol, Greek cross from the Aphasia Screening Battery), perceptual-motor (Trails A, Trails B, Digit Symbol), left motor (left finger tapping speed and strength of grip), right motor, left sensory (tactile, auditory and visual exams from the Sensory-Perceptual Exam of the HRB), and right sensory.

The bulk of the data analyses were sex by age (split at the median) by group (left, right, controls) ANOVAs. MANOVAs, using the seven composites as dependent variables, were not attempted because missing data on any variable would delete that subject from the analysis. The experiment-wise error rate was thus increased (through multiple comparisons) rather than reduce statistical power.

RESULTS AND DISCUSSION

Significant sex by group interactions were observed for verbal ($p=0.0005$), right motor ($p=0.02$), and right sensory ($p=0.003$) variables. This interaction was not quite significant for the perceptual-motor variable ($p=0.09$). On each of these four variables the right lesion group was superior to the left and the controls superior to both. The nature of each interaction was such that the left males were worse than the left women, but the right men were slightly better than the right women. The only significant age by group interaction was on the right motor variable ($p=0.05$).

Can these differences be attributed to lesion parameters? A sex by age by group MANOVA was performed on the lesion parameters, as well as education and time postlesion. No main effects or interactions approached significance. The only group difference of potential interest was a trend for the left males to have slightly larger lesions than the left females. ANCOVAs (with lesion size as the covariate) were per-

formed for each neuropsychological variable, for those subjects whose CT scans had been analyzed. The same pattern of sex differences emerged, though significance levels were attenuated. This attenuation appeared to be due more to the exclusion of subjects without analyzed scans than to treating lesion size as a covariate, because there were only slight differences between the ANCOVAs and ANOVAs performed on the same group of subjects.

There were differences in the etiologies of the age groups, and to a much less extent, males and females. The possible confounding effects of etiology were examined in two ways. First, analyses were limited to patients with infarctions. Second, age and sex groups were constructed matched for etiology. In each case, the same sex by group interactions were significant as in the total sample analysis. The only age by group interaction to reach significance was on the left sensory variable among the infarct group. Also observed in the infarct group were triple interactions (sex by age by group) on three variables: non-verbal, left motor, and left sensory. Each of these interactions was of the same pattern. Among left patients, age had a similar effect on both males and females, whereas among right patients age had a much stronger effect on females than males.

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