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# Dreaming in agenesis of the corpus callosum: laboratory and home assessment of four cases

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**SUMMARY** Laboratory and home dream recall was studied in four subjects with agenesis of the corpus callosum and in four control subjects who were matched for age, gender, and handedness. In addition, the structural and emotional content of home dreams was compared for these two groups.

Results indicate that acallosal subjects recalled fewer dreams in the laboratory than did control subjects, but recalled the same number of dreams at home. They also reported more contentless dreams in both situations. Furthermore, although acallosal subjects used fewer words to describe their dream content in both contexts, the number of content categories they reported differed little from the number reported by control subjects. However, some trends were found for acallosal's home dreams to differ from those of controls, i.e. more dreams with known characters and fewer dreams with unknown characters, animals, and colours. Differences in emotional contents were few; acallosals reported more distress than controls.

The shorter length of acallosals' dreams might be explained, in part, by their lower verbal IQs. Other characteristics of dream content (e.g. more distress, fewer dreams with unknown and animal characters) may reflect limited social experiences in this group. However, the greater frequency of contentless dreams and the lower frequency of dreams with colour are trends consistent with the possibility that the corpus callosum may be implicated in processes of dream production and dream recall.

KEYWORDS agenesis of the corpus callosum, dreaming, dream recall, emotion, right hemisphere, sleep.

## INTRODUCTION

Agenesis of the corpus callosum (ACC) is a relatively rare congenital abnormality in which cortical fibres in one hemisphere wholly or partially fail to cross to the opposite hemisphere (Reil 1812; Jeret *et al.* 1987). Although ACC is often associated with other chromosomal abnormalities, syndromes, mental retardation, and seizures (Jeret *et al.* 1987), there are populations of relatively asymptomatic patients whose psychological and developmental status have been extensively studied (e.g. Lassonde *et al.* 1991; Lassonde *et al.* 1988; Chiarello 1980). Such patients could provide useful information about whether the corpus callosum plays an essential role in the processes of dreaming or dream recall.

Although the dreams of acallosal individuals have not been investigated systematically, several lines of research nevertheless implicate the corpus callosum in dreaming and provide a theoretical framework approach to the study of acallosal dreaming. These include research on (1) visuo-spatial and right-hemisphere determinants of dreaming, (2) contentless dream recall, and (3) alexithymia.

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### Visuo-spatial and right hemisphere determinants of dreaming

One early hypothesis about the relationship between the corpus callosum and dreaming was that dreaming (in left-handed individuals) is a primarily visuospatial process mediated by the right hemisphere which – for verbal reporting – requires transfer of information across the corpus callosum to processes in the left hemisphere (Bakan 1978). This hypothesis was supported by early lesion studies (e.g. Humphrey and Zangwill 1951) and analyses of the REM sleep EEG (e.g. Goldstein *et al.* 1972). However, recent reviews of the clinical and experimental literature (Antrobus 1987; Greenberg and Farah 1986), although not totally discrediting the notion of right-to-left hemisphere transfer, nevertheless conclude that left hemisphere processes are more pivotal to the organization of dream content than are right hemisphere processes.

Studies of the dream activity of epileptic patients with surgical section of the corpus callosum also provide clues as to whether an absence of right-to-left hemisphere transfer interferes with dream production. Greenwood *et al.* (1977) found that visual dreaming was reported by all three of their partially or completely callosotomized patients while studies in our laboratory also showed that dream recall persisted, albeit in a diminished form, after posterior section of the corpus callosum (Montplaisir *et al.* 1985). These studies, too, seem consistent with the view that no right-to-left transfer over the corpus callosum is essential for either dream production or recall. However, it has been argued (Kerr and Foulkes 1981) that subjects' habitual use of visual metaphoric language to describe their dreams may lead to the erroneous attribution that right hemisphere, visuo-spatial determinants influence dream content when such determinants are not, in fact, present. Assessment of the phenomenological determinants of dream experience independent of visual metaphoric language is thus critical to research in this area and is further explored in the present research.

### Contentless dreams

Contentless dreams, or reports consisting of an impression of having dreamt vividly without recollection of specific contents, have also been implicated in the functioning of the corpus callosum. That contentless dreams are not simply failures to recall dreams is suggested by evidence that the EEG power spectrum accompanying contentless dreams differentiates them from the EEG spectra of both recalled and unrecalled dreams (Meier 1989). Contentless dreams are also reported by partial callosotomy patients much more often after surgery than before it (Montplaisir *et al.* 1985). Contentless dreams are also reported more frequently by asthmatic patients (Monday *et al.* 1987) for whom a 'functional callosotomy' has been postulated as an etiological factor (Hoppe 1977). Together, these studies support the possibility that contentless dreams are symptomatic of a blocking of right-to-left transfer of information over a dysfunctional corpus callosum.

### Alexithymia

There is evidence linking the emotional disturbance of alexithymia both to ACC and to anomalies in dream recall. The original conceptualization of alexithymic patients was that they suffered from – among other symptoms – an inability to express feelings in words and a restricted access to dreaming imagery. This notion was recently confirmed in a sample of asthmatic men (Nielsen *et al.*, 1993). Whether alexithymia also characterizes acallosal patients is unknown, although it is a symptom seen in callosotomized patients (Hoppe and Bogen 1977; TenHouten *et al.* 1988). Others have reported an emotionally restrictive style among acallosal children (O'Brien 1991). In sum, there is research suggesting that alexithymia may be associated with dysfunction of the corpus callosum.

To further explore the possible involvement of the corpus callosum in processes of dreaming, dream recall, and alexithymia, we studied both laboratory and home dream recall in 4 acallosal subjects and 4 controls who were matched for age, gender and hand preference. We approached the problem of right and left hemisphere determinants of dream experience by assessing dream content with both standard verbal measures of dream recall and with a checklist of content categories which was less dependent upon verbal abilities. The latter included some content categories, such as the presence of colours, which refer specifically to visual-spatial determinants of dream imagery. We also asked subjects questions designed to identify contentless dreams. Finally, to investigate the possible implication of alexithymia in ACC we examined the emotional content and variety of recalled dreams.

## SUBJECTS

Two female and two male subjects (mean [*M*] = 23·0 y) with ACC were studied. They were paid participants recruited from a population collaborating with one of the authors (M. Lassonde) at the Université de Montréal. Diagnoses of ACC in all cases were confirmed with CT scan and/or nuclear magnetic resonance imaging (MRI). Three of these subjects (MG, LG and SG) are siblings in a French-Canadian family with four children. More extensive descriptions of the psychiatric, neuropsychological, and cognitive status of these subjects has been described elsewhere (Lassonde *et al.* 1988; Lassonde *et al.* 1991; Sauerwein and Lassonde 1983; Sauerwein *et al.* 1981).

*Case* 1: MG (19 y), a left-handed male, is the youngest sibling. He was first seen by a neurologist at age four for a condition of motor incoordination, delayed speech acquisition and enuresis. A complete agenesis of the corpus

callosum was revealed by pneumoencephalography (PEG) and later CT scan. He scored a full-scale IQ of 77 (Verbal: 71, Performance: 87) on a French version of the WAIS-R.

*Case* 2: LG (27 y), a right-handed female, is the second youngest child. She was hospitalized once at age three for a mild concussion and once for ataxia. Callosal agenesis with sparing of the anterior commissure was diagnosed by a PEG performed during her second hospitalization, and subsequently confirmed by CT scan and MRI. Two years after testing, an EEG showed her to have a unilateral left hemispheric temporal epileptic focus, which is now treated with Phenobarbital and Carbamazepine. She has a full-scale IQ of 78 (Verbal: 81, Performance: 81) on the Ottawa-Wechsler.

*Case* 3: SG (29 y), a right-handed female, is the second oldest child. Because of the prevalence of agenesis in her family she volunteered to a CT scan; the latter revealed complete callosal agenesis. Her development was normal except for a slow acquisition of walking. She has a global IQ of 84 (Verbal: 88, Performance: 82) on the WAIS-R.

*Case* 4: SB (17 y), a right-handed male, was adopted at 6 months. During childhood he underwent surgery both to correct strabismus and for a stomach hernia. He had his first epileptic seizures at age six and an EEG implicated the left temporal region. His epilepsy is now well-controlled with Carbamazepine. A CT scan revealed a complete agenesis of the corpus callosum. At age 16, he scored 68 on the global IQ of the WISC-R (Verbal: 58, Performance: 81). He has dyslexia.

The four control subjects were persons known to members of the research team and were recruited to match the age ($M = 24.5$ y) gender, and hand preference, but not the IQ, of the acallosal subjects. None reported a history of neurological, psychiatric, or sleep problems. Like the acallosal subjects, none abused alcohol or took psychotropic medications.

## METHODS

### Laboratory procedures

Each subject spent two consecutive nights in the sleep laboratory where all-night polysomnograms were recorded with a 10–20 EEG montage (Jasper 1958) and a standard EEG, EOG, and EMG montage for sleep staging (Rechtschaffen and Kales 1964). The first night of sleep was for adaptation to the laboratory and was not analysed further. Records for the second night were scored visually by an experienced technician and standard sleep parameters were calculated. Digitized EEG signals were subjected to both intra- and interhemispheric coherence analyses. The results of these sleep and EEG coherence analyses are reported elsewhere (Nielsen *et al.* 1992; Nielsen *et al.* 1993).

On both mornings, subjects were awakened from their last REM sleep period to report dreams. These awakenings occurred after at least 7.5 min of REM sleep had elapsed and as close as possible to each subject's planned wake-up time. Subjects were asked whether they thought they had been dreaming and whether they would verbally report whatever they could remember. Verbal reports of any reported dreams were tape-recorded. Dream contents were further rated by each subject for whether at least one of each of the following 10 categories was present: known characters, unknown characters, animals, speech, music, other sounds, movements, emotions, colours, and odours. They were also asked to specify what emotions they experienced and were read some examples as prompts: joy, sadness, surprise, shyness, anger, disgust, fear.

### Home diary dreams

The three acallosal siblings (LG, SG, and MG) and their three matched control subjects agreed to maintain home dream diaries for a two-week period following the laboratory study. Subject SB was not asked to complete a diary because of his dyslexia and low verbal IQ. The diaries contained blank pages sufficient for recording up to 14 dreams as well as 14 of the same 10-item checklists used for describing presence or absence of dream contents in the laboratory study. Two acallosal subjects each returned 15 diary pages; these were also included in subsequent analyses.

### Recall and content measures

Several features of dream recall and content were assessed in both the laboratory and the home diary dream reports. *Dream Recall* measures were derived from a word count of all reports and from the subject's indication of whether or not he or she had dreamt. Three separate measures included: Dream Recall—any report with 5 or more words; Contentless Dream—any report with less than 5 words, the impression of having dreamt, but having forgotten the content; No Recall—any report with 0 words and the impression of not having dreamt. A *Verbal Elaboration* measure consisted of a count of the number of words comprising the report of each dream. A *Non-Verbal Elaboration* measure consisted of a count of the total number of categories on the 10-item checklist that were scored as 'present' in each dream. Relative proportions of occurrence of each of the 10 categories were also assessed. A measure of *Emotional Elaboration* was defined as the number of distinct emotions reported per dream. All emotion words used to describe dreams were classified into one of 10 basic categories of emotion (Izard 1977) or into an 'other' category, and the relative frequencies of these were calculated. Two independent judges agreed on 95.8% of the classifications. Together they resolved their disagreements

about the remaining 4.2% and these compromise values were used in subsequent analyses.

### Statistical analyses

Between-groups differences for elaboration scores were compared using two-tailed *t*-tests. Differences in proportions of dream recall and frequencies of content categories and emotions for the home diary dreams were calculated using two-tailed normal curve Z-tests (Edwards, 1972).

## RESULTS

### Laboratory dream reports

*Dream Recall.* Although all acallosal subjects recalled at least one dream in either the laboratory or home diary phases of the study, their capacity to recall dreams in the laboratory was impaired to some extent. Whereas control subjects recalled dreams on all 8 laboratory awakenings (100%), ACC subjects recalled dreams on only 4 awakenings (50%, $z = -2.30$, $P = 0.02$). On the remaining 4 awakenings, 2 ACC subjects reported contentless dreams (25%) and one ACC subject failed to recall dreams on both awakenings (25%, $z = -1.74$, $P = 0.12$).

*Verbal Elaboration.* The laboratory dreams that were recalled by acallosal subjects were shorter in length ($M = 30.0 \pm 18.4$ words) than those of controls ($M = 107.8 \pm 64.9$; $t_{10} = -2.30$, $P = 0.044$).

*Non-Verbal Elaboration.* The mean number of categories on the 10-item checklist scored as 'present' by the acallosal subjects ($M = 5.8 \pm 0.5$) was not different from the mean number reported by control subjects ($M = 4.9 \pm 1.8$).

*Emotional Elaboration.* Acallosal subjects reported emotions in all 4 of their recalled laboratory dreams, whereas control subjects reported emotions in 6 out of 8, an insignificant difference. The number of emotions per dream report was marginally less for acallosal subjects (1/report) than for control subjects (2/report; $t_5 = -1.94$, $P = 0.11$). It should be emphasized that the differences and trends observed for the laboratory dreams are based upon a small number of dream reports and are thus limited in their generality.

### Home diary dream reports

*Dream Recall.* Unlike in the laboratory situation, acallosal subjects at home recalled the same number of dreams (24/44 or 57.1%) as control subjects (24/42 or 54.5%). The number of contentless dreams reported by acallosals (11/44 or 25.0%) was only marginally greater than the number reported by controls (5/42 or 11.9%, $z = 1.56$, $P = 0.12$), but was exactly the same proportion as reported by them in the laboratory (25.0%). This incidence of contentless dreams on the home diary task was due to the same two acallosal subjects who reported contentless dreams in the laboratory; specifically, MG who reported 6 more, and LG who reported 2 more, contentless dreams than their matched control subjects on the diary task. By contrast, subject SG, who twice failed to recall dreams in the laboratory, also reported 8/14 (57.1%) failures to recall on the diary task.

*Verbal Elaboration.* The diary dream reports of acallosal subjects were similar to their laboratory reports in that they were much shorter in length ($M = 37.4 \pm 28.6$) than those of control subjects ($M = 145.8 \pm 100.0$; $t_{46} = -5.10$, $P < 0.0001$).

*Non-Verbal Elaboration.* A similar number of categories per dream were reported by acallosals ($M = 3.9 \pm 1.7$) and controls ($M = 4.5 \pm 2.1$; $t_{46} = -1.07$, $P = 0.29$). Acallosals showed trends to report more dreams with known characters (83.3% vs 58.3%, $z = -1.91$, $P = 0.06$) and fewer dreams with unknown characters (29.2% vs 54.2%, $z = 1.76$, $P = 0.08$), animals (12.5% vs 29.2%, $z = -1.43$, $P = 0.15$), and colours (25.0% vs 45.8%, $z = 1.59$, $P = 0.11$).

*Emotional Elaboration.* Acallosal subjects reported at least one emotion in their home dreams as often (M = 85.6%) as did control subjects ($M = 84.2\%$). The mean number of emotions per dream was also similar for acallosal ($M = 1.33$) and control ($M = 1.67$) subjects. The total number of negative emotions in the dreams of the acallosal subjects was only slightly higher ($M = 56.3\%$) than in the dreams of the control subjects ($M = 47.5\%$). Few differences in the frequencies of emotion categories were found. However, acallosal subjects reported more "Distress" (21.9%) than control subjects (5.0%; $z = 2.16$, $P = 0.03$). Acallosals showed a tendency to use a more restricted range of emotion categories than did controls; specifically, acallosals failed to use 5 of the 10 (50%) basic emotion categories at least once, whereas controls failed to use 2 of the 10 (20%) at least once.

## DISCUSSION

The present results demonstrate clearly that adult subjects with congenital absence of the corpus callosum report normal dreams in both laboratory and home environments. The corpus callosum thus does not appear to be an essential anatomical structure for the production and verbal reporting of dream experiences. This conclusion is broadly consistent with the results of prior studies that have found evidence of dreaming after surgical section of the corpus callosum (Greenwood *et al.* 1977; Montplaisir *et al.* 1985). It is also consistent with previous analyses showing that the sleep

architecture and, in particular, the REM sleep architecture of these acallosal subjects is not dramatically different from the architecture of control subjects (Nielsen *et al.* 1992).

### Dream reporting

The finding that dreams of acallosal subjects were much less verbally elaborate than those of control subjects may be due, in part, to lower verbal–intellectual abilities among the acallosal group. This is possible considering that acallosal subjects were not systematically matched to control subjects on the basis of IQ. Although both home dream recall (Martinetti 1985) and laboratory dream recall (Butler and Watson 1985; Martinetti 1985) have been found to be associated with some WAIS performance subtests – Block Design and Digit Symbol in particular – it is likely that low verbal IQ was a more important influence than performance IQ on the reporting of dreams for subjects in the present study.

For instance, verbal IQ was substantially lower than performance IQ for subject MG (16 points) and subject SB (23 points). Also, acallosal and control subjects did *not* differ on the average number of content categories reported per dream, which is a relatively nonverbal measure of dream elaboration. Thus, it seems likely that the verbal deficits of the acallosal subjects may have affected their *reporting* or elaboration of dreams but not necessarily their processes of *recall* or *production* of dreaming *per se*.

### Dream recall

The dream recall abilities of the acallosal subjects in this sample were nevertheless not completely typical. Acallosals had fewer successful dream recalls in the laboratory and they had more frequent contentless dreams both in the laboratory and at home. This was especially true for ACC subjects MG and SG. Together with results from a study showing more frequent contentless dreams following callosotomy (Montplaisir *et al.* 1985), these results are consistent with the possibility that contentless dreams reflect some deficit in dream recall which is attributable to callosal absence. The fact that asthmatic patients – for whom a 'functionally callosotomy' has been suggested as a pathophysiological factor (Hoppe 1977) – report a high frequency of contentless dreams (Monday *et al.* 1987) is also consistent with this notion. One interpretation of these results is that acallosals may have a deficit in transferring some right hemisphere (visuo-spatial) activity to the left hemisphere for verbal expression. Another possibility is that acallosal subjects were more socially inexperienced or anxious in the laboratory situation than the controls and were thus more distracted from the recall task in this context. However, it is important to emphasize that the acallosal subjects in this study were very research wise, having participated regularly in research projects over several years. The control subjects did not have such experience. It is thus even likely that the dream recall of acallosal subjects was *less* affected by social inexperience or anxiety than was that of control subjects in this study.

A final possible explanation of these findings is that they are an artifact of some hereditary factor which was produced by studying three genetically related ACC subjects. This is an unlikely explanation, however, because evidence of hereditary influences on dreaming and related REM sleep variables is limited, even in the case of identical twins (e.g. Gedda & Brenci 1979; Webb and Campbell 1983; Zung and Wilson 1967; but cf. case study by Epstein 1976).

### Dream production

Comparisons of content categories in the dreams of the two groups provide only a few indications of how processes of dream formation *per se* might be altered in ACC. As was suggested previously for dream recall, certain content differences in the acallosal subjects' dreams may reflect a different level of social experience in this group, as seems to be the case for children's dreams in general (Foulkes 1982). Specifically, that acallosal subjects dreamed more frequently of known persons and less frequently of unknown persons could reflect a situation in which there is relatively greater personal experience with family members and relatively less with persons in society at large. Acallosals also tended to report fewer dreams with animal characters than controls, a feature which Foulkes (1982) also found to be correlated with an introspective, fantasy-prone personality style among some of his younger subjects.

More central to the role of the corpus callosum in dreaming, acallosal subjects tended to report fewer dreams with colours, a category which presumably reflects a specific visual determinant of dream imagery. Because a checklist procedure was used to detect this difference it cannot be attributed to subjects' differential use of visual metaphoric language (cf. Kerr and Foulkes 1981). If replicable, the finding could support a second hypothesis about right hemisphere involvement in dreaming, i.e. that in ACC right hemisphere processes are less implicated in dream production than left hemisphere processes. However, because this difference is statistically not strong and because waking state visual processes have generally not been found to be deficient in ACC (Sauerwein and Lassonde 1983), this hypothesis warrants further investigation.

Emotional attributes of the dreams of acallosal subjects provided few clues as to the potential role of the corpus callosum in dream formation. The greater incidence of distress in the home dreams of acallosals might be attributable to high levels of daytime distress or to many other factors. There was little evidence that acallosals had an alexithymic style in reporting their dreams. However, more standardized testing of the alexithymia concept with this population is desirable.

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