lin, somatostatin, adrenocorticotropin, β-endorphin, arginine vasotocin, cholecystokinin, glucagon, and salmon calcitonin (*1, 2*), none of these substances has been sequenced, and in most cases no function has been attributed to them. In the present case, the combination of sequence homology and analogous biological properties of the two peptides supports the interpretation that their similarities are not simply due to chance. Even so, it has yet to be established whether the structural and functional resemblances between the yeast pheromone and mammalian GnRH are indeed adequate to establish an evolutionary relationship between the two peptides. This reservation must be noted because the lengths of the peptides are not sufficient to permit the derivation of a compelling statistical analysis of their evolutionary relatedness. Nevertheless, GnRH and the yeast α-mating factor appear to represent a highly conserved effector system which includes the peptide ligand, the cell-surface receptor, and the physiological regulation of reproductive function.

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16. Peptides: Native GnRH and [D-Ala^6]des-Gly^{10}-GnRH *N*-ethylamide were obtained from Peninsula Laboratories Inc., San Carlos, Calif. The GnRH antagonist [Ac-D-p-Cl-Phe^{1,2},D-Trp^3,D-Lys^6,D-Ala^{10}]GnRH was a gift of D. Coy, New Orleans, La. Synthetic yeast α-factor was obtained from Peninsula Laboratories Inc. (lot 001763) and from Accurate Chemical & Scientific Corp., Westbury, N.Y. (lot E1558). The latter peptide was manufactured by Serva Co. (West Germany). The natural α-factor was purified from *Saccharomyces cerevisiae* α cell culture medium by minor modifications of the method described by E. Ciejek, J. Thorner, and M. Geier [*Biochem. Biophys. Res. Commun.* **78**, 952 (1977)].
17. The binding-inhibition potency of the natural mating factor in the GnRH radioligand-receptor assay was similar to that of the synthetic preparations, but on two occasions the natural peptide showed extremely low bioactivity in cultured pituitary cells that responded well to GnRH. Since the methionine residue of α-factor is necessary for full biological activity and can undergo oxidation during or after preparation of the peptide (*14*), we also analyzed the activity of the natural peptide after reduction to obviate any such effect of oxidation. For this purpose, a portion of the peptide solution was incubated overnight at room temperature with an excess of mercaptoethanol at *p*H 8.5 and was then repeatedly lyophilized to remove the reducing agent. After this procedure, the reduced natural peptide stimulated the release of LH with a potency similar to that of the synthetic mating-factor preparations (Fig. 1B).
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Dual Task Interactions Due Exclusively to Limits in Processing Resources

Abstract. *Information presented to each hemisphere of the commissurotomy patient is available only to the stimulated hemisphere. Despite this, the hemispheres have access to a common pool of processing resources, which, under conditions of demanding bilateral stimulation, is distributed between the hemispheres.*

The concept of "limited resources" is central to most contemporary theories of human information processing; performance of a particular task is thought to depend on both the efficacy of processing strategies and the degree of "effort" or "resource" directed toward its solution (*1*). Empirical evidence that implies a fixed resource capacity is based primarily on demonstrations of performance decrements when two tasks are performed concurrently: in general, performance of each of two concurrently presented tasks is inferior to that achieved when each task is presented alone. In addition, when the difficulty of one task is varied, a reciprocal change in performance of the unchanged task is observed (*2*). Alternatively, concurrent task performance may reflect limits in processes that are peculiar to dual tasks, termed "emergent processes" by Duncan (*3*). Emergent processes have been demonstrated for a variety of stimulus and response measures and experimental contexts (*3*). For example, the physical attributes (for example, form and color) of simultaneously presented stimuli are to some degree perceptually interchangeable; that is, one stimulus can be erroneously perceived to have characteristics that in fact belong to the other. Under single-stimulus conditions, of course, errors of this kind could not occur. Thus, variations in the performance of concurrent tasks may be due to limits in the efficiency of perceptual segregation rather than resource limitations. We attempted to avoid the possibility of performance trade-offs due to perceptual

Table 1. Correct responses and mean response latency (± standard error of the mean) on correct trials for commissurotomy patient V.P. and two control observers for each condition.

Condition	V.P.		Control subjects	
	Correct (%)	Latency (msec)	Correct (%)	Latency (msec)
Redundant-3	64	1706 ± 49	96	922 ± 24
Mixed-3	74	1618 ± 65	86	1034 ± 26
Mixed-1	87	1480 ± 79	94	912 ± 17

interference between two tasks by pairing tasks that relied on two different physiological structures in which the normal interchange of information was surgically eliminated. In addition, we avoided the possibility of interference between concurrent responses by never requiring more than one response on a given trial. Our results imply (i) that dual task performance depends at least in part on resource limitations and (ii) that resources can be distributed among structures that do not share access to a common database.

One major methodological consideration in attempting to disentangle perceptual interference and resource limitations was the selection of a reasonable criterion for the independence of processing structures. Typically independence is inferred on the basis of an absence of performance trade-offs between two tasks (*4*), but such a criterion would have been inappropriate for our purposes. The availability for research purposes of patients who have undergone surgical transection of the corpus callosum for the control of intractable epilepsy, so-called "split-brain" surgery, provides a unique potential for resolving this problem (*5*). A subset of these patients possesses sophisticated language skills in both hemispheres, but is unable to integrate information presented to the two visual half-fields; information presented to the left hemifield is isolated to the right hemisphere, and information presented to the right hemifield is isolated to the left hemisphere (*6*). Such findings imply that separate and independent processing structures reside in the disconnected hemispheres. The "perceptual interference" model of concurrent task performance would predict, therefore, that a manipulation in the cognitive load of one hemisphere's task would not alter the performance of the other hemisphere at a concurrent task, whereas the "resource" model would predict that a performance trade-off between the hemsipheres would occur. We have found that, when the difficulty of one hemisphere's task is reduced, the other hemisphere's performance improves. This finding is best accounted for in terms of competition between the hemispheres for a limited pool of processing resources.

One commissurotomy patient with bilateral language, hereafter referred to as V.P., and two neurologically intact control observers participated in our study (*7*). On each trial, two series of geometric shapes were displayed concurrently to the left and right of central fixation and thus were lateralized to the right and left hemispheres, respectively (Fig. 1). A unilateral probe figure subsequently appeared, and the observer indicated with a forced-choice key press whether it matched any of the probed field's items. On half of the trials, the same three figures were displayed in the two fields in the same order (redundant-3 condition); on half of the trials, three figures were displayed in one visual field and a single item was repeated three times in the other field. On half of these latter trials (that is, 25 percent of the total trials), the three-item field was probed (mixed-3 condition); on half, the single-item field was probed (mixed-1 condition). Trials in which the probe appeared in the left or right visual field were equally represented for each condition, as were positive and negative trials. The hand used to respond was varied in a counterbalanced order across blocks of 48 trials. Conditions were randomized within blocks.

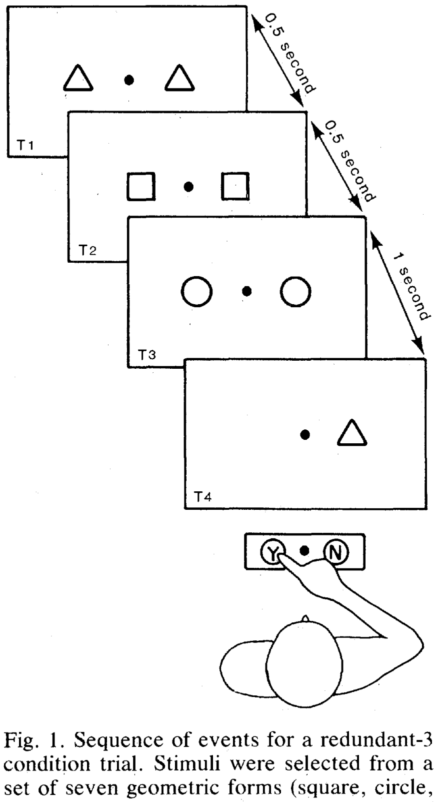

Fig. 1. Sequence of events for a redundant-3 condition trial. Stimuli were selected from a set of seven geometric forms (square, circle, triangle, and so forth), each about 3° by 2° of visual angle, and displayed 5° directly to the left and right of central fixation. Each stimulus appeared for 150 msec with an interstimulus interval of 500 msec. A 1-second delay followed presentation of the last stimulus, and the unilateral probe stimulus was presented for 150 msec. All displays were generated by a microprocessor (Apple II) and presented on a video monitor at a viewing distance of 0.5 m.

Results of 576 trials were collected from each observer. The proportion correct and average response latency (based solely on correct trials)—collapsed across visual fields and hands—are summarized for each condition in Table 1. The interesting comparison for V.P. is between the two conditions in which the probed hemisphere received three items: the mixed-3 condition in which the unprobed hemisphere received a single item, and the redundant-3 condition in which the unprobed hemisphere received three items. V.P. made fewer errors when the unprobed hemisphere received a single item [$\chi^2(1) = 4.11$, $P < .05$]. In addition, although there was no significant difference between response latencies for these conditions [$t(288) = 1.08$], the shorter mean latency was associated with the more accurate mixed-3 condition. This would be expected if the hemisphere engaged in the single-item task made relatively less processing demands; a greater proportion of the total resource pool thereby could be committed to the hemisphere engaged in the three-item task. Despite what appears to be a cooperative allocation policy between the hemispheres, V.P. was unable to integrate information presented to the two half-fields. When the same stimuli were repeated and V.P. was asked to indicate whether the same or different displays appeared in the two fields, her performance did not exceed chance (45/96, $P > .05$). Control observers performed this task without error.

In contrast to V.P., each control observer responded faster [$t(401) = 2.64$, $P < .01$; $t(395) = 4.08$, $P < .001$] and made fewer errors [$\chi^2(1) = 4.73$, $P < .05$; $\chi^2(1) = 28.74$, $P < .001$] in the redundant-3 condition (*8*). This would be expected if, unlike V.P., these subjects made use of interfield redundancy and combined information from the two visual fields. If so, the total stimulus set for control observers on redundant-3 condition trials would consist of three items, whereas that on mixed condition trials would consist of four items (*9*).

We conclude that V.P.'s sensitivity to a difficulty manipulation in the unprobed field reflects competition between the hemispheres for a shared pool of resources—resources that can be utilized by either hemisphere and, to the extent that the hemispheres do not have access to a common data base, that are not specialized for individual processing structures. In addition, these resources must either reside in subcortical structures or be transferred between the hemispheres via subcortical pathways, since the principal pathway for interhemispheric communication in this patient has been sectioned. If resources are distributed interhemispherically by, say, the anterior commissure, which was not sectioned, there must be appreciable latitude with which resources that are committed to one structure can be shared with another (*4*, *10*). Although our findings imply that processing resources can be distributed among different processing structures, it remains to be determined whether competition between tasks for a common structure is a consequence of time-sharing processing structures, or whether it reflects the limits in dedicated resources that subserve specific cognitive operations.

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5. Studies contrasting dual-task performance in commissurotomized monkeys and humans with that of neurologically intact observers have produced conflicting results. Some investigators report enhanced performance by split-brain subjects [for example, M. S. Gazzaniga and E. D. Young, *Exp. Brain Res.* **3**, 368 (1967)], whereas others report the contrary [for example, L. Ellenberg and R. W. Sperry, *Neuropsychologia* **18**, 411 (1980)]. In general, the performance of split-brain subjects tends to show decreased interference between conflicting tasks, but a failure overall to exceed that of normal observers. In addition, performance under conditions of unilateral and bilateral stimulation tends to be comparable, although under conditions of unilateral stimulation, performance is often disrupted by the unstimulated hemisphere [R. K. Nakamura, thesis, State University of New York, Stony Brook (1976)]. In order to avoid the possibility of such disruption, information was presented to both hemispheres on each trial, but only a single hemisphere was required to respond.
6. For review, see M. S. Gazzaniga, *The Bisected Brain* (Appleton-Century-Crofts, New York, 1970).
7. Of the remaining commissurotomy patients with right-hemisphere language who were available for testing, P.S. was not tested because he has demonstrated the capacity to transfer linguistic information paracallosally [M. S. Gazzaniga *et al.*, *Brain* **105**, 53 (1982)], whereas J.W. had insufficient bilateral language capacity to perform the present task in the right hemisphere [J. J. Sidtis *et al.*, *J. Neurosci.* **1**, 323 (1981)].
8. A comparison of the accuracy data for each control observer and V.P. [B. J. Winer, *Statistical Principles in Experimental Design* (McGraw-Hill, New York, 1971), pp. 855–859] revealed a significant subject by condition interaction [$\chi^2(1) = 7.05$ and 17.9, $P < .01$ and $P < .001$], thus providing statistical confirmation that the redundant-3 and mixed-3 conditions had contrasting effects on the control observers and V.P.
9. An additional study confirmed that visual information lateralized to one hemisphere of V.P. does not interact with information lateralized to the other, whereas control observers combine information from the two fields. The only difference in this study was that the mixed condition consisted of a different series of three items displayed in each field, for a total of six items. In all other respects, the two studies were identical. Results of 192 trials were collected from each observer. As expected, the accuracy and average latency of V.P.'s responses in the redundant-3 condition, 73 percent correct and 1694 ± 71 msec, were comparable to those obtained in the mixed condition, 77 percent and 1860 ± 100 msec [$\chi^2(1) = .44$, not significant; $t(142) = 1.35$, not significant]. In contrast, the control observers made fewer errors in the redundant-3 condition, 96 percent versus 80 percent correct in the mixed condition, and responded faster in the redundant-3 condition, 903 ± 24 msec versus 1180 ± 44 msec in the mixed condition [each subject analyzed separately: $\chi^2(1) = 5.69$ and 16.55, $P < .05$ and $P < .001$; $t(178) = 6.81$ and $t(154) = 5.04$, $P < .001$]. In both studies, then, V.P.'s performance was virtually unaffected by interfield redundancy, whereas each control observer performed better when interfield redundancy reduced the total number of items to be remembered.
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Human Fetal Movement: Spontaneous Oscillations Near One Cycle per Minute

Abstract. *Spectral analysis of spontaneous fluctuations in human fetal movement revealed strong oscillations at frequencies between 0.24 and 0.90 cycle per minute, which are much higher than those of the cyclic alternation of quiet and active states in the fetus and neonate. Oscillations at frequencies up to 2.88 cycles per minute were also detected, but they were usually much weaker. The prominent peaks in the fetal movement spectra are in the frequency range of recently reported neonatal motor rhythms, and indicate the existence of a cyclic process controlling spontaneous motor output that oscillates near one cycle per minute and begins to function in utero.*

The brain of the full-term human neonate provides rhythmic or cyclic control of a number of behavioral and physiological processes, such as respiration and the alternation of quiet and active sleep states (*1–4*). These rhythms are unstable or nonexistent in neonates born very prematurely, and may be disrupted by central nervous system (CNS) pathology in the full-term newborn (*5*). The function of some rhythms, like respiration, is relatively clear. Others are less well understood. For example, the function of human sleep-state cycles, which may be a manifestation of a basic rest-activity cycle (*6*), is not known. However, studies of fetal behavior and physiology suggest that major rhythms such as respiration and activity cycles are present in utero, although their mature form may be established only after birth (*7*).

Recently, evidence was found for another rhythmic process in the full-term newborn (*8*). Fluctuations in spontaneous body movement, the dominant motor output of the newborn infant, were previously thought to be without temporal organization. However, spectral analysis revealed periodicity in the fluctuations of movement, with a cycle length on the order of 1 minute. This characteristic frequency is much higher than that of the sleep states (almost hourly), but much lower than frequencies of respiration or sucking.

To determine whether the cyclic fluctuations in body movement observed in the full-term neonate are present in utero or appear only as a consequence of the major physiological changes that accompany birth, we studied fetuses in the last few weeks of gestation. Spectral analysis of the data for each fetus revealed strong oscillations in movement. Dominant frequencies were between 0.24 and 0.90 cycle per minute, or within the range of neonatal motor rhythms previously reported (*8*).