Brief Papers

W-1. Evolution of a Limb Apraxia in a Progressive Aphasia Case

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From November 1987 to February 1993, Mrs. H.C. was submitted to eight assessments of limb apraxia. While the language declined, the gestures' production remained normal until 1990. From this time, the number and the type of errors increased. The conventional communication gestures were impaired first. Next, errors in the form of the hand appeared in the pantomimes of actions. Afterwards, imitation of meaningless gestures became difficult. Finally, actions with real objects were impaired. The evolution of apraxia is discussed by reference to the model of Rothi, Ochipa and Heilman (1991).

In progressive aphasia, Croisile et al. (1991) consider that the patient does not suffer of apraxia during a long period. The gesture recognition is preserved and the patient remains able to point and to imitate for a long time. We report observations about the evolution of a limb apraxia in a progressive aphasia case which kept the capacities to carry out pantomimes and meaningless gestures during several months after the beginning of the language decline.

Mrs. H.C. is a right-handed woman with a high school level. She was 57 years old when she was assessed for the first time. She complained of language problems. At a second assessment in 1989, a primary progressive aphasia was diagnosed. From this time, the language components' decline was regular and progressive. In March 1989, the oral and written comprehension, repetition of words, oral reading, dictation, verbal fluency, and repetition of digits were impaired. Some syntactic difficulties were also present in the oral and written narration. In October 1989, difficulties appeared in comprehension of instructions about the manipulation of real objects. In August 1990, bucco-facial apraxia was present with oral command and on imitation. In November 1991, all the language components were impaired. Mrs. H.C. was hospitalized in July 1993.

From November 1987 to February 1993, H.C. was submitted to eight assessments of limb apraxia. The protocol comprised meaningful (pantomimes and communication gestures) as well as meaningless gestures, and manipulation of real objects. While the language declined, the gestures' production remained normal until 1990. In April 1990, the first signs of limb apraxia appeared. Several mimes are executed only on imitation (15%) and the patient began to use real objects when she has to mime. Communication gestures are impaired on oral command. Errors increased in imitation of meaningless gestures and excessive strength was used in movement execution.

In October 1990, orientation errors were present in gestures. We also note perseveration and parapraxic errors (a mime is produced for another, e.g., to drink in the place of to smell). The patient begin to have difficulties to point objects.

Signs of deterioration in limb apraxia began more obvious from 1991. Mrs. H.C. developed a progressive rigidity of the right limb. In May 1991, 84% of the pantomimes are executed on imitation. Several mimes were deformed and unrecognizable. Often, the form and the orientation of the hand were erroneous with recognizable movement. Communication gestures were only produced on imitation and slavishly. These gestures seemed became meaningless.

In February 1992, movements were more rigid. Actions with real objects were accurate but the mimes were not produced or unrecognizable. The rate of errors of the meaningless gestures increased (from 20% to 48%). The gestures were transformed and executed in a reduced space. In February 1993, even the actions with real objects were impaired.

In brief, the conventional communication gestures were impaired first. Next, errors in the form of the hand appeared in the pantomimes of actions. Afterwards, imitation of meaningless gestures became difficult. Finally, actions with real objects were impaired.

By reference to the model of Rothi, Ochipa and Heilman (1991), the following components are successively affected: the phonologic input lexicon, the action input lexicon, the action output lexicon and, finally, the semantic system. Indeed, the first sign of impairment is when Mrs. H.C. does not understand oral command for more abstract gestures such as conventional communication gestures. However, at this time, visual presentation of real objects produces the relevant pantomime. The limb apraxia evolves with the impairment of the action input lexicon. Because the meaningless gesture imitation is better than the pantomime imitation, it is presumed that the patient used the nonlexical route to produce gestures when she imitates. The semantic system is not impaired because the visual presentation of objects remains efficient. The next step in the evolution is the impairment of the action output lexicon. Indeed, the errors increase in the production of the mimes while they remain recognizable. The semantic system is presumed efficient at this time because the patient produces parapraxia. Finally, the semantic system itself is affected when the manipulation of real objects is impaired. The nonlexical route is also impaired, the patient being unable to imitate meaningless gesture.

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W-2. Line Bisection in French and Israeli Subjects: A Developmental Approach

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120 normal right-handed subjects, children and adults, with opposite reading habits (60 French, left-to-right readers, 60 Israeli, right-to-left readers) and 60 preschool children (30 French and 30 Israeli), were submitted to a visuomotor bisection task. Bisection is found to be dependent upon reading habits with a leftward deviation of the subjective middle for left-to-right readers, and a rightward bias for right-to-left readers. Even before formal reading learning, French and Israeli preschool children differ significantly in bisecting a line. Results are discussed with respect to hemispheric activation theories and directional hypotheses.

The use of bisection protocol with normal subjects has demonstrated an asymmetric perception of space in the form of a left bias when the subject is asked to estimate the center of a line or a rod (Bowers & Heilman, 1980; Bradshaw and coll., 1986, 1987). This phenomenon has been related to an overactivation of the right hemisphere in response to the spatial nature of the task (Bradshaw and coll., 1986, 1987). It has been shown that in a passive bisection task, the imposed directional scanning is able to influence the position of the subjective middle among normal subjects as well as patients suffering from left unilateral neglect (Chokron and coll., 1993, Reuter-Lorenz & Posner, 1990). On the other hand, cueing the left end of the line has been shown to reduce the massive rightward bias of left neglect patients (Mattingley and coll., 1993), one can hypothesize that the improvement in this condition is linked to the left-to-right scanning of the line, (Halligan, Manning and Marshall, 1991; Mattingley and coll., 1993).

Many experiments were intended to disentangle the effect of reading habits and cerebral maturation on the scanning of nondirectional stimuli in children. The results raise the question of the origin of preferential directional scanning: innate depending on cerebral maturation (Braines, 1968; Chen, 1981; Nachson, Shefler, & Samocha; 1977) or acquired depending on reading habits and environmental cues (Abed, 1991; Butler, 1981; Gibson, 1966; Harsell & Wales, 1987).

Testing here 4.5 year old subjects to adults, from opposite cultures (French and Israeli) with a line bisection protocol would permit us to test the effect of hemispheric or/and of scanning direction on line bisection.

Method

Subjects. 180 normal right-handed: for each country (France and Israel: 30 subjects were preschool children, 30 were in grade 3, and 30 adults). For each group there were 15 males and 15 females.

Stimuli. 18 black lines drawn on white paper 29.7 cm by 21.0 cm. 6 lines of each length: 5 cm, 15 cm, or 20 cm in length and centered on the sheet of paper.

Procedure. The subjects were asked to do a mark indicating the middle of the line placed in front of them in a median position (the middle of the line corresponding to the sagittal midline of the subject), using their right hand.

Results

The effect of reading habits is significant ($F1\text{–}168 = 31.49$ $p < 0.001$) with a rightward significant deviation for Israeli subjects and a non-significant deviation for French subjects (Fig. 1).

Post hoc analysis revealed that this effect of reading habits is significant for all sex and age groups.

When the results were analysed in terms of frequency to deviate leftward or rightward, abolishing then the error amplitude, the effect of reading habits on the side of the deviation is again statistically significant ($F1\text{–}168 = 34.68$ $p < 0.001$).

Discussion

A significant effect of reading habits on line bisection was found, all ages combined, thus confirming previous findings (Chokron and Imbert, 1993b). Since French subjects do not exhibit a significant deviation, olateral to the most activated hemisphere (Bradshaw and coll., 1986, 1987), our results, showing an opposite pattern between French and Israeli subjects, would mean an opposite cerebral organization relative to the opposite reading habits. However, no neuropsychological studies have reported (to our knowl-

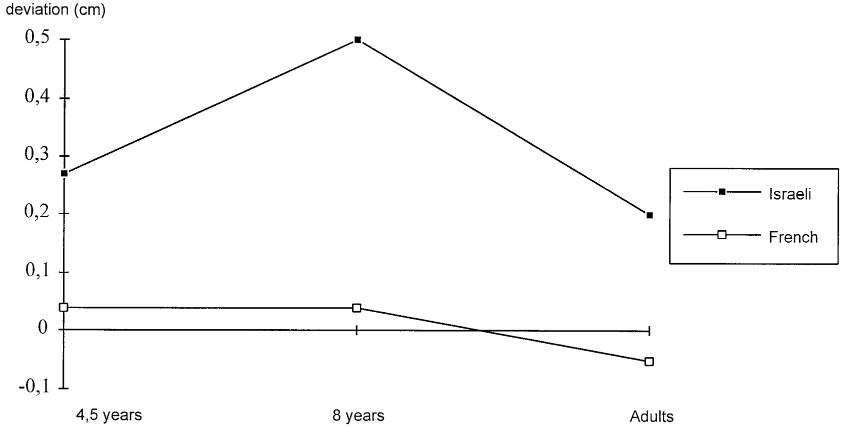

FIG. 1. Position of the subjective middle in bisection for French and Israeli subjects (constant errors in cm). A negative deviation indicates a leftward bisection. A positive deviation indicates a rightward bisection.

edge) cases of alexia, in right-handed patients, consecutive to right hemisphere lesion in right-to-left readers. Rather than reasoning in terms of level of hemispheric activation, one can imagine that the scanning direction of the line, relative to directional habits may influence the orientation of attention along the line and in this way the length representation and the position of the bisection.

In fact this hypothesis joins the one of Halligan and colleagues (1991), who argued that bisecting a line is dependent upon the ''attentional'' direction of approach to the midpoint. The analysis of pre-schooled children brought out an unexpected effect of reading habits, even before formal reading learning, for preschooled children aged about 4.5 years showing that they might already be influenced by the directional habits in the environment in which they are growing up. The present findings and the previous ones (Chokron and Imbert, 1993b) emphasize the effect of reading habits on line bisection that is interpreted here as an effect of the line bisection for French and Israeli subjects (constant errors in cm).

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W-3. Overcrowding in Semantic Neighborhoods: Modeling Deep Dyslexia

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Deep dyslexic (DD) readers produce semantic errors during word naming and are impaired at nonword naming. Previous models of DD have explained this co-occurrence of deficits by postulating damage to both lexical and nonlexical pathways in the reading system. Buchanan, Hildebrandt and MacKinnon (1994) offered an alternative explanation that resulted in the prediction that words with several semantic and phonological neighbors would be read with less success by DDs than would words with few neighbors. This paper briefly describes a test of the semantic neighborhood hypothesis using HAL, a computational model of semantic space developed by Lund and Burgess (in press).

Patients with deep dyslexia (DD) are formerly literate adults who cannot read nonwords such as ''frip'' aloud and who also have severe difficulties in word naming, such as the production of semantic paralexias. The pathway responsible for nonword naming is assumed to be independent of the whole-word pathway containing lexical and semantic information. Thus, the production of semantic errors in patients who are also unable to read nonwords presents a challenge for the dual route model. Morton and Patterson (1980) explained the co-occurrence of semantic errors with the inability to read nonwords by postulating multiple damage to the system: DD resulted from damage in the semantic system and an impaired phonological pathway (also supported by computational approaches to deep dyslexia, Plaut & Shallice, 1993).

However, recent evidence suggesting that deep dyslexics do use the phonological pathway (Buchanan, Hildebrandt, & MacKinnon, 1994; submitted) led Buchanan et al. (submitted) to propose that a selection impairment in the phonological output lexicon is responsible for the reading deficits in DD. From this theory it follows that increasing the number of active lexical representations should decrease the likelihood that a patient can read the word correctly. Buchanan et al. therefore predicted that both semantic and phonological neighborhood sizes would be negatively correlated with the reading performance of deep dyslexics. While this was true for phonological neighborhood, semantic neighborhood size was not correlated with performance.

The metric for semantic neighborhood density in that study was obtained using word association norms from 218 normal subjects. Paradoxically, these associative relationships did not account for variability in the patients' naming performance. Part of the answer to this dilemma may reside in the distinction between associative and semantic relationships. Word association norms used in the development of stimuli for tests of semantic memory confound the associational and the semantic (or categorical) aspects of word meaning. Lund, Burgess, and Atchley (1995) have provided empirical and computational data that suggests that associative and semantic components of memory retrieval can be dissociated. Thus, semantic errors characteristic of DD may be more semantic than associative in nature.

In this paper we describe a test of the semantic neighborhood hypothesis utilizing the Hyperspace Analogue to Language (HAL) model of semantic memory (Burgess & Lund, in press; Lund & Burgess, in press; Lund, Burgess, & Atchley, 1995). The HAL model uses a high-dimensional semantic space constructed from a co-occurrence matrix formed by analyzing a 160 million word corpus. The analysis procedure uses a ''window,'' representing a span of words, that is passed over the corpus. Words within the window are recorded as co-occurring with a strength inversely proportional to the number of other words separating them within the window. At each one-word increment of window movement along the corpus, the co-occurrence values are summed in a 490 million cell data matrix that represents the raw co-occurrence information for 70,000 lexical items. Each lexical item has a corresponding row and a column of co-occurrence information. In HAL each word is represented by a 140,000 unit vector, however, only 200 or so of the most variant vector elements are required to replicate a broad range of semantic experiments.

These 200 elements in each word's vector representation serve as coordinates in high-dimensional semantic space. Similar words tend to be clustered in the same space, thus making it straightforward to define semantic neighborhoods of particular words given some distance parameter.

Semantic density can be defined as the standard deviation of N items in the semantic neighborhood. In this study, N = 50, so the density measure used in the analysis represents the standard deviation of 50 items in each semantic neighborhood.

Method

Patient descriptions. Three patients (GZ, PB and JC) fit the DD profile; they produce semantic errors, are impaired in nonword reading, and are sensitive to the lexical status and imageability of words (Buchanan et al., submitted).

Stimulus set and procedure. The stimulus set consisted of 300 three-to-seven-letter words with varied orthographic neighborhoods, phonological neighborhoods, and semantic neighborhoods. Stimuli were printed on individual cards, and patients read aloud each item.

The goal in this study was to determine whether the semantic density (SDen) of the semantic neighborhood generated by HAL can account for the semantic errors. Density measures (the standard deviations of the neighborhoods) for each of the words in the list was correlated with patient performance. Errors were coded as ‘‘0’’ and correct responses as ‘‘1’’; a positive correlation indicates a facilitory relationship.

Results

The Buchanan et al. theory predicts that semantic neighborhood size will be negatively correlated with performance since it was assumed to increase the competition for selection during response production. In contrast, a less dense semantic neighborhood should produce fewer competitors in the phonological output lexicon so that SDen should be positively correlated with performance.

SDen accounts for some variability in the patients' errors (see Table 1). While only JC produced data that resulted in a reliable effect, the correlations for the HAL measure were greater than for the associative measure in every case. The combined effect was calculated by adding the log probabilities of the individual correlations (Guilford, 1956) and thus provides something

TABLE 1
Semantic Effects

	JC	GZ	PB
Assoc. neighborhood (Buchanan et al.) Combined $\chi^2 = 10.36$	$r = -.10$	$r = -.04$	$r = -.02$
Semantic density (From HAL) combined $\chi^2 = 20.59$*	.23*	.07	.04

*$p < .05$.

akin to a sign test. This resulted in a reliable effect of SDen but not of neighborhood.

The dissociation between SDen and neighborhood provides further support for the idea that the semantic errors caused by deep dyslexia are in fact essentially semantic in nature and not simple associative mistakes.

Furthermore, we conclude that semantic density does play a role in the reading performance of deep dyslexics, and, as suggested by Buchanan et al., words with high density neighborhoods produce more errors than words with low density neighborhoods.

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W-4. A Case Study of a Strong Perceptual Deficit without Agnosia: Evidence against Sequential Perception and Memory?

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This paper reports the case of P.G., a patient who is not agnosic despite massive failure in low level visual perceptual processing tests dealing with spatial or shape information. P.G.'s preserved abilities to identify objects is difficult to be accounted for in the framework of standard models of visual identification which presume that construction of a structural code by perception is necessary in order to access memory. Our data argues against this hypothesis of sequential processing of perception and memory, and indicates that knowledge influences our way of ''seeing'' from the first stages of the so called perceptual processing.

Poster Description

Visual object identification is usually seen as the result of several hierarchical processes. The first one, perceptual processing, is generally conceived as a series of sequential and bottom-up operations (see Humphreys and Riddoch, 1987; Treisman, 1986). The early stages detect the elementary visual features, while the next code the relations between them in order to build a description of the object's shape. Moreover, some models (e.g., Kosslyn, Flynn, Amsterdam & Wang, 1990) distinguish between two types of processing applied to visual input: Those processing shape properties (ventral system) and those responsible for processing spatial properties (dorsal system).

Theoretically, the two systems must function conjointly in order to build an object's perceptual representation, which can then be matched with a stored structural representation, which in turn activates semantic memory.

The case of P.G. seems likely to question this theoretical option.

(I) Case Description

P.G. (27 years old) sustained a head trauma with a three weeks coma. The initial clinical picture was very severe, and dominated by cortical blindness. To date, T2 weighted MRI shows bifrontal lesions, diffuse lesions of the white matter, and a more obvious cortical–subcortical right parieto-occipital lesion. P.G. still exhibits important motor defects (inability to write or draw), an optic ataxia in the left field, an alexia and important visual impairments. These cannot be accounted for by elementary sensory perturbations, as the last neuro-ophtalmological examination only shows a partial left homonymous hemianopia: Central vision is perfect; visual acuity and ocular movement control are normal and P.G. does not show any ocular ataxia.

(II) Experimental Study

(a) Spatial information processing. P.G.'s pattern of relative perturbations and preservations agrees with the dissociation described by Kosslyn between metric and categorical coordinate processing. P.G.'s performance is impaired in most of the tests assessing spatial processing: the reproduction of an orientation is impossible, as well as the tracing and the description of a line. His performance is at chance level in judging which of two squares contains a dot which is exactly in the center (VOSP, Warrington and James, 1991, subtest 6) and far below the norm in tasks requiring to estimate the parallelism of lines or the position of a gap in a contour (BORB, Riddoch and Humphreys, 1993, subtests 4–5).

These results could then lead to believe that P.G. suffers from a global disorganization of spatial information processing. However, a more fine-grained approach shows that, in the above-mentioned tests, P.G.'s answers are correct if the two items are very different or if the difference can be described verbally (e.g.: one circle broken at the top, the other at the bottom). What's more, he is always able to judge whether a point is inside or outside a circle, above or below a line. The data are, therefore, compatible with a selective preservation of categorical spatial information processing.

(b) Shape processing. Despite the integrity of his visual *sensory* capacities (figure-ground discrimination, VOSP screening test: 19/20), P.G. is largely impaired in all tasks which tap shape processing: he is unable to compare the length of lines, or the size of circles (BORB, subtests 2–3), to identify fragmented letters (VOSP, subtest 1), and his performance is practically at chance level in all shape discrimination tests, even using the simplest forms (e.g.: discrimination between a rectangle and an elongated form or between two very different potato-like shapes).

His impairment arises at a very elementary level: in target detection tasks (cf. Treisman; Donnelly, Humphreys & Riddoch, 1991) P.G.'s results indicate that he totally fails to detect feature conjunctions and that even primitive features detection is slow compared to normal. Finally, P.G.'s results in standard global precedence tasks (cf. Navon, 1977) clearly show a lack of global shape processing.

(c) Visual object identification. The severe perceptual deficits described above contrast sharply with P.G.'s virtually normal object identification abilities. This patient is not agnosic, since he recognizes objects in everyday life and has only a slight deficit for pictures, independent of item size but correlated with the realism of the stimulus (Real objects: 30/30, Photographs: 32/32, realistic drawings: 127/152, Snodgrass stimuli: 196/258, Silhouettes: 0/20).

What's more, even his perceptual discrmination abilities become satisfactory when concerning objects, be they totally different, or different examplars of the same object. When asked to judge two realistic drawings of dolphins, for example, as being same or different, P.G. scores 17/22, whereas his performance is at chance level in the same task using controlled unknown forms matched on perceptual complexity. It seems then that knowledge of the items to be processed has a serious influence on P.G.'s perceptual capacities.

Discussion

The main point of interest here appears to be the contrast between P.G.'s perceptual deficits and the absence of visual agnosia. P.G.'s perceptual deficits are massive and involve early visual processing. Thus, they are likely to prevent him from building an integrated structural representation. However, they don't disrupt either identification or comparison of known object. This argues against the sequential nature of visual object identification, such as it is usually described, with perception building a structural code which is necessary for subsequent memory access.

This data favours the hypothesis that memory can directly compensate for perceptual deficits. This is compatible with the principle of completion in PDP models: a system which has been adapted to perceive some objects when all the perceptual processes worked, needs less cues for these same objects, and can complete the low level perceptual dimension, which is now missing, by memory. This completion follows a similarity principle: the more the object to be identified is similar to an object that has already been processed, the better the completion.

Applied to P.G.'s case, this explanation would simply imply that he sees ''badly'' any new shape, and ''well'' any known object on the basis of information which is as deficient in both cases.

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W-5. The Origins of Neologisms in Picture Naming by Fluent Aphasics

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An apparent dichotomy in target segment preservation among aphasic neologistic utterances has prompted proposals that abstruse neologisms arise at lexical retrieval and target-related neologisms arise at lexical retrieval and target-related neologisms arise during phonological encoding. This study sought evidence for two origins of neologism generation. A corpus of 253 neologisms produced by 20 aphasics in a picture naming task was examined for evidence of bimodality in degree of target relatedness; none was found. The prediction that lexical effects should be associated with abstruse neologisms and postlexical effects with target-related neologisms was also not confirmed. The findings fail to support two distinct stages of origin.

It has been noted that some neologisms produced by aphasics retain much of the intended word's phonology and structure (target related neologisms), while others capture very little (abstruse neologisms). On the other hand, instances of intermediate target preservation have been noted to be relatively rare (Buchingham & Kertesz, 1976). Such observations have led a number of investigators to propose a dual mechanism account of neologism generation: Abstruse neologisms arise primarily from failures of lexical retrieval, thus preserving less of the target; target-related neologisms arise from failure at the subsequent stage of phonological encoding, thus preserving more of the target (Butterworth, 1992; Kohn & Smith, 1994; Miller & Ellis, 1987). This study revisits the underlying assumption, that there are two types of neologisms, and seeks evidence for this duality in a corpus of aphasic neologisms.

Methods

Previous investigations into this question have often focused on individual aphasics and/or on neologisms produced in continuous speech for which there is often uncertainty regarding the intended word. The present study removes much of this guesswork by using a test of picture naming in which the target labels have been carefully normed (Philadelphia Naming Test), and is broader in that it involves a relatively large number of subjects (20 fluent aphasics) each provided with ample opportunity to produce nonword errors (175 naming trials). Extracted for analysis were nonword errors that constituted the subject's first complete response to a test item. Each trial could contribute, at most, one neologism to the corpus of errors. In total, 253 target-neologism pairs were analyzed.

Results

Bimodality. The dual mechanism account predicts a bimodal distribution of target relatedness among an unselected set of neologisms. The proportion of target segments in the 253 neologisms relative to (1) the total number of target segments, (2) the total number of resposne segments, and (3) the sum of the number of target and response segments were used as measures of target segment preservation in an attempt to find evidence of bimodality. None of these provided it, however. In fact, contrary to Buckingham and Kertesz's report, we found that most of the neologisms fell into intermediate rather than low and high preservation categories. For example, using the first measure, 9% of the neologisms preserved 0–25% of their targets' segments, 30% preserved 26–50%, 32% preserved 51–75%, and 29% preserved 76–100% of their targets' segments.

Dual origins. Neologisms were examined for evidence of different origns: If abstruse neologisms arise at lexical retrieval and target-related neologisms at phonological ecncoding, lexical factors should play more of a role for abstruse neologisms while post-lexical effects should be more evident among target-related neologisms. For these analyses, the corpus of neologisms was divided into roughly two halves, adopting the criteria of Kohn and Smith (1994): A neologism was considered target-related if it shared (a) a stressed rhyme, (b) a consonant cluster, and/or (c) a syllable onset and coda with its target.

Word frequency effects are indicative of lexical invlovement. Thus, one might expect a target frequency efect (more neologisms produced to low frequency targets than high) for abstruse, but not target-related, neologisms. A distribution of the neologisms' target frequencies into low, medium, and high categories for targets of one syllable, two syllable, and greater lengths, however, revealed a strong frequency effect for both abstruse ($X2(4) = 14.49$, $p < .006$) and target-related ($X2(4) = 14.13$, $p < .007$) neologisms. The distributions were essentially the same for the two types of neologisms ($p > .5$), failing to provide an indication of different origins.

A serial order effect in target segment preservation is predicted of neologisms arising at phonological encoding, but not at lexical retrieval. A serial order analysis that controls for targets of different lengths was adopted (Wing & Baddeley, 1980). This procedure compares the distribution of response segments in five normalized serial positions to chance (the target distribution). Neither set of neologisms deviated from the chance distribution ($p > .2$ for abstruse; $p > .8$ for target-related), failing to support dual mechanism expectations.

Syllable structure should also be differentially affected in the two types of neologisms: Abstruse neologisms should show an increase in syllable complexity while target-related neologisms should show a decrease. Target and neologism first syllables were scored for markedness (Favreau, Nespoulous, & Lecours, 1990), and the proportion that increased, decreased, and remained the same was determined. The patterns were different for target-related and abstruse neologisms ($X2(2) = 23.3$, $p < .0001$). However, the patterns did not conform to the predictions: Abstruse neologisms actually showed a tendency to decrease in markedness (43% decrease vs 22% increase), whereas target-related neologisms showed an almost equal tendency to increase (20%) as decrease (15%).

Discussion

The search for evidence of two types of neologisms was unsuccessful. Not only was there no evidence for a bimodal distribution of target preservation, but none of the predicted effects of a dual mechanism view were confirmed. We conjecture that the bimodal distribution that Buchingham and Kertesz observed was more apparent than real—that if the targeted words could have been determined, that at least some of the neologisms considered to be abstruse would actually have fallen into an intermediate level of target relatedness and their distribution would have taken on a shape more like ours. To conclude, the evidence does not support two distinct stages at which neologisms may arise.

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W-6. Rotated Drawing and Object Recognition

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A patient was recently reported who showed rotated drawing, together with intact object recognition (Turnbull *et al.,* 1995). This dissociation between a knowledge of object orientation and identity has been interpreted as support for orientation-independent accounts of the object recognition—and related to the processes pre-

sumed to be subserved within occipitotemporal structures (Kosslyn et al., 1990). In this paper, four further instances of rotated drawing are reported. All of the patients rotated the Rey Figure, on at least one occasion, by 90°. None of the patients had clinical evidence of an object recognition disorder—indeed, the primary clinical deficits were ''frontal,'' with some extending into the domain of speech and language. These findings are discussed in relation to, and tentatively interpreted as supportive of, the previous theoretical account.

Recently, a patient (L.G.) was reported who rotated figures, notably the Rey Complex Figure (Rey, 1941) and a bicycle, through 90° from their expected orientation. There have been several reports of such gross rotations in the literature (Pillon, 1981; Regard & Landis, 1984; Solms et al., 1988). However, in that case (Turnbull et al., 1995) it was also possible to show that the rotation of the Rey Figure was part of a more general loss of knowledge of the orientation of objects—L.G. also failed to provide the correct canonical orientation for drawings of common objects (e.g. a camel). Critically, she retained the ability to recognise the objects that she failed to correctly orient. This finding was taken as support for orientation-independent accounts of the recognition process (e.g. Biederman, 1987), and related to the processes which are presumed to be subserved by the object recognition systems of the occipitotemporal region (Kosslyn et al., 1990). Thus, we (Turnbull et al., 1995) interpreted ''rotated drawing'' as a result of a patient having intact access to a representation of an object which did not carry information about its orientation, because the ''dorsal'' (occipitoparietofrontal) systems that subserve visuomotor behaviour and a viewer-centered visual representation (Milner & Goodale, 1995) had been disrupted. In this paper, four further instances of rotated drawing are reported, which also support the claim that object recognition is spared in such patients.

Case Reports

Case 1: B.R. This 33 year-old right-handed male engineer was involved in a motor-vehicle accident four months before testing. He suffered multiple skull fractures, together with a orbitofrontal pneumocoele and meningitis (both successfully treated). He was profoundly adynamic during the acute recovery period, with a dense anosmia. When tested at four months postinjury he had intact language, memory and object recognition abilities. His only deficits were those typical of patients with orbital frontal lesions. He was impulsive, distractible and socially inappropriate. He also showed some difficulty in recalling complex stories (although he could retain simple details well), and showed imperfect learning on a complex (10 by 10) maze.

His copy (Fig. 2A) of the Rey Figure was poorly planned (22/36) and correctly oriented. His immediate recall (Fig. 2B) was relatively good considering the quality of the copy, and better organized (16/36) but was rotated through 90° counterclockwise. His delayed (30 min) recall (Fig. 2C) was

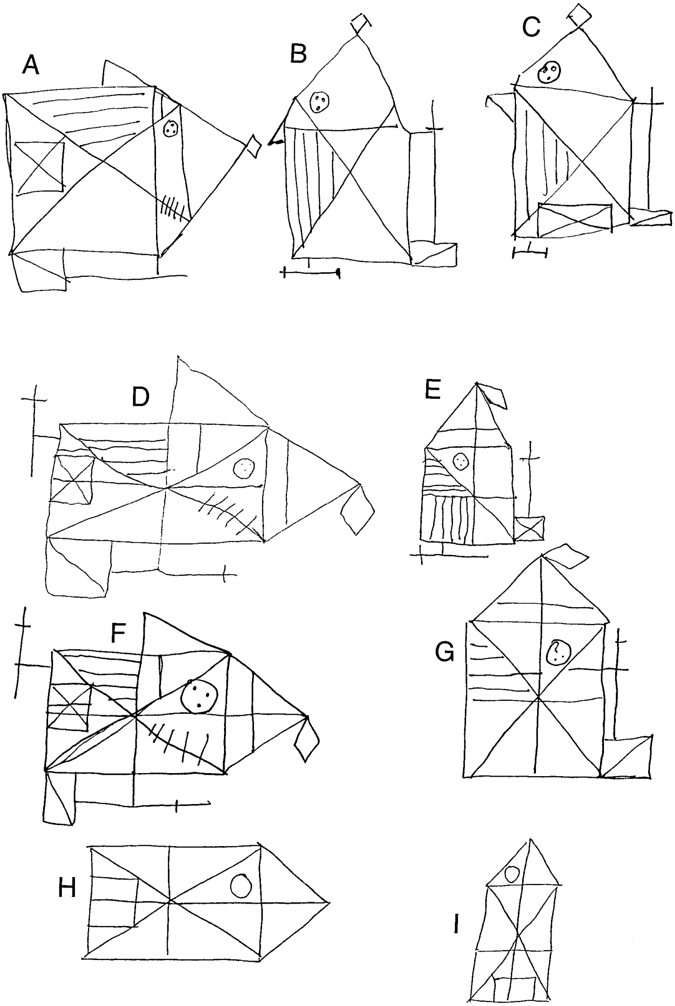

FIGURE 2

improved to a level within normal limits (20/36) although it was rotated to the same orientation as the immediate recall.

Case 2: R.A. This 19 year-old right-handed male student had a left fronto-parietal subdural haemorrhage. When tested at 9 months postinjury a right-sided paresis had largely resolved, but he retained a bucco-facial apraxia, although without notable aphasic features in speech or writing. He was also slowed in thinking, and mildly disinhibited—with reports of aggressive outbursts from his family. His memory and object recognition abilities appeared normal.

His copy (Fig. 2D) of the Rey Figure was well-executed (36/36) and correctly oriented. His immediate recall (Fig. 2E) was also well-structured (25/36). However, the entire drawing was rotated through 90° counterclockwise.

Case 3: A.G. This 22 year-old right-handed male hospital porter was involved in a motor-vehicle accident with widespread intracerebral trauma. When tested at four years postinjury his deficits were a tremulous right hand, which often went into spasm when attempting to write; slow, slurred speech free of significant aphasic features; and a general slowness of thought and action. He also had a mild frontal syndrome, involving some difficulty with complex problem solving, particularly for verbal material, and some impulsivity. His memory and object recognition abilities appeared normal, except for problems secondary to the executive deficits described above.

His copy (Fig. 2F) of the Rey Figure was well planned (33/36) and correctly oriented. His immediate recall (Fig. 2G) was well organized (21/36) but was rotated through 90° counterclockwise.

Case 4: J.K. This 40 year-old right-handed male clerk (with only three years of formal education) suffered a left frontoparietal extradural hemorrhage. When tested at 10 months postinjury he had mild right-sided weaknes, and a mild dysphasia with word-finding difficulty and some agrammatism. There was no true alexia or agraphia, an no apraxia. Although not assessed in detail, there were no complaints of visual difficulties, and his object recognition abilities appeared normal.

Because of his restricted intellectual background it was felt that J.K. should only be given a simple version of the Rey Figure. The original (i.e., the version which J.K. was asked to copy) is shown in Fig. 2H. His attempted copy of this form is shown in Fig. 2I. It was well-planned and executed (17/18). However, the entire drawing was rotated through 90° counterclockwise.

Discussion

The four instances of rotation reported above show a strong consistency of basic features in comparison with those reported in the literature (Pillon, 1981; Regard & Landis, 1984; Turnbull et al., 1995). All of the misoriented drawings were rotated anti-clockwise by 90° relative to the original. The fact that four of the five examples of rotation (Fig. 2B, 2C, 2E, and 2G) occurred only on the recall trial of the task might suggest that they are examples of ''reversion to an inert stereotype.'' For example, the patient may have only poorly remembered the orientation of the figure, and instead reproduced it as a version of a more familiar form, such as drawing the figures as a ''house.'' However, the fact that in one instance (Fig. 2I) the error occurred in copying the Figure argues against this. In this case, the patient would have been forced to glance repeatedly from the original figure (Fig. 2H) to his copy (Fig. 2I), but still failed to note the 90° misorientation.

With regard to one of the previously reported patients (L.G.) who rotated the Rey Figure by 90° (Turnbull et al, 1995) it was possible to show that the rotation of the Rey Figure was part of a more general loss of knowledge of the orientation of objects. The fact that L.G. could recognize objects for which she could not provide the correct canonical orientation makes the independence of rotated drawing and visual agnosia an important theoretical issue. The matter of testing knowledge of object orientation and object recognition with the same stimuli could not be directly tested in the four patients described above, as the patient data was retrieved retrospectively. However, it is notable that none of the four patients had any reported disorders of object recognition. Indeed, their primary clinical presentation appeared to be disinhibition, and other frontal/executive signs, with speech and language impairment in some instances. While not directly testing the hypothesis proposed for L.G. (Turnbull et al., 1995), the four cases presented above are entirely consistent and tentatively supportive of that theoretical account.

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W-7. Hemispheric Asymmetry in an Artificial Grammar Task

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In this experiment participants memorized letter strings, formed using a finite state grammar, and subsequently discriminated between new ‘‘grammatical’’ items and similar ‘‘nongrammatical’’ items. Test items were presented briefly in either the left or right visual field, and formed either from the same letter set as during training or a different set. Only when items were formed from the same letters as

at study, and presented in the *right* visual filed, was discrimination performance better than chance. These results are consistent with the concept of an abstract visual form system that operates more effectively in the left hemisphere than in the right (Marsolek, 1995).

W-8. Noninvasive Predictors of Laterality in Speech Production and Comprehension[1]

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The intracarotid amobarbital procedure (IAP) has been described as providing the best available estimate of speech lateralization (Channon, Schugens, Daum, & Polkey, 1990; Zatorre, 1989). However, it is difficult to administer, involves some degree of physical risk, and is uncomfortable for the patients. For these reasons, noninvasive measures of laterality are commonly used as preliminary screening procedures to ensure that speech functions are spared in patients undergoing brain surgery (Channon et al., 1990; Zatorre, 1989). Dichotic listening, tachistoscopic tasks and manual asymmetry measures have proven useful for this purpose (Strauss, Gaddes, & Wada, 1987). With few exceptions (e.g., Lee, Loring, Newell, & Meador, 1994), previous studies investigating the relation between the IAP and noninvasive laterality measures were limited by treating speech lateralization as a dichotomous rather than a continuous variable, by lumping right-handers and nonright-handers, and by using expressive speech errors during the IAP as the sole criterion.

The present study utilizes regression analysis to identify the best predictors of speech lateralization in right- and nonright-handers when the laterality measures are treated as continuous variables. A second purpose is to determine whether or not the percentage of variance accounted for by the significant predictor varies depending on the type of errors used in the IAP procedure (expressive vs receptive speech errors).

Method

Subjects. Thirty-five males (25 right-handers, 9 left-handers, 1 ambidextrous) and 35 females (28 right-handers, 5 left-handers, 2 ambidextrous) participated in the present study. All were surgical candidates for medically intractable complex partial seizures seen at the University Hospital in Lon-

[1]The authors thank Drs. Allan Fox, Warren Blume, and John Girvin as well as all the patients who participated in the study.

don, Ontario. Handedness was measured by asking subjects to pantomime eight unimanual activities. Participants using the right or left hand for writing and to perform 6 out of the 7 other activities were classified as right- and left-handers, respectively. Subjects who did not meet these criteria were classified as ambidextrous. The left-handed and ambidextrous subjects were grouped together and labeled nonright-handed for the purpose of analysis.

Predictor variables. A dichotic listening task (Kimura, 1986) was administered on a stereophonic tape recorder through a set of earphones. Subjects were presented with four pairs of words (one to each ear) on each of 10 trial. Participants were required to name the words presented on each trial. The maximum score possible per ear was 40.

Three tachistoscopic tasks employed letters, dots, and two-dimensional drawings of objects presented for 100 msec to either side of a central fixation point by means of a carousel slide projector equipped with a shutter. The objects occurred either in the upper or lower quadrant, and the letters and dots straddled the horizontal meridian. Practice trials followed by 10 test trials occurred for each task. The maximum scores in the left and right visual field for letters (3 per trials), dot enumeration, and object naming were 30, 10, and 10, respectively.

Criterion variables. The expression and comprehension tasks were administered from 30 sec to 6 min after the injection of 150 to 175 mg sodium amobarbytal. The three expressive tasks consisted of saying the days of the week forward, naming 8 objects, and repeating 4 phrases. The comprehension task consisted of a modified Token test whereby the subject responded to the experimenters commands by pointing to geometric forms. The percent total errors in expression and comprehension for the left and right injection were calculated separately.

Results

The laterality scores for the 4 noninvasive predictor measures and the expression and comprehension measures were transformed into lambda laterality indices to control for variability in overall performance (Bryden & Sprott, 1981). The data from the total group were then subjected to a multiple regression analysis. Forced entry of the predictors in successive steps was used. The effect of each predictor on R^2 was assessed at each step. Predictors were entered in the following order: sex, handedness, dichotic listening, letter naming, object naming, and dot enumeration. The categorical variables (sex of subjects, handedness) were effect coded. The IAP laterality indices for expression and comprehension were the dependent variables.

In expression, handedness (increment in R^2 = 0.175, $F(1, 67) = 7.13$, $p < .01$), laterality on the dichotic listening task (increment in R^2 = 0.093, $F(1, 66) = 8.46$, $p < .01$), and laterality on the object naming task (increment in R^2 = 0.049, $F(1, 64) = 4.59$, $p < .05$), were significant predictors, accounting for a total of 31.7% of the variance. In comprehension, handedness (increment in $R^2 = 0.300$, $F(1, 67) = 14.16$, $p < .01$) and dichotic listening task laterality (increment in $R^2 = 0.101$, $F(1, 66) = 11.02$, $p < .01$) were significant predictors, accounting for 40.1% of the variance.

A regression analysis was also performed separately in right- and non-right-handers. Results of this analysis indicated that in right-handers, dichotic listening laterality was a significant predictor of laterality in comprehension only, increment in $R^2 = 0.129$, $F(1, 50) = 7.45$, $p < .01$. In nonright-handers, laterality in dichotic listening was a significant predictor only in expression, increment in $R^2 = 0.485$, $F(1, 14) = 13.44$, $p < .01$. No other predictors were significant (all p's $> .10$).

Discussion

The present study replicates others who found that handedness and dichotic listening are predictors of speech representation (Strauss & Wada, 1988). However, it appears that asymmetries in tachistoscopic measures contribute little unique variance. The present findings further emphasize the need to take-into-account patients' handedness and the type of task administered (comprehension or expression) when attempting to predict speech lateralization. In view of the finding that the significant predictors accounted for approximately 40% of the variance in comprehension and 32% of the variance in expression, we are the first to report that noninvasive measures better predicted the receptive than the expressive index of speech lateralization. This suggests that future researchers should not neglect the importance of comprehension errors in the IAP (McGlone, 1984). Another implication of the present study is that the use of handedness and dichotic listening is likely to be valuable in the preoperative assessment of epileptic patients, especially when language comprehension is concerned. However, it is important to remember that a large percentage of variance in speech lateralization remains unexplained by the noninvasive procedures. This makes it quite clear that such procedures cannot replace the IAP when a precise localization of speech functions is required.

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W-9. Improved Cognitive Performance Following ATL

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We report here specific memory improvement obtained following modified anterior temporal lobectomy (ATL). Twenty-nine, left language and memory dominant patients (IAP) with pharmacologically intractable epilepsy underwent tailored ATL. Computerized neuropsychological testing pre- and postsurgery for memory (gist, inferences, and details) from short paragraphs showed over the course of 1 year that the ability to remember improved significantly, regardless of side of resection. Results suggest extended delay cued recall of connected discourse to be a bihemispherically distributed event, involving widely disparate topotonological cortical areas susceptible to interference.

Introduction. Detrimental effects of anterior temporal lobectomy (ATL) on recognition and recall memory are widely reported (Frisk & Milner, 1990). Reports indicated that memory functions showed little change following surgery, while several studies point to memory improvement. Unfortunately, research on improvement following ATL is sparse. Few studies testing patients repeatedly over time postsurgery are reported due to learning effects in standardized tests. The durability and variance of memory change postunilateral surgery has led to a scattering of results with no definitive guide to improvement of memory post ATL. We examined, using a computerized memory battery (BMAB 3.1), linguistically lavish memory for possible improvement over a 12-month period following ATL. We assessed skills and their time course.

Methods. Subjects comprised 18 females, 11 males, range 13–62 years. (Mean = 35.84, SD = 11.41) with intractable temporal lobe epilepsy who subsequently underwent ATL. Each underwent Sodium Amobarbital procedure (IAP) for lateralization of language functions and memory before any invasive procedure. All but 2 patients were left language dominant, the exceptions being very mildly bilateral. Patients were grouped into 15 left, 14 right resections, acting as their own controls for age of onset, seizure frequency, medication levels following ATL. Pretesting was conducted prior to invasive (depths, foramen ovale, grids) neurosurgical procedures, while posttesting was conducted at 1 week, 1 month, 2 months, 6 months, and 1 year. Previous data have shown that there is no learning effect with the computerized memory test battery (BMAB 3.1: test–retest $r2 = 0.99$). Prior to testing, all subjects signed consent forms approved by the IRB. Tests were delivered by computer using digitized voice with visually presented text. Timing and pacing between tasks was controlled by the experimenter and held constant. Test order was invariant, and no prompting by the experimenter occurred.

The assessment comprised a complete range of memory, both verbal/lexical and visual/spatial, using 23 tasks. Of relevance to this study was the ''linguistically lavish'' paragraph recall task. The computer auditorily and visually presented three paragraphs to subjects. After 30 min of other memory testing, subjects were asked five cued recall questions about each paragraph.

An example of a paragraph follows:

> Randy is leaving the bank wearing dark sunglasses and a hat. He is lugging a heavy bag with his right arm. His left arm is tucked inside his jacket with a bulge. Inside the bank, everyone is lying on the floor.

Examples of cued recall sentences follow:

> What do you think Randy was doing?
> What do you think is in his jacket?
> What do you think he will do now?

Answers were recorded verbatim and scored for presence/type of gist, inference, and detail: i.e., subject recalled the story was about robbing a bank (gist); subject remembered it was a bank Randy robbed (detail); and Randy had a gun in his pocket (inference).

Results. Analyses for memory performance prior and subsequent to ATL revealed a significant increase in recalling gist of paragraphs over time (ANOVAR: MS = 7252.06, $F = 6.15$, $p < 0.02$), inference over time (ANOVAR: MS = 5852.17, $F = 5.21$, $p < 0.03$), and details over time (ANOVAR; MS = 5384.06, F = 5.65, p < 0.03). Mixed factorial ANOVAS showed no significant difference between L vs. R resection groups for gist, inference or detail. Recovery curves show course of recovery to be between 2 and 8 months.

Discussion. Tailored ATL can produce significant improvement in patients' ability to recall gist, inferences and details from short paragraphs after 30 min of distraction. Each discourse measure provided a differing aspect of cognitive processing of discourse, giving a profile of patients' ability to remember and construct complex linguistic knowledge. Moreover, these tasks measured patients' capacity to hold and use knowledge over the span of 30 min, providing a reliable estimate of how a person might function independently, where recall is essential for successful living. An important finding connected with these results is that no lateralization differences were demonstrated with these assessments. Most improvement was only documented in the nondominant lobe (verbal/lexical performance improved in patients resected in non-language dominant lobe). (Ivnik et al., 1987); Selwa et al., 1994) There have been few studies that have shown improvement when patients had their dominant lobe resected (Pigott & Milner, 1994; Hermann & Wyler, 1988).

Although all patients were left hemisphere dominant for language, we found improvement in all patients, both L and R resections. We take this to mean that remembering connected discourse over 30 min is bihemispherically distributed, involving disparate topotonological cortical areas. If the paragraph test actually measures bihemispheric events that healthy hippocampus binds together, the improvement of recall skills is understandable following surgery which removes pathological hippocampus.

The interference hypothesis, that pathological brain interferes with healthy brain functions, allows for the recovery of skills once pathological brain is resected. Our results indicate that resection of abnormal brain tissue from either dominant or nondominant lobe probably decreases interference and leads to improvement in the recall functions of connected discourse.

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W-10. Processing of Semantic Ambiguity as Reflected by Event-Related Negativities[2]

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Event-related negativities (N4a, N4b, N6) and P3b were investigated in an attempt to elucidate the electrophysiological correlates of semantic ambiguity. Eleven subjects read sentences and decided whether terminal words were congruent, impossible or improbable. Both motor and nonmotor response conditions were used. Only N6 was found to discriminate semantic improbability from both congruous and impossible terminal words, while RT was not sensitive. Response mode did not effect results. Findings suggest that improbable and impossible words are only differentiated at N6 latency, consistent with the idea that the improbable words require further processing.

The processing of semantic ambiguity has received considerable attention in behavioral studies (Spivey-Knowleton, Trueswell, & Tanenhaus, 1993). Previous work by Kutas and colleagues has demonstrated that the N4 event-related potential (ERP) is sensitive to the processing of semantic incongruities (for a review see Kutas & Van Petten, 1988). While some attention has been paid to ERPs elicited by lexically related–unrelated probe words following ambiguous terminal words of sentences (Van Petten & Kutas, 1987), little information is available with regards to the ERP correlates of ambiguous words per se.

N4 has been found to be sensitive to ambiguous words embedded within sentences in a visual sentence verification task (Garnsey, Tanenhaus, & Chapman, 1989). In a similar task, Hervé and Baribeau (1994) found that N6, but not N4a or N4b, was of larger amplitude to improbable than impossible and congruent words. It was suggested that N6 may be related to the enhanced late negativity observed in non-linguistic tasks in which a decision is required. This late negativity has been interpreted as reflecting further processing of stimuli (Ritter et al., 1984).

The present study attempted to crossvalidate the observations on anglophone subjects of Hervé and Baribeau (1994) with francophone subjects in order to permit generalization. Given the use of unilingual anglophone subjects in other investigations, we deemed important to use stringently screened unilingual francophones. Furthermore, response mode was manipu-

[2]This study was funded by grants from CASA-Concordia, FCAR-Québec, and NSERCanada to the senior author, Jacinthe Baribeau. Equipment was supported by an NSERCanada grant to André Achim.

lated in order to determine whether the N6 effect is due to overlapping motor potentials.

Method

Subjects. Eleven right-handed francophone university students (6 females and 5 males) participated. Subjects were recruited for their low level of proficiency in English language expression and comprehension according to results obtained from self-report and a computer screening task (Segalowitz, 1991).

Procedure. 214 French sentences were presented, one word at a time, with an average of six words per sentence. There were 122 congruent, 42 impossible, and 42 improbable sentences arranged into two practice blocks and two test blocks. Sentences that produced systematic errors were excluded from averaging. Words were presented in the center of a computer monitor for 100 msec, with a 900 msec interstimulus, and 3 sec intertrial, interval. In one block subjects were required to read the sentences and make a decision concerning the type of terminal word without any overt response. A key press for each stimulus type was required in the other block. The two sets of blocks were counterbalanced between subjects.

Evoked potential recording. Electroencephalograms (EEGs) were recorded from midline (Fz, Cz, Pz, Oz), and lateral (C3, C4) sites, refered to linked mastoids. Eye movements (EOG) were monitored and trials with EEG or EOG activity $\pm$100 mV were excluded from the final averaged waveforms. Electrode impedance was below 5 KOhms. Data was digitized at 250 Hz for 800 msec, including a 50 msec baseline. Filters were set at 1 and 40 Hz, respectively.

Data analysis. Reaction time (RT) to terminal words was analyzed using a repeated measures ANOVA. N4a, N4b, and N6 were identified as the highest negative peaks amongst the recorded electrodes from Fz to Oz, respectively from 280–380 msec, 380–500 msec, and 500–650 msec. P3b was measured as the largest positivity in the 250–400 msec range. Data was collapsed across response mode as preliminary analyses failed to reveal a significant effect of this factor. Data for longitudinal midline electrodes were analyzed using a 3 (stimulus) $\times$ 4 (electrode) repeated measures ANOVA. Lateral sites (C3, C4) were analyzed separately. The Geisser–Greenhouse correction was used where appropriate, original degrees of freedom are presented before corrections followed by post hoc comparisons.

Results

Data from two subjects was excluded from analyses due to excessive myogenic artifacts. ANOVA on RT indicated a significant effect of stimulus (F (2, 18) $=$ 17.00, $p < 0.001$). RT was significantly longer for impossible (M $=$ 1489 msec) and improbable (M $=$ 1612 msec) than congruous sentences

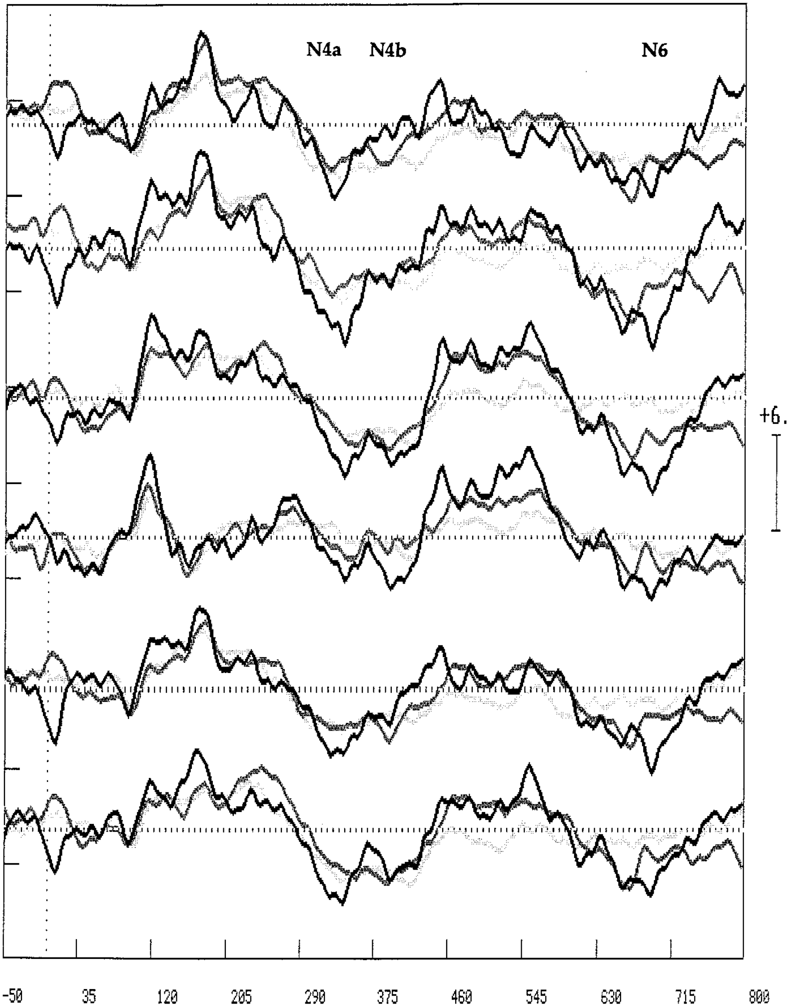

FIG. 3. Grand-averaged waveforms (n = 9) elicited in response to congruous (light gray), impossible (dark gray) and improbable (black) stimuli in the manual condition.

(M = 1190 msec). No difference between improbable and impossible words emerged.

Figure 3 presents the grand-averaged waveforms for the three types of stimuli in the manual condition. A main effect of stimulus on N4a amplitude at midline indicated larger amplitude for improbable than congruous sentences ($F(2, 16) = 12.27$, $p < 0.001$, $\varepsilon = 0.981$), $F(1, 16) = 6.06$, $p < 0.05$). A significant electrode effect indicated that N4a amplitude was larger at Fz-Cz-Pz than Oz ($F(3, 24) = 4.74$, $p < 0.05$), $\varepsilon = 0.501$), $F(1, 24) = 4.57$, $p < 0.05$)

A main effect of stimulus was found for N6 at midline ($F(2, 16) = 10.7$, $p < 0.01$, $\varepsilon = 0.973$) and lateral ($F(2, 16) = 11.11$, $p < 0.01$, $\varepsilon = 0.764$) electrodes. At midline, amplitude was larger for improbable than congruous sentences ($F(1, 16) = 5.28$, $p < 0.05$). At lateral sites, larger amplitude was found for improbable than both congruent ($F(1, 16) = 11.05$, $p < 0.01$) and impossible sentences ($F(1, 16) = 5.46$, $p < 0.05$). A midline electrode effect was also obtained indicating significantly larger amplitude for Fz-Cz than Pz-Oz ($F(3, 24) = 9.47$, $p < 0.01$, $\varepsilon = 0.515$), ($F(1, 24) = 6.8$, $p < 0.025$).

A main effect of stimulus was obtained for P3b mplitude. At midline it indicated significantly larger amplitude for improbable and impossible than congruous sentences ($F(2, 16) = 6.75$, $p < 0.025$, $\varepsilon = 0.95$), ($F(1, 16) = 4.92$, $p < 0.05$). At lateral sites larger amplitude was found for improbable than congruous sentences ($F(2, 16) = 6.95$, $p < 0.025$, $\varepsilon = 0.95$), ($F(1, 16) = 6.09$, $p < 0.05$).

Discussion

Consistent with Hervé and Baribeau (1994), the present study found no significant difference between impossible and improbable sentences on the N4a, N4b or reaction time. Although P3b in sentence verification tasks such as that employed in the current investigation may sometimes influence effects on late negativities such as the N4 (Kutas, Van Petten, & Besson, 1988), improbable words did not elicit larger P3b than impossible words.

In contrast to the earlier N4 negativities, and in support of Hervé and Baribeau's (1994) observation on anglophone subjects, N6 was larger in response to improbable than both congruent and impossible terminal words at Cz, C3, C4. Response mode did not influence this finding. Given its later latency than N4, it is plausible that N6 may be reflecting a further processing required by the ambiguous words. Such an interpretation is consistent with studies indicating enhanced late negativities following P3b in decision making tasks (Ritter et al., 1984).

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W-11. Right Hemisphere Priming for Subordinate Meanings of Homographs

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The representation of subordinate meanings of ambiguous words in each cerebral hemisphere was investigated in two priming experiments where primes and targets were projected to the left or right visual fields. Homographs and their subordinate meanings (e.g., BALL–DANCE) were employed as related pairs in a lexical decision task. Pairs were separated by a stimulus onset asynchrony (SOA) of 250 msec in the first experiment and 350 msec in the second. Priming was present only at SOA 350 msec, when primes were projected to the LVF. The findings are consistent with the suggestion that the right hemisphere plays a role in disambiguating text (Burgess & Simpson, 1988).

The left cerebral hemisphere (LH) has long been attributed with superior language abilities, although recent investigations suggest that the right hemisphere (RH) also contributes to language processing (e.g., Abernethy & Coney 1993; Brownell, 1988; Chiarello, 1988). Evidence derived from clinical patients suggests that the RH plays an important role in drawing inferences (Beeman, Friedman, Grafman, Perez, Diamond & Lindsay, 1994) and interpreting ambiguous text (Kaplan, Brownell, Jacobs & Gardner, 1990). Burgess and Simpson (1988) confirmed this in a priming study with normal subjects which investigated the activation of dominant and subordinate meanings of ambiguous words in each hemisphere. Ambiguous primes (e.g., BANK) were followed 35 or 750 msec later by targets associated with the prime's dominant (e.g., MONEY) or subordinate meaning (e.g., RIVER). They found that subordinate meanings remained active in the RH for longer than in the LH, and suggested that when disambiguating text, the RH supplies infrequent meanings to the LH.

The aim of this study was to obtain a fuller understanding of the time-course of activation of subordinate meanings in each hemisphere. To this end, prime-target pairs were separated by two SOAs intermediate to those used by Burgess and Simpson (250 and 350 msec). Their suggestion that the RH supplies subordinate meanings of ambiguous text to the LH was also examined by including cross-hemisphere priming conditions in the design. Ambiguous primes projected to the RH are expected to activate subordinate meanings within the RH (i.e., LVF–LVF priming) and also the LH (i.e., LVF–RVF priming).

Method

Two experiments were conducted to investigate these questions. They differed in the subject samples used and SOA employed. Primes and targets were separated by an SOA of 250 msec in the first experiment, and 350 msec in the second.

Subjects

Subjects were 54 psychology students: 30 in experiment 1 and 24 in experiment 2 (mean age 25.1 years). All had normal or corrected-to-normal vision, English as their first language, and were right-handed.

Apparatus

Subjects were tested on an IBM personal computer system which controlled randomization of trial sequencing, stimulus presentation, timing, and data collection. Reaction time (RT) was measured via the keyboard's spacebar. Stimuli were printed in white enlarged uppercase letters (8 $\times$ 4 mm) on a high resolution, nonglare monitor.

Design

Reaction time (RT) was the principal dependent variable, with errors also recorded. A lexical decision task was used, requiring subjects to discriminate words from nonwords with a GO–NOGO response procedure.

The first experimental variable, stimulus pair relationship, incorporated three prime-target conditions. 128 homographs were used as primes in the related-word condition. Each was paired with a target associated with its subordinate meaning (e.g., BALL–DANCE, not BALL–ROUND). These pairs were selected from homograph norms (Cramer, 1970; Nelson, McEvoy, Walling & Wheeler, 1980). The unrelated-word condition was formed by repairing these primes and targets (e.g., BALL–TREE). For the word–nonword condition, 128 additional matched primes were each paired with an orthographically legal, pronounceable nonword target (e.g., CAR–DENCA). All stimuli were between 3 and 7 letters. Words were nouns or adjectives. None of the pairs were orthographically or phonologically similar.

The second experimental variable, visual field of presentation, comprised four levels: (i) RVF prime and target; (ii) LVF prime, RVF target; (iii) LVF prime and target; (iv) RVF prime, LVF target. Stimuli were presented 2 degrees of visual angle from a central fixation. Each subject was exposed

TABLE 2
t-Test Statistics Comparing Mean Correct Reaction Time for Related and Unrelated Word Pairs in Each Visual Field Condition

	Priming effect[a]	t observed	p
Visual field			
LVF–LVF	+12.5 msec	$t(29) = 1.5$	$p = .145$, ns
RVF–LVF	+9.7 msec	$t(29) = 1.54$	$p = .135$, ns
RVF–RVF	+8 msec	$t(29) = 1.49$	$p = .149$, ns
LVF–RVF	+0 msec	$t(29) = 0.02$	$p = .986$, ns

[a] Priming effect = RT unrelated − RT related.

to a unique distribution of pairs in each visual field condition, and a different randomized sequence of prime-target conditions.

Procedure

Subjects sat with their heads directly in front of, and 45 cm distant from, the center of the screen. Each trial began with a central fixation cross which remained on throughout the trial. After 750 msec, a prime was displayed in the LVF or RVF for 150 msec. The target was subsequently presented to the LVF or RVF for 150 msec. The fixation then disappeared and the screen remained blank for 1500 msec, while the subject signalled a response. When the target was a word, S's were required to depress the spacebar with both index fingers. The temporal interval separating prime and target was 150 msec in the first experiment, and 250 msec in the second. Trials were presented in 8 blocks of 64 trials.

Results

Experiment 1. A two-way ANOVA was computed on mean correct RT for stimulus pair relationship and visual field of presentation. The main effect for visual field ($F(3, 87) = 23.42$; $p < .001$) reflected faster responses to RVF targets. There was no main effect for stimulus pair relationship ($F(1, 29) = 3.87$; $p = .059$) and no interaction ($F(3, 87) = .76$; $p = .519$). To examine whether priming differed in each visual field, four related-samples t-tests were used to carry out planned comparisons between each related condition and its unrelated baseline. None were significant (see Table 2). Interestingly, although not significant, the largest priming facilitation occurred when related pairs were projected to the LVF. An ambiguous prime may take longer than 250 ms to activate its subordinate meanings in the RH. Experiment 2 investigated this.

Experiment 2. A two-way ANOVA returned significant main effects for stimulus pair relationship ($F(1, 23) = 5.27$; $p = .031$) and visual field ($F(3, 69) = 5.81$; $p < .001$). There was an overall priming facilitation of 8.5 msec and faster responses to RVF targets. A trend towards an interaction between stimulus pair relationship and visual field was present ($F(3, 69) = 2.63$; $p = .057$). Four related-samples t-tests showed significant facilitation for LVF–LVF (29 msec: $t(23) = 2.94$; $p < .05$) and LVF–RVF presentations (16 msec: $t(23) = 2.13$; $p < .05$). In the remaining two conditions, responses were slightly slower to targets preceded by related primes (by 4 msec for RVF–RVF: $t(23) = .48$; $p > .05$; and 7 msec for RVF–LVF: $t(23) = 0.8$; $p > .05$).

Error rates for both experiments were also analyzed using two ANOVAs. These data were consistent with the RT data, and no speed–accuracy trade-offs were present.

Discussion

Ambiguous primes in the LVF facilitated responses to subordinate meanings presented 350 msec later in either the LVF or RVF. This is consistent with the suggestion that the RH plays a role in interpreting ambiguous text, by supplying subordinate meanings to the LH (Burgess & Simpson, 1988). It is also clear that the activation of subordinate meanings has a different timecourse in each hemisphere. A homograph projected to the RVF activates its subordinate meanings in the LH within 35 msec (Burgess & Simpson, 1988), but this activation dissipates by 250 msec, possibly because dominant meanings are the focus of processing therein (Beeman et al., 1994; Burgess & Simpson, 1988). In contrast, subordinate meanings take longer to become activated in the RH (see Abernethy & Coney, 1993), but remain active for longer. They are unavailable early (after 35 msec) and exert only a small effect 250 msec after presentation of the prime. However, subordinate meanings are available in the RH after 350 msec and remain so for at least 750 msec (Burgess & Simpson, 1988).

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W-12. Parietal Lobe Morphology Predicts Phonological Skills in Developmental Dyslexia

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Using brain magnetic resonance imaging, we measured asymmetry of a parietal region including parietal operculum and supramarginal gyrus in 16 young developmental dyslexic adults and 10 matched controls. Dyslexics also performed four cognitive tasks exploring different aspects of phonological processing. Results showed: (1) a more symmetrical pattern in dyslexics than in controls; (2) a positive correlation in dyslexics between asymmetry coefficients and performance in two out of the four phonological tests, having in common their particular reliance on verbal short-term memory. It is suggested that working memory-based phonological impairment in dyslexics may relate to parietal lobe morphology.

Introduction

Since the pioneering neuropathological works of Galaburda and colleagues (Galaburda, Sherman, Rosen, Aboitiz, & Geshwind, 1985), it has been widely recognized that developmental dyslexia (DD) is associated with atypical anatomofunctional brain organization. These authors described, on a limited number of dyslexic brains, an abnormally symmetrical pattern of cortical anatomy in the superior temporal surface (*Planum temporale*). Since this region is known to belong to the classical language area in the left hemisphere, its lack of asymmetry was thought to contribute to defective development of language-related abilities in dyslexics. More recently, several studies examining these asymmetries *in vivo* in larger samples of dyslexics by means of brain MRI have yielded conflicting results (see for instance Kushch et al., 1993; Leonard et al., 1993; Schultz, Cho, & Staib, 1994).

In addition to those involving the temporal lobes, striking right–left asymmetries are also observable on the other bank of the Sylvian fissure, in a region of the parietal lobe known as the *parietal operculum* (LeMay & Culebras, 1972; Habib et al., 1984) which is typically larger on the left due to asymmetry in direction of the Sylvian fissure. A larger left parietal operculum has been related to righthandedness (Habib, Robichon, Levrier, Khalil, & Salamon, 1995) and to left-hemisphere language lateralization (Ratcliff, Dila, Taylor, & Milner, 1980). Finally, just caudal to the parietal operculum lies the supramarginal gyrus (Brodmann’s area 40), whose posterior part has been found larger on the right hemisphere in righthanded males (Jäncke, Schlaug, Huang, & Steinmetz, 1994). In the present study, we compared asymmetry of an area including the parietal operculum and the adjacent supramarginal gyrus on MRI scans obtained in adult male dyslexics and nondyslexic controls. Moreover, in order to assess the functional correlates of this asymmetry, dyslexics also underwent a specific neuropsychological evaluation, especially devoted to assessing phonological impairment.

Methods

Participants and handedness. Sixteen adult male dyslexics (mean age = 21.0, SD = 0.2) and ten sex- and age-matched controls (mean age = 22.3, SD = 1.0), all french-speaking students, gave informed consent to participate in this experiment. The inclusion criteria for dyslexics were (1) childhood history of at least 2 years of school retardation, (2) familial occurrence of dyslexia or reading impairment (in at least one first-degree relative), and (3) diagnosis and past speech therapy. The exclusion criteria were (1) IQ, assessed by Raven's Progressive Matrice, lesser than the low level of the age-range, and (2) history of epileptic seizures, neurological, or psychiatric disorders, and attention deficit disorder or hyperactivity as defined by the DSMIII-R. Handedness was assessed by the Edinburgh Handedness Inventory. For the dyslexic group, nine out of the participants were righthanded and for controls, ten out were.

Neuropsychological assessment. Our dyslexic subjects performed more poorly than controls on tests exploring phonological abilities, including (1) tasks aimed at evaluating graphophonemic conversion (nonword oral reading) and graphophonemic conversion (spelling nonwords on dictation); and (2) two tasks of so-called ''phonological awareness,'' a process known as crucial to the development of reading and spelling skills (phoneme deletion task and sound categorization task). In the latter task, participants had to detect the odd one among four phonologically similar mono- or bisyllabic words read aloud by the examiner, i.e., to choose the only word which did not include a sound shared by the other three.

Magnetic resonance imaging and anatomical definitions. All exams were performed on a General Electric Signa 1.5 Tesla Magnet with a gradient-echo sequence (repetition time = 35 msec, echo time = 9 msec, flip angle = 30°). An axial series of 124 contiguous 1.00-mm thick slices with an in-plane Field of View of 240 mm across a 256 × 192 pixel matrix was collected.

Measurements were performed on sagittal slices with simultaneous generation of axial slices in order to eliminate uncertainty about anatomical landmarks. Parietal asymmetries were assessed by measuring, on two sagittal slices chosen at equal distance from the midline, an arbitrary area named ''parietal suprasylvian area'' (PSSA), limited anteriorly by the central sulcus, posteriorly by Jensen’s sulcus, superiorly by the intraparietal sulcus and inferiorly by the Sylvian fissure. A coefficient of asymmetry was calculated according to the formula: PSSA $= (R - L)/[0.5(R + L)]$.

Results

Mean comparison (Student *t*-test) performed between controls and dyslexics yielded a significant group difference ($t = -2.61$, $p = .015$): asymmetry coefficient PSSA was significantly more negative, indicating more leftward asymmetry, in controls than in dyslexics. More precisely, dyslexics displayed, as a group, a rather symmetrical pattern of parietal morphology compared to controls who all showed leftward asymmetry.

Significant correlations were found, in the dyslexic group, between PSSA and the number of errors in both nonword dictation and sound categorization tasks (respectively, $r = .529$, $p = .035$ and $r = .550$, $p = .027$). No correlation was found between asymmetry coefficient and performances on the phoneme deletion or nonword reading tests.

Discussion

Our results suggest that dyslexics as a group display reduced right-left asymmetry in a region of parietal cortex including the parietal operculum and the supramarginal gyrus.

In addition, asymmetry in the PSSA was found inversely proportional to dyslexics’ performance in two phonological tests: nonword spelling to dictation and sound categorization task. In both tasks, subjects have to keep in short-term memory an auditory information made of several syllables, thus probably resorting on the ‘‘phonological store,’’ whose role, according to classical models of verbal short-term memory (Baddeley, 1992), is to maintain in immediate memory and to rehearse speech-based information. Interestingly, impaired short-term memory has been proposed as a causal mechanism at the origin of reading disorder in dyslexia.

Our findings are discussed in reference to recent data obtained with Positron Emission Tomography (Paulesu, Frith, and Frackowiak, 1993), showing that the left supramarginal gyrus and adjacent parietal operculum are specifically activated by tasks requiring the storage of phonological information for subsequent processing.

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W-13. Activating the Right Hemisphere by a Prior Spatial Task: Equal Lexical Decision Accuracy in Left and Right Visual Fields in Normal Subjects

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Improvement of left visual field lexical decision performance in normal subjects was obtained after right hemisphere (RH) activation by means of a prior spatial task (compared to left- and bihemispheric activation). The longer the hemispheric activation, the greater the improvement. The left hemisphere (LH) was accurate for all types of words and the RH was accurate for high-imagery words. There was a strong improvement in the processing of low-imagery words presented in the left visual field after right hemispheric activation. One can hypothesize that RH systems mediate a lexicon support for low-imagery words, and that the ''accessibility threshold'' of this lexicon can be modified during right hemispheric activation.

Words are processed faster and more accurately when presented in the right visual field (rvf-LH). This is usually taken to reflect left hemisphere specialization for language: the LH is thought to encode words as units and subtend a complete lexicon. It remains unclear which aspects of the word recognition process can actually be carried out by the left visual field-right hemisphere (lvf-RH). For Chiarello (1988), words in the lvf-RH are encoded letter by letter by a slow serial process after which lexical coding is available. Following Chiarello's paper, most authors consider the RH lexicon to be incomplete and limited to short, high-imagery words on which a lexical process operates.

Kinsbourne and Byrd (1985) report an improvement in rvf-LH accuracy on a spatial task when preceded by a verbal task. The activation is thought to spread from the specialized LH areas to other LH areas, which would allow for the expression of LH competence in the spatial task. Faure and Blanc-Garin (1994) demonstrated facilitated processing of words by the RH after a prior spatial activity in a split-brain patient, and proposed a spreading activation process within the RH to explain this result.

In the light of controversial results regarding the lexical abilities of the RH, our study tested the hypothesis that a similar intrahemispheric activation effect can benefit RH word processing in normal subjects. It was hypothesized that different hemisphere-specific activation patterns may be generated by three different preliminary tasks performed before a tachistoscopic, divided visual field, lexical decision task. Immediately after one of the preliminary tasks, lexical decision performance was measured in each visual field. The ''duration'' of the hemispheric activation was manipulated by varying the number of trials, where a trial is defined as a preliminary task followed by lexical decision stimulation. The duration was long (16 trials), intermediate (8 trials), or short (3 trials).

Experimental Design

Tasks and Stimuli

Preliminary tasks. Left hemisphere activation: rhyme task. Two words were presented in central vision for 1000 msec. Subjects answered ''yes'' if the words rhymed and ''no'' if they did not.

Right hemisphere activation: shape comparison task. Two geometric shapes were presented in central vision for 1500 msec. Subjects responded ''same'' when the figures were identical and ''different'' when they were not.

Bi-hemispheric activation: number comparison task. A written numeral was presented on the right of a central fixation point at the same time as a set of triangles was presented on the left, for 200 msec. Subjects responded ''same'' if the numeral corresponded to the number of triangles and ''different'' if it did not.

Main task: lexical decision. Words and pronounceable nonsense words were presented horizontally for 100 msec, in an angular window of 4.7 to 7.1° to the left or right of a central fixation point. Subjects responded ''yes'' for a word and ''no'' for a nonsense word. Nonsense words and words were controlled for the number of letters, and the words, for imageability and frequency.

In all tasks, the subjects responded (yes/no, same/different) by pressing one of two keys on the keyboard. On the lexical decision task, a subject responded with the left index finger in one half and with the right index finger in the other half.

Factors

—Visual hemifield for lexical decision presentation: lvf-RH/rvf-LH

—Response hand for lexical decision: left/right

—Imageability: low-imagery words/high-imagery words

—Preliminary task (hemispheric activation): rhyme (LH-act.)/shape (RH-act.)/number comparison (BiH-act.)

—Activation duration (number of similar trials in succession): 3 (R3)/ 8 (R8)/16 (R16)

Data analysis. Accuracy data (P(a), a discrimination index from Signal Detection Theory) and response time (RT) on the lexical decision task were analyzed using an analysis of variance. In lexical decision making, for each visual field of stimulus presentation (lvf-RH, rvf-LH), two Anovas were conducted, one on P(a) and one on RT, with preliminary task (3) and activation duration (3) as within-subject factors.

Subjects. Twenty healthy, strongly right-handed male and female students between the ages of 19 and 23 participated.

Results

Preliminary tasks. Response accuracy for all preliminary tasks was clearly above the chance level.

Lexical Decision Performance

Accuracy. (See Fig. 4.) In the rvf-LH, there was a monotonic, significant improvement in lexical decision making when the activation duration increased, but no preliminary task effect. In the lvf-RH, there was a significant interaction between the preliminary task and duration. As activation duration increased, lexical decision making (a) remained stable for bihemispheric activation and tended to decline for left hemispheric activation and (b) improved significantly for right hemispheric activation, with lvf-RH approaching lvf-LH accuracy.

Response time. For lexical decision RTs in the rvf-LH, there was a significant interaction between the preliminary task and the activation duration, with longer RTs as activation time increased, except for bi-hemispheric activation. In the lvf-RH, RTs were longer for long activation times than for

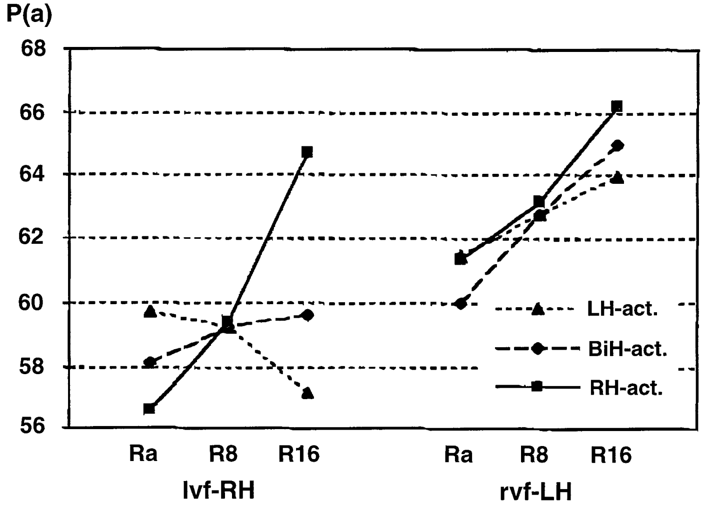

FIG. 4. Lexical decision making accuracy in each visual field, as a function of preliminary activation task and duration.

short ones, but there was no significant effect or interaction with the preliminary task.

Discussion

In this study with normal subjects, improvement in lvf-RH lexical decision performance was obtained after right hemisphere activation by means of a preliminary visuospatial task. This improvement appears to depend on the ''duration'' of the activation. The rvf-LH was accurate for all types of words, without a preliminary activation effect. Lvf-RH performance for high-imagery words was very near rvf-LH performance, suggesting that the RH can process these words as lexical units from a right lexicon supporting that kind of word. The strongest lvf-RH gains in accuracy after right hemispheric activation were for low-imagery words. One can hypothesize that RH systems mediate a lexicon support for low-imagery words, and that the ''accessibility threshold'' of this lexicon can be modified during right hemispheric activation. When the representation of a low-imagery word becomes accessible in the right lexicon, RH systems may carry out a purely lexical process.

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W-14. Power Laws, Critical Phase Transitions, and Shifts in Hemispheric Advantage: "The First Shall Be Last"

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Making use of some aspects of Logan's (1988) instance theory of the power law speedup in reaction-times (RTs), we propose a dynamic systems approach to an understanding of the critical phase transition from performance based on algorithms to performance based on direct memory retrieval. We then apply this understanding to explain shifts in hemispheric differences as a function of repetitive practice.

Logan's (1988) account of the characteristic power function shape for RT speedup acknowledges the transition from algorithm to direct memory retrieval but emphasizes, instead, a race between multiple memory traces recruited at the time of retrieval, the greater the number of traces in the race to control retrieval and RT performance, the faster the retrieval and RT. Logan's account requires a Weibull distribution for Rts and also that RT block means and standard deviations decline at the same rate. However, the RT distributions appear to be lognormally distributed (Herrington, Hoffmeyer, Kennelly, & Hall, 1995) and the rate of decline is significantly faster for standard deviations than for means (Kennelly, Hall, Herrington, & Baggett, 1995; Logan & Etherton, 1994, p. 1043).

As Manfred Schroeder (1991) reminds us, power laws are associated with critical phase transitions. We consider the transition from algorithm to direct memory retrieval as the critical phase transition associated with the power law of practice. Kelso (1994, p. 236) suggests that power law scaling in repetitive learning means that there is no characteristic time scale. Rather, learning processes occur over a wide range of time scales, demonstrating long range anticorrelation, with measures alternating between positive and negative values.

Of course, instances, information, or chunks must be encoded in memory (or learned) before they can be retrieved from memory. This cooperative relationship across trials is an important assumption. Logan relates these two cognitive operations in terms of their joint dependence upon attention: both encoding and retrieval are unavoidable consequences of attention (Logan, 1988, p. 493).

However, this cooperative relationship between encoding and retrieval, mediated as it is by attention, occurs only across time or trials, not within a moment of time or a single trial. To paraphrase Scott Kelso (1994, p. 11), in dynamic, self-organizing systems, competition frequently lurks underneath cooperation, producing instabilities and critical phase transitions. Perhaps, if we consider a different time scale, that within rather than between trials, we may see the basis for competition between encoding and retrieval.

For Newell and Rosenbloom, ''. . . there exists a basic constant rate of chunk acquisition (with respect to time, not trials). This same view underlies the appeal of the total time hypothesis of verbal learning [Cooper & Pantle, 1967]'' (Newell & Rosenbloom, 1981, p. 45). This constant rate of chunk encoding (or learning) assumption (for time, not trials) places the operations of encoding and retrieval in competition during each particular RT trial.

We assume, then, a cooperative relation across trials and a competitive relation within trials for encoding and retrieval. Earlier encodings provide the basis for later trial retrievals. Relatively novel and unfamiliar tasks lead to algorithm based performance on early trials, which is generally slower than direct retrieval, thus producing more time for chunk encoding of relevant cues and responses. Paradoxically, this leads to a quicker transition to direct memory retrieval based performance on later trials and a faster speedup of RTs than will fast initial RT trials already based on direct memory retrieval. Subsequent fast RTs quickly reduce the rates of further improvements. Therefore, if we accept Newell and Rosenbloom's (1981) constant rate of chunking assumption, slow initial RTs give rise to fast rates of RT speedup across trials and fast initial RTs give rise to slow rates of RT speedup.

For tasks relatively novel for subjects, this analysis requires a negative correlation between initial RT values (power function intercepts) and power function exponents (the estimates of the rates of learning), based on subjects' RTs across trials. With repetition, however, as the slow initial RTs fuel a rapid phase transition from algorithm to direct memory retrieval, and the fast initial RTs lead to a slow phase transition to direct memory retrievals, the correlation between each subsequent trial's RTs and the power function exponents should rise to zero and then become increasingly positive as the subjects are gradually reversed in order. Truly, ''the first shall be last and the last shall be first.'' The control parameter driving this phase transition between algorithm and direct memory retrieval is frequency of repetition. The different rates of transition for individual subjects (or items, or hemispheres) are caused by the widely different amounts of time allotted to chunk encoding during initial trials. Such differences are probably caused by variations in the speed of different algorithms, slower, less efficient ones, allowing more time for chunk encoding of relevant cues and responses.

At what level does this reordering produced by critical phase transitions occur? Perhaps, all levels. So far, we have found it to apply at the level of RT task item difficulties, individual subjects, groups, and hemispheres. As Goldberg and Costa (1981) emphasized, repetitive practice shifts visual-field (VF) advantages. With novel tasks, an initial left VF advantage gives way to a late right VF advantage with repetitive practice. Our analyses and simulations have also demonstrated that, subsequent to the zero correlation point between trial RTs and rates of learning, RT distributions become increasingly well fit by a lognormal distribution function, even if, in the simulations, learning is started with the RTs generated by a Weibull distribution.

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W-15. Phonologically Based Spelling Errors and Their Implications in the Specification of Phonology to Orthography Conversion Processes

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We report a case of severe dysgraphia whose characteristics suggest an exclusive reliance on sublexical phonology to orthography conversion processes. In addition to numerous phonologically plausible errors (PPEs), ML produces many context errors and grapheme substitutions, indicating that conversion processes are also impaired. Interestingly, most of the errors produced on consonants consist of substitutions of letters corresponding to voiced phonemes with letters corresponding to unvoiced ones and vice-versa—a phenomenon which is much more frequent in written than in oral spelling. We conclude that conversion processes represent correspondences between graphemes and phonological features rather than between graphemes and phonemes.

Introduction. Most current models of reading aloud and of spelling to dictation consider that sublexical knowledge about the correspondences between phonology and orthography involve phonemes or groups of phonemes and letters or groups of letters. In addition, dissociations between performance in oral versus written spelling are commonly intepreted as indicative of an impairment to modality-specific processing components. We report a case that challenges both of these views.

Case report. ML is a 34-year-old French woman with a college education who was working as a specialized educator when she was victim of a road traffic accident in January 1992. A CT scan revealed that the head trauma she sustained provoked bilateral temporal lesions. She is left with a variety of cognitive impairments of which the more striking are: a retrograde amnesia, a learning impairment, and a semantic impairment that affects her identification performance independently of input modality (visual, auditory, tactile). ML experiences word finding difficulties in spontaneous speech and produces word substitutions; her syntax and phonology are normal. Repetition of words and nonwords is normal. Reading aloud and spelling are severely impaired.

Analysis of spelling performance. ML's performance in written spelling to dictation of a list of over 500 stimuli was severely impaired across all categories of items (90% errors on average). About 30% of the errors she made on words were phonologically plausible (e.g., ''crapaud'' (/krapo/) → CRAPO). Other errors consisted of consonant and vowel substitutions (''mode'' → mote), context errors (i.e., errors where she used a letter which could correspond to the target phoneme in another orthographic context, e.g., ''qui'' → ci) and various combinations of the above (e.g., PPE component + substitution: ''corbeau'' → corpo, PPE component + context: ''muguet'' → mugé). Apart from a very small proportion of high frequency words all of ML's responses to words with irregular or ambiguous spellings included a PPE component. This suggests that she has virtually no access word-specific spelling knowledge. Further analyses indicated that the vast majority of ML's errors were phonologically based rather than graphemically based—she generally substituted graphemes that corresponded to similar phonemes and was just as likely to substitute visually dissimilar letters like f and v than visually similar letters like p and b. Moreover, she often replaced a letter with a group of letters corresponding to a similar phoneme and vice-versa (e.g., ''broche'' → broge). Such errors were equally likely to occur on word and nonword stimuli. A finer analysis of ML's performance with stop consonants and fricatives (see Table 3) revealed that virtually all of her errors consisted in substituting a letter corresponding to a voiced phoneme with a letter corresponding to an unvoiced phoneme and vice-versa (i.e., p/b, t/d, ch/g, f/v . . .).

Overall, the evidence suggests that ML is primarily relying on nonlexical conversion processes when she spells. The very high proportion of errors including a PPE component and the observation that other errors apply similarly to words and nonwords supports this interpretation. However, an additional impairment must be assumed to explain the substitution errors. One possible source of damage that may lead to phonologically based spelling errors would be input phonological analysis. This interpretation seems unlikely because phoneme discrimination, word and nonword repetition and

TABLE 3
Spelling Errors (%) on Stop-Consonants and Fricatives

	Written spelling	Oral spelling
Phonemes corresponding to similar sounding letter names (e.g., /p/→/pe/, $n = 206$)		
Correct	60	96
Voicing errors	39	4
Sounding out errors	–	0
Others	1	0
Phonemes corresponding to dissimilar sounding letter names (e.g., /k/→/se/, $n = 88$)		
Correct	60	52
Voicing errors	33	13
Sounding out errors	–	23
Others (mostly context errors)	7	12

auditory lexical decision were intact. The only alternative explanation is that ML's error pattern reflects an impairment to conversion processes themselves; the observation that ML also produces context errors is consistent with this interpretation.

ML's performance in oral spelling to dictation of the same set of items was also severely impaired (17% correct) and in many respects is similar to her performance in written spelling. The proportion of pure phonologically plausible errors (42%) was also very high as expected under the hypothesis of an impairment to the lexical route. One puzzling aspect of the data is that her voicing errors were far less frequent in oral spelling than in written spelling as previously shown for Case OE (Béland et al., 1994)—a case very similar to ML's. This result would seem to pose problems for our interpretation since under most current spelling models a deficit in the phonology to orthography conversion processes should have comparable effects in oral and written spelling. This lead Béland et al. (1994) to propose that either (a) there are two conversion systems or (b) voicing errors are due to an unspecified downstream component specific to written spelling. Closer inspection of the data suggests that the fact that while ML produces many more voicing errors in written than in oral spelling, this does not necessarily require a modification of the architecture of current spelling models. Rather, one possible interpretation of this asymmetry is that, when ML spells orally, she resorts to a strategy of comparing the sound of the phonemes to be spelled with the sounds of the letter names themselves. In many cases, this would be a very successful strategy. For example, in trying to spell the word ''bat'' the patient could use the knowledge that the phonology of the name for the letter B (/be/ in French) overlaps with the phonology of the word's first phoneme whereas the phonology of P (/pe/) does not. Such a strategy would fail when the phonology of the letter name does not overlap with the phoneme to be spelled, as is the case of the letter C (/se/) that is often used to transcribe the sound /k/. Table 3 shows that errors on this latter type of letter names are just as frequent in oral and in written naming. In such cases, ML either produces a voicing error like in written spelling or else she sounds out the letter instead of naming it (i.e., instead of saying C–A–T for cat she may say ‘‘the keuh’’–A–T). In conclusion, if one removes the cases in which ML could make use of an overlap between the phonology of the word to be spelled and the letter name, performance in oral and written spelling are closely parallel.

Conclusion. To the extent that the most likely source of MC’s phonologically based spelling errors lies in an impairment to sublexical conversion processes, the nature of the errors produced can be used to constrain claims about the organization of these processes. Consistent with Béland et al. (1994), our proposal is that these conversion processes encode correspondences between phonological features or sets of features and graphemes rather than between phonemes and graphemes as is more commonly assumed. ML’s performance can thus be interpreted as resulting from a loss of the associations between specific features (notably voicing) and graphemes leaving her with information which is compatible with more than one grapheme.

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W-16. Orthography/Phonology Relations and Hemispheric Functioning

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A lateralized CVC identification paradigm was run on English and Hebrew speakers in their respective native language, using vertical and horizontal presentations. The task yields quantitative asymmetries reflecting hemispheric specialization and qualitative asymmetries reflecting hemispheric strategies. The quantitative patterns were identical across conditions, reflecting left hemisphere dominance for the task. The qualitative patterns in English and Hebrew using vertical presentation were opposing, while the patterns in the horizontal conditions were not. This is interpreted as reflecting the differing task demands of nonword naming in English and Hebrew based on the different orthography/phonology relations in the two languages.

Introduction

Cross-language studies have reported that hemispheric functioning in language tasks is similar across all orthographies studies, such that subjects

A

Horizontal Condition

	LVF	RVF		BVF		
POG	X	X	POG	POG	X	POG

Vertical Condition

	LVF	RVF		BVF		
P			P	P		P
O	X	X	O	O	X	O
G			G	G		G

B

First Errors (FE): First letter is reported incorrectly and last letter is correct, irrespective of the correctness of the middle letter.

FE= X * * , or X X *

Last Errors (LE): First letter is reported correctly and last letter is incorrect, irrespective of the correctness of the middle letter.

LE= * * X, or * X X

Other Errors (OE): all other errors.

OE = * X *, or X * X, or X X X.

FIG. 5. A. Presentation conditions of English stimuli (Hebrew stimuli were presented in the same format). B. Qualitative error definitions. (These are computed separately in each VF and normalized by dividing them by the total errors in that VF; X = incorrect report; * = correct report).

reveal a left hemisphere (LH) advantage. Specific effects of orthography/phonology/semantic relations seem to affect the order and strategic deployment of processing mechanisms (Frost & Bentin, 1992; Ben-Dror, Frost, & Bentin, 1995). The research reported here presents evidence that the characteristics of Hebrew orthography may result in hemispheric strategies that are different than those used for English orthography by skilled readers of the languages.

Method

Design. The task was the CVC identification paradigm developed by Levy, Banich, Heller, & Burton (1983) and used extensively by Hellige and his colleagues (e.g., Eng & Hellige, 1994). Letter trigrams are presented either vertically or horizontally in the three visual field (VF) conditions as shown in Figure 5.

Subjects. Forty native English speakers performed the task in English, 20 in the vertical and 20 in the horizontal format. Forty-three native Hebrew speakers performed the task in Hebrew, 21 in the vertical and 22 in the horizontal format. All were right handed.

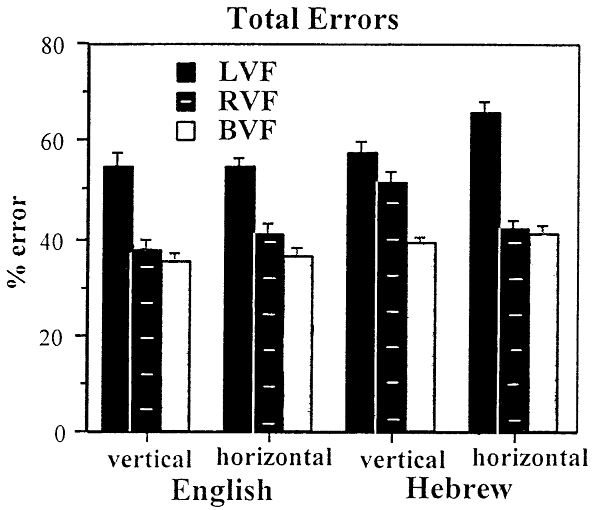

FIGURE 6

Materials. 111 English and 111 Hebrew CVC nonsense trigrams were created. The vowel in English was always "A," "O," or "E"; the middle letter in Hebrew was always "vav," "yod," or "aleph," which double as vowels in this consonantal orthography. The stimuli were presented vertically or horizontally with the middle letter 2° of visual angle from fixation. The letters subtended .5 × .5° of visual angle each. The trials were equally distributed between the three visual presentation conditions. These were in pseudorandom order to ensure that each condition preceded the others an equal number of times. The stimuli were presented in 3 blocks of 37 trials with the first trial in each block not scored. A 36 trial practice set preceded the experimental trials. Initial exposure duration was 200 msec. If the response contained no error, exposure duration was titrated down by 15 msec. Maximum exposure duration was 215 msec. The experimental trials began with appropriate exposure duration resulting from the last trial of the practice set. The stimuli were presented on a Silicone Graphics work station model Personal Iris 4D30, which also collected the responses.

Results

Figure 6 presents the quantitative error patterns showing that all conditions resulted in a right visual field advantage, suggesting LH specialization for the task in both orientations and languages. Figure 7 shows the qualitative error patterns in the three VF conditions, revealing that in the vertical condition the qualitative pattern in the two unilateral visual fields (UVFs) is exactly opposed in English and Hebrew, (interaction of language X UVF X

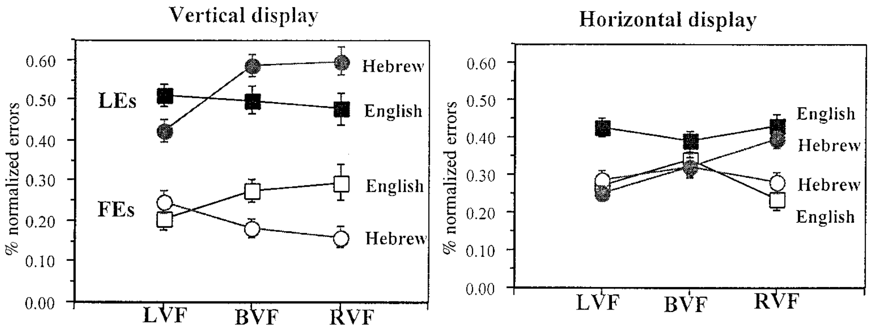

FIGURE 7

error type: $F(1, 80) = 19.44$, $p < .001$). The horizontal condition does not show this interaction ($p < .26$).

Discussion

The quantitative patterns and the qualitative pattern in the English vertical condition conform to those reported by Hellige and his colleagues. Previous studies with English versions of the task have reported a qualitative LH advantage and the qualitative hemispheric pattern shown here, where the RH makes relatively more errors on the last letter than on the first, while the relative difference in error types is smaller in the RVF/LH. Eng and Hellige (1994) have proposed two sources for this finding: that the RH uses a sequential strategy to identify the letters while the LH uses a more parallel, phonological strategy, and that the LH is better able to process the local elements in a multipart visual array. The results of the Hebrew vertical condition clearly contradict the generality of these interpretations. Here the relative difference between first and last errors is smaller in the LVF/RH than in the RVF/LH.

I believe that this difference occurs as a result of different task demands for nonword naming in the two languages. Unvoweled Hebrew orthography is ‘‘deep’’ in sense that the orthograph string does not uniquely specify a phonological form, such that the phonological representation of words is assessed postlexically. This does not allow subjects to use the grapheme–phoneme conversion route to name nonwords. These are named via a neighborhood route—they are compared to real words which they resemble, and the phonological form of the words is used to create the nonword form. Koriat and Norman (1984) have shown that vertically presented Hebrew words are mentally rotated to the canonical horizontal position before lexical access. They suggest that transgraphemic information is needed to access the lexicon, and that this information is extracted from the horizontal form. If this is the case, the vertical nonsense CVCs in Hebrew were rotated in a clockwise direction, in order to be able to read them from right-to-left, as

Hebrew is read. Burton et al. (1992) have shown that there are hemispheric differences in rotation direction, such that the RH is better at clockwise, and the LH is better at counterclockwise rotation. Thus, the LH in the Hebrew condition was rotating the letters in the nonpreferred direction, and the last letter, that had to be mentally moved the largest distance, was lost more often than in the LVF/RH condition. This hypothesis is supported by the results of the horizontal conditions, where no rotation was necessary. Here the interaction of error types, VF, and language was not significant.

It is probably the case that this difference in rotation direction is not the full explanation of the language differences (e.g., there are significantly less LEs in Hebrew than in English in the LVF of the vertical condition as well). More detailed analyses of errors, which look at the accuracy of the middle letter as well, do reveal differences between the languages in the horizontal condition. Further research using voweled CVCs, which do fully specify the phonological form is also needed. The analyses and experiments are in the process of being carried out.

These results support the hypothesis that cognitive habits can affect hemispheric functioning, together with a dissociation between quanitative hemispheric specialization (the RVFA across all conditions) and qualitative measures of hemispheric strategies, which are affected by the characteristics of orthography/phonology relations specific to a language.

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W-17. Effects of Vowel Pitch and Task Demands on Latency and Amplitude of the Auditory Evoked M100

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A recent MEG-based observation suggests that, in addition to spatial tonotopy, stimulus frequency is encoded in the latency of the auditory evoked M100: low and high frequencies generate longer latencies than midrange (1–2 kHz) frequencies. This study extends that finding to speech by demonstrating that vowel pitch correlates with latency changes. The results reveal a dissociation: vowel pitch is associated with latency shifts but not amplitude changes, task execution (categorization) is associated with amplitude increases but not latency shifts. The tone and pitch results combined suggest that there may be a further frequency coding mechanism, relying on temporal response properties of neuronal populations.

Introduction. The development of the functional imaging methods (PET, fMRI, MEG) has made it possible to study the neural basis of speech perception *in vivo.* Although these methods all provide important physiological data, magnetoencephalography (MEG) is particularly suited to study auditory processing. MEG has the appropriate (msec) temporal resolving power and is especially sensitive to neuronal activity in areas such as the supratemporal plane. Magnetic source imaging (MSI) is the coregistration of MEG data with high-resolution magnetic resonance images to determine the location of auditory-evoked electromagnetic activity.

The dominant auditory evoked neuromagnetic field is a large-amplitude response occurring at a latency of approximately 100 msec poststimulus (M100). It has been observed that the tone-elicited M100 evoked field localizes to supratemporal auditory cortex (Hari, Aittoniemi, Jarvinen, et al., 1980). Source analyses of the M100 have been used in modeling spatial tonotopy of the human auditory cortex (Romani, Williamson, Kaufman, et al., 1982; Pantev, Hoke, Lehnertz, et al., 1988).

Tone and as well as synthesized speech stimuli were used and the auditory evoked neuromagnetic responses were recorded over the temporal lobe using a large-array biomagnetometer. In particular, the study investigated using speech stimuli a phenomenon previously seen using pure tones: MEG recordings show that there is a systematic relation between tone frequency and the latency of the M100 (Roberts & Poeppel, submitted). That is, the characteristic evoked field of the recruited neuronal population reaches a peak at a latency that depends on the frequency of the stimulus. The latency varies parabolically with frequency, with low (100–500 Hz) and high (3–5 kHz) frequencies yielding longer latencies.

This study investigated whether the M100 latency also varies systematically with differences in the pitch of speech stimuli. Also, the experiment tested the observation that the execution of simple categorization tasks affects latency or amplitude properties of the M100 (Poeppel, Yelli, Phillips, et al., submitted).

Methods. Four 400ms duration synthesized vowels (/a/ and /i/, with a male [100 Hz] and a female [200 Hz] fundamenal frequency F0) were presented in the three experimental conditions: passive listening, phonetic categorization (male and female /a/ versus male and female /i/), and pitch categorization (male /a/ and /i/ versus female /a/ and /i/). The three conditions allow for a comparison of fundamental frequency effects and task effects on M100 properties.

Neuromagnetic fields were recorded bilaterally from the temporal lobes using two 37-channel biomagnetometers (Magnes II, Biomagnetic Technologies, Inc., San Diego, CA). Stimuli were presented 100 times each pseudorandomly to the right ear, and 600 msec epochs were recorded. The M100 latency peaks and amplitudes (r.m.s.) were determined subsequent to averaging and band-pass filtering (1–20 Hz).

Results. Volunteers made very few errors in the two categorization conditions, indicating that the task was easily executed. All stimuli elicited the characteristic auditory evoked M100, the sources of which localized to auditory cortex. For all stimuli, the M100 peak latency was significantly shorter in the contralateral than the ipsilateral hemisphere, as has been previously observed. (Pantev, Lutkenhoner, Hoke, et al., 1986; Makela, 1988).

The peak M100 latency revealed no differences among the three experimental conditions, suggesting that the presence of task demands is not associated with M100 latency shifts. Compared to the passive listening condition, the two task-driven conditions yielded significantly larger M100 amplitudes in both hemispheres. The higher-pitched vowels ($F0 = 200$ Hz) were associated with M100 latency shifts of up to 12 msec in both hemispheres, independent of task demands.

Conclusion. The results confirm the previously observed M100 latency asymmetry that arises from monotic presentation: contralaterally recorded M100 fields are associated with significantly shorter peak latencies (Pantev et al., 1986; Makela, 1988).

The absence of M100 amplitude changes between vowels of different pitch indicates that pitch is associated with latency shifts but not amplitude changes. The absence of M100 latency shifts among the three experimental conditions indicates that task demands are associated with amplitude increases but not latency shifts. The amplitude increases observed in the task-guided conditions are consistent with previous observations of this effect (Poeppel et al., submitted), in which contralateral presentation of speech stimuli generated larger responses when a simple categorization task was executed.

The main effect of pitch—lower frequency vowels yielded longer-latency M100 peaks—extends observations previously made using pure tones (Roberts & Poeppel, submitted) to speech stimuli. The fact that the pitch-dependent latency shift is observed in both hemispheres with speech stimuli as well as with pure tones suggests the existence of an early neuronal encoding mechanism that is independent of processing the stimulus as a phoneme. This hypothesized mechanism can use the temporal characteristics of the M100 to help encode the pitch of auditory stimuli, including speech. Because the pitch-dependent latency shift was observed in both hemispheres (ipsilateral and contralateral records) and independenty of the execution of experimental task demands, we speculate that the neuronal mechanism acts independently of or prior to any phonetic analysis mechanism.

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W-18. A Growth Curve Representation as an Alternative to Logan's "Race Model of Automaticity"

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This study evaluates the predictions made by Logan's ''race model of automaticity'' through computer simulation. Logan's use of extreme value theory assumes that each memory trace that enters the race must be sampled from the same Weibull distribution. Since Logan tests his theory empirically between individuals, this implies a fixed effect assumption for the Weibull distribution that produces each individuals reaction time. Logan's model predicts that the inverse of the Weibull shape parameter for reaction times equals the learning function exponent for the reaction times. This implies that all individual's learning exponents are equal. We demonstrate through stimulation that the failures in Logan's model can be predicted by assuming heterogeneity of learning exponents across individuals.

Goldberg and Costa (1981) have provided a theoretical account of lateralization that places an emphasis on the relative differences that the left and right hemisphere have in terms of the encoding and acquisition characteristics of long term and working memory. Kennelly et al. (1996) have confirmed that visual field shifts in performance to occur utilizing both between subjects and within subjects data analysis. The similarities of Goldberg and Costa's theoretical position to that of Logan's race model and instance theory (Logan, 1992), prompted us to initially use Logan's general approach as a quantitative model to formally test Goldberg and Costa's theory. Logan attempts to account for several phenomenon in the skill acquisition literature, one of which is the ''power law'' of learning. Our own data supports the view that in a consistent mapping environment (where ceiling and floor effects are absent; and where there is substantial learning), the power function is a good description of the time course of both response latency and accuracy in lateralization paradigms (Kennelly, 1995).

Logan's ''race model of automatization'' (Logan, 1992), attempts to derive the parameters of the learning curve (power function) from the parameters of the reaction time distribution of the learning curve. His theory assumes that novices begin with a general algorithm that is sufficient to perform the task. As experience is gained, solutions are encoded that can be retrieved when the same problem is encountered again. At any point, responses can be made with the solution retrieved from memory or the solution as computed by the algorithm. Once the algorithm is abandoned and an initial memory trace is retrieved, a ''race'' occurs between the first trace and each subseqent trace which can described by the statistics of extreme value theory. Automaticity has been achieved whenever performance is based on direct-access of past solutions from memory. As a statistical consequence of the race, several predictions can be made about the performance data, two of which are: (1) a power function speed up in the means and standard deviations (with equal exponents) and (2) a power function speed up in the quantiles of the reaction time distribution (with equal exponents).

Initially, Logan claimed these results were a consequence of his assumptions, but this position has since been modified in that the power function speedup now becomes a crucial assumption of the theory (Logan, 1995). Colonius (1995) demonstrates that under the race assumption, the equivalent power function speedup in means and standard deviations is both necessary and sufficient for the Weibull shape to show up, and if there is empirical evidence against the Weibull shape of the response time distribution, the race assumption of the instance theory would have to be dropped because it would not be consistent with the power law. Our own research indicates that the lognormal distribution is a much better description of response latencies than the Weibull distribution (Herrington, et al., 1995).

We appreciate Logan's theory for two reasons: (1) it seems to be a consistent theory which embodies major aspects of Goldberg and Costa's theoretical position, and (2) it is a highly testable model whose predictions precede naturally from the assumptions of the model. Logan's theory of memory and automaticity, while it is a within-individual theory, has in large part been tested at the between individual level. That is, the particular aggregation method that he uses to obtain parameter estimates of the group Weibull distribution averages across subject's estimated quantiles. In this way, average distributions are created for each experimental cell at each level of practice as well as a group learning curve across blocks (Logan, 1992). An assumption of Logan's model is the memory traces are all sampled from the same Weibull distribution. In terms of the experimental design, this is a fixed effects assumption with regard to the probability distribution that produces the reaction times for each subject. That is, each subject's true score estimate of the Weibull distribution shape parameter for a particular experimental cell is assumed to be the same across subjects. According to Logan's theory, the group power function exponent estimate is the inverse of the shape parameter estimate for the group Weibull distribution. Consequently, the common Weibull distribution assumption for memory traces implies that each subject's own learning curve exponent is identical to every other subject's exponent. Logan's theoretical development cannot accommodate Weibull shape parameters or learning curve exponents that vary randomly across subjects (Logan, 1992).

The usual assumption in a randomized blocks design or a repeated measures design is that the subject by treatment interaction is null. As pointed out by Raudenbush (Raudenbush, 1993), this assumption is probably the most tenuous of assumptions. If a block by treatment interaction is large and falsely assumed zero, the treatment effect is less general than if the effect is invariant across subjects. Additionally, the estimate of the variance of the subject effects and the associated test could be wrong, possibly misleading researchers into believing that the basis upon which the subjects were selected is irrelevant to the outcome. Bryk and Raudenbush (1988) argue that the presence of heterogeneity of variance across treatments indicates that the standard statistical model for fixed treatment effects no longer applies and that treatments have differential effects on individuals. There are a class of statistical techniques which allow one to more flexibly model subject by treatment interactions—''hierarchical linear models'' (Bryk & Raudenbush, 1987). Growth curve modeling as outlined by Willet (1988) is formally related to hierarchical linear models and provides the exploratory and analytical tools necessary to simply and effectively model heterogeneous change that exists across individuals. We assert that the patterns of failure in Logan's predictions are a result of the heterogeneity of learning exponents across subjects and can be accounted for from a growth curve modeling perspective. Specifically, it is argued that if one assumes a growth curve representation of change within an individual, and one assumes that there is significant variance in the learning exponents across individuals, then the predictions that Logan makes will fail in systematic ways. We provide evidence that the pattern of simulation results match the pattern of failures in Logan's predictions (e.g., see Logan, 1992, p. 897). These results demonstrate four outcomes that are not predicted by Logan: (1) the variance will decrease then increase over time, (2) the quantiles of the reaction time distribution change at different rates depending on when the collection of learning functions intersect, (3) a reversal in the decile ranking of the learning functions occurs at the intersection point, and (4) the means and standard deviations do not have equal power function exponents. Our results also indicate that the variance of the exponents is the most important factor in influencing the pattern of results. As the variance of the exponents decreases to zero, the simulation results agree with the predictions as suggested by Logan.

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W-19. Reading Habits Affect Asymmetries in Facial Affect Judgments: A Replication

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Right- and left-handed native readers of scripts with opposing directionality were tested on a facial affect judgment task in free vision. Faces with smiles in viewers' left visual field were judged happier predominantly by (right-handed) readers of the left-to-right script (Hindi) whereas a right field preference was observed among the right-to-left readers (Urdu) and among the left-handers; no preference characterized illiterate controls. These findings replicate Vaid and Singh (1989) and indicate that reading habits may influence performance even on ostensibly nonlinguistic tasks thought to measure right hemispheric functioning.

In a widely used measure of facial affect perception (e.g., Heller & Levy, 1981), subjects are shown photographs of pairs of faces with asymmetric smiles and are asked to judge which face looks happier. The typical finding from this task is a strong preference for the face with the left-sided smile (from the viewer's perspective). This effect has been reported in countless replications by Levy and her colleagues, as well as by others (e.g., Carlson & Harris, 1985; Levy, Heller, Banich, & Burton, 1983; Levine & Levy, 1986). The feasibility of this paradigm, together with its ''avoid(ance) of verbal processing demands'' (Hellige, Bloch & Taylor, 1988, p. 179) have rendered it a particularly promising experimental tool for assessing right hemisphere involvement in facial affect judgment.

However, a recent study using this paradigm (Vaid & Singh, 1989; Vaid, 1995) drew attention to a possible confound in previous studies: subjects in all these studies were native readers of left-to-right scripts (typically, English). In their own study, Vaid and Singh (1989) found different patterns of preference depending on reading direction, with a right-sided preference among two groups of right-to-left readers (Arabic and Urdu). If this task is primarily a reflection of hemispheric specialization for affect, one would not have expected to find differences related to reading habits. Interestingly, the only other group in the literature who did not show a left field (or any) preference on this task were preliterate 5 year olds (reported in Levine and Levy, 1986).

In view of the persistence of the hemispheric-based interpretation given to the chimeric faces task and its continued use as a ''pure'' nonlinguistic task, it was felt that a replication of Vaid and Singh (1989) was warranted. To this end, the present study was conducted using an extended sample of left-to-right (Hindi) and right-to-left (Urdu) readers, and illiterate controls. Inasmuch as Hindi and Urdu are practically identical languages on the spoken level, differing primarily in script type and directionality, they provide a clearer test of the reading scan hypothesis than might other languages (e.g., Arabic vs. English) which differ in several respects besides script direction. Both right- and left-handed subjects per group were tested.

Method. The sample consisted of 120 brain-intact subjects between 15–20 years of age drawn from New Delhi. Forty subjects were native Hindi readers, 40 were native Urdu readers, and 40 were illiterate age-matched controls. The groups contained equal numbers of men and women and right- and left-handers.

Stimuli. The stimulus set of 36 pairs of photographs of chimeric faces on 9 male posers was exactly the same as that used by Levy et al. (1983). The two chimeric faces of each stimulus pair were vertically arranged one above the other with each stimulus pair presented twice to counterbalance the location of the smile—left and right—and the picture position—top or bottom.

Procedure. Subjects were tested individually at Delhi University. All 36 stimulus pairs were presented in booklet form; the booklet was placed on a table in front of Ss. For each pair, subjects were to decide which face (the one at the top or the bottom one) looked happier to them, and to circle a ''T'' or a ''B'' on a response sheet. They were allowed as much time as they needed to respond. Subjects also participated in a series of other perceptual tasks reported in detail elsewhere (Sakhuja, 1990).

Results. Responses were coded in terms of whether the smile in the face perceived as happier was to the viewer's right or left visual field.

Following Levy et al. (1983), a laterality measure was computed per subject from the total number of pairs in which a rightward response was chosen minus the number of pairs in which a leftward response was chosen, divided by the total number of pairs ($N = 36$). Thus, a positive score would signal a rightward preference while a negative score would signal a leftward preference. An analysis of variance was performed on the asymmetry scores as a function of Handedness, Script group (Hindi, Urdu or illiterate) and Gender. See Table 4 for the anova output. There was a significant effect of Script, of Handedness and of Script by Handedness, all at the $p < .01$ level.

Analysis of the means per Script group indicated that Hindi readers showed a significant leftward bias (the mean score was -0.14) whereas Urdu

TABLE 4
Summary of ANOVA Outcomes for Chimeric Faces Test

Source of variation	Mean square	d.f.	F
Script	0.867	2	12.16*
Handedness	0.683	1	9.57*
Sex	0.034	1	0.48
Script × handedness	0.626	2	8.78*
Script × sex	0.202	2	2.33
Handedness × sex	0.053	1	0.73
Script × handedness × sex	0.066	2	0.92
Residual	0.071	108	
Total	0.101	119	

* Significant at .01 level.

readers showed a clear rightward bias (the mean score was +0.15). Illiterate subjects showed no consistent bias in either direction (mean score was 0.02).

The Handedness effect indicated a rightward bias among left-handers (+0.07) and a left-ward bias among right handers (−0.08). The interaction of Script by Handedness showed that a leftward preference characterized right handed readers of Hindi and of Urdu; however, Hindi right handers were significantly more leftward oriented in their preference than were Urdu right handers. Urdu left-handers showed a rightward preference, while illiterates (whether right or left handed) showed no consistent preference.

Discussion. These results corroborate previous findings by Vaid and Singh (1989) and indicate that reading habits clearly affect performance on even an apparently nonverbal, visual task designed to measure hemispheric specialization. Future work in this field should seek to ensure that this variable is controlled or else demonstrate its influence on other ostensibly nonverbal tasks.

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W-20. Sentence Reading: An fMRI Study at 4T

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In this study blood flow was monitored while monolingual right handed subjects read English sentences. Our results confirm the role of the left perisylvian cortex in language processing. However, individual subject analyses reveal a pattern of activation characterized by several, small, limited patches rather than a few large anatomically well-circumscribed centers. Between-subject analyses confirm a lateralized pattern of activation, indicate as active classical language areas such as Broca's, Wernicke's and the angular gyrus, and also point to areas only more recently considered as language-relevant including the anterior portion of the superior temporal lobe and the dorsolateral prefrontal cortex.

Introduction

The field of the neurobiology of language has been dominated for over a century by a proposal put forward by Broca and his followers of a cortical organization for language in a few, well-circumscribed language centers. For the last thirty years, however, a number of observations from lesions studies as well as from electrical stimulation and subdural electrophysiological recordings experiments directly question the notion of a few, well-delineated language centers. Indeed, these new findings suggest a cortical organization of language in small, nonadjacent, focal spots distributed throughout the left perisylvian cortex. Further clarification of the nature of cortical organization for language will not only impact our present interpretation of lesion studies and the conditions for recovery from damage, and they will also be a key step in our understanding of how high level complex cognitive capacities are implemented at the physical level. The goal of our study was to take advantage of the high spatial resolution of the fMRI technique to assess, at the level of individual subjects, the nature of the cortical organization for sentence processing in normal healthy subjects. Subjects were scanned while reading English sentences or viewing consonant strings. The comparison of these two conditions was hypothesized to reveal brain areas concerned with several subsystems related to language processing, including orthographic and phonological coding, syntactic and semantic processing and even verbal short-term memory.

Method

The right and left hemispheres of eight young, healthy, monolingual, right handed subjects were imaged in separate sessions. English sentences, presented one word at a time, alternated with nonsense strings of consonants for blocks of 32 sec. Subjects read the sentences and the nonwords carefully. At the end of each run, subjects were presented with sentences and nonwords and indicated whether or not they had seen those before. As a control, these subjects were also presented with similar stimuli in a language they were not familar with (American Sign Language). Eight contiguous 5 mm parasagittal slices (centered 20 mm from the lateral tip of either the right or left temporal lobe, voxels size was 2.5×2.55 mm) were acquired using echo planar imaging (gradient echo MBEST). At the beginning and end of each run, high resolution gradient-echo GRASS reference scans were obtained that permitted identification of activated areas in relation to sulcal anatomy. Data were analyzed by performing correlations, voxel by voxel, between the MR signal time series and a sine wave which modeled the alternations between sentences and nonwords/nonsigns. This correlation map was thresholded to retain only voxels whose activity over time correlated ($r \geqq 0.5$; $p = 3.1 \times 10^{-5}$) with the stimulus alternation. For each subject, anatomical regions were delineated according to sulcal anatomy (Rademacher et al., 1992); active voxels were classified according to these anatomical regions. Averages across subjects were performed for each of these anatomical regions.

Results and Discussion

For ASL stimuli, there were no difference in performance between sentences and nonsigns and analysis of the fMRI data revealed no activation. For Written English, however, performance was more accurate for sentences than nonwords; the fMRI data are presented below.

Individual data. Analysis of the individual data revealed a large variability in amount and exact location of the activation from one subject to the other. The pattern of activation in each subject was characterized by a number of scattered, small (e.g, 2–4 pixels) patches of activation. Typically, highly active voxels with very low activation values. Furthermore, for each subject, at most 10% of the voxels within an anatomical region were found to be active in a given run.

Hence, in this sentence reading experiment, the activation was rather focal and variable across subjects. It was distributed throughout the left perisylvian cortex and it was not restricted to classical language areas but extended into the left prefrontal structures and left temporal lobe. This pattern of findings supports the view of a cortical organization for language in a network of focal areas distributed throughout the left perisylvian cortex (Mesulam, 1990; Ojemann, 1991; Mazoyer, et al., 1993).

Between subjects data. Across subjects activation occurred largely in the perisylvian cortex of the left hemisphere. Active regions can be classified in three main categories. First regions that have been classically thought of as language centers, such as Broca's area (pars triangularis and opercularis; inferior precentral sulcus), Wernicke's area (posterior superior temporal sulcus and the supramarginal gyrus) and the angular gyrus (angular sulcus and anterior occipital sulcus) were found to be active. Such activation is consistent with the fact that the task involved syntactic processing/short-term memory, sentence comprehension/lexical retrieval, and written word processing respectively. Second, we observed activation within regions whose participation in the language system has only been recently hypothesized, including the whole extent of the superior temporal sulcus (Dronkers et al., 1994; Ojemann, 1991) as well as part of the prefrontal cortex (Mazoyer et al., 1993; Petersen et al., 1988). Third, the central sulcus, which has not been previously associated with language processing was active.

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W-21. Hemispheric Advantage for Point-Light McGurk Effects

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There is evidence for a LH advantage for speechreading moving faces (Smeele, in press) and a RH advantage for using visual speech to influence auditory speech (Baynes, Funnell, & Fowler, 1994; Deisch, 1995). Smeele (in press) explained her observed LH advantage based on its sensitivity to dynamic visual information. Deisch (1995) explained his observed RH advantage based on its ability to extract ambiguous visual information. To test these competing hypotheses, point-light visual speech stimuli were implemented which simultaneously isolated dynamic information and degrade the facial image. Results showed an enhanced LVF/RH visual influence for these stimuli supporting Deisch's hypothesis.

While there is a large literature on hemispheric specialization for auditory speech, there is relatively little research on hemispheric specialization for visual speech information. Campbell (1992) has found some evidence with normal subjects for a left visual field/right hemisphere (LVF/RH) advantage for recognizing visual speech syllables from static pictures of a speaker. However, Smeele (in press) has found a right visual field/left hemisphere (RVF/LH) advantage for recognizing visual speech from a moving face. Thus, it is possible the hemispheres are differentially involved in extracting dynamic and static visual speech information.

Two studies (Baynes, Fowler, & Funnel, 1994; Deisch, 1995) have examined hemispheric differences for dynamic visual speech information using the McGurk effect (McGurk & MacDonald, 1976). In the McGurk effect, mismatched auditory and visual speech syllables are dubbed, leading the listener to report ‘‘hearing’ a syllable that is influenced by the visual information. The McGurk effect is a useful tool for ensuring that visual speech information is being used in a perceptual, rather than post-perceptual, manner (Rosenblum & Saldaûa, in press). Baynes et al. (1994) and Deisch 1995) both showed a LVF/RH advantage for the McGurk effect (in some contexts), which is inconsistent with Smeele’s (in press) speechreading findings mentioned above. Deisch (1995) found that this LVF/RH advantage holds only for McGurk stimuli in which the visual information is ambiguous. He suggests that the RH’s superior ability to extract visual information accounts for its greater involvement.

Deisch’s (1995) explanation suggests that a degraded facial image should enhance the RH advantage in the McGurk effect. This can be tested using point-light stimuli. For point-light facial stimuli, glowing dots are applied to a speaker’s articulators and shown to participants such that only moving dots can be seen on a black background. The degraded stimuli retain the dynamic movement information of visual speech while excluding facial feature information (see Rosenblum & Saldaûa, in press, for a review). Based on Deisch’s (1995) degraded stimulus explanation, point-light stimuli should enhance the LVF/RH advantage for the McGurk effect. However, Smeele’s (in press) findings would suggest that the dynamically sensitive LH could show a larger relative increase in McGurk effects for the isolated dynamic information available in point-light stimuli.

The following experiment tests hemispheric differences for the McGurk effect using fully illuminated and point-light face stimuli. It is expected that fully illuminated stimuli will induce a greater overall McGurk effect than point-light stimuli (Rosenblum & Saldaûa, in press). However, there are two ways in which the effect with point-light stimuli can decrease across the hemispheres. Based on the explanation of Deisch, the greater involvement of the RH with degraded visual stimuli should induce less of decrease in the effect with LVF/RH presentations. Conversely, based on Smeele’s hypothesis that the LH is more sensitive to dynamic visual speech information, the

LH should have greater involvement with point-light stimuli and induce less of an effect decrease with RVF/LH presentations.

Method

Participants. Forty students at the University of California, Riverside participated in the experiment. Participants were right-handed native English speakers with normal hearing and normal or corrected vision.

Stimuli. The experimental stimuli and procedure were based on those used by Baynes, et al. (1994). A male speaker was videotaped producing speech syllables under both fully illuminated and point-light face conditions. For the point-light face, the speaker was recorded in a fluorescent black-light environment with 32 fluorescent-sensitive dots attached to various locations on the face and articulators. Video syllables were dubbed with auditory syllables to produce the following stimuli for each type of visual stimuli: audio /ba/-/video /ba/, audio /va/-video/va, audio /ba/-video /va/, audio /ma/-video /ma/, audio /ga/-video /ga/, an audio /ba/-video /ga/.

Six presentations of each trial type were randomized over a total of 288 presentations. Before each trial, an arrow pointed to an orange LED centered on either the left (6 trials) or the right (6 trials) side of the monitor. The participants were positioned in a chin rest at a distance of 45 inches from the monitor, allowing the facial image to subtend a 5.5° horizontal visual angle.

Procedure. Each participant was instructed to fixate and maintain his eyes on the indicated LED for the entire duration of the speech syllable. Eye movements were monitored by the experimenter. The subjects were instructed to repeat the syllable they heard and responses were logged by the experimenter.

Results

The overall visual influence was stronger for fully illuminated stimuli than for point-light stimuli. Fully illuminated stimuli showed a greater LVF/RH than RVF/LH visual influence. Point-light stimuli also showed a greater LVF/RH visual influence. Examining performance between fully illuminated and point-light stimuli, it was found that the relative drop in visual influence was less for the LVF/RH than the RVF/LH.

Discussion

The results with fully illuminated stimuli replicate both Deisch's (1995) and Baynes et al's (1994) findings of a LVF/RH advantage for McGurk stimuli (in some contexts). Also, the point-light stimuli findings of a greater relative decrease in visual influence for the RVF/LH are consistent with Deisch's suggestion that the RH has an increased role in when the visual stimulus extraction is difficult. These results are not consistent with Smeele's (in press) findings of a RVF/LH advantage for moving visual speech stimuli. These results suggest that the RH plays an important role in extracting ambiguous visual speech information and/or in integrating audiovisual speech.

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W-22. Task Demands in Reaching and the Magnitude of Manual Assymetries in Performance

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The influence of task demands on manual asymmetries was examined in a reach and place task involving three conditions which increased in precision demands. Movements were recorded using an optoelectric analysis system. The effect of precision demands was most clearly seen in the second phase of the task (move and place the object) as opposed to the first phase (reach and pick up the object). The movements in the second phase, then, required more skill and it was in this phase only where manual asymmetries were observed. The implications of this findings for a skill interpretation of handedness are discussed.

Manual asymmetries in performance have been found to vary depending on task demands such as movement time (e.g., Roy & Elliott, 1986). This study was designed to examine the influence of the movement goal in a reach and place task. Movement goal was defined in two ways: (1) the phases in the task, the reach phase (i.e., reach and pick up the object) and the move phase (i.e., move and place the object) and (2) the precision requirements of the second or move phase, that is, placing or tossing the object. Research has revealed that the movement time in the reach phase is longer if the object must be placed (e.g., Marteniuk, MacKenzie, Jeannerod, Athenes, & Dugas, 1987). These more precise placing movements were also characterized by lower peak veloci ties and more time in deceleration. The question of interest in this study was whether these task demands affect the magnitude of manual asymmetries.

Method

Subjects. Ten right-handed male undergraduate students participated in this study.

Movement task and procedures. Three movement conditions were involved. Two required placement of the dowel, one in a receptacle about the same size as the dowel (small-place, SP) and the other in a large receptacle (large-place, LP). The third (toss, T) involved tossing the dowel into the large receptacle. Reaching movements were made with each hand, with half the subjects beginning with their right hand. The order of conditions were randomized independently for each subject. Movements were recorded using optoelectric system with infrared markers placed on the wrist (reflecting the transport component, i.e., movement of the arm) and on the thumb and index finger (reflecting the grasp component, movement of the thumb and index finger).

Data analysis. The transport component of reaching was examined in both phases for movement time, peak velocity and time to and after peak velocity. The grasp component was examined in the reach phase for peak aperture and time to and after peak aperture.

Results

Reach phase. The effect of task demands on the transport component were observed where movement time to grasp the dowel was longer (SP = 534 msec; LP = 531 msec; T = 491 msec) and peak aperture was larger (SP = 81 mm; LP = 85 mm; T = 88 min) in the place conditions.

The precision demands of the ensuing movement task, then, did affect how subjects picked up the dowel. There were, however, no performance differences between the hands in this phase of the reaching movement.

Move phase. Task demands also affected the transport component in the move phase, but to a somewhat greater extent than in the reach phase. Movement time (SP = 751 msec; LP = 479 msec) amd time after peak velocity (SP = 590 msec; LP = 360 msec) were longer and peak velocity (SP = 635 mm/sec; LP = 664 mm/sec) was smaller in the small than the large place condition. The more precise small placing task, then, took a longer time to complete since subjects moved more slowly and spent a longer time in deceleration as they placed the dowel in the smaller receptacle. In contrast to the reach phase a hand effect was observed. The right hand exhibited a shorter movement time (LH = 634 msec; RH = 596 msec) and a greater peak velocity (LH = 615 mm/sec; RH = 615 mm/sec), although this right hand advantage did not change with the place condition, that is, with increased spatial precision.

Discussion

These observations support other work (e.g., Marteniuk et al., 1987) showing that precision demands affect the reaching movement to pick up an object. These early effects of precision demands in the reach phase reflect the planning of the ensuing object-placing movements. The execution of the placing movements during the move phase were also clearly affected by the spatial precision demands of the task. The fact that the precision effect was greater in the move phase indicates that this dimension of spatial precision, the size of the target receptacle, impacts most clearly on movement execution.

Task demands affect the presence but not the magnitude of performance differences. A right hand advantage was present only in the move phase, but this advantage was not affected by the precision demands of the task. The fact the precision effect was much greater in this move phase suggests that these placing movements require more skill than the preceding reaching movements. The presence of the right hand advantage only in this move phase, then, may relate to these differences in skill demanded, with this advantage appearing in the more skillful move phase. Steenhuis and Bryden (1989) have shown that skill is a factor in hand preference in that both self-professed and performance-based measures of hand preference were stronger for skilled than unskilled activities.

If skill is a factor in manual asymmetries, why would the magnitude of the right hand advantage not increase with the spatial precision demands of the place movement. Possibly the precision effect (the range in size of the target receptacles) was not sufficiently large. Alternately, some task demands such as this precision effect may serve to elicit performance asymmetries, while other more process-oriented demands such as the time to process feedback information may be more important determinants of the magnitude of these asymmetries. Roy and Elliott (1986), for example, found that the right hand advantage in an aiming movement increased as movement time decreased. Our future work will examine these various dimensions of task demands as they affect the presence and magnitude of manual asymmetries.

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W-23. Opposed Left and Right Neocortical Involvement in the Immune Response Indexed by Cerebrovascular Accidents in Humans: Preliminary Results[3]

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This is the first human neocortical study revealing left and right hemispheric influence on hematological and immunological parameters. Cerebrovascular accident (CVA) male patients were selected with doppler ultrasound and tomodensitometry without infusion. Left stroke caused a disturbance of the ratios of lymphocytes, monocytes and granulocytes to whole blood leukocytes. Moreover, a crossed double dissociation occurred between left and right CVA groups at the level of the percentage of T and B lymphocytes. Finally, left stroke significantly reduced the proliferation of T lymphocytes stimulated with the mitogen phytohemagglutinin, but right stroke patients were not affected.

Introduction. Many studies have shown the importance of the control that the brain exerts on the immune system. Animal studies have revealed that large neocortical lesions of the dorsolateral portion of the frontal, parietal and occipital lobes significantly reduce proliferation of the T cell population (Renoux & Bizière, 1991). The same lesion practiced on the right hemisphere produced opposite effects. Proliferation was so important that the thymus and the spleen were hyperthrophied. The effect of a similar lesion of both hemispheres was the same as those of the left hemispheric lesion but more pronounced. There was no disturbance of humoral immunity supported by B cells. We investigated the impact of neocortical blood supply deprivation in left and right CVA patients on the count of peripheral blood cells and the proliferation of mitogen-stimulated T lymphoctyes.

Subjects. We selected five right hemisphere, five left hemisphere CVA male patients, and five age and sex-matched normal controls (57–82 years) excluding subcortical and bilateral damage. The patients were selected on the basis of thrombotic CVA, excluding embolus and hemorrhage. Left and right internal carotid arteriopathology and brain damage were determined by doppler ultrasonographic and tomodensitometric analysis, respectively.

[3] This research was supported by the Fonds de Recherche en Santé du Québec, the Conseil National de Recherche en Sciences Naturelles et Génie, and from the ENIM Corporation Ltd.

Hematological, phenotypical and immunological tests were performed on blood samples drawn once a week for three consecutive weeks beginning at least 15 days post-CVA.

Method. The total and differential count of blood leukocytes was obtained by a standard coulter analysis. The percentage of T and B lymphocytes was measured by two-color immunofluorescence with fluorescein-conjugated anti-CD3 (pan T lymphocytes) and phycoerythrin-conjugated anti-CD19 (pan B lymphocytes) monoclonal antibodies, and analyzed by flow cytometry with a FACScan flow cytometer (Becton Dickinson). Proliferation of T lymphocytes stimulated in vitro for 48 hr with the mitogen PHA (5 μg/ml) was measured by thymidine incorporation.

Results. ANOVA was performed to isolate significant dependent variables, and Tuckey HSD was used as the post-hoc procedure. Absence of a re-test effect justified pooling of re-tests. The absolute count of whole blood leukocytes (10^9/liter) was not significantly different between our groups (left (L): mean (M) = 6.86, SD = 1.27; right (R): M = 7.39, SD = 3.34; normal (N): M = 4.94, SD = 1.37). Furthermore, the absolute count of lymphocytes (10^9/liter) (L: M = 1.425, SD = .22; R: M = 1.723, SD = .59; N: M = 1.480, SD = .45) monocytes (10°/liter) (L: M = .70, SD = .22; R: M = .61, SD = .16; N: M = .48, SD = .17) and granulocytes (10^9/liter) (L: M = 4.72, SD = .95; R: M = 5, SD = 3.17; N: M = 2.76, SD = .76), were not significantly different between groups. However, the lymphocyte/leucocyte ratio of the left CVA group was significantly lower than that of the normal group (L: M = .211, SD = .013; R: M = .259, SD = .082: N: M = .300, SD = .027, df(2, 12), F = 3.91, p = .049). No statistical difference was found for monocyte/leukocyte ratio (L: M = .102, SD = .03; R: M = .089, SD = .02; N: M = .095, SD = .008), or for granulocyte/leukocyte ratio (L: M = .69, SD = .02; R: M = .64, SD = .11; N: M = .61, SD = .03) although the values were higher in the left CVA patients. The right CVA patients were not different from the normals or the left lesioned patients.

Phenotypical analysis was performed on T and B lymphocytes. We noted a crossed double dissociation between the two CVA groups (Pillai's multivariate test for CD3 and CD19, p = .05). The percentage of T lymphocytes measured with anti-CD3 antibody was significantly increased in the left CVA compared to the right CVA patients (L: M = 74.2; SD = 9.1; R: M = 60.2, SD = 8.93; N: M = 71.8, SD = 6.18, dl(2, 12), F = 4.19, p = .04), on each side of the normal control group. Conversely the percentage of B lymphocytes measured with anti-CD19 antibody was significantly decreased in the left CVA compared to the right CVA group (L: M = 5, SD = 2.8; R: M = 16.6, SD = 9.9; N: M = 13, SD = 5.6, dl(2, 12), F = 3.88, p = .05), both again on each side of the normal control group. Finally, the proliferation of T lymphocytes stimulated with PHA was significantly reduced in the left CVA group compared to the normal group (Proliferation index: L: M = 65, SD = 43.1; R: M = 87.3, SD: 46.2; N: M = 147.2, SD = 55.4, dl(2, 12), F = 5.83, p = .01), but no effect was noted in the right CVA group.

Discussion. We found a reduction of the lymphocyte/leukocyte ratio between the left and the normal group. This reduction is compensated by both an elevation of monocytes and granulocytes. The crossed double opposition of T and B lymphocytes between right and left patients suggests that the left hemisphere positively controls the percentage of B lymphocytes and the right hemisphere positively controls the percentage of T lymphocytes and that the left hemisphere suppresses the T cell and that the right hemisphere suppresses the B cell percentages. The PHA proliferation test revealed that although the left CVA group had a higher T cell percentage, this group was found to respond the least to mitogenic activation (see the Khil'ko et al., 1990 study of traumatic brain injury patients tested for the phagocytic activity of monocytes and the Kawaharada and Urasawa, 1992 study with CVA patients including hemorrhage and subcortical involvement which found that the left CVA patients are more susceptible to pneumonia in the post CVA period). We extend to humans the finding of Renoux and Bizière (1991) of T cell proliferation impairment in mice with the left hemisphere surgically removed, but not the augmentation of proliferation following equivalent right hemisphere damage. The present study extends the contribution of neocortex to several additional parameters of immune function in humans and introduces immunomodulation to the vast array of functions subject to cortical hemispheric specialization.

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W-24. Hemisphere Competence at Different Ages: Possible Role of Frontal Lobes Maturation

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Intrahemispheric functional organization (assessed with EEG coherence) was studied during a prestimulus attention task of equal subjective difficulty in two groups of children (aged 7 and 9) and one of adults, 10 ss in each group. Subjects had to classify lateralized auditory and tactile stimuli according to their duration

(short or long). Visual indication of forthcoming stimulus modality provided the canalization of attention. In adults, a local modality-specific functional integration of cortical regions was revealed in the left hemisphere (LH), and distributed unspecific organization in the right hemisphere (RH) was noted. At age 7, functional organization of both hemispheres was similar to that of adults' LH. In children aged 9, mixed LH and RH features were observed for each hemisphere. The age differences observed, and the long-lasting and nonlinear course in the development of the cerebral hemispheres are discussed in relation with comparative data on frontal lobes maturation.

W-25. The Brain Potential N400 in Alexia

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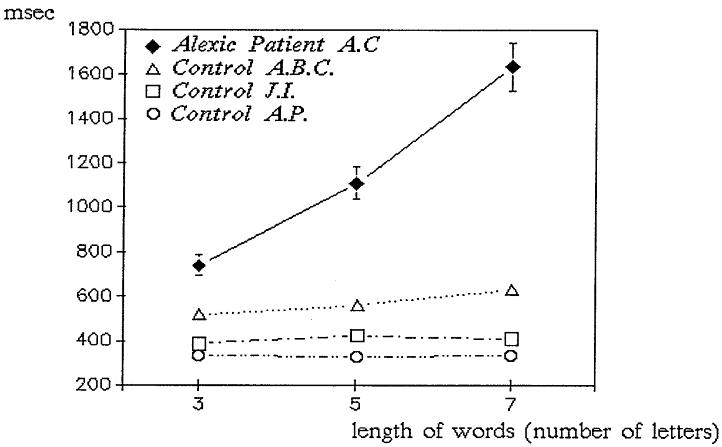
The onset of N400 could be an index of how early semantic codes are activated. In some cases of ''letter-by-letter'' readers evidence has been found for semantic priming in letter detection, with relatively brief stimulus durations. The goal of this study was to examine the N400 in a ''letter-by-letter'' reader, as a clue to the time course of semantic code activation in this type of alexia. The subjects, an alexic patient and three controls matched in age, sex and educational level, had to perform a semantic matching task on pairs of words that were sequentially presented. Reaction times and ERP were recorded. A dissociation between overt behavioral responses and the latency of N400 onset was found in alexic patient, which can be interpreted as evidence for early covert semantic activation.

Introduction. The component N400 is enhanced in situations where the eliciting word has weak semantic links with the preceding context (Kutas & Hillyard, 1984). The time latency at which congruent and incongruent words diverge, places an upper limit on the duration of processes leading to the activation of meaning during word recognition. In other words the onset of N400 could be an index of how early semantic codes are activated (Pérez-Abalo, Rodriguez, et al. 1994).

Some cases of Alexia have been described as ''letter-by-letter'' readers. The normal (quasi-parallel) identification of letters in reading, is transformed into a laborious, serial, process (Farah & Wallace, 1991; Arguin & Bub, 1994). Very brief presentations of words cannot be read aloud in ''letter-by-letter'' readers, apparently because all letters cannot be identified. However in some cases evidence has been found for semantic priming (Coslett & Saffran, 1989) and the ''word superiority'' (Bub, Black, & Howell, 1989) effect in letter detection, with relatively brief stimulus durations. Both phenomena are present only if contact with the appropriate entries in the lexicon has occurred. Therefore these reports have been construed as evidence for a dissociation between explicit and implicit recognition processes.



	Intercept	Slope	Correlation	Significance
Alexic patient A.C.	234 msec	223 msec/letter	0.63	0.00001
Control A.B.C.	458 msec	23 msec/letter	0.3	0.002
Control J.I.	330 msec	1 msec/letter	0.01	N.S.
Control A.P.	389 msec	4 msec/letter	0.06	N.S.

FIG. 8. Pronunciation time (means) vs length or words. A marked slowing of reading was found for A.C. in comparison with several matched controls.

The goal of this study was to examine the N400 in A.C., a ''letter-by-letter'' reader, as a clue to the time course of semantic code activation in this type of alexia.

Method. A.C. was diagnosed as suffering from a cerebral vascular infarct at the age of 52. A small lesion was demonstrated by CAT and MRI scans in the left occipital regions. Although he read letters and numbers without difficulty, he had trouble identifying words, having to spell the component letters aloud first. At the time of this study, four years after his lesion, he had gained somewhat in reading speed but still was very slow compared to his premorbid abilities. Laboratory test showed a strong dependence of reading time on the length of the words read. On comparing the pronunciation times of A.C. with several matched controls, a marked slowing of reading was found for A.C., who took almost 2 sec to read seven letter words (Fig. 8). The correlation between pronunciation time and letter length was large (0.63) and very significant ($p < 0.00001$). The slopes for the controls were much lower.

The patient A.C. and three controls matched in age, sex, and educational level participated in the ERP study. The subjects had to perform a semantic matching task on pairs of words that were sequentially presented. All stimuli were concrete nouns, 5 to 6 letters long, and of high frequency (mean fre-

TABLE 5
Reaction Time for the Semantic Matching Task (in msec)

Subject	Congruent trial RT	Incongruent trial RT
Control D.P.	737	925
Control A.B.C.	918	970
Patient A.C.	1324	1729

quency 44 per million). Only 50% of the pairs were semantically related. Each trial was preceded by a warning signal and consist on the presentiation of the word context for 1 sec followed by the stimulus, displayed until the subject respond by pressing a key. Electrophysiological recordings was carried out from the 8 derivations of the 10/20 international system, all referred to linked earlobes. Recording and analyzing was made as described in Bobes and colleagues (1994).

Results and discussion. The reaction times of A.C. in the semantic matching task are compared with the two slowest controls in Table 5. The reaction time was 406 msec slower for A.C. than the slowest control (A.B.C.) in the congruent trials, and 759 msec slower for the incongruent trials. The ERPs obtained in the semantic matching task in the slowest control (A.B.C.) and A.C. are shown in Fig. 9. The onset latency of N400 at Pz in the control was about 300 ms, whereas in A.C. it was about 280 msec.

The duration of N400 was abnormally prolonged in the patient A.C., with the convergence of congruent and incongruent trials falling to the right of the margin of the figure. In this patient at Pz the duration of N400 was about 1.1 sec. In normal subjects the mean N400 duration is about 450 msec (Pérez-Abalo, Rodriguez, Bobes, et al., 1994), and in control A.B.C. was about 380 msec.

The N400 onset latency within normal range suggests that access to semantic codes is not delayed in this patient, a finding that stands in marked contrast to his very prolonged pronunciation times, and the slow semantic matching reaction times. This dissociation between overt behavioral responses and the latency of N400 onset can be interpreted as evidence for early covert semantic activation, which is compatible with the findings of Coslett and Saffran (1989). Early semantic activation could explain semantic priming with presentations of words at exposure times too brief for reading aloud.

The finding of an abnormally prolonged N400 indicates that the duration of this component is associated with the time needed for performance of the assigned and explicit recognition task, which would depend on slower mechanisms than the early semantic activation.

We speculate that if A.C. is actually processing letters serially, then his reading in some sense presents analogies with spoken word recognition

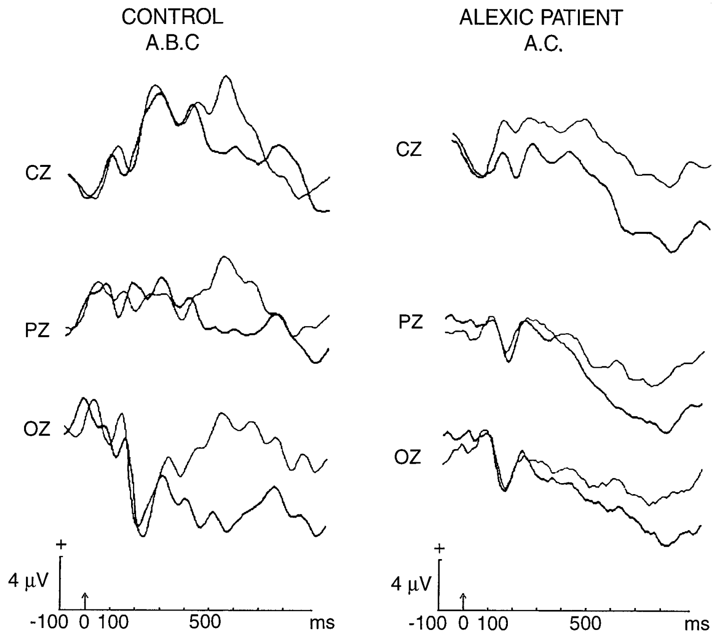


FIG. 9. ERPs for Control A.B.C. and A.C. patient in semantic matching task. Each ERP is the average of about 50 trials. In thin lines the responses to congruent trials; thick lines correspond to incongruent trials. The arrow indicates stimulus onset. Positive deflections point up.

(which is inherently serial in nature). As in ''cohort models'' (Marslen-Wilson, 1987), perhaps in A.C. the number of candidate entries activated in the lexicon should decrease with time, as each additional letter is identified. The prolongation of N400 in this patient could be related to a slower elimination of these potential candidates for word recognition. Thus, N400 would be related to processes initiated with early and implicit semantic activation (which would have normal timing in A.C.) and that are completed as the visual information from the printed word is utilized in explicit tasks (which are abnormally prolonged in A.C.). A model of word reading in line with these ideas has been described recently (Johnson & Pugh, 1994).

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W-26. Computing Spatial Relations in Left and Right Visual Fields

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The paper reports a study in which subjects estimate whether a dot is left or right, above or below, near or far, or on or off the centre of a circle. Our results show that tasks vary in their difficulty and that, within a task, all decisions are not equally difficult. Specifically, near estimates are always slower than far estimates but especially so when presented to the left visual field–right hemisphere (LVF–RH). There was no evidence of an interaction between hemisphere and task. We discuss the data as showing a hemispheric difference in efficiency for computing spatial relations.

Introduction. Kosslyn and his co-workers (Kosslyn, Koenig, Barrett, Cave, Tang, & Gabrieli, 1989) have proposed that two distinct types of representation underlie the encoding of spatial relations. Categorical relationships capture the general properties of spatial structure (for example, left-of, above etc.) whereas coordinate relationships capture more fine-grained metric information. Kosslyn et al. suggested that categorical relationships are computed by the left hemisphere and coordinate relationships by the right hemisphere. Their history is supported by a large body of data (e.g., Hellige & Michimata, 1989) based on subjects performance in tasks where, for example, they have to judge whether a dot is within 3 mm of (or above or below) a reference line.

The distinction between a left-hemisphere sensitive to spatial categories and a right-hemisphere sensitive to spatial coordinates has been criticized on principled grounds by Sergent (1991). She pointed out that categorization was really the judgement of relative position and that there was no reason to believe that both coordinate and categorical judgements could not be made from a single coordinate representation. Moreover, she suggested that these two types of spatial judgment were so fundamental to human visual processing that it was unlikely that one hemisphere would not have some capa-

TABLE 6
Mean RTs (with SE)

Task	LVF		RVF		LRVF	
	Near	Far	Near	Far	Near	Far
Above/below	538 (35)	535 (38)	587 (44)	551 (36)	560 (39)	528 (37)
Left/right	714 (48)	691 (58)	765 (62)	723 (51)	723 (51)	683 (48)
Near/far	588 (27)	565 (26)	629 (28)	606 (22)	606 (22)	593 (33)
On/off	513 (25)	476 (22)	519 (24)	507 (22)	507 (22)	469 (25)

bility at processing both kinds of relationship. However, it is an empirical question as to whether both hemispheres process categorical and coordinate relationships equally efficiently.

Sergent used more complex stimuli than had been used previously but could only find evidence for differential efficiency of hemispheric processing for the two kinds of spatial relationship under conditions where stimuli were relatively degraded. Under these degraded stimulus conditions a visual field effect emerged at the same time as an overall advantage for dual-field presentations (the simultaneous presentation of stimuli in both left and right visual fields; LRVF). A crucial point here is that hemispheric differences are caused by low-level factors which also cause the overall LRVF advantage. If conditions can be found in which a hemisphere effect is observed in the absence of an overall LRVF advantage then the independence of these effects will have been established. In the present study, we find a hemisphere effect for computing spatial relations without an overall LRVF advantage.

Method. The Method followed was similar to that of Sergent (1991, Experiment 1) in that subjects had to judge the position of a dot in a circle when the dot could appear in any one of nine separate locations. The locations were arranged so that there were four ‘‘far’’ and four ‘‘near’’ locations with one location directly over the center of the circle. Subjects were then asked to perform a series of blocked tasks in which they asked to judge whether the dot was above or below, left or right, near or far, or on or off (in this study only the off trials were analyzed) center. Each task was 196 trials except the on or off task which was 288 trials and the order of the trials and responding hand were counter-balanced. Stimuli were presented equally often unilaterally to the RVF and LVF and bilaterally to RLVF and were shown for 100 msec with no difference in pretrial and trial display illumination.

Results. RTs were analyzed in a 3 (visual field: LVF vs RVF vs LRVF) $\times$ 2 (distance: near vs far) $\times$ 4 (task: above/below vs left/right vs near/far vs on/off) ANOVA repeated over all factors.

The main effects of task and distance were significant (see Table 6) [$F(3, 33) = 12.88$ and $F(1, 11) = 63.2$ respectively, both $p < 0.01$]. The left/

right task was performed more slowly than all other tasks and the near/far task was performed more slowly than the on/off task. Near targets were responded to more slowly than far targets. The main effect of visual field missed significance [$F(2, 22) = 2.37$].

The main effect of distance was moderated by an interaction with visual field [$F(2, 22) = 4.7$, $p < 0.05$]. Analysis of this interaction showed distance affects all visual field conditions. However, there were no differences between visual fields for far estimates but slower responses in the RVF for near estimates.

There were no other significant interactions, all F ratios <1.01.

Error analyses of the arcsined data were in the same direction as the RTs and differed only in that there was an interaction between task, hemisphere, and distance ($F(6, 66) = 2.8$, $p < 0.05$). This interaction was caused by a particularly high error rate in the near/far task for RVF near presentations.

Discussion. The results show that distance affects spatial judgments most strongly in the LVF–RH: these data suggest that the cerebral hemispheres do not process spatial information equally efficiently. In addition, we found no evidence of an interaction of task with either visual field and/or distance. The results suggest, contrary to Kosslyn et al. (1989), that there are no grounds for distinguishing the cerebral hemispheres in terms of the kinds of spatial information they can compute; rather, both left and right hemispheres can process categorical and coordinate relationships.

We suggest that the visual field effect is a direct consequence of the structure of the spatial maps that underlie perception. Spatial maps in the right hemisphere are composed of larger and more overlapping receptive fields whereas those in the left have smaller and relatively nonoverlapping receptive fields as in the model suggested by Kosslyn, Chabris, Marsolek and Koenig (1992). With the poorer capability for spatial localization in the left hemisphere, subjects could not easily make judgments on targets presented near the implicit boundary or reference point required to perform the task; hence, RTs were longer in the near target, right visual field condition.

We also discuss the broader issue of how task characteristics interact with visual field effects. We suggest that analysis of task differences have the potential to offer the most important insights into the nature of hemispheric differences in spatial perception.

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W-27. Event Related Potentials to the Subject's Own Face

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This paper studies the effect upon ERPS of using the subject's own face as stimulus. In EEG recording from Cz obtained from a sample of 12 normal subjects, this stimulus produces a late positive component that is statistically significant in two different time windows. These windows reflect two different subcomponents. The first one might correspond to the automatic recognition of the face and the second one to the decision process involved in the experimental paradigm. The study also confirms the appearance of a negativity for unfamiliar faces.

Introduction. Even Related Potentials have proven to be a powerful tool for studying human information processing. Both the stimuli presented to, and the tasks required of the subjects have been of different degrees of complexity. Particularly important to psychophysiologists are the family of positive and negative waves around the 300 to 500 msec, frequently studied in the context of language processing. In recent years various studies have explored the use of faces as stimuli. These are complex, natural stimuli that apparently trigger information processing modules that are different from those of language.

For example, Valdes and Bobes (1989) have demonstrated that an analog to the classical incongruent negativity of Kutas and Hillyard (1980) for linguistic tasks may be found with an appropriate paradigm though with a different spatiotemporal distribution in the scalp.

Faces seemingly mediate a larger number of cognitive processes than any other type of visual stimuli. An important variable is the degree of familiarity of the subject with the faces presented. A number of authors have described components associated with the dichotomy: familiar (FF) versus unfamiliar (UF) faces. Smith and Halgren (1987) identified a negativity around 445 msec for unfamiliar faces. Deecke and coworkers also encountered an N500 component to UF as compared to FF when the sex of the face had to be identified. Barret and colleagues (1988) also encountered an negativity around 400 msec to UF in a stimuli matching tasks. Additionally, Naumann (1988) has found a later positivity around 500 to the FF in a recogntion task.

These reports show that in general, the FF produces a positive peak when the recognition is produced and a negative peak corresponding to the UF faces, though the specific experimental manipulations originate morphology and latency variations of ERP components.

Our assumption is that the greater the familiarity, the larger the increase of the ERP positivity. However previous studies used as familiar faces famous people, politicians or actors, that is, faces of other people with whom the subject was related via mass communication media. To our knowledge the faces of relatives or friends have not been used as stimuli. As an extreme case, the subject's own face is the most familiar stimulus to each subjects. ERP amplitude should reflect this effect.

The characteristics of the aforementioned studies are twofold:

- The faces present only two degrees of familiarity (UF vs FF)
- A given face is usually presented very few times. The kind of face employed in each experiment is variable and is strongly related to the hypothesis.

Objectives. The main objective of this paper is to include in the studies of ERPs the face which is most familiar to each subject: ‘‘his own face’’ when scale the familiarity from maximal to minimal value.

Another objective is to increase the number of repetitions of each face in order to study the effect, if any, of habituation upon the responses. We want to know if initial repetition can faciliate the storage in memory of the unknown face and improves recognition in the later repetitions.

Sample and EEG recording. The study included 12 right handed normal subjects, 7 male and 6 female with an age range of 25 to 45 years.

The entire experiment was under the control of the MINDTRACER psychophysiology software for the MEDICID 03M Digital EEG system. This system presents stimuli to a subject viewing a Video monitor. It records simultaneously the responses of the subject to the stimuli and the EEG recording. Of relevance for this study is the activity at the Cz electrode, recorded with respect to the linked ears as a reference. The EOG was monitored simultaneously. ERPs were obtained by averaging after eliminating trials with mistakes on the tasks, artifacts or excessive eye movements.

The task designed required the subject to answer the question ‘‘Do you know this person?’’ The stimuli consisted of a randomized sequence of 100 faces. The subject's own face was presented 20 times, that of a friend 20 times and a unknown face 20 times. The control set of different pictures of familiar and unfamiliar people was presented with two objectives:

- to interrupt the monotonous presentation of only 3 stimuli
- to provide a basis for comparison with previous results between FF vs UF faces, looking for the negativity for the UF

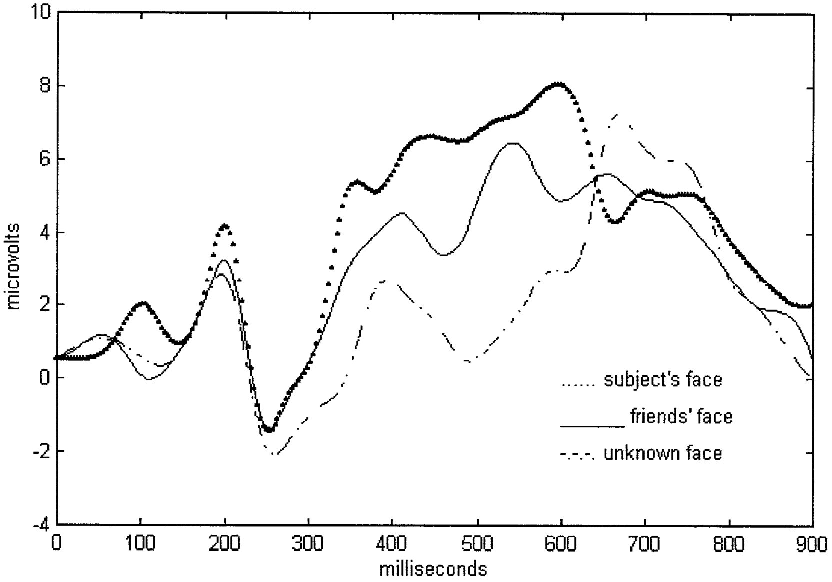

FIGURE 10

Results. Figure 10 shows the grand average of the sample for the three levels of familiarity. As can be seen, there is a robust positivity for the subject own face that appears around 308 msec and peaks at 540 msec. On the other hand the unfamiliar face presents a negative peak at around 400 msec. The friend's face wanders somewhere in between. There is no evidence for earlier components. These impressions are corroborated by statistical analysis. The time range was divided into a limited number of time windows on the basis of a priori assumptions. The mean of each time window for each subject's average ERP was entered into an ANOVA, to compare differences among degrees of familiarity.

The usual repeated measure version of ANOVA was used in all analyses. When appropriate the Geisser-Greenhouse correction was applied in order to correct the degrees of freedom of the F ratio tests.

A two way classification was used to test for the effect of the familiarity and that of repetition: first 10 repetitions versus the second 10 repetitions.

There are no significant results for the early components. Also there are no interactions. As to the main effects repetition was never found to be significant.

On the other hand the latencies in the time windows analysis from 386 to 442 msec ($p = 0.019$) and those of 530 to 587 ($p = 0.071$), and 530 to 578 msec ($p = 0.038$) were significant.

Discussion. The subject's own face produces a late positive component that is statitically significant in two different time windows. It is tempting to speculate that there are two different components to the positivity elicited by the subject own face, corresponding to the domains of statistical significance. The first one could reflect the automatic recognition of the face. The second one might correspond to the decision process that produces the reponse to the experimental question. The study confirms the appearance of a negativity for the UF; the repetition of very familiar faces does not produce habituation. Components in the time range of 100 msec are not evident in this design.

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W-28. Phonological Disruption in Atypical Dementia of the Alzheimer's Type

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Models of speech production suggest dissociable phonological difficulties may arise in the semantic versus non-semantic routes to speech output (McCarthy & Warrington, 1984), or at processing levels common to all output tasks (Caplan et al., 1986). An investigation of the phonological disruption in three patients with a non-fluent presentation of Dementia of the Alzheimer's Type (DAT) suggests they have difficulty in activating stored phonological representations, especially from semantic specifications.

Language deficits in DAT are typically lexico-semantic, rather than phonological or syntactic (e.g. Miller, 1989). Recently, however, two cases with histologically confirmed DAT who presented with a progressive non-fluent

TABLE 7
Summary of Patient Details

	KM	VB	MT
Gender	M	F	F
Handedness	R	R	R
Age at present study	65	58	67
Years of Education	9	10	9

aphasia (Green, Morris, Sandson, McKeel & Miller, 1990; Greene, Xuereb, Patterson & Hodges, submitted) have shown that DAT may also disrupt phonological aspects of speech production. The current study investigated the nature of this disruption in 3 further patients with a non-fluent presentation of DAT.

We sought to determine whether the DAT patients' phonological disruption was specific to semantically driven speech output, or also affected the direct (nonsemantic) transcoding of phonological input to speech output which occurs in single word repetition. These differing ''routes'' to speech production were proposed by McCarthy and Warrington (1984) to account for the double dissociation between conduction aphasia (in which word repetition is impaired while word production in spontaneous speech may be near-perfect) and transcortical motor aphasia (where the reverse is true). We therefore compared the DAT patients' naming and repetition performance, and further included a picture name judgment task (in which no speech was required) to establish whether their phonological deficits were restricted to speech output. If the impairment were occurring at a level common to all output tasks, the patients should show equivalent deficits on naming and repetition (Caplan, Vanier & Baker, 1986), with picture name judgment relatively preserved.

Case Studies

Table 7 gives some basic information about the patients. All three show generalised atrophy on MRI imaging (left > right), and KM has a hearing loss of 50–70 dB at and above 4000 Hz. The patients make phonological as well as lexicosemantic errors on neuropsychological tests requiring language production, and show deficits in syntactic, visuospatial and mnestic abilities.

Method

The same 180 concrete nouns were used in picture naming, repetition, and picture name judgment tasks. The words were of 1, 2, and 3 syllables to manipulate phonological difficulty (60 of each, matched for frequency). In the speech production tasks, the stimuli were line drawings (naming), and

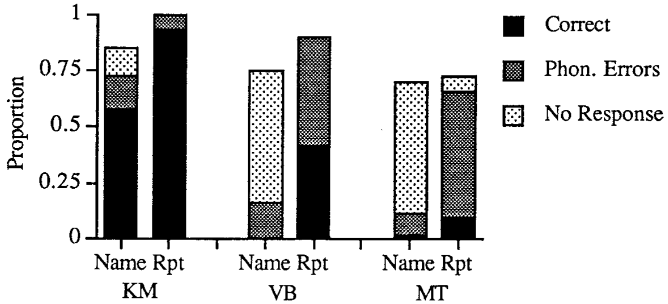

FIG. 11. Proportions of correct responses, phonological errors, and no responses given in naming and repetition.

words spoken by the experimenter (repetition). Each word was elicited in only one task in each testing session.

In the picture name judgment task (Allport, 1983), the patients saw each picture from the naming task and then judged whether spoken stimulus presented on tape was a correct or incorrect pronunciation of the picture name. Incorrect pronunciations were phonotactically legal nonwords, created by varying one consonant phoneme of the target word by 1, 2, or 3 features of articulation (place, voice, manner), thus manipulating the acoustic–phonetic ''distance'' of distractors from targets. The altered phoneme occurred equally in word-initial, -medial, and -final positions. Correct and incorrect pronunciations of each target were presented in different sessions; half the items in each session were correct pronunciations and half incorrect. The task was also performed by 6 age-, hearing-, and education-matched controls.

Results

Speech production. Each patient produced fewer words correctly in naming than in repetition (Figure 11). When unable to give a correct response, the patients were most likely to give no response in naming, and to make phonological errors in repetition. Other responses (not shown) were semantically related and unrelated utterances. In naming, where phonological representations must be activated from conceptual information provided by a picture, few responses were fully correct, and frequently there was insufficient phonological activation to generate even an attempt at the target. By contrast, in repetition, the availability of a direct phonological model of the target increased the likelihood of either a correct response or a phonological approximation to the target. Errors in both repetition and naming were related to the length, and thus phonological difficulty, of the target word.

Picture name judgment. The DAT patients accepted more nonwords as correct pronunciations than did controls (Fig. 12). Their errors increased with target length (Fig. 13a), and decreased with number of feature changes made

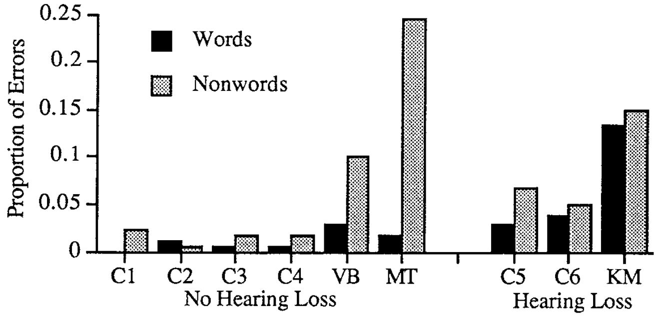

FIG. 12. Proportions of errors made by DAT patients and controls in picture name judgement.

(Fig. 13b), showing they were sensitive to both measures of distractor difficulty. They also more accurately detected changes occurring late rather than early in the distractor (Fig. 13c). To interpret this position-of-change effect, we suggest that on some trials, a patient's phonological representation of the picture name was not activated upon presentation of the picture, so he/she would have been unable to monitor the spoken stimulus for error until that stimulus itself activated the appropriate phonological representation. On these occasions, word-initial and -medial changes would be more difficult to detect ''online'', but word-final changes would be detectable with reference to an activated phonological representation.

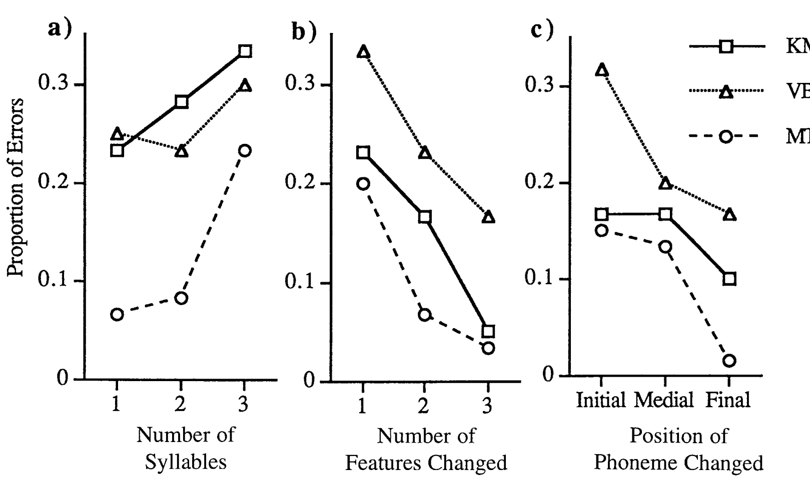

FIG. 13. Proportions of errors made by the DAT patients according to (a) length (all items), (b) number of feature changes (nonwords), and (c) location of altered phoneme (nonwords).

Conclusions

The patients' speech production difficulties in naming compared with repetition, and their position-of-change effect in picture name judgment, suggest impaired activation of phonological representations from the conceptual information provided by pictures. Their relative success in repetition, and their ability to detect many distractors in picture name judgment, demonstrate a more efficient activation of stored phonological representations from phonological input, although even this does not guarantee fully correct output.

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W-29. Contrasting Abstract Orthographic Processing and Phonological Access in Letter-by-Letter Reading

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Abstract orthographic and phonological encoding of visual words were contrasted in a patient with letter-by-letter reading using a priming paradigm. Lower case primes displayed for 100 msec preceded upper case target words the subject had to name. Primes were the same word as the target, homophones to the target, or unrelated words. Relative to unrelated primes, same-word primes resulted in a significant reduction of naming times. In contrast, homphone primes had no effect. The results suggest that a crucial constraint on reading performance in letter-by-letter reading is phonological access, not orthographic processing.

Introduction

Letter-by-letter reading (LBL) results from left occipital lesions and is characterized by a reading performance which is slow and effortful—although usually accurate. The defining feature of LBL is that reading latencies increase massively (from 500 msec to several sec) and regularly with every additional letter in the word. Current theories of the disorder propose that it originates from a deficit affecting orthographic encoding (Arguin & Bub, 1993), the transfer of letter identities to lexical representations (Patterson & Kay, 1982), or from an impaired word-form (i.e. lexical–orthographic) system (Warrington & Shallice, 1980).

Contrasting with these theories however, previous results from our group have provided evidence for fast and highly accurate lexical–orthographic encoding in a patient (IH) with LBL (Bowers, Arguin & Bub, 1996). The patient was shown a word prime for 100 msec, followed by a 17 msec mask, and then by a target word to be named as rapidly as possible. In one condition, the prime and target were the same word while in the other they were orthographically unrelated. All primes were printed in lower case letters and targets were upper case. All items had a majority of their letters which greatly change shapes between upper- and lowercase print. Thus, no priming effect can be attributed to shape overlap between prime and target. The results from IH show large response time reductions for targets preceded by same-word primes relative to unrelated primes. In contrast, word primes that overlap the target on all letters but one (i.e. orthographic neighbors) produced no benefit; this was true whatever the letter position by which neighbor-primes and targets differed.

These priming results indicate that abstract orthographic encoding and lexical access occur with stimuli exposed for a duration (100 msec) that is not sufficient to support overt recognition in IH (Bowers, Bub, & Arguin, 1996) and that is disproportionately shorter than the time the patient requires for word naming (his average naming times for four-letter words are systematically above 1000 msec). It appears then that LBL reading in IH is unlikely to be explained by a deficit at or preceding the lexical-orthographic access stage. What Bowers et al. proposed was rather that IH's reading impairment was the result of a deficit in gaining access to phonology following orthographic encoding. The experiment reported here is a test of this hypothesis.

Method

Subject. The subject studied was IH, who suffered a left temporal–occipital hematoma 12 years prior to testing. His main behavioral complaints are: right homonymous hemianopia, anomia, surface agraphia, and reading difficulties. His reading is characterized by response times which increase linearly by 500 msec with every additional letter in a word, and by a large regularity effect on reading accuracy. IH's reading disorder can be qualified as letter-by-letter surface dyslexia.

Stimuli and procedure. Targets were four- and five-letter words printed in uppercase that had frequencies varying between 1 and 298 per million (average of 53). These were preceded by 100 ms lower case primes and by a 17 msec pattern mask. Primes were either the same word as the target, an homphone to the target (e.g., bale–BAIL), or an unrelated word. All stimuli were displayed 1 cm to the left of a central fixation point and the target remained visible until the subject's response. IH was asked to read each target aloud as rapidly and accurately as possible. Response times were measured by a voice-key connected to the computer controlling the experiment (1.9% of trials were measured by a voice-key connected to the computer controlling the experiment (1.9% of trials were rejected due to a malfunction of the microphone).

Results

Correct response times (RTs) averaged 1135 msec across conditions. RTs were shorter with same-word primes than with unrelated primes [$p < 0.01$]. In contrast, no significant benefit occurred with homophone primes relative to unrelated primes. IH's average error rate was of 13.6% and accuracy did not vary significantly as a function of priming condition [$\chi^2(1) = 2.44$; *n.s.*]. The correlation between RTs and error rates was positive and high ($r = 0.94$).

Discussion

Same-word primes with a 100 msec duration significantly reduced the time required by IH to name the target. This result is congruent with the notion of fast and accurate orthographic–lexical access in LBL. If an account of LBL must involve a single factor, it would appear that, as far as IH is concerned, this factor does not concern orthographic processing.

The present results failed to show evidence for homophone priming. This form of priming is easily elicited in normal observers, however (Lukatela & Turvey, 1994). The lack of homophone priming in IH along with significant abstract repetition priming supports the theory that a crucial constraint on reading performance in LBL is phonological access, not orthographic processing.

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W-30. Computation Abilities in Nonsavant Autistic Subjects

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The present study aimed to evaluate the presence of dissociations in computation skills, in a group of high-functioning autistic patients. We used the NECO-Battery (1994) which separately assesses each sub-components of number processing, arithmetical and numerical abilities. Preliminary results failed to reveal dissociations between the different tasks under investigation. The autistic subjects showed intact performance on all of the battery's tasks. These results incite the need for detailed case-studies of prodigious autistic calculators with more sensitive paradigms, like chronometric tasks, in order to reveal possible dissociations in the computation abilities.

T-1. Developmental Dysphasia for Oral and Sign Language in a Deaf Child with Idiopathic Partial Childhood Epilepsy

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A congenitally right-handed deaf girl of normal intelligence evidenced striking dissociation in the development of manual gestural abilities and buccofacial movements with specific disorders for verbal gesture and speech articulation. This developmental language disorder (DLD) was concomitant of an age-related partial epilepsy with temporal left predominant subcontinuous spike and wave discharges. Despite normal visuospatial, visuoconstructive and movement coping abilities, the acquisition of French sign language code was severely impaired. The features of language disorder and their relationship with a focal epileptic activity involving the temporal cortex during the establishment of the functional neural circuitry for various language modalities are discussed.

Comparative studies of hearing and deaf infants have shown parallels in the time course and structure in the development of verbal communication for both spoken and signed language (Petitto & Marentette, 1991). Moreover, exceptional observations of sign language aphasia in left lesioned adult deaf signers suggest that the use of gesture for verbal communication which is dissociable from non verbal gestural capacity has lateralization to the left hemisphere similar to spoken languages (Corina, Poizner, Bellugi, Feinberg,