Various explanations for the positive correlation between subjects' asymmetry scores have been proposed. LEVY *et al.* [16] suggest that a subject's asymmetry score on a particular laterality task reflects his/her characteristic arousal asymmetry as well as his/her pattern of hemispheric specialization. They suggest that individual subjects vary in a stable trait, "characteristic arousal asymmetry", that reflects the relative arousal levels of the left and right hemispheres. According to this hypothesis, a subject's asymmetry scores on all tasks may be shifted towards the left or right due to his/her characteristic arousal asymmetry. These stable individual differences in characteristic arousal asymmetries may mediate positive correlations between subjects' asymmetry scores on different laterality tasks.

Alternatively, HELLIGE *et al.* [7] suggest that stable individual differences in asymmetry scores may be mediated by variations in peripheral factors, such as asymmetric pathway strength. More recently, BOLES [2] has proposed that stable individual differences may be due to variations in hemisphericity. According to this hypothesis individual subjects show a shift pattern in which one hemisphere shows strong lateralization for the functions it serves, while the opposite hemisphere shows weak lateralization for the functions it serves. It is argued that this would result in a positive correlation for left- and right-hemisphere specialized tasks. Although the explanations offered for the positive correlation among subjects' asymmetry scores differ from study to study, all of the proposed accounts posit stable individual differences in some task-independent trait. This trait will be referred to as "characteristic perceptual asymmetry" in the current paper.

In the present study we investigate a method of differentiating effects of characteristic perceptual asymmetry on asymmetry scores from effects of the underlying patterns of hemispheric specialization on asymmetry scores. An assumption made in applying this method is that characteristic perceptual asymmetry and hemispheric specialization are stably superimposed and that they do not interact. That is, we assume that characteristic perceptual asymmetry and hemispheric specialization are additive in their effects on asymmetry scores. Based on this assumption, we predicted that asymmetry scores for left hemisphere specialized tasks would be greater than asymmetry scores for right hemisphere specialized tasks (asymmetry scores computed as RVF − LVF for both tasks) for subjects with typical patterns of hemispheric specialization. Conversely, we predicted that asymmetry scores for right hemisphere specialized tasks would be greater than asymmetry scores for left hemisphere specialized tasks for subjects with atypical patterns of hemispheric specialization.

Two tachistoscopic laterality tasks, one involving recognition of words and the other involving recognition of faces, were administered to both dextrals and sinistrals.* The same word task has been shown to yield a significant RVF advantage and the same face task has been shown to yield a significant LVF advantage among a group of dextrals [14]. Classifying subjects into Group Typical or Atypical according to the relative magnitude of their asymmetry scores on the left-hemisphere specialized word recognition task and the right-hemisphere specialized face recognition task enabled us to explore the question of whether our two-task criterion yields estimates of typical and atypical

*Subjects were also given three more lateralized tasks for purposes not directly related to the current article. The results from these tasks are described in [8].

hemispheric specialization more consistent with clinical data than either of these tasks alone [19].

METHOD

Subjects

Subjects were recruited from the University of Chicago community. The sample included 63 adults (14 dextral males, 17 dextral females, 16 sinistral males, 16 sinistral females) ranging in age from 17 to 40 years with a mean age of 21.4 years. Subjects were classified as dextrals and sinistrals according to their writing hand and a six-item questionnaire (throwing ball, using hammer, brushing teeth, dealing cards, using soup spoon and sawing). Subjects who wrote with their right hand, and carried out at least five of the six other activities with their right hand were classified as dextrals. Subjects who wrote with their left hand, regardless of hand preference pattern on the questionnaire, were classified as sinistrals as sinistrals are known to have more inconsistent hand preferences than dextrals [17]. In fact, hand preferences as assessed by our six-item questionnaire indicated that dextrals had more consistent hand preferences (right-hand preference: $M=5.84$, $SD=0.37$) than sinistrals (left-hand preference: $M=4.93$, $SD=1.32$). All subjects had normal or fully corrected vision according to self-report.

Stimuli

Stimuli were bilaterally presented to binocular view in a Gerbrands two-channel tachistoscope (Model T-2B1). Two different stimulus types were used: four- and five-letter words which were common object names, and black-and-white photographs of faces. The words were aligned vertically and typed in black capital letters (IBM Bookface). The face photographs were black-and-white front view pictures of previously unfamiliar faces. Stimuli were placed symmetrically on white stimulus cards, one member of each pair appearing in the LVF and the other in the RVF. The medial edge of each member of a stimulus pair was located at 1°20′ for words and 1°30′ for faces. The maximal horizontal visual angle was 20′ for words and 3° 40′ for faces. One of six symbols (+, =, Δ, ∞, *, o) appeared at the center of each stimulus card. For faces, two choice arrays of 12 pictures were formed (each arranged three rows × four columns). For each choice array, nine bilateral stimulus pairs were constructed using eight faces twice, two once and two never. The faces were used a variable number of times as stimuli in order to discourage a guessing strategy for pairs shown late in the series.

Procedure

For each stimulus type subjects were presented with 12 practice trials immediately followed by 18 test trials. Subjects began each trial by viewing a pre-exposure field consisting of the outline of a small black rectangle at the center of the field. The stimlus card appeared 500 msec after the subject initiated a trial by depressing a telegraph key, simultaneous with the offset of the fixation field. On each trial, the subject's first task was to identify the symbol which appeared at the fixation point and then to report the lateralized stimuli. Accurate report of the central symbol served as an index of central fixation. Trials on which this symbol was reported incorrectly were excluded and administered again at the end of each block. For words, subjects verbally reported the stimuli. For faces, following each stimulus presentation, subjects were presented with a 12-item array from which they responded by attempting to select the two items presented. Stimuli were blocked by type (words, faces) and the order of the face and word tasks was counterbalanced across subjects. Within each stimulus type, items were presented in a fixed random order, with the side of the members of each stimulus pair counterbalanced across subjects.

Because asymmetry scores may be sensitive to overall accuracy [16], the exposure duration was varied from trial to trial in an attempt to equate overall performance level across both subjects and stimulus types. Based on pilot work, the starting exposure duration in the practice trials was set at 180 msec for words and 80 msec for faces. The exposure duration remained the same if a subject responded correctly to one item of a pair, was increased by 10 msec if both items were missed, and was decreased by 10 msec if both items were correct. However, the exposure duration was never allowed to exceed 200 msec, estimated to be the latency to initiate an eye movement [18].

RESULTS

Group results

An analysis of variance (ANOVA) was carried out on accuracy scores with Visual Field and Stimulus Type as within-subject variables and Handedness and Gender as between-subject variables. Mean visual field scores and standard deviations are shown in Table 1, for each handedness group. The main effect of Stimulus Type was significant [$F(1, 59)=7.22$, $P<0.01$], showing that performance for words was lower than faces despite the use of the

Table 1. Mean number of stimuli correctly recognized in left and right visual fields (standard deviations) for dextrals and sinistrals on the word and face recognition tasks

	Words		Faces	
Handedness	LVF	RVF	LVF	RVF
Dextrals (n=31)	5.35 (3.26)	7.70 (3.48)	9.29 (2.86)	5.77 (2.33)
Sinistrals (n=32)	4.90 (3.77)	7.96 (4.76)	7.43 (2.73)	7.43 (2.51)

titration procedure (36% vs 42%). This was due to some subjects having difficulty recognizing words even when stimuli were shown for 200 msec, the maximal exposure duration used.

As expected, the interaction of Visual Field × Stimulus Type was highly significant [$F(1, 59) = 40.81$, $P < 0.0001$]. This interaction was due to a significant RVF superiority for the word task [$F(1, 118) = 21.71$, $P < 0.001$] and a significant LVF superiority for the face task [$F(1, 118) = 8.78$, $P < 0.01$].

The interaction of Visual Field × Handedness was also significant [$F(1, 59) = 5.24$, $P < 0.05$]. However, this interaction was modified by a nearly significant Visual Field × Handedness × Stimulus Type interaction [$F(1, 59) = 3.73$, $P < 0.06$]. Bonferonni tests ($\alpha = 0.05$) showed that the Visual Field × Handedness interaction was significant for the face task but not for the word task. The interaction for the face task was due to dextrals having a LVF advantage but sinistrals having no significant visual field advantage.

The absence of a Visual Field × Handedness interaction for the word task may be attributable to sinistrals in our sample including an over-representation of subjects with characteristic perceptual asymmetry in favor of the RVF. It is also possible that the use of bilateral presentation decreases the likelihood of finding asymmetry differences between dextrals and sinistrals because so much of the variance in subjects' asymmetry score using this presentation technique is attributable to differences in characteristic perceptual asymmetry [9].

Finally, the interaction of Visual Field × Gender × Stimulus Type was significant [$F(1, 59) = 10.78$, $P < 0.01$]. Bonferonni tests ($\alpha = 0.05$) showed that the Visual Field × Gender interaction was significant for the word task but not the face task. The significant interaction for the word task was due to females having a larger RVF advantage than males.

Classification of subjects

As expected, subjects' asymmetry scores on the two laterality tasks (computed as RVF − LVF for both tasks) were extremely variable in both magnitude and direction, ranging from 15 to −10 for the word task and 9 to −13 for the face task. Records of individual performance are provided in Table 2 for readers who wish to closely examine individuals' data. Once corrected by the Spearman–Brown formula, the split-half reliability of asymmetry scores on the word task was 0.796 (uncorrected: 0.661, $P < 0.0001$), and that on the face task was 0.451 (uncorrected: 0.291, $P < 0.05$).

As expected, the number of subjects with RVF and LVF advantages on the word and face tasks was largely inconsistent with available neurological data on the incidence of typical and atypical patterns of hemispheric specialization among dextrals and sinistrals. The incidence of LVF and RVF advantages on the two tasks is shown in Table 3, for each handedness group. On the word task, excluding the two subjects with equal left and right visual field scores, only 18/29 (62%) dextrals and 24/32 (75%) sinistrals showed a RVF advantage. This handedness difference was not significantly different from chance (Fisher's exact test, $P=0.407$).

On the face task, excluding the three subjects with equal left and right visual field scores, only 25/31 (81%) dextrals and 16/29 (55%) sinistrals showed a LVF advantage. This difference between dextrals and sinistrals was significantly different from chance (Fisher's exact test, $P=0.027$). Thus, despite the higher reliability of the word task than the face task, the incidence of LVF and RVF advantages on the face task was, if anything, more compatible with available neurological data than that on the word task. This result supports the hypothesis that higher reliability of laterality tests does not necessarily indicate higher validity of the tests as measures of hemispheric specialization.

The two-task criterion was applied to subjects' asymmetry scores in the following manner. An individual subject was classified as having a typical pattern of the hemispheric specialization (Group Typical) if his/her word asymmetry score was greater than his/her face

Table 2. Individual performance: number of stimuli correctly recognized in left (L) and right (R) visual fields, asymmetry score (R–L) and patterns of hemispheric specialization determined by the two-task criterion

	Words			Faces			Patterns of Hemispheric
Subject #	L	R	R-L	L	R	R-L	Specialization*
				Dextral Males			
1	1	7	6	15	2	-13	T
2	7	5	-2	11	1	-10	T
3	8	13	5	11	6	-5	T
4	14	12	-2	10	7	-3	T
5	7	4	-3	12	6	-6	T
6	3	10	7	4	7	3	T
7	3	9	6	8	4	-4	T
8	2	8	6	9	7	-2	T
9	7	6	-1	7	3	-4	T
10	6	7	1	3	6	3	AT
11	10	8	-2	7	10	3	AT
12	4	0	-4	10	7	-3	AT
13	12	10	-2	12	10	-2	?
14	7	4	-3	8	5	-3	?
				Dextral Females			
15	6	3	-3	9	5	-4	T
16	3	3	0	11	8	-3	T
17	6	7	1	7	4	-3	T
18	0	6	6	6	8	2	T
19	3	7	4	13	4	-9	T
20	2	11	9	10	4	-6	T
21	6	11	5	10	6	-4	T
22	2	10	8	7	11	4	T
23	0	15	15	5	9	4	T
24	5	6	1	15	5	-10	T
25	4	10	6	8	6	-2	T
26	8	15	7	9	6	-3	T
27	6	5	-1	13	4	-9	T
28	8	9	1	8	6	-2	T
29	3	6	3	9	3	-6	T
30	7	6	-1	10	4	-6	T
31	6	6	0	11	5	-6	T

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			Sinistral Males				
32	1	10	9	6	7	1	T
33	5	8	3	9	4	-5	T
34	9	12	3	9	11	2	T
35	0	12	12	3	12	9	T
36	4	5	1	9	8	-1	T
37	9	14	5	12	7	-5	T
38	0	8	8	8	6	-2	T
39	12	5	-7	4	10	6	AT
40	3	4	1	6	10	4	AT
41	10	0	-10	14	8	-6	AT
42	9	13	4	5	12	7	AT
43	4	1	-3	4	5	1	AT
44	2	0	-2	4	5	1	AT
45	2	7	5	5	12	7	AT
46	8	2	-6	9	7	-2	AT
47	6	2	-4	6	6	0	AT
			Sinistral Females				
48	10	14	4	5	7	2	T
49	6	10	4	9	7	-2	T
50	3	12	9	9	4	-5	T
51	3	9	6	7	7	0	T
52	3	7	4	8	6	-2	T
53	8	15	7	6	5	-1	T
54	0	9	9	6	10	4	T
55	0	1	1	5	4	-1	T
56	1	15	14	4	9	5	T
57	5	7	2	10	8	-2	T
58	7	3	-4	8	3	-5	T
59	2	6	4	13	5	-8	T
60	1	15	14	10	9	-1	T
61	3	8	5	10	6	-4	T
62	13	14	1	7	10	3	AT
63	8	7	-1	8	8	0	AT

*T=Typical ($Word_{R-L} > Face_{R-L}$). AT=Atypical ($Word_{R-L} < Face_{R-L}$)

Table 3. Number of dextral and sinistrals subjects with left visual field advantage (L > R) and right visual field advantage (L < R) on the word and face recognition tasks

	Words		Faces	
Handedness	L>R	L<R	L>R	L<R
Dextrals	11	18	25	6
Sinistrals	8	24	16	13

asymmetry score (asymmetry scores computed as RVF − LVF for both tests). Concomitantly, an individual was classified as having an atypical pattern of hemispheric specialization (Group Atypical) if his/her face asymmetry score was greater than his/her word asymmetry score. Two right-handed males showed equal visual field asymmetries for the two tasks and were excluded from further analyses.

Of the 61 remaining subjects, 47 were placed in Group Typical and 14 were placed in Group Atypical. Within the group of dextrals, 26/29 (90%) were placed in Group Typical and within the sinistrals, 21/32 (66%) were placed in Group Typical. As expected, the distribution of dextrals and sinistrals in Groups Typical and Atypical significantly differed from chance (Fisher's exact test, $P=0.034$; see Table 4a).

Of the male subjects, 16/28 (57%) were placed in Group Typical and of the female subjects, 31/33 (94%) were placed in Group Typical. The distribution of males and females in Groups Typical and Atypical also differed significantly from chance (Fisher's exact test, $P=0.002$). Subsequent analyses within each handedness group revealed that the distribution of males and females in Groups Typical and Atypical significantly differed from chance for sinistrals (Fisher's exact test, $P=0.023$). The difference failed to reach statistical significance for dextrals (Fisher's exact test, $P=0.060$). In any case, given the infrequent incidence of atypical hemispheric specialization in dextrals, our sample size is too small to address the sex difference in incidence of typical and atypical hemispheric specialization in the dextral population. The distribution of males and females in Group Typical and Atypical is shown in Table 5, for each handedness group.

Examination of the asymmetry scores of Group Typical revealed a highly significant RVF advantage for the word task [$F\,(1, 47)=42.00$, $P<0.0001$] and a highly significant LVF advantage for the face task [$F\,(1, 47)=18.32$, $P<0.0001$]. In contrast, the asymmetry scores of Group Atypical were not significant for either the word task [$F\,(1, 13)=2.98$, $P>0.10$] or the face task [$F\,(1, 13)=2.86$, $P>0.10$]. The mean visual field scores of Group Typical and Group Atypical are shown in Fig. 1. Consistent with the hypothesis that subjects' asymmetry scores are influenced by characteristic perceptual asymmetries, asymmetry scores on the word and face tasks were positively correlated for both Group Typical [$r\,(45)=0.544$, $P<0.0001$] and Group Atypical [$r\,(12)=0.730$, $P<0.005$].

In order to determine whether the two-task criterion yields an estimate of typical and atypical hemispheric specialization consistent with clinical data, we compared the proportions of dextral and sinistral subjects in Group Typical and Group Atypical to RASMUSSEN and MILNER'S [19] estimates based on sodium amytal testing. The subjects in the bilateral speech dominance group and the right hemisphere speech group in RASMUSSEN and MILNER [19] were merged and assumed to have atypical patterns of hemispheric specialization (see Table 4b). The two-task criterion and the sodium amytal testing did not significantly differ in the proportion of subjects classified as having typical and atypical hemispheric specialization either for dextrals (Fisher's exact test, $P=0.185$) or sinistrals (Fisher's exact test, $P=0.667$).

DISCUSSION

The present results reveal that subjects' asymmetry scores on a left hemisphere specialized word recognition task and a right hemisphere specialized face recognition task are positively correlated. This positive correlation is consistent with the hypothesis that subjects' asymmetry scores reflect individual variations in characteristic perceptual asymmetries as well as patterns of hemispheric specialization [8, 14, 16]. Moreover, the finding of a positive correlation is not consistent with the hypothesis that a subgroup of subjects is strongly lateralized, in opposite directions, for left- and right-hemisphere specialized tasks (i.e. strong left hemisphere specialization for verbal functions and strong right hemisphere specialization for certain visuo-spatial functions) whereas another subgroup is weakly lateralized for both left and right hemisphere specialized tasks (i.e. bilateralization of both verbal and visuo-spatial functions) (e.g. [25]). If asymmetry scores mainly reflect such individual variations,

Table 4. Number of dextral and sinistral subjects with typical and atypical patterns of hemispheric specialization determined by the two-task criterion vs sodium amytal test

(a) Two-Task Criterion

	Patterns of Hemispheric Specialization	
Handedness	Typical (W>F)	Atypical (W<F)
Dextrals	26 (90%)	3 (10%)
Sinistrals	21 (66%)	11 (34%)

(b) Sodium Amytal Test *

	Speech Representation	
Handedness	Left	Right or Bilateral
Dextrals	134 (96%)	6 (4%)
Sinistrals	86 (70%)	36 (30%)

*Adapted From Rasmussen & Milner, 1975.

Table 5. Number of male and female subjects with typical and atypical patterns of hemispheric specialization determined by the two-task criterion in each handedness group

	Patterns of Hemispheric Specialization	
Gender	Typical (W>F)	Atypical (W<F)
	Dextrals	
Males	9	3
Females	17	0
	Sinistrals	
Males	7	9
Females	14	2

asymmetry scores on the left- and right-hemisphere specialized tasks would be negatively correlated. The positive correlations in the current study suggest that even if a factor like "specialization strength" exists, its effect on asymmetry scores is not strong enough to offset that of characteristic perceptual asymmetry.

The finding of a positive correlation between subjects' asymmetry scores on the word and face recognition tasks, presumably reflecting stable individual differences in characteristic perceptual asymmetry, suggests that the relative magnitude of subjects' asymmetry scores on the word and face task might provide a more valid index of underlying hemispheric specialization than the magnitude or direction of asymmetry on either task considered alone. In particular, our data indicate that 90% (26/29) of dextrals and 66% (21/32) of sinistrals

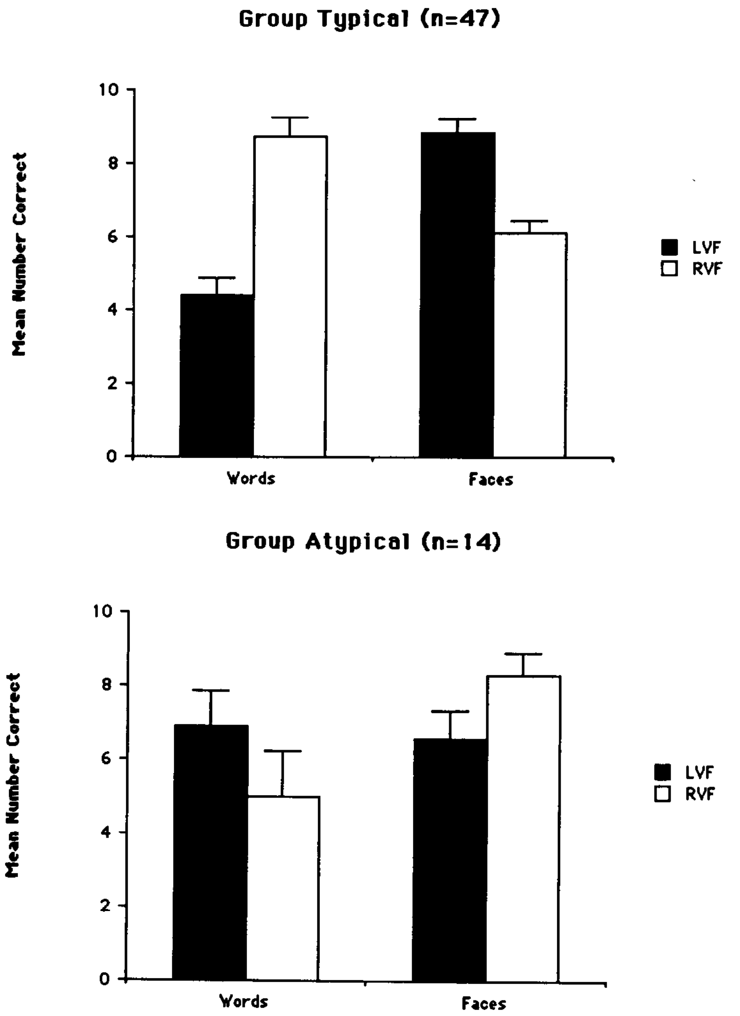

Fig. 1. Mean number of left visual field (LVF) and right visual field (RVF) correct responses for group typical and group atypical for the word and face recognition tasks.

have larger word than face asymmetry scores (asymmetry scores computed as RVF – LVF for both tasks). These estimates of typical and atypical hemispheric specialization, for dextrals and sinistrals, do not significantly differ from clinical estimates obtained from sodium amytal testing [19] and incidences of aphasic symptoms following left and right brain damage [3, 10]. While the absence of a statistically significant difference must be interpreted extremely cautiously, the similarity of findings using diverse methods suggests that the discrepancies between normal and clinical estimates are largely attributable to normal subjects' laterality scores reflecting individual differences in characteristic perceptual asymmetries as well as patterns of hemispheric specialization.

Of course, tachistoscopic laterality tasks and sodium amytal testing do not measure the same functions. In particular, sodium amytal test results reflect the hemisphere that controls speech production. In contrast, the lateralized tachistoscopic word task primarily tests word reading ability, a function that may be lateralized differently from speech production [22]. In addition, all of the subjects in RASMUSSEN and MILNER'S [19] study had a longstanding history of epilepsy that may have altered their patterns of hemispheric specialization. Thus, it is possible that discrepancies between asymmetry scores of normal subjects and estimates of left hemisphere involvement in language functions from clinical testing are attributable to these differences. However, the close correspondence between the present estimates and clinical data, once the influence of subjects' characteristic perceptual asymmetries is removed, suggests that the discrepancies typically obtained are at least partially accounted for by the influence of a stable, task-independent trait, such as characteristic perceptual asymmetry, on subjects' laterality scores.

Consistent with our findings, BOLES [2] tested dextrals and sinistrals on two laterality tasks involving judging whether a number was odd or even. On one of the tasks the numbers to be judged were represented as bargraphs and subjects showed a LVF (right hemisphere) reaction time advantage. On the other, the numbers to be judged were represented as number words (e.g. "two"), and subjects showed a RVF (left hemisphere) reaction time advantage. The results indicated that 91% of dextrals and 67% of sinistrals had larger asymmetry scores for left than right hemisphere specialized tasks (asymmetry score computed as $RVF_{rt} - LVF_{rt}$ for both tasks). These estimates closely correspond to those obtained in the current study as well as to clinical estimates, such as results from sodium amytal testing [19]. Thus, it appears that subjects' characteristic perceptual asymmetries may mask patterns of hemispheric specialization on laterality tasks where reaction time is the dependent variable, just as is the case when response accuracy is the dependent variable.

Dichotic listening tasks appear to yield results comparable to those obtained in the present study. LAUTER [12] found that the majority of dextral subjects showed larger ear asymmetry scores for left than the right hemisphere specialized tasks (asymmetry scores computed as right ear–left ear accuracy for both tasks), although she did not relate this finding to the incidence of typical and atypical hemispheric specialization. Further, in a review of the literature, LAUTER [13] found that this was a general feature of dichotic listening studies in which more than one task was given.

It is suggested that the two-task criterion leads to a "better" classification of subjects than the magnitude or direction of asymmetry on a single task, because the relative magnitude of asymmetry scores on the two tasks is a more "valid" measure of hemispheric specialization than the asymmetry score itself. Individual variations in asymmetry scores reflect variations in characteristic perceptual asymmetries as well as patterns of hemispheric specialization. Alternatively, it can be suggested that the two-task criterion leads to better classification of subjects because more data generally lead to more reliable estimates of laterality. According to this hypothesis, the reliability of the relative asymmetry scores (word asymmetry score [RVF – LVF] – face asymmetry score [RVF – LVF]) should be greater than the reliability of asymmetry scores on either task alone. Inconsistent with this hypothesis, however, computation shows that the split-half reliability of the relative measure (0.548) is smaller than the split-half reliability of the word task (0.796), but greater than the reliability of the face task (0.451). While moderate reliability of this index leaves much to be desired, the present results indicates that even a moderately reliable index can yield incidences of typical and atypical hemispheric specialization highly consistent with clinical observations. This may be attributable to the relative measure being more directly related to hemisphere specialization than asymmetry on a single task, even when that task is more reliable.

Both the two-task criterion and the statistical criterion used by WEXLER *et al.* [24] yield incidences of typical and atypical hemispheric specialization consistent with clinical observations. However, the two-task criterion has certain advantages. First, the two-task criterion allows classification of most subjects (97% in the current study), whereas a statistical criterion such as that used by WEXLER *et al.* [24] allows classification of only a subset of subjects. In the current study, a statistical criterion set at the $P<0.10$ level on the word task would allow classification of only 45% of subjects. More stringent statistical criteria would allow the classification of even fewer subjects. Second, and perhaps more importantly, it is conceivable that even subjects who meet a statistical criterion do so not because of their patterns of hemispheric specialization, but because of rather extreme patterns of characteristic perceptual asymmetry. In fact, the effect of characteristic perceptual asymmetries on asymmetry scores provides a plausible explanation for why some subjects have significant asymmetry scores whereas others do not. The two-task criterion helps to differentiate variations due to hemispheric specialization from those due to characteristic perceptual asymmetry.

As would be expected on the basis of numerous reports of handedness differences in hemispheric specialization, our data reveal that significantly more dextrals are in Group Typical and significantly more sinistrals are in Group Atypical. Although not the primary focus of the present study, our data also indicate that among sinistral subjects, there is an over-representation of females in Group Typical and concomitantly, an over-representation of males in Group Atypical. This finding suggests that among sinistral subjects, the incidence of atypical hemispheric specialization is more frequent among males than females. To our knowledge, the question of whether atypical speech lateralization is more frequent among sinistral males than sinistral females has not been specifically addressed in sodium amytal testing. HECAEN *et al.* [3] reported that the frequency of aphasia following left lesions is higher in sinistral females [89% (25/28)] than sinistral males [69% (41/59)]. The frequency of aphasia following right lesions did not differ between sinistral females [33% (4/12)] and sinistral males [33% (14/42)]. Although the right lesion results involve rather a small number of female subjects and are therefore somewhat inconclusive, the left lesion results suggest that an atypical pattern of speech control may be more frequent among sinistral males than females.

The present finding of a higher incidence of atypical hemispheric specialization among males than females, especially within the sinistral population, also appears to be consistent with GESCHWIND and GALABURDA'S [6] theorizing on the development of hemispheric specialization. They have proposed that an elevated level of testosterone in the male fetus delays the maturation of the left hemisphere, resulting in a shift towards greater right hemisphere participation in functions such as handedness and language. Thus, their theory predicts that on average, males would show greater right hemisphere involvement in manual and linguistic functions and a higher frequency of atypical hemispheric specialization than females. Supporting evidence includes a higher frequency of left-handedness in men and a predominance of males with various sorts of linguistic deficits, including dyslexia, dysphasia and stuttering [6].

In conclusion, the current findings provide strong support for the view that normal subjects' asymmetry scores reflect both characterisitic perceptual asymmetry and hemispheric specialization. Thus, subjects' patterns of hemispheric specialization are not apparent from examining their asymmetry scores on a single laterality task. However, subjects' patterns of hemispheric specialization can be revealed by comparing the magnitude of their asymmetry scores on left and right hemisphere specialized tasks. The question of whether the patterns of hemispheric specialization obtained are related to individual differences in performance on cognitive tasks is now being investigated in our laboratory.

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