gen ratio or by converting relatively refractor organic compounds into digestible material or recyclable nutrients (2). Finally, high bacterial concentrations in macroaggregates may explain the occurrence of bacterivorous ciliates in an environment where bacterioplankton concentrations may be too low to support ciliate growth (28). Some species observed in this study are more typical of a benthic than a planktonic environment [for example, *Peritromus* (Heterotrichida) and *Euplotes* (Hypotrichida) (Fig. 1, F and G)]. Macroaggregates in the open ocean constitute microenvironments which, like the sea-air interface (29), are sites of elevated heterotrophic microbial activity in an otherwise oligotrophic environment.

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Aphasia and Speech Organization in Children

Abstract. *A long-standing controversy concerns whether lateralized cerebral specialization for speech and language is present at the time of language origins (developmental invariance) or whether it gradually develops from initial bilaterality (developmental progression). This controversy is complicated by conflicting reports of the incidence of childhood aphasia. The discrepancies are largely due to one early study. When methods for estimating speech organization distributions are applied to later studies, the developmental invariance position is supported.*

The rarity of speech disturbance following unilateral right-hemisphere brain damage provides conclusive evidence that the vast majority of right-handed adults are left-hemisphere dominant for speech. Evidence concerning the speech organization of children is much less clear, as some studies have reported a higher incidence of aphasia after right-sided lesions in children than in adults (*1*). On the basis of these reports, it is commonly believed that children are born with hemispheric equipotentiality for language and that lateralization occurs as the child matures (*2, 3*). If so, the lateralization seems to be complete by 5 years of age (*3*). There is considerable variability between studies, however, in the reported incidence of aphasia following right lesions. Not all of these studies support the developmental maturation position (*4*). Furthermore, electrophysiological, neuroanatomical, and behavioral data, which are at least as important as aphasia data for judging speech laterality in young children, do not support the developmental maturation position (*5*). Thus, several authors have adopted the developmental invariance position that speech organization in children is similar to that in adults and does not change with age (*4–6*). The relative validity of the developmental maturation and developmental invariance positions seems to depend solely on the relative magnitudes of the proportions of bilaterally organized children and adults.

Methods have recently been proposed for estimating from aphasia incidence the proportions of right- and left-handed adults with right speech, *P(RS)*, left speech, *P(LS)*, and bilateral speech, *P(BS)* (*7, 8*). When applied to adult data these methods suggested a unilateral model for right-handers with an estimated 99 percent and 1 percent having left and right speech, respectively (*8*). We have now applied these methods to childhood aphasia data from the literature. Our overall results support the developmental invariance position.

In a recent review of the literature on childhood aphasia, Satz and Bullard-Bates (*5*) used a method developed by Satz (*7*) to investigate the validity of the developmental maturation and invariance positions. Here we used different exclusionary rules and improved statistical methods (*8*) to assess this issue. The following criteria were required for the inclusion of subjects in our data analyses: (i) Some speech was reported before the onset of the lesion, regardless of how minimal (in some cases this was the expression of several words only). (ii) The patient was under 16 years of age at the time of lesion onset. (iii) Evidence was available that the lesion effects were unilateral. In each study reviewed, the unilaterality of lesions was confirmed by at least one of the following: autopsy, clinical testing, radiographs, arteriograph, pneumoencephalogram, or electroencephalogram. (iv) The presence or absence of aphasia had been assessed after unilateral injury. Aphasic symptoms included any one of the following: loss of speech accompanied by hemiplegia or hemiparesis, paraphasia, or problems in comprehension, expression, reading, writing, or naming. Subjects that were reported with only dysarthria or with only mutism were classified as nonaphasic. (v) Lesion onset occurred

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Table 1. Incidence of aphasia in right-handed children with unilateral left- or right-sided lesions from five studies.*

Group (age)	Study	Subjects (No.)	Left-sided lesion: Aphasia		Left-sided lesion: No aphasia		Right-sided lesion: Aphasia		Right-sided lesion: No aphasia		Total incidence of aphasia	
			Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
≤ 5 years	*(9)*	23	8	80	2	20	6	46	7	54	14	61
	(4, 10–12)	41	16	84	3	16	3†	14	19‡	86	19	46
	(4, 9–12)	64	24	83	5	17	9	26	26	74	33	52
5 to 16 years	*(4, 9–12)*	107	48	73	18	27	1	2	40	98	49	46

*The subjects included from each study were: *(4)* 1, 2, 4, 8 to 21, 23 to 48, 50 to 56, and 58 to 65; *(9)* II to IV, VI to XX, 27 to 30, and 32 to 35; *(10)* 1 to 9, 12 to 14, 16 to 19, and 22 to 25; *(11)* 1 to 8, 10 to 12, 17 to 23, 29, 31 to 38, 40, 41, 45, 52, 53, 60, 66, 68 to 70, and 73 to 81; and *(12)* 1 to 12, 14, 16, 18, 19, 21, 22, 24, and 25. †One of these subjects had suffered a traumatic lesion and the handedness of the other two was unknown. ‡Two of these subjects had suffered traumatic lesions and four others were known to be right-handed.

after 1940. This date was chosen in light of Woods and Teuber's *(4)* suggestion that possible undetected bilateral damage caused by infectious processes may have occurred in patients before antibiotics were in general use. We did not require established hand preference prior to lesion onset.

Using these inclusion criteria, 171 "right-handers"—defined as children not known to be left-handed—from five studies *(4, 9–12)* were retained for analysis *(13)*. Table 1 presents the summary statistics for young right-handers from four studies combined *(4, 10–12)* and from all five studies combined, and for older right-handers combined across studies.

Young and older children were kept separate, as the proportion of aphasias following right-hemispheric lesions, $P(A|RL)$, for older children was significantly less than that for younger children [$\chi^2(1) = 7.01$, $P = .008$] *(14)*. Furthermore, one study *(9)* was kept separate for young children because the Agresti-Wackerly test *(15)* showed overall differences ($P = .04$) between studies with respect to $P(A|RL)$ and four studies *(4, 10–12)* did not differ significantly ($P > .20$) but differed from this one *(9)* when combined [$\chi^2(1) = 4.84$, $P = .028$]. In case the outlier study *(9)* had resulted from an unlikely chance occurrence, we also analyzed the data for all young children combined. The data for older children were combined across studies as the Agresti-Wackerly test for homogeneity of studies did not reach significance ($P \geq .28$).

In order to apply our methods for estimating speech organization distributions *(8)* to the data in Table 1, we assumed that (i) older right-handed children have unilateral speech organization, (ii) the probability of aphasia following a lesion to a language hemisphere of an older right-handed child is the same regardless of speech organization and likewise for a young right-hander, and (iii) the likelihood of aphasia given a lesion to a language hemisphere is the same for young as for older children. Given assumption (i) and using the data from all five studies combined, we estimate that 97 ± 6 percent and 3 ± 3 percent of older right-handed children are left- and right-hemisphere dominant for speech, respectively, where the range of values define approximate 95 percent confidence intervals *(8)* for $P(LS)$ and $P(RS)$ times 100.

Given assumptions (i) to (iii) and using the data from four studies *(4, 10–12)* combined, we estimated that 84 ± 20, 0 ± 28, and 16 ± 36 percent of young right-handed children are left, right, and bilaterally organized for speech, respectively *(16)*. The null hypothesis that $P(BS) = 0$ was not rejected ($P = .18$) by the test derived in *(8)*. Using the data from young right-handed children in the outlier study *(9)*, we estimated that 42 ± 38, 0 ± 38, and 58 ± 56 percent have left, right, and bilateral speech representation. These data provided significant evidence that $P(BS) > 0$ ($P = .02$). The estimates obtained for young right-handers from all five studies combined are 69 ± 20, 0 ± 26, and 31 ± 36 percent, respectively, and the hypothesis $P(BS) = 0$ was rejected ($P = .04$).

A comparison of these estimated speech organization distributions with those for adults permits two conclusions concerning the current version of the developmental maturation position *(3)*. (i) That the distribution for older right-handed children is nearly identical to that for right-handed adults corroborates the belief that, if lateralization does occur, it is complete by age 5. (ii) Although proponents of the maturational hypothesis have not specifically stated what percentage of individuals are believed to lateralize, 100 percent is implied. Since the 95 percent confidence interval for $P(BS)$ obtained from the young right-handed children's data combined is 0.31 ± 0.36, the developmental maturation position is either incorrect or needs modification. An intuitively appealing restatement of the maturational hypothesis is that very young (≤ 5 years of age) right-handed children have speech organization distributions similar to those of left-handers, but right-handers lateralize while left-handers remain invariant with age. Even this modified position is inconsistent with our results, however, as the estimated $P(BS)$ for young right-handed children is 0.31 and that for left-handed adults is about 0.70 *(7, 8)*. Although further modification of the maturational position could result in a restatement consistent with reported childhood aphasia incidence, we believe that these data support the invariance position. We have drawn this conclusion, in spite of a rejection of the null hypothesis that $P(BS) = 0$ by childhood data from young right-handers, for two reasons. (i) Woods and Teuber *(4)* convincingly argued that Basser's *(9)* data may be severely contaminated by lesions with bilateral effects. If so, the combined data for young right-handers would overestimate $P(BS)$. When Basser's data were excluded, we estimated a statistically nonsignificant 16 percent of all young right-handers to have bilateral speech organization. (ii) Even with Basser's study excluded, the data are likely to be contaminated by left-handers and perhaps by bilateral lesions in some cases of trauma *(10)*. After excluding all trauma cases and cases with undetermined hand preference from the four remaining studies *(4, 10–12)*, four right-hemisphere lesions remain, none of which caused aphasia. Thus, from this "clean" but small data set, $P(BS)$ is estimated to be 0, supporting the developmental invariance position. If we exclude trauma cases but keep cases with undetermined handedness, 19 right-hemisphere lesions remain, two of which resulted in aphasia. Four of these 19 cases are known right-handers, leaving two of 15 aphasias following right lesions in young children of unknown hand preference. Given that 10 percent of these youngsters would have become left-handed, that 70 percent of these are at risk to a right-sided lesion, and that 75 percent of those at risk suffered aphasia, it is reasonable to expect that one of the two aphasics was left-handed. Thus, the estimated *P(A|RL)* adjusted for left-hander contamination is .056 = 1/18. The estimated proportion of aphasias following left-hemisphere lesions (that is, .84) should not be appreciably affected by contamination by left-handers, bilateral lesions, or both, and need not be adjusted. These adjusted proportions are similar to those for adults and result in similar estimates of *P(LS)* and *P(RS)*—.94 and .06, respectively. Stricter inclusion criteria would likely place even less emphasis on right-hemisphere lesions as cause of aphasia (*17*) and thereby result in an even lower estimate of *P(RS)*. Hence, if Basser's study (*9*) is excluded, the childhood aphasia data are consistent with electrophysiological, neuroanatomical, and behavioral data in their support of the developmental invariance position.

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Odor Quality: Semantically Generated Multidimensional Profiles Are Stable

Abstract. *Odors of ten compounds were characterized by approximately 150 subjects who used a list of 146 descriptors. Duplicate profiles correlated highly ($P < .001$) and consistently higher than profiles of different odors. Profiles also agreed with those obtained previously. Thus, profiles based on combined responses of many subjects are stable constructs.*

Methods for characterizing odors have applications in a variety of disciplines. There are two principal methods. In reference odorant methods, the odor is rated for similarities by direct comparison to a series of reference odorants (*1*). In semantic methods, the odor is described by words or rated for the applicability of various odor descriptors (*2, 3*). Both methods can produce multidimensional profiles that can be depicted by two-dimensional bar graphs. The profile depends on the selected reference odorants or descriptors.

The semantic method is logistically simpler, but has been considered significantly "noisy" because of interindividual differences in the meanings of specific descriptors (*4*). I now report the extent to which the semantic profile stabilizes if a large number of subjects are used.

The study was a part of a cooperative exercise conducted by the American Society for Testing and Materials (ASTM) Sensory Evaluation Committee E18, with 15 laboratories, each of which contributed ten subjects (*5*). The samples were 12.5 by 9 by 1.6 mm balsa wood chips impregnated with solutions of odorants in odorless dipropylene glycol (Olin) and enclosed in a rip-apart disposable aluminum packet. Each of 150 participants (*6*) received an individual sample attached to a multidimensional rating form (*3*).

The form utilizes 146 descriptors and is based on Harper's 44-descriptor list (*2*). The 44-descriptor scale gave almost identical profiles for odors that were clearly different, so over a period of years more descriptors were added in stages. The major expansion resulted after the ASTM Sensory Evaluation Committee reviewed literature and industrial sources and collected over 830 odor descriptors in use. A group of participating laboratories screened this long list and reduced it to approximately 160 descriptors judged useful in odor evaluations. The list used here represents most of these descriptors, after some obvious synonyms were removed.

The suitability of each descriptor to the odor being tested was scored on a scale of 0 to 5. Both the sample and the form were coded, and the identity of the odorant was revealed to the experimenters and the subjects only after the test.

The following ten odorants were used (concentrations in grams per liter of the solvent in parentheses): acetophenone (50), anethole (100), 1-butanol (160), *l*-carvone (100), *p*-cresylmethylether (25), cyclohexanol (350), 1-heptanol (350), 1-hexanol (200), phenylethanol (40), and pyridine (150). The same odorants had been used in a previous study (*3*), and at that time were selected to represent several with similar odors (aliphatic alcohols) as well as those with very different odors. All are chemically stable and were of the highest purity available commercially. Each odorant was profiled twice, under different code names, and more than 2 months apart. There was no requirement to use the same subjects either for all samples or for a duplication of the same sample; in practice, most of the subjects remained the same.

Profiling an odor by a group of subjects produces two types of values for each descriptor: frequency of use of the descriptor and a sum of scores assigned to the descriptor. Two profiles of the same odorant expressed in terms of either the frequency or the sum of scores were highly correlated (all $r > .96$, $P < .001$). Since the frequencies alone do not contain information on the scores, a hybrid method was selected in which both types of values are considered (*3*). This "percent applicability" method tends to reconcile cases in which a descriptor was used frequently but with low scores, with cases in which this descriptor was used infrequently but with high scores. The findings apply equally to profiles constructed on the basis of frequency, score sum, or percent applicability.

The applicability of each descriptor was calculated as follows. Suppose that six of ten subjects used a particular descriptor for a specific odor, and the sum of the scores given by these six was 20. The frequency and the sum of scores were expressed as percentages of the maximum possible value (10 is maximum for the frequency and 50 is maximum for the sum of scores, so in this case, the frequency was 60 and sum 40 percent). The geometric mean of the two percent-