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Gender and Aphasia in the Stroke Data Bank

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Aphasia was present in 19.4% of the men and 22.5% of the women in the Stroke Data Bank. There were no gender differences in aphasia incidence among the intracerebral hemorrhages. Aphasia was more frequent among women with infarcts (37.0%) than men (28.3%). When stroke mechanism was controlled for, there was an excess of aphasia among the women with stroke due to cardiac embolism. When stroke site was controlled for, there were no gender differences in aphasia frequency. Wernicke's, global, and anomic aphasias were more common in women than men; Broca's aphasia was somewhat more common in men. Although there were no gender differences in infarct size overall, men with aphasia had larger infarcts than women with aphasia. Although gender differences were small, the infarct lesions producing aphasia in men were more posteriorly placed and the infarct lesions in women were more anteriorly placed, suggesting possible gender differences in the positioning of the language zone in the brain.

The existence of gender differences in aphasia incidence, aphasia severity, and aphasia type after stroke has been debated over the past 15 years. When uncontrolled samples of aphasic patients are selected from aphasia clinics or rehabilitation centers, there is often an excess of men over women. For example, Brown and Grober's (1983) sample from an aphasia clinic consisted of 273 men and 116 women, Harasymiw, Halper, and Sutherland's sample (1981) from a rehabilitation hospital consisted of 194 men and 164 women, and Basso, Capitani, and Morachini's sample (1982) from an aphasia clinic consisted of 264 men and 121 women. Other

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samples of aphasics have shown an excess of men over women (Schecter, Sheiter, Abarbanel, Koren, Mendelson, Ring, & Becker, 1985; Sarno, Buonaguro, & Levita, 1985; Kertesz & Sheppard, 1981; Pizzamiglio, Mammucari, & Razzano, 1985; Kertesz & Benke, 1989; Steinvil, Rin, Schechter, & Solzi, 1985). A Norwegian sample of aphasics showed an excess of women over men (Sundet, 1986). McGlone (1977) has suggested that aphasia is more frequent in men than women. Although many aphasic samples show an excess of men over women, these studies do not indicate that aphasia is more likely to occur after stroke in men than women since they do not control for gender differences in stroke incidence, stroke severity, stroke type, or stroke location.

Gender differences in aphasia recovery have been examined. Some investigators have reported better recovery in women than men (Pizzamiglio, Mammucari, & Razzano, 1985), whereas others have doubted any gender differences in aphasia recovery (Sarno, Buonaguro, & Levita, 1985). Most studies have found no gender differences in aphasia type or severity (Basso et al., 1982; Schecter et al., 1985; Kertesz & Sheppard, 1981; Kertesz & Benke, 1989; Scarpa, Colombo, Sorgato, & De Renzi, 1987).

Based on the topographic distribution of brain lesions producing aphasia, Kimura (1983, 1984) has suggested that the language zone is more anteriorly placed in women than men. This view has received support from intra-operative stimulation studies of Ojemann (1989, 1991) which have shown a trend for the language zone to be more anteriorly placed in women than men. Kertesz and Benke (1989) were unable to find any gender differences in the location of stroke lesions producing aphasia.

The purpose of our study was several-fold. First, to determine whether there were any gender differences in stroke type, stroke location, or stroke severity in the Stroke Data Bank. Second, to determine whether there were gender differences in aphasia incidence or type in the Stroke Data Bank. Third, to determine whether gender differences in aphasia incidence reflected gender differences in stroke type, location, or severity. Finally, to determine whether there were gender differences in the topographic distribution of lesions producing aphasia in the Stroke Data Bank.

METHODS

From July, 1983 to June, 1986, the NINDS Stroke Data Bank, a cooperative effort involving four teaching hospitals and the NINDS, enrolled 1805 patients with acute stroke (237 with intracerebral hemorrhage, 936 with ischemic infarction (not-lacune), 337 with lacunar infarction, 243 with subarachnoid hemorrhage, and 52 with stroke due to other etiology). Design, methods, and baseline characteristics are described elsewhere (Foulkes, Wolf, Price, Mohr, & Hier, 1988). For infarction cases, the neurologist's discharge diagnosis for location and CT scan diagnosis for location were compared. Discrepancies between the CT scan location code and the neurologist's discharge diagnosis code were resolved by re-

viewing drawings of infarctions made from the CT scans. Discrepancies in the coding of the infarction location were resolved in 19 patients (10 men, 9 women). Two patients (1 man, 1 woman) misclassified as having aphasia from brainstem lesions were reclassified as non-aphasic. Strokes were classified as either infarcts or hemorrhages. Strokes were assigned one of nine stroke mechanisms (Table 2).

An axial CT scan template of the brain divided into nine levels were drawn based upon the CT atlas of Gado, Hanaway, and Frank (1979). Axial sections were re-drawn with right–left symmetry. Investigators drew the infarctions onto the templates with regard to size and location across appropriate levels. If there was extensive mass effect or distortion, brain structures were drawn as if they were not displaced. A research assistant applied a transparent overlay. For each axial section, a grid scheme consisting of up to 100 discrete cells per CT scan level allowed coding of areas involved. Lesions were coded by level (1 to 9), density (high or low), and cell address. A cell was coded as occupied if the lesion involved more than 50% of the cell area. On a identical grid scheme of the CT scan template, each cell of the left hemisphere was gray-scale coded for relative lesion frequency in the aphasic men and women (Figs. 1 and 2). A contingency table was created for each CT scan template cell in the left hemisphere for all aphasic patients (gender by presence of lesion). Tables were evaluated by a χ^2 test ($df = 1$). Cells were then gray-scale coded for gender differences in distribution of CT scan lesions. Cells were labeled as either no gender difference, higher frequency in men, or higher frequency in women (Fig. 3).

Hemorrhage volumes and ischemic infarction volumes were estimated from drawings based on the CT scan. Weakness was rated on a 60 point scale (0 = normal, 30 = complete hemiplegia, 60 = bilateral hemiplegia). Neurologists rated aphasia, neglect, and dementia as either absent or present. Aphasia was further classified as Broca's, Wernicke's global, conduction, anomic, or transcortical.

RESULTS

When the Stroke Data Bank is considered as a whole ($n = 1805$), there are no gender differences in the frequency of aphasia, dementia, or neglect (Table 1). Intracerebral hemorrhage and atherosclerotic infarction were more common in men whereas subarachnoid hemorrhage was more common in women (Table 2). When controlling for stroke mechanism, aphasia was more common in the women with embolic infarction (42.0%) than the men (31.6%). Gender had a significant influence on stroke site ($\chi^2 = 40.4$, $df = 6$, $p = .00$). Women had more left surface lesions than men, whereas men had more cerebellar and brainstem lesions. When

TABLE 1
Frequency of Aphasia, Dementia, Neglect, and Cortical Atrophy by Gender

	Men ($n = 842$)	Women ($n = 963$)	p*
Aphasia	19.4%	22.6%	.09
Dementia	7.7%	7.6%	.91
Neglect	14.4%	15.1%	.68
Cortical atrophy	44.3%	43.0%	.58

* χ^2 test for gender difference, $df = 1$.

TABLE 2
Aphasia Frequency by Stroke Type

Stroke type**	Men	Women	Men with aphasia	Women with aphasia
INF CU	203	256	26.6%	32.8%
INF NA	24	25	25.0%	44.0%
INF TAP	35	34	42.9%	35.3%
INF EMB*	114	132	31.6%	42.0%
INF ATH	73	40	21.9%	27.0%
INF LAC	156	181	2.6%	3.3%
ICH	134	103	15.7%	15.5%
SAH	76	167	2.6%	3.0%
OTH	27	25	33.3%	44.0%
Total	842	963	203	256

Note. Abbreviations used: INF CU, infarction cause unknown; INF NA, infarction with normal angiogram; INF TAP, infarction with tandem pathology (probable artery-to-artery embolism); INF EMB, infarction due to cardiac embolism; INF ATH, infarction due to atherosclerosis; ICH, intracerebral hemorrhage; SAH, subarachnoid hemorrhage; OTH, other stroke.

* Aphasia more frequent in women with embolism, $\chi^2 = 6.0$, $df = 1$, $p = .014$.

** Stroke type differs by etiology, $\chi^2 = 49.3$, $df = 8$, $p < .0001$.

controlling for stroke site, there were no gender differences in aphasia incidence (Table 3).

Ischemic Infarctions

The ischemic infarctions (lacunes excluded, $n = 936$) showed a gender difference in aphasia incidence. Aphasia was more frequent in women than men (Table 1). Aphasia syndrome differed by gender ($df = 6$, $\chi^2 =$

TABLE 3
Aphasia Frequency by Stroke Site

Stroke Site	Men*	Women*	Aphasic men**	Aphasic women**
Left surface	207	288	58.0%	61.5%
Right surface	173	183	4.1%	2.8%
Left deep	137	130	21.7%	23.1%
Right deep	108	137	3.7%	1.4%
Cerebellum	28	19	0.0%	0.0%
Brainstem	121	77	0.0%	0.0%
Other	68	129	4.4%	2.4%
Total	842	963	19.4%	22.5%

* Stroke site differs by gender, $\chi^2 = 40.4$, $df = 6$, $p < .001$.

** Aphasia frequency does not differ by gender at any stroke site, $df = 1$, $p > .05$.

TABLE 4
Distribution of Aphasia Syndrome by Gender and Stroke Class (Counts)

Aphasia syndrome	Infarcts		Hemorrhages	
	Men*	Women*	Men**	Women**
Broca	22	18	1	2
Wernicke	16	24	2	3
Global	46	81	5	7
Anomic	15	27	6	1
Conduction	4	0	0	0
Transcortical	8	9	3	2
Other	16	21	4	1
Total	127	180	21	16

Note. Excluding strokes due to "subarachnoid hemorrhage" or "Other" etiologies.

* Distribution of aphasia syndrome in infarct class differes by gender, $df = 6$, $\chi^2 = 18.3$, $p < .006$.

** Distribution of aphasia syndrome in hemorrhage class does not differ by gender, DF $= 5$, $\chi^2 = 5.2$, $p = .39$.

18.32, $p = .006$). There was an excess of women with global, Wernicke's, and anomic aphasias compared to the men (Table 4).

Aphasics had larger infarcts than non-aphasics (Table 5, $df = 1$, $F = 14.8$, $p = .0001$). Gender had no influence on infarct size ($df = 1$, $F = .4$, $p = .53$). For infarct size, the aphasia × gender interaction was significant ($df = 1$, $F = 4.1$, $p = .4$) with aphasic men having larger infarcts (mean = 34.5 ml) than aphasic women (mean = 25.2 ml). Infarct size differed by aphasia syndrome ($F = 19.0$, $df = 1$, $p = .0001$). Infarct sizes were larger for the global and Broca's aphasics (Table 6). Although there was no main effect of gender on infarct size ($F = .03$, $df = 1$, $p = .86$), there was a significant interaction between gender and aphasia syndrome infarct size ($F = 2.8$, $p = .02$, $df = 5$) so that for a given aphasia syndrome, men tended to have larger volumes than women.

Age did not differ by presence of aphasia (Table 5). Men (mean age = 65.3) were younger than women (mean age = 69.2). There was no interaction for age between gender and presence of aphasia or between gender and aphasia syndrome. There was a marginal effect of aphasia syndrome on age ($F = 2.0$, $df = 6$, $p = .06$). Global and Wernicke's aphasics tended to be older than anomic and Broca's aphasics (Table 6).

Aphasia had a main effect on both right-sided and left-sided weakness. Aphasics had more right-sided and less left-sided weakness than non-aphasics. Gender had significant main effects on weakness with women having more left-sided and more right-sided weakness than men (Table 7).

For aphasic patients, the ischemic lesions were mapped onto probabil-

TABLE 5
Infarct Size, Age, and Weakness Score for Ischemic Infarctions (Lacunes Excluded)

Group	Infarct size* (ml)	Age* (yrs)	Left-sided weakness*** (score)	Right-sided weakness**** (score)
Aphasic	29.1	67.7	2.6	13.0
Non-Aphasic	18.8	67.1	9.6	5.4
Men	23.0	65.3	6.6	7.1
Women	21.4	69.2	7.9	8.7
Aphasic men	34.5	65.5	2.8	11.8
Non-aphasic men	18.3	65.2	8.2	5.2
Aphasic Women	25.2	69.3	2.5	13.9
Non-aphasic women	19.3	69.1	11.1	5.6

* Aphasics had larger infarcts ($F = 14.8$, $df = 1$, $p = .0001$). For infarct size, there was a significant gender × aphasic interaction ($F = 5.1$, $df = 1$, $p = .04$) with male aphasics having larger infarcts than female aphasics.

** Men with stroke were younger than women with stroke ($F = 18.3$, $df = 1$, $p = .001$). There was no main effect of aphasia on age.

*** Aphasics had less left-sided weakness than non-aphasics ($F = 115.7$, $df = 1$, $p = .0001$). Women had more left-sided weakness than men ($F = 4.6$, $df = 1$, $p = .03$). There was a significant gender × aphasia interaction for left-sided weakness (ANOVA, $F = 11.4$, $df = 1$, $p = .0008$).

**** Aphasics had more right-sided weakness than non-aphasics ($F = 130.7$, $df = 1$, $p = .0001$). Women had more right-sided weakness than men (F 6.7, $df = 1$, $p = .01$). There was no gender × aphasia interaction for right-sided weakness.

TABLE 6
Age, Weakness, and Infarct Size by Aphasia for Ischemic Infarctions (Lacunes Excluded)

Syndrome	Infarct size (ml)	Age (yrs)	Left-sided weakness (score)	Right-sided weakness (score)
Broca	24.5	63.6	2.8	11.7
Wernicke	13.9	68.0	1.1	5.6
Global	49.7	70.4	2.5	21.1
Anomic	6.6	65.8	2.6	6.0
Conduction	14.0	59.8	0.5	1.3
Transcortical	14.1	64.2	1.2	8.7

TABLE 7
Hemorrhage Size, Age, and Weakness Score for Intracerebral Hemorrhages[a]

Group	Hemorrhage size (ml)	Age (yrs)	Left-sided weakness (score)	Right-sided weakness (score)
Aphasic	19.0	62.4	4.3	13.1
Non-aphasic	12.9	58.5	16.2	14.1
Men	18.2	57.7	14.9	14.1
Women	17.9	61.0	13.7	13.8
Aphasic men	13.2	58.3	5.5	11.7
Non-aphasic men	19.1	57.6	16.6	14.5
Aphasic women	12.5	67.8	2.7	15.0
Non-aphasic women	18.9	59.7	15.7	13.6

[a] No main effects for gender or aphasia on hemorrhage size, age, right-sided weakness, or left-sided weakness (ANOVA). None of the gender × aphasia interactions were significant for any of the variables (ANOVA).

ity plots (Figs. 1 and 2). Men and women showed similar patterns with lesions clustered in the territory of the left middle cerebral artery. For each cell, contingency tables were created to examine gender differences in probability of finding a lesion for aphasic cases. A cutoff of $p < .10$ ($df = 1$) was used. This probability map showed (Fig. 3) that certain cells in the anterior part of the brain were more likely to be occupied by women with aphasia and certain cells in the posterior part of the brain (including thalamus) were more likely to be occupied by men with aphasia.

Hemorrhages

Hemorrhage volume did not differ by presence of aphasia ($F = 3.2$, $df = 1$, $p = .07$) or gender ($F = .01$, $df = 1$, $p = .92$). There was no interaction between presence of aphasia and gender for hemorrhage volume (ANOVA, $F = .01$, $df = 1$, $p = .93$). For hemorrhage cases, mean age did not differ by presence of aphasia ($F = 1.8$, $df = 1$, $p = .18$) or by gender ($F = 2.3$, $df = 1$, $p = .13$). For age, there was no interaction between aphasia and gender (ANOVA, $F = 1.6$, $df = 1$, $p = .21$). ANOVA for degree of weakness showed no effect for gender in the hemorrhage cases ($F = .02$, $df = 1$, $p = .88$). Left-sided weakness was greater for the non-aphasic cases ($F = 27.1$, $df = 1$, $p = .001$). Right-sided weakness did not differ by presence of aphasia ($F = .2$, $df = 1$, $p = .68$). There was no interaction between aphasia and gender for either right-sided weakness ($F = .7$, $df = 1$) or left-sided weakness ($F = .2$, $df = 1$).

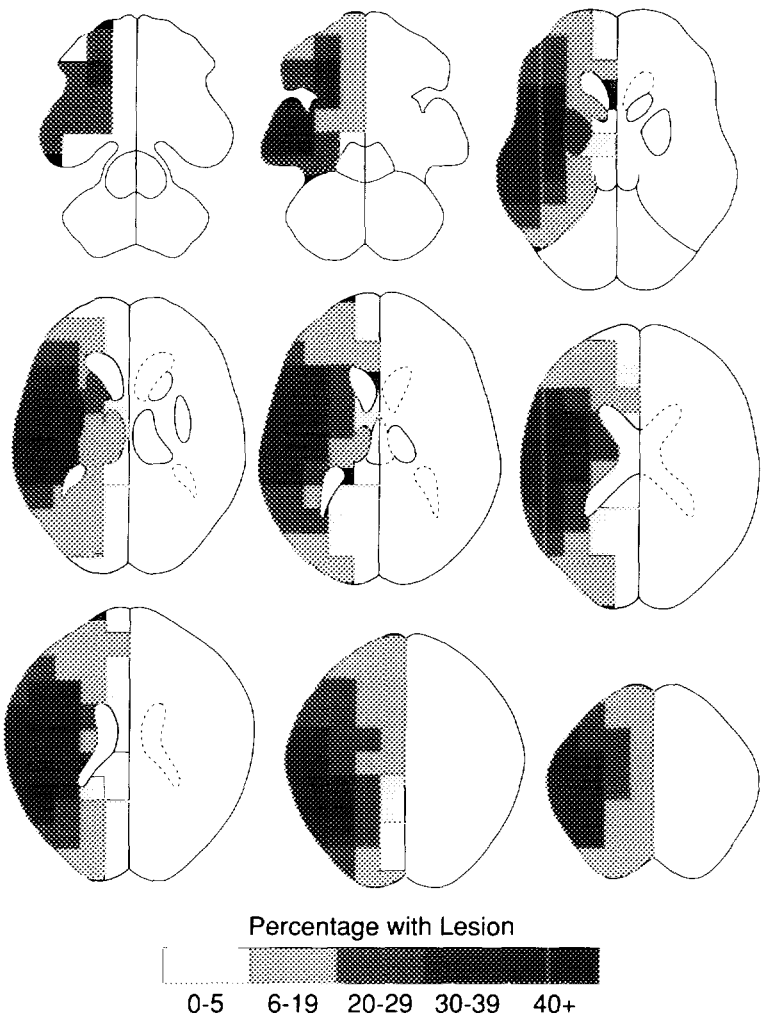

FIG. 1. Probability map for left hemisphere infarcts. Grid cells are gray-coded according to frequency for men with aphasia.

DISCUSSION

There Are Gender Differences in Stroke Type and Stroke Site

Women had more surface lesions (especially left-sided) and men had more cerebellar and brainstem lesions. Men had more intracerebral hemorrhages and atherosclerotic infarctions, whereas women had more car-

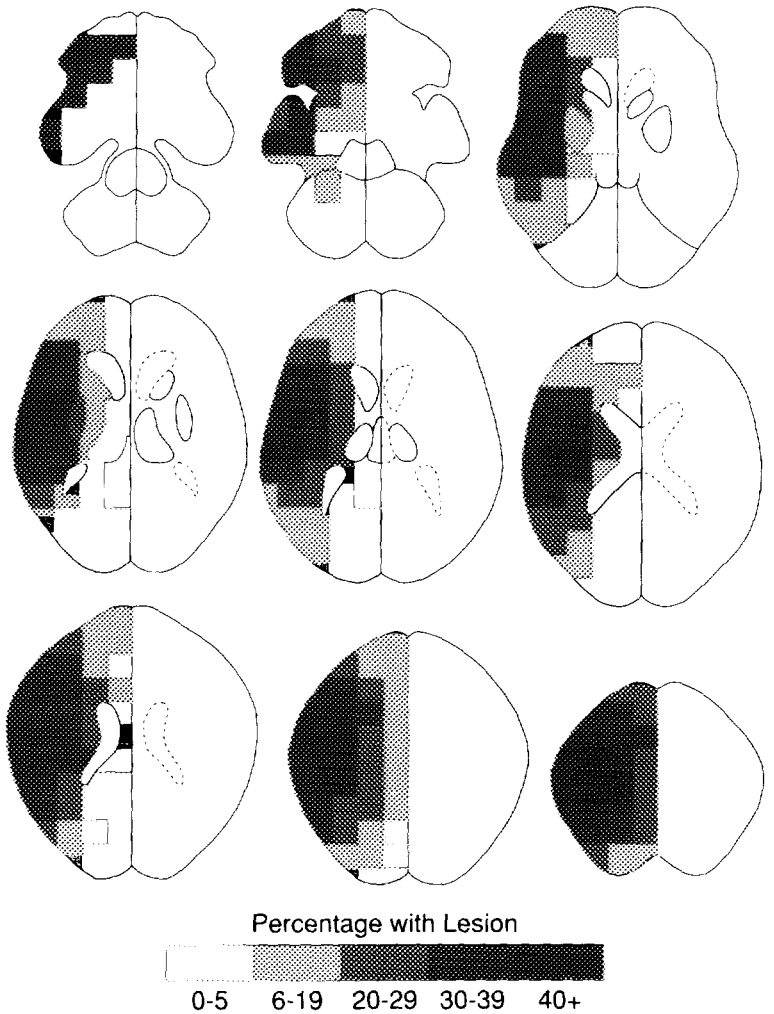

FIG. 2. Probability map for left hemisphere infarcts. Grid cells are gray-coded according to frequency for women with aphasia.

diac emboli, subarachnoid hemorrhages, and infarcts of causes unknown. Since this is a case-based stroke registry, rather than a population-based study, it is subject to sampling biases. Nonetheless, our results suggest that there may be gender differences in stroke type and stroke site. These differences may be important in predicting the frequency of aphasia after stroke since aphasia incidence is 39.8% for cardiac emboli, 23.9% for

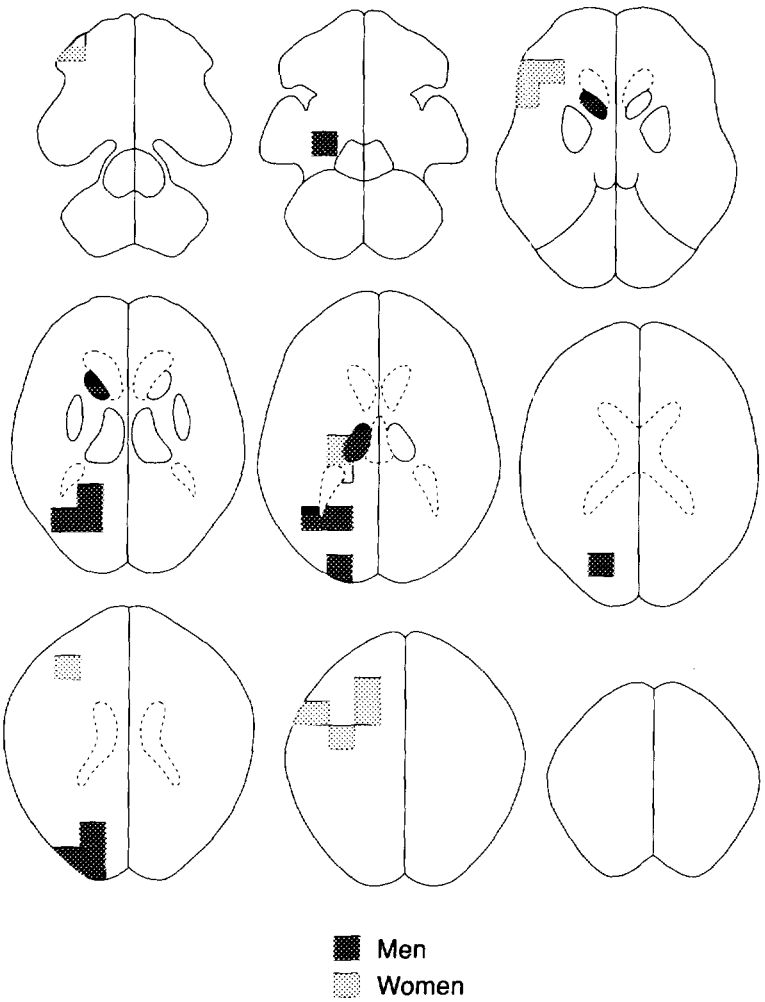

FIG. 3. Topographic map showing grid cells where probability frequency differed between men and women ($p < .10$). Black cells indicate cells where men with aphasia were more likely to have an infarct than women. Gray cells indicate cells where women with aphasia were more likely to have an infarct than men.

atherosclerotic infarction, and only 15.6% for intracerebral hemorrhage. Furthermore, aphasia incidence drops from 58.4% for left surface lesions to 22.1% for left deep lesions to less than 3% for other sites in the brain.

After Controlling for Stroke Type and Stroke Site, There Is Little Gender Difference in Aphasia Incidence

Within the Stroke Data Bank, 22.6% of the women and 19.4% of the men were aphasic. When stroke site is controlled for (Table 3), there is no significant gender difference in aphasia incidence. When stroke mechanism is controlled for (Table 2), only the cardiac emboli subgroup showed an excess of women with aphasia. The explanation for this gender difference is uncertain but may reflect an artifact in that there is an excess of women with left surface lesions (288 versus 207) in the Stroke Data Bank (Table 3).

Aphasia Subtype Differed by Gender

In the Stroke Data Bank there is an excess of women with global, Wernicke's, and anomic aphasias and an excess of men with Broca's aphasia. The explanation for this gender difference in aphasia syndrome is uncertain. Wernicke's aphasia is usually due to embolism (Knepper, Biller, Tranel, Adams, & Marsh, 1989) and more women had embolic strokes in the Stroke Data Bank. Global aphasia may be due to either atherosclerosis of the carotid artery or cardiac embolism, although the predominant mechanism is probably cardiac embolism. Broca's aphasia is often associated with atherosclerosis (usually of the carotid artery), a subtype favoring men in the Stroke Data Bank. DeRenzi, Faglioni, and Ferrari (1980) did find an excess of men with Broca's aphasia, consistent with our findings in the Stroke Data Bank. Others have found no relationship between gender and aphasia syndrome (Schecter et al., 1985; Kertesz & Sheppard, 1981; Scarpa et al., 1987).

Ischemic Lesions Producing Aphasia Were Larger in Men Than Women

Although there were no gender differences in mean ischemic lesion size, aphasic men had larger mean ischemic lesions than aphasic women. The explanation for this gender difference is uncertain. For each aphasic syndrome (anomic, Broca's, global, transcortical, and Wernicke's), men had larger mean ischemic lesions than women. This occurred despite the fact that mean infarct size was comparable between women (mean = 21.5 ml) and men (mean = 23.0 ml). This raises the speculation that smaller ischemic stroke lesions may be capable of producing aphasia in women than men. Further study of this speculation is warranted.

Age Was a Weak Correlate to Aphasia Type in the Stroke Data Bank

As expected, mean age for men was less than that for women in the Stroke Data Bank. Women with aphasia were older than men with aphasia. As demonstrated in previous studies (Basso et al., 1987; Eslinger & Damasio, 1981), global and Wernicke's aphasics tended to be older than Broca's aphasics.

Gender Has an Influence on the Topographic Distribution of Lesions Producing Aphasia

Topographic maps of ischemic lesions producing aphasia in men and women were grossly similar (Figs. 1 and 2). However, cell-by-cell comparisons of these maps showed that ischemic lesions were more anteriorly situated in women and more posteriorly situated in men (Fig. 3). One explanation for this finding is a gender difference in the topographic location of the language zone (more posteriorly in men and more anteriorly in women). Our findings are consistent with this hypothesis. Nonetheless, additional studies to examine this hypothesis are needed including further studies of stroke lesions, SPECT language activation studies, PET language activation studies, and intro-operative language mapping studies.

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