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Lesion-aphasia discordance in acute stroke among Bengali-speaking patients: Frequency, pattern, and effect on aphasia recovery

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ABSTRACT

Introduction: Contemporary research papers have highlighted the issue of lesion-aphasia discordance in reference to the classic 'associationist' model provided by Wernicke-Lichtheim. The objective of the present study is to explore frequency, pattern and evolution of lesion-discordant aphasia following first ever acute stroke in Bengali-speaking subjects.

Methods: Bengali version of Western Aphasia Battery, a validated scale, was used for language assessment in our study subjects. Lesion localization was done by using Magnetic resonance imaging (MRI) (3T) for ischemic stroke (if not contraindicated) and computed tomography (CT) for hemorrhagic stroke. Among 515 screened cases of first-ever acute stroke, 208 presented aphasia. Language assessment was done between 7 and 14 days in all study subjects and was repeated between 90 and 100 days in patients available for follow-up. Ischemic stroke cases with contraindication for MRI underwent CT imaging. Discordance between lesion and aphasic phenotype was determined only for right-handed subjects with cortical involvement (isolated or in combination with sub-cortical white matter) in the left hemisphere. Appropriate statistical tests were used to analyze the collected data.

Results: Lesion-aphasia discordance was found in 20 out of 134 patients with aphasia who were dextral and had cortical involvement in the left hemisphere (14.92%). The pattern of discordance observed were- posterior lesion with Broca's aphasia (4; 20%); posterior lesion with global aphasia (8; 40%); anterior lesion with global aphasia (4; 20%), and posterior lesion with mixed transcortical aphasia (4; 20%). On univariate analysis, the factors significantly associated with lesion-aphasia discordance were hemorrhagic stroke ($p = 0.000$); posterior perisylvian location ($p = 0.002$), and higher education ($p = 0.048$). After adjusting for all other variables, hemorrhagic stroke was found to have strong association with lesion-aphasia discordance ($p = 0.001$, OR = 11.764, 95% CI, 2.83–50.0). Discordant cases were more likely to recover or change to a milder type compared to concordant cases ($p = 0.007$, OR = 11.393, 95% CI, 1.960–66.231), after adjusting for all other variables including initial severity of aphasia ($p = 0.006$, OR = 8.388, 95% CI, 1.816–38.749).

Conclusion: Lesion-aphasia discordance following acute stroke is not uncommon among Bengali-

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speaking subjects. In the discordant group, preponderance towards non-fluent aphasia was observed. Discordance occurred more frequently after hemorrhagic stroke. Subjects with lesion-discordant aphasia presented better recovery during early post-stroke phase.

1. Introduction

The study of lesion-aphasia association has its roots in Wernicke- Lichtheim model (Lichtheim, 1885; Wernicke, 1874) which was later refined by Geschwind (1974, pp. 105–236). Owing to simplicity, it has remained the most widely used model of brain representation of language up todate (e.g., Coppens, 2016; Fridriksson et al., 2018; Howard & Hatfield, 2018). This model associates major type aphasic syndromes with specific lesion locations, such as Wernicke's and Broca's aphasia were associated with damage to Wernicke's and Broca's areas, respectively. However, subsequent research came to conclude that localized damage to these aforementioned areas not necessarily give rise to the classic picture of Wernicke's and Broca's aphasia. Basso et al. (1985) described the frequent lesion-aphasia discordance. Recent studies which explored the specific linguistic functions of the classic cortical language areas concluded that to produce the classic aphasia phenotypes, quite wider damage is required than what was conceived in Wernicke-Lichtheim model (e.g., Ardila, Bernal, & Rosselli, 2016; Dronkers, Plaisant, Iba-Zizen, & Cabanis, 2007). Thus, it would be more prudent to associate specific brain regions with particular linguistic abilities and not with aphasic phenotypes as a whole. From the clinical perspective, however, the concept of aphasic phenotype remains important. The most widely used aphasia batteries for evaluation of aphasia such as the Boston Diagnostic Aphasia Examination (Goodglass, Kaplan, & Barres, 2000) and the Western Aphasia Battery (Kertesz, 2006) also acknowledge the aphasia typology.

In reality, Wernicke-Lichtheim model has proven to be limited for explaining the diversity of language disturbances observed in cases of brain pathology. For instance, Fridriksson, Fillmore, Guo, and Rorden (2014) examined brain damage associated with Broca's aphasia in a group of 70 patients and found that damage to the posterior portion of Broca's area, the *pars opercularis*, is associated with Broca's aphasia. Nonetheless, several patients with other aphasia syndromes had significant damage to *pars opercularis,* suggesting that damage to this area is not sufficient to cause Broca's aphasia. In a further analysis, when including only patients with *pars opercularis* damage, it was found that patients with Broca's aphasia had more extended damage in the left superior temporal gyrus. Than those with other aphasia types. The authors suggest that individuals with Broca's aphasia have damage to both Broca's and Wernicke's areas. Yourganov, Smith, Fridriksson, and Rorden (2015) also found that Broca's aphasia is strongly associated with damage to *pars opercularis*. Its posterior neighbor, rolandic operculum, also has high predictive relevance. Conduction aphasia is associated with damage to the posterior segment of the arcuate fasciculus, Heschl's gyrus, and optical tracts. Global aphasia is associated with extensive cortical damage. Wernicke's aphasia can be predicted from damage to angular, Heschl's, and superior temporal gyri, as well as temporal pole and putamen. Within the same vein, using high resolution magnetic resonance imaging it has been found that the two patients initially described by Paul Broca had lesions extended into medial regions of the brain, in addition to the surface lesions reported by Broca (Dronkers et al., 2007). No question, classical Wernicke-Lichtheim, and also the so-called Wernicke-Geschwind model (Geschwind, 1974, pp. 105–236) require significant re-interpretation (Tremblay & Dick, 2016). However, few aphasia re-interpretation proposals are currently available (e.g., Ardila, 2010).

One of the most influential contemporary neuropsychological models of speech and language organization in the brain is the dual stream model (Hickok & Poeppel, 2004, 2007), which is also associationist, like the Wernicke-Lichtheim model, but emphasizes on the connections between cortical regions. During recent years, however, the concept of bilateral representation of language abilities has gained attention (e.g., Bernal & Ardila, 2014). Some of the lesion-aphasia discordance situations could actually be explained assuming a bilateral representation of language. Clinicians are often faced with the issue of lesion-aphasia discordance particularly in settings of acute stroke. Although the subject of lesion-aphasia mismatch has been often analyzed (Coppens, Hungerford, Yamaguchi, & Yamadori, 2002), the frequency and pattern of such discordance has not adequately been dealt within existing literature.

The study of possible lesion localization for a given aphasic phenotype may also provide clues about the cerebral language representation in the study population. It has already been established that language representation in the brain may be variable across different languages (e.g., Tzeng, Chen, & Hung, 1991). In a recent article by Bohra et al. (2015), it was observed that the majority (65%) of the patients did not show any conformity between the location of the brain lesion and the type of aphasia according to ‘traditional localizationist model’. Noteworthy, this particular study was done on Hindi-speaking subjects of northern part of India, and suggests that the aphasia models when applied to non-western languages may require some adaptations. Lesion aphasia association in Bengali language – an Indo-Aryan language primarily spoken in Bangladesh and India–has not been reported. In a previous study, the authors documented the pattern of vascular crossed aphasia in Bengali-speakers, absence of crossed Wernicke's aphasia was noted (Lahiri et al., unpublished).

In the present study, we intended to investigate the lesion-aphasia association following first ever acute stroke among Bengali-speaking subjects. The lesion-aphasia association was investigated in terms of possible lesion locations in a given type of aphasia taking into account the major aphasic syndromes along with comparison of lesion spectrum among these aphasic phenotypes. An attempt to evaluate the factors associated with lesion-aphasia discordance and its effect on language recovery was made in this study.

2. Methods

We conducted an observational study in the stroke unit of a tertiary care neurology teaching hospital of eastern India on subjects

with first ever stroke over a period of two years (2016-2018). The study was initiated with prior approval from the Institutional Ethics Committee.

2.1. Participants

Consecutive patients with first ever acute stroke presenting to our stroke unit were recruited for the present study. The inclusion criteria were (1) adult (> 18 years) literate subjects with aphasia due to first ever stroke; (2) conscious (according to WHO definition) at the time of language assessment; (3) speakers of Bengali (that is, able to communicate in and understand Bengali language during pre-morbid state). The following exclusion criteria were used: (1) aphasia caused by vascular catastrophe inside intra-cranial space-occupying lesion; (2) pre-morbid psychiatric illness affecting communication (such as personality disorder); (3) pre-morbid dementia (documented or, suspected); (4) alcohol or drug abuse; (5) non-linguistic cognitive disturbance hindering language assessment (Lahiri et al., 2019).

During study period, 607 patients of first ever acute stroke were encountered, of whom 92 were excluded due to following reasons- death before first language assessment (33); complete resolution of aphasia before initial assessment (12); severe systemic complications in early post-stroke phase (25); anarthria or severe dysarthria hindering language assessment (15); extensive bilateral micro-vascular ischemic changes (7).

In the present study, bilingualism was defined as the ability to communicate in two or more languages during interaction with other speakers of these same languages (Mohanty, 1994). This definition highlights the ability for active language use rather than grammatical proficiency and hence is aligned with the current concepts of bilingualism as life-long activity rather than passive learning (Bak, 2016).

2.2. Language examination

The Bengali version of Western Aphasia Battery (BWAB), a validated tool for assessing the language function in adults, was used to pinpoint the presence, severity, and type of aphasia (Keshree, Kumar, Basu, Chakrabarty, & Kishore, 2013). The parameters of BWAB included Spontaneous Speech, Comprehension, Repetition, Naming, and Aphasia Quotient (AQ). The AQ is a measure of severity of language impairment and is a composite score based on the oral-auditory language subscales of Fluency, Comprehension, Repetition, and Naming. Aphasia quotient below 93.8 is considered the quantitative cut-off for diagnosis of aphasia. For the purpose of this study, initial language examination was performed between 7 and 14 days post-stroke. The tests were repeated between 90 and 100 days in available patients for follow up.

Edinburgh's Handedness Inventory (EHI) (Oldfield, 1971) was used as a formal test to determine the handedness of the study subjects.

2.3. Brain imaging

Brain imaging for ischemic strokes in the present study was performed by Siemens 3T MRI machine (Magnetom Verio DOT, 16 channels) using a standard quadrature head coil. Computed tomography (CT) scan (Philips, 16 slice) was used for initial brain imaging of subjects with hemorrhagic stroke. Three patient of ischemic stroke, with contraindications (artificial metallic heart valve or permanent pace-maker) for MRI, was assessed by CT scan. The images were read by neuro-radiologists to determine the location of lesion. Infarcted tissue was defined as tissue having abnormal high signal onT2 weighted and/or FLAIR (Fluid attenuated inversion recovery sequences) images. Diffusion weighted imaging was employed for detection and localization of acute infarct in cases where MRI was performed within 48 h post-stroke. Location and extent of the lesion were determined in respect to the sulcal anatomy. Lesion volume was determined by using standard ABC/2 method in CT images for intra-cerebral hemorrhage (Kothari et al., 1996) and in MRI images (DWI or FLAIR) for ischemic stroke (Sims et al., 2009). For subjects (3) with ischemic stroke and contraindication for MRI, infarct volume was determined by ASPECT scoring and CT perfusion score (Gaudinski et al., 2008).

Visual analysis was done in Siemens^{R} Syngo viewer for lesion assessment. Cortical and mixed lesions were first localized to the extent of lobes and gyri according to standard sulcal anatomy by studying axial, coronal and sagittal sections of brain in T2-weighted and diffusion weighted sequence. Similarly, for hemorrhagic stroke, CT brain was studied in 3 orthogonal planes to determine location and extent of lesions. In the next step, cortical and mixed lesions were broadly divided into 3 categories- anterior perisylvian (involving the inferior frontal gyrus); posterior perisylvian (involving the posterior superior temporal gyrus)and combined antero-posterior lesions. The area above the lateral sulcus and anterior to central sulcus in sagittal section was taken as anterior perisylvian and therefore any lesion with its centre around inferior frontal gyrus was considered anterior perisylvian. Lesions with centre around superior temporal gyrus were taken as posterior perisylvian. For a lesion to be designated as combined there had to be either involvement of both inferior frontal gyrus and superior temporal gyrus or extension of the lesion on either side (that is anterior extension for a posterior lesion and vice versa) by more than 1/3 rd of its volume. Pure sub-cortical lesions were divided in 4 categories- basal ganglia; thalamus; para-ventricular white matter, and striato-capsular.

Discordance between lesion and aphasic phenotype was determined only for right-handed subjects with cortical involvement (isolated or in combination with sub-cortical white matter) in left hemisphere. For the purpose of present study, aphasia was considered lesion-discordant if in any the following categories: anterior lesions with fluent aphasia or global aphasia; posterior lesions with non-fluent aphasia or global aphasia; combined antero-posterior lesions with any aphasia phenotype other than global aphasia.

2.4. Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (version 25.0). Univariate analysis for categorical variable (gender, type of stroke, location of lesion) was performed using Chi square and Fischer's exact test (as applicable) and for continuous variables (age and number of years of formal education) were performed using student's *t*-test or non-parametric tests (Man Whitney *U* test) as applicable. Logistic regression analysis was carried out to evaluate the factors associated with discordance and also to determine the effect of discordance on recovery of aphasia.

3. Results

During the study period 515 screened cases of first ever stroke were recruited, out of which 208 patients presented aphasia. However, only 134 patients with aphasia were dextral and had cortical involvement in the left hemisphere. The mean age of people with aphasia was 52.19 years (SD = 10.96) with majority being of male gender (69.2%). Mean number of years of formal education in aphasic subjects was 7.80 years (SD = 4.90) with 60 subjects (28.8%) being never exposed to formal education. Among the aphasic subjects, 53 (25.48%) qualified as bilingual and rest 155 were monolinguals.

Ischemic strokes were majority (68.3%) and hemorrhagic strokes represented 31.7% of aphasic sample. Aphasia due to pure sub-cortical strokes occurred in 62 patients (29.8%). The remaining 70.2% of the patients with aphasia had cortical involvement either in isolation or in combination with adjoining sub-cortical white matter. Crossed aphasia was diagnosed in 12 participants among the study population (details of this finding have been included in a separate paper; Lahiri et al., unpublished). Table 1 presents the distribution of aphasic phenotypes in the study population according to the location of lesion, and Table 2the aphasia types in cases with and without lesion-aphasia discordance at first visit and during follow-up after 3 months.

The most noteworthy observations were-

- Global aphasia revealed wide variability in lesion location with the 2 most frequent locations being basal ganglia (29/58; 50%) and combined antero-posterior perisylvian lesion (16/58; 27.58%)
- Posterior perisylvian lesion resulted in wide spectrum of aphasic phenotypes with the commonest being Wernicke's aphasia (27/58; 46.55%). Global and Broca's aphasia each were found in 13.79% (8/58) cases with posterior lesions. These figures are irrespective of handedness or side of lesion.
- Lesion-aphasia discordance was found in 20 (14.92%) patients with aphasia who were dextral and had cortical involvement (either in isolation or in combination with sub-cortical white matter) in left hemisphere (n = 134).
- The pattern of discordance observed were- posterior lesion with Broca's aphasia (4/20; 20%); posterior lesion with global aphasia (8/20; 40%); anterior lesion with global aphasia (4/20; 20%) and posterior lesion with mixed transcortical aphasia (4/20; 20%).
- The median AQ value for anterior lesions was 6.8 (IQR 5.2–8.6) and for posterior lesions was 5.0 (IQR 4.1–54.0). There was no statistically significant difference (p = 0.088) between severity (as measured by AQ) of anterior and posterior lesions as derived by non-parametric tests of significance. The median AQ for combined lesions was presumably observed to be low with a value of 4.6 (IQR 3.2–4.6).
- On univariate analysis, the factors significantly associated with lesion-aphasia discordance were hemorrhagic stroke (p = 0.000); posterior perisylvian location (p = 0.002), and higher education (p = 0.048). After adjusting for all other variables, hemorrhagic stroke was found to have strong association with lesion-aphasia discordance (p = 0.001, OR = 11.764, 95% CI, 2.83–50.0) (See Table 3).
- In the initial evaluation 134 patients were included for analysis of lesion-aphasia discordance. For the second evaluation, it was possible to include only 99. Out of these 99 patients, 13 had presented a complete aphasia recovery (with an AQ score higher than 93.8) as per WAB.
- In the follow-up visit, the composition of the discordant group according to the aphasia typology was as follows: Broca's aphasia (9/14; 64.28%); global aphasia (1/14; 7.14%); transcortical motor aphasia (1/14; 7.14%). Three patients (3/14; 21.42%) were

Table 1
Distribution of aphasic phenotypes in the study population according to the location of lesion.

Initial type	Location			
	Anterior peri-sylvian	Posterior peri-sylvian	Combined (Anterior + Posterior)	Total
Global	4	8	16	28
Broca's	53	4	1	58
Isolation	0	3	0	3
TCM	8	0	0	8
Wernicke's	0	26	0	26
TCS	0	6	0	6
Conduction	0	3	0	3
Anomic	0	2	0	2
Total	65	52	17	134

Note: Only dextral patients with cortical involvement are included.

Table 2
Aphasia types in cases with and without lesion-aphasia discordance at first visit and during follow-up after 3 months.

Aphasia types	First visit		After 3 months	
	Concordant	Discordant	Concordant	Discordant
Global	16	12	6	1
Broca's	53	5	37	9
Isolation	0	3	0	0
TCM	8	0	10	1
Wernicke's	26	0	15	0
TCS	6	0	6	0
Conduction	3	0	1	0
Anomic	2	0	0	0
Recovery	–	–	10	3
Total	114	20	85	14

Table 3
Comparison between cases with and without lesion-aphasia discordance.

Parameters	Concordant	Discordant	p-value
Age	50.52(SD = 12.39)	50.10(SD = 4.76)	0.792
Male/Female	75/39	9/11	0.123
Education	7.94(SD = 5.04)	10.35(SD = 6.35)	*0.048*
Monolingual/Bilingual	86/28	15/5	*0.965*
Ischemic/Hemorrhagic	95/19	9/11	*0.000*
Location			
Anterior	61	4	
Posterior	37	15	*0.002*
Combined	16	1	
Non-severe/Severe	15/99	3/17	0.756
Volume	14.15 (2.3–79.3)*	14.90 (8.9–75.2)*	0.822
No change/change	57/28	4/10	*0.006*

Table 4
Effect of discordance on type change or recovery of aphasia.

Parameters	Sig	OR	Lower	Upper
Age	.664	1.012	.960	
Gender (Male)	.070	3.284	.906	1.066
Volume	.468	.967	.884	11.899
Severity (Non-severe)	*.006*	8.388	1.816	1.059
Discordance	*.007*	11.393	1.960	38.749
Location	.243			66.231
Location (A)	.109	.024	.000	
Location (P)	.161	.037	.000	2.288
Stroke (Ischemic)	.771	.798	.175	3.709
Education	.241	1.063	.960	3.649

Location (A)- Anterior peri-sylvian; Location (P)- Posterior peri-sylvian.

found to have recovered fully from aphasia.

- Discordant cases were more likely to recover or change to a milder type compared to concordant cases (p = 0.007, OR = 11.393, 95% CI, 1.960–66.231), after adjusting for all other variables including initial severity of aphasia (p = 0.006, OR = 8.388, 95% CI, 1.816–38.749) (See Table 4).

4. Discussion

The most variable lesion location during acute phase assessment was found in patients with global aphasia. The commonest observed location of lesion in global aphasia was basal ganglia in our study population. Other locations associated with global aphasia in descending order of frequency were- anterior and posterior combined lesion; posterior perisylvian; anterior perisylvian and thalamus. The lesion-aphasia association for patients with Broca's aphasia revealed significant conformity to the anterior peri-sylvian area with a few exceptional lesion locations in posterior perisylvian, combined antero-posterior perisylvian and thalamus. All cases of Wernicke's aphasia revealed lesion location in posterior perisylvian areas. No other lesion localization was observed for

Wernicke's aphasia among our study subjects. However, from the perspective of lesion location, posterior perisylvian area presented most variability in clinical aphasia phenotypes. All types of aphasic phenotype, except TCM, were observed with posterior perisylvian lesion. This observation can be accounted for by bringing into consideration the wide range of linguistic functions sub-served by the posterior areas. Although it can explain the occurrence of various fluent aphasias with posterior lesion localization, the presentation of non-fluent aphasias in few exceptional cases among our study population needs further consideration.

Lesion-aphasia studies (Axer, Keyserlingk, Berks, & Keyserlingk, 2001; Damasio & Damasio, 1980; Fridriksson, Kjartansson & Morgan, 2010)as well as functional neuro-imaging studies (Buchsbaum et al., 2011; Indefrey & Levelt, 2004)have implicated that the posterior perisylvian cortex is involved in the phonologic retrieval stage of speech production. As the role of classic Wernicke's area in speech production is considered quite specific, the anticipated defect would be phonemic paraphasias (Binder, 2015). It is within the realm of possibilities that non-fluent aphasia may occur in posterior lesions as a consequence of diaschisis during acute post-stroke phase (Carrera & Tononi, 2014). However, in all such study subjects, there was extension of lesion into the prerolandic area, which may be considered to be part of the “Broca's complex” (Ardila et al., 2016; Papathanasiou, Coppens, & Potagas, 2012). Thus, cases of Broca's aphasia with posterior lesion might reflect importance of the Broca's complex in fluency. Nevertheless, the preserved comprehension abilities in such cases may be linked to bi-hemispheric language representation. According to Bernal and Ardila (2014), the model of parallel or serial processing of language receptive abilities in both hemispheres might account for our observation. No case of anterior lesion with fluent aphasia was observed in our sample. As a whole, a strong predilection towards non-fluent aphasia was noted in subjects with lesion-aphasia discordance.

Around 1 out of 7 cases of Bengali-speaking patients presented lesion-aphasia discordance in our sample. This observation is in contradistinction to the results of a contemporary Indian study with Hindi-speaking patients (Bohra et al., 2015), in which only 1/3 rd of cases showed lesion-aphasia concordance according to classic associationist model. However, in this aforementioned study pure sub-cortical strokes were also included in the analysis of lesion-aphasia concordance. Owing to the wide variability of sub-cortical aphasic phenotypes, a higher magnitude of discordance can thus be accounted for. In the present study, only cortical and cortico-subcortical mixed strokes were included for analysis of lesion-aphasia association.

Most cases of discordance in our sample manifested as global aphasia (12/20, 60%). During early post-stroke phase, the patient may remain mute or produce only isolated syllables (Cappa, 2015). If combined with comprehension deficit, such cases are classified as global aphasia, which is irrespective of lesion location. It is thus understandable that global aphasia is initially the most common type of aphasia in stroke patients (Vidović et al., 2011). From the perspective of aphasic phenotype global aphasia could be interpreted as an amalgamation of Broca's, Wernicke's and conduction aphasia. This interpretation fits well with massive left perisylvian stroke which typically leads to global aphasia (Cappa, 2015). However, Pai, Krishnan, Prashanth, and Rao (2011) documented different lesion locations underlying global aphasia for which this aforementioned interpretation becomes questionable. Nevertheless, current concepts of cortical language network can better resolve this question. Hickok and Poeppel (2007) proposed that both the ventral speech network and the dorsal motor-articulatory systems must interact with the widely distributed conceptual network in the cortex. In light of this current model of language representation, global aphasia may be considered to represent a network dysfunction, which can explain the high occurrence of global aphasia in the acute stage not only in our sample of lesion-discordant aphasia butalso in other aphasia samples (Pedersen, Vinter, & Olsen, 2004). In our sample, subjects without discordance, however, revealed Broca's aphasia as the most frequent type (53/114, 46.49%).

The factors which were found to be significantly associated with lesion-aphasia discordance were higher education, hemorrhagic stroke, and posterior perisylvian location. Age and gender were found to have weaker impact on occurrence of lesion-aphasia discordance. After adjusting for all other variables, hemorrhagic stroke remained the only factor significantly associated with discordant lesion-aphasia relation. It is possible that hemorrhagic stroke owing to its high likelihood of violating vascular territories and causing peri-lesional edema was more commonly found to be associated with deviations from usual lesion-aphasia relation. In regression analysis, posterior perisylvian location of stroke was also found to influence discordance. Although it did not reach statistical significance ($p = 0.069$), the observation is meaningful. Frequent extension of posterior lesions into pre-rolandic area, insula or sub-cortical white mattermay have been responsible for the observed discordance (Cappa & Vignolo, 1988). Among our study subjects with posterior lesions and non-fluent aphasia, 81.25% (13/16) had lesion extension into pre-rolandic area. Insula was involved in 9 (56.25%) of these cases whereas sub-cortical white matter involvement was also quite frequent (14/16, 87.5%). This observation emphasizes importance of the contemporary concept of Broca's complex in aphasiology.

Subjects with lesion-discordant aphasia were found more likely to undergo change to milder type or complete recovery. The exact reason behind this observation is not obvious at this point. If one attributes the discordance to diaschisis then the observation that discordant cases presented better recovery or type change can be well accounted for. However, discordant cases which presented relatively preserved comprehension with posterior lesion hint towards bilateral language representation. In these cases a possibility of compensation by the right hemisphere also comes within consideration. Pai et al. (2011) reported variability in aphasia recovery among subjects with lesion-discordant global aphasia. They also documented a relatively faster type change in global aphasia cases with non-classical lesion. Taken together, some discordant cases may represent outliers from the perspective of cerebral language representation and thus reveal different recovery pattern. In our discordant cases, a better aphasia recovery cannot be explained departing from the initial aphasia severity, because after adjusting for all other variables including initial severity of aphasia, it was found that recovery was anyhow faster in discordant cases compared to concordant cases. Furthermore, it does not seem to exit any reason to assume that there were differences in the diagnosis accuracy among the subgroups of patients.

Finally, it needs to be emphasized that our patients were Bengali speakers. Some variability in the brain organization of language across different languages has been suggested (Paradis, 2001a) in literature. It seems evident that general principles of brain organization of language has to be similar across languages, including non-oral languages (Hickok, Bellugi, & Klima, 1998); but also, it

is noticeable that some variations in the brain organization of language could be found depending upon the idiosyncrasies of each specific language (Paradis, 2001b). Although it remains to be substantiated if our observations owe something to the specific linguistic features of Bengali, a pertinent question in this regard was raised through this study. Much more cross-linguistic studies of aphasia are required to further our understanding about the brain organization of language. Besides exploring the underpinnings of cerebral language network, study of aphasic symptoms in different languages across the globe may have therapeutic implications, particularly in bilinguals or polyglots (Paradis, 2001a), which is important from both research as well as clinical perspectives.

There is an important limitation in this study that should be taken into consideration. The BWAB, as any assessment instrument, has significant shortcomings related not only to the limited number of language domains that are included, resulting in decreased sensitivity, but also the BWAB is based in a specific aphasia interpretation –the classical Wernicke-Lichtheim aphasia model—which has been proven to have important clinical and conceptual limitations (e.g., Tremblay & Dick, 2016; Yourganov et al., 2015). Another potential limitation in the current study is that the used neuro-anatomical classification between "anterior" and "posterior" does not intricately analyze (owing to unavailability of DTI for this study) lesions of the white matter between the two sites. It has been observed that lesion is aphasia can be found not only in the gray matter, but also in the white matter tracts (e.g., Ivanova et al., 2016) and hence our classification may be insufficient.

5. Conclusion

Lesion-aphasia discordance is not uncommon in acute stroke. An attempt was made in this study to explore the pattern of discordance among Bengali-speaking subjects. Posterior perisylvian lesion, hemorrhagic stroke, and higher education were found to be associated with occurrence of discordance. Subjects with lesion-discordant aphasia presented better recovery during early post-stroke phase.

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