# The association between aphasia severity, naming, verbal fluency and demographic variables in nonfluent post-stroke aphasia

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# The association between aphasia severity, naming, verbal fluency and demographic variables in nonfluent post-stroke aphasia

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SAŽETAK

**Svrha rada**: U literaturi su nedovoljno jasni i kontradiktorni rezultati istraživanja kako varijable povezane s demografskim obilježjima pacijenta s moždanim udarom i s jezikom, predviđaju težinu afazije nakon moždanog udara i međusobnu povezanost tih varijabli. Cilj ovog istraživanja je utvrditi povezanost između težine afazije i Imenovanja, verbalne tečnosti i demografskih varijabli.

**Metodologija**: U istraživanje je uključeno 40 osoba s afazijom, koje su preboljele moždani udar u lijevoj hemisferi i imaju nefluentnu afaziju. Cijela baterija Sveobuhvatnog testa za procjenu afazije (CAT-HR, Swinburn et al., 2020.) primijenjena je kod svih ispitanika. Na temelju ukupnog rezultata na Jezičnoj bateriji, izdvojeni su podaci o težini afazije. Promatrana je i uspješnost na subtestovima Imenovanje i Verbalna tečnost. Hijerarhijskim regresijskim modelom analizirana je povezanost između Težine afazije i Imenovanja, Verbalne tečnosti i demografskih varijabli. Izračunat je Spearmanov koeficijent korelacije između navedenih varijabli, uključujući i dijelove subtesta Verbalne tečnosti (životinje, glas).

**Rezultati**: Rezultati pokazuju da demografske varijable ne predviđaju težinu afazije, dok Imenovanje objašnjava većinu varijance Težine afazije. Analiza korelacije pokazuje značajnu povezanost između Težine afazije i jezičnih varijabli, ali ne i demografskih varijabli. Demografske varijable, Vrijeme nakon moždanog udara i Dob, značajno su povezane s Verbalnom tečnošću (glas).

**Zaključak**: U ovom istraživanju, težina afazije ne može se objasniti promatranim demografskim varijablama. Međutim, utvrđeno je da je imenovanje snažan prediktor težine afazije. Moguće je da težina afazije osoba s nefluentnom afazijom više ovisi o varijablama povezanim s moždanim udarom, nego o demografskim varijablama.

**Ključne riječi:** nefluentna afazija, težina afazije, imenovanje, verbalna tečnost, demografske varijable

ABSTRACT

**Background:** There are insufficiently clear and contradictory results in literature about how patient-related, stroke-related and language-related variables predict the aphasia severity after stroke and how these variables are interrelated. This study aimed to explore the association between aphasia severity and naming, verbal fluency, and demographic variables.

**Methods:** 40 PwA with a left hemisphere stroke and nonfluent aphasia are included in this study. The entire battery of the Comprehensive Aphasia Test (CAT-HR, Swinburn et al., 2020), was administered to all subjects. Data on the severity of aphasia based on the total score on the Language Battery and performance on subtests Naming and Verbal fluency were extracted. Hierarchical regression model evaluated the association between Aphasia severity and Naming, Verbal fluency and demographic variables. Using nonparametric Spearman's Rho coefficient, the correlations analyses between those variables and additional subtests of Verbal fluency (animals, sound) were conducted.

**Results:** The results showed that demographic variables do not predict aphasia severity while naming explains most of the variance of aphasia severity. Additional correlation analysis showed significant correlation between aphasia severity and language variables, but not with demographic ones. Demographic variables Time post-stroke and Age were significantly correlated with Verbal fluency (sound).

**Conclusion:** In this study, aphasia severity cannot be explained by used demographic variables. However, naming was found to be a strong predictor of aphasia severity. It is possible that the aphasia severity of nonfluent PwA is more dependent on stroke-related variables than demographic variables.

**Keywords**: nonfluent aphasia, aphasia severity, naming, verbal fluency, demographic variables

## Introduction

Aphasia is an acquired language disorder which most often occurs as a result of a stroke (Engelter et al., 2006; Sinanović et al., 2011). Half of the stroke individuals have some cognitive dysfunction (Hadanny et al., 2020) and 55% of them demonstrate some residual disability up to 4 years after the stroke (Donellan and Werring, 2020). Approximately 21% to 38% of all stroke patients will experience aphasia, which affects not only their daily communication, but their social activities and quality of life, as well (Berthier, 2005; Gronberg et al., 2020).

Different variables can affect aphasia severity after the stroke such as stroke-related (e.g., stroke severity, lesion size and location, time post-stroke), language/nonlanguage (e.g., aphasia type, naming, verbal fluency, memory, executive function, visual perception) and patient-related factors (e.g., gender, age, education level, SES, race, family size, physical and mental health). Most of the research analysed these variables as predictors of language recovery, and less as predictors of current or initial language difficulty. For example, it was shown that stroke-related factors (such as stroke severity, lesion size and location, time post-stroke) and language related factors (initial aphasia severity) are strong predictors of recovery (Plowman et al., 2012; Hope et al., 2013; Rehabilitation and recovery of peopLE with Aphasia after StroKE (RELEASE); Collaborator, 2021).

Difficulties in word retrieval or anomia as a cognitive function is common clinical sign in all aphasia types after stroke (Saber-Moghadame et al., 2022; La Pointe, 2005; Goodglass and Wingfield, 1997; Whitworth et al., 2005), and naming is often used as a consistent target to measure improvements in aphasia treatment (Kang et al., 2011; Kristensson et al., 2022; Kristinsson et al., 2021). Furthermore, most authors agree that aphasia severity is a strong predictor of naming difficulties (Saber-Moghadam et al., 2022; González-Fernández et al., 2011; Pedersen et al., 2004). Unlike stroke and language related factors, there is conflicting evidence about how demographic factors (such as age, gender and education) are related to recovery or language difficulties in general.

When we discuss the association between gender and aphasia severity, to our knowledge there are just a few and even contradictory findings. For example, Sharma et al. (2019) found greater impairment (lower scores) among males when compared to females in a study of 294 individuals with aphasia using data from the Aphasia Bank. Gonzalez et al. (2021) found evident difference between men and women in Broca's aphasia - that type of aphasia appeared significantly more severe in men than in women. For the other types of aphasia, the severity was relatively similar. In contrast, in the research of Jacobs et al. (2023), males had a significantly higher Boston Naming Test Score Percentile than females.
Many studies have observed the effect of age on overall aphasia severity and recovery (Gilmore et al., 2019; Holland et al., 2017; Smith, 1971; Johnson et al., 2019; Laska, 2001; Osa Garcia et al., 2020; Liu et al., 2022; Gonzalez et al., 2021). Some studies have shown that aphasia severity increases with age (Smith, 1971; Johnson et al., 2019) and that younger people recover better (Laska, 2001). It is possible that the association between age and aphasia severity depends on the recovery period in which the analysis is carried out, which has been reported in some studies where the relationship between aphasia severity and age and time post-stroke exists in the chronic stage (Johnson et al., 2019; Osa Garcia et al., 2020), but not in the acute stage after stroke (Liu et al., 2022). Gonzalez et al. (2021) found that age negatively correlated with naming, in other words, the older PwA, the poorer naming abilities are.

Time post-stroke has also been shown as an important factor for both recovery and aphasia severity. For example, recovery is better if therapy has started earlier (Rehabilitation and recovery of peopLE with Aphasia after StroKE (RELEASE); Collaborator, 2021) and individuals who are in the later stage of recovery present with less severe aphasia (Johnson et al., 2022). There are also studies that have not shown a statistically significant association between age and time post-stroke and recovery (Hope et al., 2013; Dignam et al., 2023; Pedersen et al., 2004; Moss and Nicholas, 2006). However, according to Griffith et al. (2013), the time post-stroke does not influence the confrontation naming ability of PwA, but it has been qualitatively observed that PwA with a longer post-stroke period use many strategies for self-cueing (finger spelling, alphabet supplementation, categorization).

The level of education has been considered for years as a measure of cognitive reserve. It is claimed that a higher level of education results in the formation of a greater number of synaptic connections in the brain, thus making the brain more resistant to aging and pathological processes such as stroke (Staff et al., 2004). However, there is conflicting evidence about how the level of education affects aphasia severity in general or specific language difficulties such as naming. Some studies have shown that the level of education is related to the initial aphasia severity (Connor et al., 2001), naming abilities (Deloche et al.; 1996), and language improvement after the first-year post-stroke (Kim et al., 2019), but a large number of studies have shown exactly the opposite. For example, Liu et al. (2022) and Lazar et al. (2008) reported that initial aphasia severity was not associated with educational level in the acute stage and González-Fernández et al. (2011) reported that higher levels of education are associated with less aphasia impairment, but in his study, there was no significant effect of education on oral naming.

In fact, stroke-related factors were shown to have a better association with language difficulties than demographic variables, and the results of such research are more consistent. It is generally accepted that larger lesions are associated with more severe initial aphasia and poor aphasia recovery. Smaller lesions are associated with better recovery (Goldenberg & Spatt, 1994; Mass et al., 2012; Mazzoni et al., 1992). In addition to lesion size, lesion location has also been shown to significantly predict aphasia severity (Plowman et al., 2012) and that damage to opercular and insular cortex in conjunction with inferior frontal damage (Hart & Gordon, 1990) and superior longitudinal fasciculus and posterior insula (Johnson et al., 2022) has been associated with more severe aphasia. Thye and Mirman (2018) found that aphasia severity and naming deficits were predicted by lesion size, but not by lesion location. Naming abilities are associated with lesions involving the superior temporal gyrus, middle temporal gyrus, middle frontal gyrus, inferior frontal gyrus, precentral gyrus, postcentral gyrus, supramarginal gyrus, angular gyrus and insula (Liu et al., 2022).

Considering the very contradictory results in literature and the lack of research on the relationship between the severity of aphasia and demographic and linguistic variables in PwA in the Croatian-speaking area, this research aims to examine the contribution of demographic and linguistic variables to the aphasia severity and to explore how all variables (age, gender, level of education, time post-stroke, naming, verbal fluency, and aphasia severity) are interrelated.

## Methods

### *Participants*

This study included 40 persons with aphasia (PwA) recruited from SUVAG Polyclinic. The first inclusion criteria were that the included PwA had a stroke in the left dominant hemisphere, that they spoke Croatian as their first language and were premorbidly right-handed. The second inclusion criteria were that all participants were diagnosed with a nonfluent type of aphasia. Demographic variables (Gender, Age, Education, Time post-stroke) and total scores on the CAT-HR test (representing aphasia severity) are presented in Table 1. Data on additional patient characteristics are also available. Verbal apraxia was present in 19 PwA, and 5 individuals exhibited symptoms of both verbal apraxia and dysarthria. All included PwA survived a stroke in the left hemisphere - most of them (N = 34) suffered an ischemic stroke, while only six suffered a hemorrhagic stroke. Information about the type and localization of the stroke were taken from medical histories and computerized tomography scan reports. In an ischemic group of patients, 20 of them had a stroke in the supply area of ACM, 1 in the supply area of ACI, 2 in the basal ganglia, and 7 in the frontal lobe. In the hemorrhagic group of patients, 3 of them had strokes in a supply area of ACM, 2 in basal ganglia, and 1 in the frontal lobe.

*Table 1 Demographic characteristics and aphasia severity of PwA*

Values are n (%), unless otherwise mentioned, M - mean, SD - standard deviation

| | **Gender** | | **Age** | | **Education (in years)** | | | | **Time post-stroke (in months)** | | **Aphasia severity (CAT-HR test)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | M (SD) | Range | 8 | 9-12 | 15-17 | >1 | M (SD) | Range | M (SD) | Range |
| **PwA (N=40)** | 28 (70%) | 12 (30%) | 62.1 (14.3) | 23 – 88 | 1 (2,5 %) | 28 (70%) | 9 (22,5 %) | 2 (5%) | 12.5 (19.1) | 1 - 72 | 90.9 (13.8) | 74.1 - 114.75 |
| **Shapiro-Wilk** | **W**<br>**p** | 0.576<br>< .001 | 0.968<br>0.315 | | 0.689<br>< .001 | | | | 0.647<br>< .001 | | 0.943<br>0.043 | |

**Procedure**

This is a retrospective study in which subjects underwent first or follow-up speech and language diagnostic assessment in SUVAG Polyclinic in Zagreb, during the period January 2022-September 2024. All PwA were assessed on the Croatian version of the Comprehensive Aphasia Test (CAT-HR, Swinburn et al. 2020), a test that has good psychometric properties (e.g., the measures on the modality mean can discriminate 85% of PwA from HS; Kuvač Kraljević et al. 2019). All participants were examined individually in a quiet room, through one or two diagnostic meetings lasting about 60 to 90 minutes. Patient assessment was carried out by licensed speech-language therapists with many years of experience in working with people with neurological brain damage. For this research, the approval of the SUVAG Polyclinic Ethics Committee was obtained.

**Statistical analyses**

Statistical analyses were performed using the free statistical package Jamovi version 2.3 (2022). A two-step hierarchical regression model was used to evaluate which set of independent variables (demographic: Gender, Age, Education, Time post-stroke vs. linguistic: Naming, Verbal fluency) predict the dependent variable (Aphasia severity) in PwA after ischemic stroke. Before conducting correlation analyses, a Shapiro-Wilk test was used to assess whether the variables were normally distributed. Some of the variables showed a deviation from the normal distribution (Gender, Education) while others were normally distributed (Age and Aphasia severity). Therefore, the nonparametric Spearman's rank correlation coefficient test was used to explore the association between all demographic variables and aphasia related ones, with Verbal fluency separately for animals and sound as cuing factor. The significance level was set at 0.05.

**Results**

In the first step of the model, when only demographic variables were included, hierarchical regression analysis showed that demographic independent variables (Gender, Age, Education, and Time post-stroke) explain only 2,66% variance of the dependent variable, where no independent variable was found to be statistically significant. That means that these variables do not predict aphasia severity on a significant level ($F(4,35)=0,239$; $p=0.9114$, $R2=0.0266$). In the second step, when language variables (Naming, Verbal fluency) were added to the model, it was shown that language variables are those which explain the additional

78% variance of the dependent variable, in other words significantly predict aphasia severity (F(6,33)=23,17; p<0,001, R2=0,8082).

*Table 2 Demographic and language associations with aphasia severity*

Model Fit Measures

| | | | Overall Model Test | | | |
|---|---|---|---|---|---|---|
| **Model** | **R** | **$R^2$** | **F** | **df1** | **df2** | **p** |
| 1 | 0.163 | 0.0266 | 0.239 | 4 | 35 | 0.914 |
| 2 | 0.899 | 0.8082 | 23.170 | 6 | 33 | < .001 |

As can be seen in Table 3, in the first step of the hierarchical analysis, none of the demographic variables have a statistically significant independent contribution to explaining the variance of the Aphasia severity. In the second step, when all predictors were included in the analysis, the analysis showed that only Naming had a statistically significant independent contribution to explaining 80.82% of the variance of Aphasia severity.

*Table 3 The contribution of the independent variables in step of the model*

Model Coefficients - Aphasia Severity

| Model | Predictor | Estimate | SE | t | p |
|---|---|---|---|---|---|
| **1** | Intercept [a] | 980.900 | 12.094 | 8.111 | < .001 |
| | GENDER (2 – 1) | 15.839 | 4.877 | 0.325 | 0.747 |
| | AGE | -0.1043 | 0.156 | -0.669 | 0.508 |
| | EDUCATION | 0.8258 | 3.563 | 0.232 | 0.818 |
| | TIME POST-STROKE | 0.0377 | 0.115 | 0.329 | 0.744 |
| **2** | Intercept [a] | 239.300 | 97.046 | 2.466 | 0.019 |
| | GENDER (2 – 1) | -15.745 | 22.524 | -0.699 | 0.489 |
| | AGE | -0.0586 | 0.0723 | -0.811 | 0.423 |
| | EDUCATION | -0.8766 | 16.578 | -0.529 | 0.600 |
| | TIME POST-STROKE | -0.0285 | 0.0528 | -0.538 | 0.594 |
| | NAMING | 0.7829 | 0.1527 | 5.129 | < .001 |
| | VERBAL FLUENCY | 0.0619 | 0.1971 | 0.314 | 0.756 |

Correlation analyses were conducted to evaluate how all variables are related to each other (Table 4). Results showed a statistically significant negative correlation between Age and Gender (females are younger than males) and between Gender and Verbal fluency (sound) (females better recall words cued by the first sound). There was also a positive correlation between Time post-stroke and Verbal fluency (sound) and a positive correlation between Aphasia severity and other linguistic variables such as Verbal fluency, Verbal fluency sound, Verbal fluency animal, and Naming. There was no statistically significant correlation between aphasia severity and none of the demographic variables examined.

*Table 4 Correlation between demographic and language-related variables*

Correlation Matrix

| | | GEN | AGE | EDU | TPS | NAMING | VFa | VFs | VF |
|---|---|---|---|---|---|---|---|---|---|
| **AGE** | Spearman's rho | -0.324* | — | | | | | | |
| | p-value | 0.041 | — | | | | | | |
| **EDU** | Spearman's rho | -0.003 | 0.144 | — | | | | | |
| | p-value | 0.986 | 0.375 | — | | | | | |
| **TPS** | Spearman's rho | 0.249 | 0.004 | 0.057 | — | | | | |
| | p-value | 0.122 | 0.982 | 0.726 | — | | | | |
| **NAM** | Spearman's rho | 0.135 | -0.116 | 0.184 | 0.237 | — | | | |
| | p-value | 0.405 | 0.474 | 0.257 | 0.141 | — | | | |
| **VFa** | Spearman's rho | 0.017 | -0.060 | 0.118 | 0.207 | 0.885*** | — | | |
| | p-value | 0.919 | 0.712 | 0.468 | 0.199 | < .001 | — | | |
| **VFs** | Spearman's rho | 0.425** | -0.017 | 0.022 | 0.512*** | 0.741*** | 0.724*** | — | |
| | p-value | 0.006 | 0.918 | 0.891 | < .001 | < .001 | < .001 | — | |
| **VF** | Spearman's rho | 0.138 | -0.018 | 0.086 | 0.304 | 0.880*** | 0.966*** | 0.851*** | — |
| | p-value | 0.396 | 0.911 | 0.596 | 0.057 | < .001 | < .001 | < .001 | — |
| **AS** | Spearman's rho | 0.104 | -0.127 | 0.051 | 0.090 | 0.889*** | 0.811*** | 0.678*** | 0.809*** |
| | p-value | 0.523 | 0.434 | 0.755 | 0.579 | < .001 | < .001 | < .001 | < .001 |

Note. * p < .05, ** p < .01, *** p < .001
Legend: Gender (GEN); Education (EDU); Time post-stroke (TPS); Naming (NAM); Verbal fluency animal (VFa); Verbal fluency sound (VFs); Verbal fluency (VF); Aphasia severity (AS)

## Discussion

The aim of this study is to explore how demographic variables, such as Age, Gender, Education level, and Time post-stroke, and linguistic variables, such as Naming and Verbal fluency, can explain aphasia severity and how these variables are associated.

Hierarchical regression analyses showed that only one independent variable, Naming, as the most prominent difficulty present in all types of aphasia, is a strong statistically significant predictor of the Aphasia severity. In this sample, the greater the naming difficulty is, the lower is the result on the CAT-HR test, or the more severe aphasia is. These results are consistent with all studies that examined the relationship between naming and the severity of aphasia presented in the introduction (Kang et al., 2011; Kristensson et al., 2022; Kristinsson et al., 2021; Saber-Moghadam et al., 2022; González-Fernández et al., 2011; Pedersen et al., 2004). Unlike Naming, Verbal fluency was not found to be a statistically significant predictor of Aphasia severity.

Our results also show that demographic variables such as Gender, Age, Education, and Time post-stroke are not significant predictors of Aphasia severity. These results are in line with other authors (Jacobs et al., 2024; Plowman et al., 2012; Døli et al., 2021; Gadson et al., 2022; Thye and Mirman, 2018) who have shown that other factors might play a greater role in the manifestation of the aphasia severity and aphasia recovery than demographic variables, for example the initial stroke severity, the lesion size, etc., which was not taken into account in this study.

Although some studies have shown that men with aphasia have more difficulties than women (Sharma et al., 2019), this study did not show a relationship between gender and aphasia severity. However, in the correlation analysis where additional variables were included, it was shown that women recall words on a given phonological key better than men. It is possible that the difference between men and women would be more visible when looking at each language skill separately, and not just within the overall aphasia severity. Another reason why this study failed to show the association between stroke severity and gender might be in the unequal distribution of male and female participants in the sample.

In a normal aging population without neurological diseases, healthy adults can have difficulty recalling words that increase with age (Schmitter-Edgecombe et al., 2000), mostly because increased age may lead to mild cognitive declines and significantly slower recognition (Messer, 2017). Therefore, it is to be expected that the same effect of age on Naming and/or Aphasia severity will be present in people with aphasia. However, in this study, there was no association between Age and Aphasia severity or between any other variable, which is contrary to the results obtained by some other authors (Gilmore et al., 2019; Holland et al., 2017; Smith, 1971; Johnson et al., 2019; Johnson et al., 2022; Gonzalez et al., 2021; Jacobs et al., 2023). It is possible that the reason for this is that most of the subjects included in this study were in the acute or early post-acute phase after stroke. The association between age and severity of aphasia was not confirmed in those phases in the study by Lui et al. (2022), as well. Another explanation could be that other factors play a greater role in the manifestation of aphasia severity than age, for example, the initial stroke severity (Jacobs et al., 2024), the lesion size, etc.

Although some researchers have shown that a lower level of education is associated with an increase in the initial aphasia severity (Connor et al., 2001) or an increase in the naming severity (Gonzales et al., 2020; Deloche et al., 1996), the level of education was not found to be a significant predictor of aphasia severity in this study, nor was it related to other demographic or language variables. Our results are consistent with some other studies which also concluded that the level of education had no significant effect on naming, aphasia severity or aphasia recovery (Lui et al., 2022; Lazar et al.,2008; Gonzales-Fernardes et al., 2011; O'Halloran et al., 2024) or they found even negative correlation between education and naming (Jacobs et al.,2024). It is important to note that the majority of participants in this study (70%) had completed high school level of education, which may be one of the reasons for the absence of an association between this variable and the aphasia severity.

The Time post-stroke also did not prove to be a significant predictor of the Aphasia severity, nor was a connection found with Naming, which is in line with the research of Griffith et al. (2013). In this study, Time post-stroke was statistically significantly associated only with the variable Verbal fluency sound, that is, the more time that passed since the stroke, the better people recalled words cued by the first sound. Studies in which such an association proved to be statistically significant mainly looked at the time post-stroke variable in the context of recovery from aphasia (Johnson et al., 2022) and not in the contents of initial aphasia severity, as it was the case in this study.

**Conclusion**

In this sample of participants, aphasia severity cannot be explained by variables such as gender, age, education, and time post-stroke. However, naming was found to be a strong predictor of aphasia severity. It is possible that some stroke-related variables that were not the subject of this research (for example, the initial stroke severity and the lesion size) have a more important role in explaining the variability in aphasia in people after a stroke than demographic ones. So, it is possible that aphasia impairment is less severe in older adults, less educated and/or in adults tested in a shorter time after the stroke due to less severe strokes.

**Clinical implication**

Knowledge about the relationship between aphasia severity and factors such as patient, stroke and language-related variables, enables speech-language pathologists to better predict the level and degree of recovery as well as, in the framework of therapeutic planning, to decide which tasks will be the most effective and will best contribute to aphasia recovery, consequently leading to the improvement of the quality of life of PwA and their families. Considering our results, naming therapy should be one of the basic and mandatory therapeutic approaches in the rehabilitation of all non-fluent PwA.

**Study limitation and future direction**

This research has several limitations that should be taken into account in future research. First, some potentially important variables that could affect the total result on the CAT-HR test were not controlled, such as visual perception and other cognitive abilities or involvement in therapy and the number of therapy sessions completed. Some results showed that non-linguistic cognitive reserve can be related to aphasia severity even after controlling for the influence of lesion size and location (Johnson et al., 2022). It is possible that some PwA had a shorter period from the stroke to the examination, but they had a larger number of therapy sessions due to which the aphasia severity at the time of the examination was milder. Second, since the population of people with aphasia is an extremely heterogeneous group, even if many variables are controlled, in order to obtain more reliable results and generalize the conclusions, it is necessary to expand the sample, which is the future intention of the authors of this paper. Third, it would be advisable to investigate how other language skills, apart from naming (e.g. picture description, repetition, comprehension, or reading and writing), are related to aphasia severity to elucidate whether naming is truly the only or the strongest predictor of aphasia severity. Fourth, since this is a retrospective study in which CT/MR scans of the brain were not available to the researchers, on the basis of which data on the precise location and size of the lesion would be obtained, it would be advisable that future studies of predictive factors of aphasia severity include stroke-related variables, such as the size of lesion and stroke severity. Finally, to better explain the connection between naming ability and the aphasia severity, it is recommended to conduct qualitative analyses of patients' responses in naming tasks, e.g. type of answer, number of cuing etc.

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