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A double dissociation between plural and possessive “s”: Evidence from the Morphosyntactic Generation test.

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Abstract

People with aphasia demonstrate impaired production of bound inflectional morphemes, such as noun plurals (-s) and noun possession (‘s). They often show greater difficulty in marking possession versus plurality. Using a new tool for eliciting nouns, modifiers, and inflectional morphemes in aphasia, the Morphosyntactic Generation test, we assessed people with primary progressive aphasia and those in the acute and chronic phase following left hemisphere stroke. Clinical profiles were associated with different strengths and weaknesses in language production when controlling for age and education. Overall, performance of the plural -s was stronger than possessive ‘s in group analyses. However, some individuals demonstrated the inverse pattern of performance with an advantage for possessives. These participants provide counterevidence to the theory that difficulty with marking possessives is purely the result of their greater cognitive-linguistic complexity, suggesting that there is a functional double dissociation between the marking of possessives and plurals. The deficits we observed resulted from morphosyntactic impairments, at least in those patients who showed clear dissociations. Future work is needed to understand why plural and possessive markers were differently sensitive to neurological disorders of language.

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Keywords

stroke; assessment; production; plural; modifiers; dementia

Introduction

In addition to impaired production of nouns and verbs, a classic characteristic of speech production for people with aphasia is the impaired production of bound inflectional morphemes. Bound inflectional morphemes in English include those used to mark noun plurality (-s), noun possession (‘s; genitive case), and verb person and tense (e.g., third-person-singular -s; Goodglass & Berko, 1960; Goodglass & Hunt, 1958; Kean, 1977). Individuals with agrammatic aphasia generally demonstrate greater difficulty in producing the genitive than the plural (Goodglass & Hunt, 1958), despite their identical phonological properties. This difference in difficulty has been observed even when controlling for phonological complexity of the free morpheme (Stemberger, 1984; Szupica-Pyrzanowska, Obler, & Martohardjono, 2017). The reason for this effect remains the subject of some debate.

There are competing theories to account for why possessive production may be more syntactically demanding and require greater cognitive processing, which would lead to people with agrammatism to find this form more difficult. From the perspective of generative grammar (Chomsky, 1981), the plural -s in English is marked at the morphological level, i.e., affixed to the noun. In contrast, the possessive -s and genitive case are marked at the phrasal level, i.e., affixed to the noun *phrase*. The computation of hierarchical structure includes multiple elements. Computing a noun phrase is more complicated than identifying a noun, a single element. This explanation is consistent with the observation that people with aphasia have difficulty identifying syntactic relationships (Goodglass & Menn, 1985). It is also possible that genitive production is not more difficult than plurals, but that the two skills are dissociable, and a deficit in genitives is more commonly observed. Thompson, Fix, and Gitelman (2002) described a monolingual English speaker with agrammatism secondary to seizure disorder. The patient performed the plural with 54% accuracy and the possessive with 94% accuracy during narrative speech. The authors’ account of the distinction was that genitive marking lacks a zero-morpheme default alternative, whereas plural agreement does not (i.e., there is both a plural and a singular word-level form).

Despite these contrasting observations, inflectional morpheme production is not systematically targeted in the most commonly used assessments designed for those with adult neurogenic disorders of language. This is, in part, due to the difficulty designing tasks that target bound morpheme production in the absence of significant confounds. For example, sentence anagram tests have been used in the past (Nadeau, 1988; Weintraub et al., 2009). However, these are sensitive to executive function deficits and can be difficult even for healthy controls. Moreover, sentence anagram tests do not represent a naturalistic type of language usage. Here, we have utilized a new assessment tool, the Morphosyntactic Generation test (MorGen), to target a patient’s differential production of high-frequency

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nouns, modifiers, and bound inflectional morphemes. The tool is designed to be used in people with aphasia due to stroke or secondary to neurodegenerative disease (primary progressive aphasia, PPA).

The aim of this investigation is to examine whether performance differed for the two phonologically similar morphemes: the plural and possessive “s.” The plural versus possessive ‘s is a particularly interesting contrast. On their phonological surface, both morphemes involve just adding /s/. However, they differ grammatically, nonetheless. Plurals are suffixes applied to a stem *word*. Possessives are clitics applied to *phrasal level constituent*. Thus, different grammatical operations are involved in processing these two types of elements.

Method

Recruitment

All work was conducted with the formal approval of the Institutional Review Board (ethical review board). Participants were recruited based on one of four profiles: (1) individuals with primary progressive aphasia (PPA; also reported on in Stockbridge et al., submitted), (2) individuals in the acute post-stroke phase (<14 days post-onset), (3) individuals in the sub-acute to chronic post-stroke phase (> 30 days post-onset), and (4) individuals with no known neurological diagnosis (control group). Participants were recruited from three sources: Johns Hopkins Hospital outpatient clinic (PPA, sub-acute to chronic post-stroke, and control participants), Johns Hopkins Hospital Brain Rescue Unit (acute post-stroke participants), and University of South Carolina outpatient clinic (chronic post-stroke participants). As scheduling permitted, native English speaking patients belonging to either the post-stroke or PPA profile who visited the outpatient clinics between November 2018 and November 2019 were asked if they would like to participate in an additional assessment after standard testing was completed. Control participants were recruited from those who escorted or accompanied patients for their outpatient visit (often family members) and were willing and available to complete a task during the patient’s visit. Individuals were excluded if they had uncorrected hearing or visual loss. Inpatients received the MorGen as part of an existing left hemisphere post-stroke longitudinal study protocol between January 2019 and July 2019. Participants included in that protocol must have clinical evidence of acute left hemisphere stroke, premorbid proficiency in English, and be 18 or older. Exclusion criteria are pregnancy, severe claustrophobia, cardiac non-MRI compatible pacemaker or ferromagnetic implants, and prior history of neurological disease affecting the brain other than stroke, known hearing loss or uncorrected visual loss. No additional exclusion criteria were applied. PPA diagnosis was made by a behavioral neurologist, based on language and cognitive testing, neurological exam, and magnetic resonance imaging (MRI), using consensus criteria (Gorno-Tempini et al. 2011). Stroke diagnosis was made by history, neurological exam, and MRI. Aphasia diagnosis and classification were determined on the basis of performance on the Western Aphasia Battery (WAB; Kertesz, 1982); not all individuals who were tested post-stroke were found to have aphasia.

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Morphosyntactic Generation test

The purpose of the MorGen is to elicit the production of high-frequency nouns, modifiers, and bound inflectional morphemes in adults with neurogenic disorders of language. Participants respond with two-word descriptions of the indicated picture in each of the 60 test items. For each item, participants see two pictures that differ in only one morphosyntactically relevant feature. One of the two pictures is indicated using a red arrow. For example, the two pictures may show a single shoe beside Bob and a single shoe beside Mary. An arrow will indicate the picture they have to describe using only two words: either "Bob's shoe" or "Mary's shoe." The MorGen includes five common nouns. Each noun is targeted 12 times. Additionally, plural -s is targeted 31 times (singular noun is targeted 29 times), number (one or two) is targeted 8 times, size (big or small) is targeted 16 times, color (red or blue) is targeted 19 times, possessive 's is targeted 17 times, and a proper name (Bob's or Mary's) is targeted 17 times. Images for each noun were retrieved from the web using Google's image search (under the United States "fair use" doctrine) and selected for clarity and rapid identifiability. Performance is calculated for the overall mean percent correct and for each of the seven morphosyntactic targets independently, resulting in seven separate performance scores. Interrater reliability in scoring the MorGen (in tests of 35 participants and 31 controls) was 98.7 point-to-point percent agreement.

Since the MorGen is designed to elicit structured productions, administration of the MorGen takes on two phases. There is a training phase followed by a response phase. The training phase has three parts. First, the administrator checks participants' familiarity with the five highly imageable, high-frequency nouns used in the test: cat, shoe, chair, tree, and book. Accurate naming of these illustrations is noted. Second, the administrator describes the response modality and models the desired response to 14 examples using the noun "apple." Third, the participant has the opportunity to practice generating responses and to receive feedback on 10 trials. These trials use the targeted set of five nouns. Participants who are not able to produce at least some correct responses for the practice items or appear not to understand the directions do not receive the test (such individuals were not included in the study).

After training is complete, participants respond to 60 items without feedback. Responses are recorded and scored for accuracy and error type (omission, unrelated substitution, related substitution, or wrong word order). If the participant's response is accurate but does not follow the correct response form (e.g., if the participant says, "This woman Mary has two shoes" instead of "two shoes"), the participant is reminded of the response rule (e.g., "Remember to describe the image using two words only."). Synonyms for targeted modifiers are counted as correct (e.g., "large" for "big").

Analysis

To determine whether clinical groups' performance differ in the plural and possessive "s," repeated measures statistics were conducted for the entire sample and then for each profile independently. In order to examine individual subject effects, Fisher's exact tests were calculated for each participant's performance on the two morphemes based on the proportion of trials performed correctly.

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Results

Participants

One hundred sixty-eight participants were recruited (described in Tables 1–3). Individuals with PPA were diagnosed an average of approximately four years prior to testing (4.1 ± 2.8). Individuals acute stroke were tested in the first 4.5 days (± 3). Those with chronic stroke were an average of two years since their infarct but varied widely (2.2 ± 4.1). Groups differed in age and education but not gender distribution (Table 1). Individuals with stroke were similar in age to controls. As anticipated, individuals with PPA tended to be older. Individuals with PPA, chronic stroke, and controls tended to have completed at least three years of post-secondary education, whereas individuals with acute stroke tended to be high school graduates.

MorGen performance

MorGen performance by clinical profile is summarized in Table 2 and Table 3. In a mixed analysis of variance that compared performance on the plural and possessive (within-subjects variables) and clinical profile as the between-subjects variable (excluding controls), there was a main effect bound morpheme (Mauchly's W = 1, $p < 0.001$; $F(1, 113) = 39.8$, $p < 0.001$, $\eta_P^2 = 0.3$) and of clinical profile ($F(2, 113) = 3.4$, $p = 0.04$, $\eta_P^2 = 0.1$), but the interaction term did not reach the conventional significance threshold, ($F(2, 113) = 2.7$, $p = 0.07$). In subsequent t-tests to examine the significant main effects, the difference in plural and possessive performance was significant within all three clinical profiles considered independently in repeated-measures t-tests: PPA, $t(43) = 5.3$, $p < 0.001$, acute stroke, $t(20) = 2.8$, $p = 0.01$, and chronic stroke, $t(50) = 3.0$, $p = 0.01$. In each case, plural performance was more successful than possessive performance on average. As anticipated, control participants performed at ceiling on all morphemes.

We then compared each participant's performance of possessive 's and plural -s individually using Fisher's exact tests on the original proportions of successful and unsuccessful trials. Forty-six clinical participants showed a significant difference in performance between these two inflectional morphemes (Tables 4–6). Four demonstrated a significantly stronger performance in possessives than plurals (Figure 1). No control participants demonstrated a dissociation in plural and possessive performance. The frequency of a dissociation was significantly higher in each clinical group relative to the control group (PPA, $p<0.0001$; acute stroke, $p<0.0001$; chronic stroke, $p<0.0001$).

Discussion

The purpose of this investigation was to examine relative performance of the plural and possessive "s" on the novel MorGen assessment tool. The majority of participants with either PPA or stroke did not demonstrate a differential profile between these two morphemes. However, consistently, when a difference in performance was noted, all groups more frequently produced the plural than the possessive "s" when appropriate. This is consistent with previous findings (Stemberger, 1984; Szupica-Pyrzanowska et al., 2017). Beyond these analyses, it is informative to determine whether trends are consistent within individuals. In general, the answer to this question is "yes." Of the 116 clinical participants, 40% showed a significant difference between the performance on the plurals and possessives, and the most common pattern was the relative preservation of plurals (42/46, 91% of those who showed significant differences). This might be expected given that possessive markers attach to phrasal-level constituents, which may require more complex morphosyntactic processing compared to plurals which attach to individual words.

Four individuals (9% of clinical participants with a significant difference in inflectional morpheme performance) demonstrated the opposite pattern. Their performance of possessives was preserved relative to plurals. This suggests that better performance on plurals than possessives does not reflect the fact that plurals are easier because they require fewer operations. Individuals with this pattern of performance have been reported in the literature previously. Thompson et al. (2002) described their patient, R. B., who had considerable difficulty producing both regular and irregular plural -s while maintaining a nearly completely intact possessive 's. The pattern of performance by R. B. is similar to the performance by KBN, AWR, and JH (Figure 1). They performed at or near ceiling in the possessive 's (88.2% and above). In contrast, VCLM demonstrated difficulty across both morphemes (possessive 's performance of 58.8%), although plural -s was more severely impaired. The four participants with preserved possessives further differed from one another in their relative performance of nouns and modifiers. KBN and VCLM demonstrated considerable difficulty across remaining noun and modifier targets. AWR and JH performed near ceiling across targets with the unique exception of plurals -s. These participants provide counterevidence to the theory that difficulty with marking possessives is purely the result of their greater cognitive-linguistic complexity. Instead, they provide evidence of a potential double dissociation in function.

All individuals with PPA who were examined for the significant dissociation demonstrated relative preservation of the plural over the possessive marking. Those with svPPA demonstrated the greatest difficulty, perhaps indicating that these items rely heavily on both word-retrieval and syntax. Two individuals with PPA completed the assessment more than once. Of particular interest is the performance of JSE, a participant who had been diagnosed with svPPA approximately two years prior to completing two administrations of the MorGen. At the first administration, the two morphemes were not distinct in their performance (plural: 100%, possessive: 88.2%). Six months later, he showed only a slight decline for the plural -s marker (93.6%) but marked absence of the possessive 's marker in his speech production during the MorGen (0%). A second individual, who had nfavPPA, MWF, also received the MorGen approximately 3 months apart. She too demonstrated a negligible decline in the plural -s (100% to 96.8%), but a greater decline in the possessive 's (100% to 88.2%).

It is not clear why individuals with PPA show only the dominant pattern of greater preservation of the plural relative to the possessive marker while some individuals with stroke exhibit the rarely identified reversed pattern. It is possible that difficulty producing the genitive relative to the plural reflects greater syntactic demands and greater cognitive processing, as has been postulated, leading to more rapid relative decline of genitives among those with PPA. Perhaps this speaks to a contrast between bilateral, more diffuse

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neurological degeneration associated with PPA and relatively focal damage associated with left-hemisphere stroke. However, it is possible that some people with PPA will show the reverse dissociation when followed from onset of symptoms. Further work is needed to determine whether individuals with possessive- and plural-preserved patterns have differing lesion characteristics and to better understand the relationship between nature and site of damage and bound morpheme performance.

The dissociability of plural and possessive forms is consistent with their underlying linguistic differences. Despite the fact that surface phonological forms can be identical, they are generated by different morphosyntactic processes. Plurals are inflections that attach to word-level linguistic nodes whereas possessives are clitics that attach to phrase-level nodes. To illustrate phrase-level possessive attachment consider “The editor’s request was followed” versus “The editor of the journal’s request was followed.” The possessive ‘s appears at the end of the noun phrase (“the editor” vs.” the editor of the journal” in both cases, which requires sensitivity to the hierarchical structure of the linguistic elements. In contrast, it is clear from the following examples that plurals attach to words, in this case to the word “editor”: ”The editors requested some changes” vs. “The editors of the journal requested some changes.”

The observed pattern of performance leads to the following conclusions regarding the processing and neural basis of plural and possessive marker generation. First, the deficits we observed resulted from morphosyntactic impairments, at least in those patients who showed clear dissociations: lower-level articulatory, phonetic, or phonological deficits would impact both plurals and possessives equally since they have the same surface phonological complexity. Second, morphosyntactic processes are sensitive to latent hierarchical structure (phrasal versus word-level attachment) even when the possessive phrasal attachment involves only a simple structure (e.g., “Mary’s shoe”); indeed, the number of morphemes to be produced in both classes of elements were matched. Third, ability to generate possessive markers is more sensitive to brain injury than plural marking. Our study cannot speak to the basis of this observation. Perhaps possessive require more computational steps than plurals giving more opportunities for interruption. Alternatively, there is independent evidence that high frequency inflectional forms can be stored in the lexicon rather than generated productively (Pinker & Ullman, 2002). The ability to lexicalize plurals may make them more resilient in the face of disruption to morphosyntactic processes. Finally, and importantly, the evidence for a double-dissociation in the ability to generate plurals versus possessives argues strongly against their dissociability resulting from complexity effects alone. Some neural computational divergence must underlie the processing of the two linguistic markers. Future research will be needed to fully understand these networks.

One limitation of our study is that we did not control for *plural dominance*. Plural dominance refers to nouns for which the plural form of a noun is higher frequency than the singular form. When this occurs, the noun is accessed in its plural form or as a noun with a very strong rule connection with its plural marker. Prior work has observed this phenomenon across several languages (e.g., Beyersmann et al., 2018; Biedermann et al., 2018; Lorenz & Biedermann, 2015; Luzzatti, Mondini, & Semenza, 2001). Nevertheless, this limitation does not detract from the double dissociation between possessive and plural forms.

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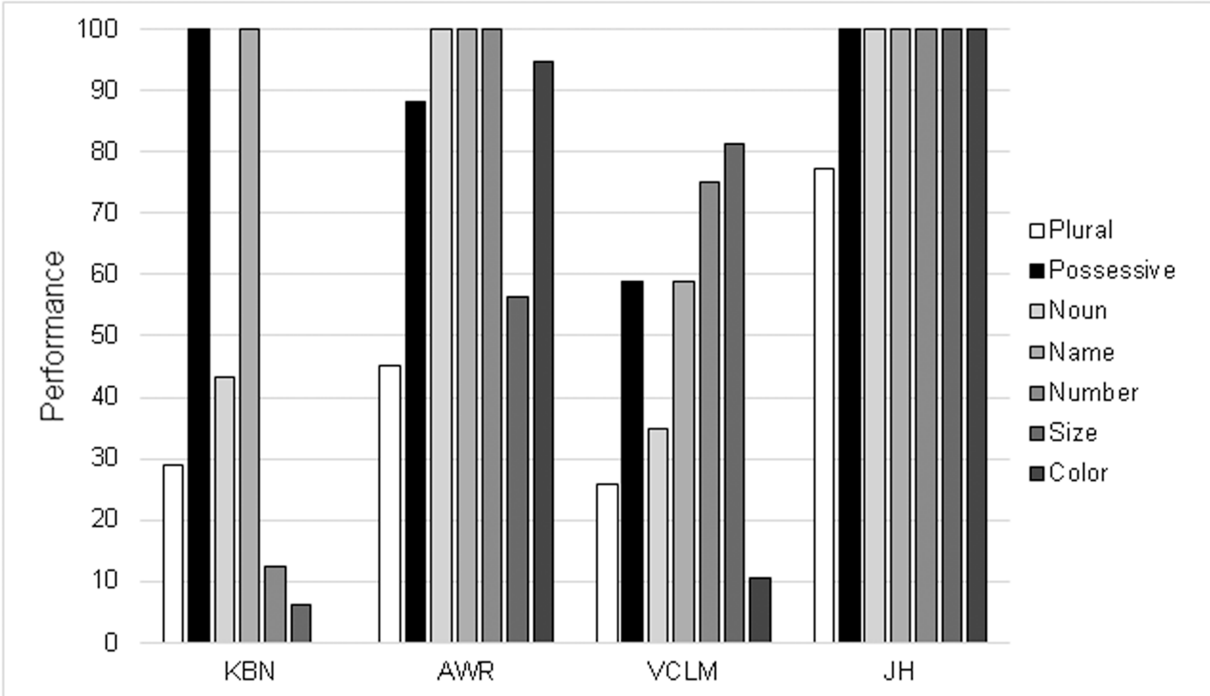

Figure 1:
Possessive > Plural participant performance characteristics

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Table 1:

Group characteristics

	Controls	PPA	Acute Stroke	Chronic Stroke	Statistics
Age	61.0(14.6)	70.2(8.1)	63.4(10.2)	65.2(11.8)	$F(3, 157) = 4.9^{**}$
Education	16.5(2.7)	15.9(3.0)	13.2(1.7)	15.4(2.6)	$F(3, 133) = 7.5^{**}$
M:F	24:26	23:21	8:13	25:25	Fisher's exact = 1.2, p = 0.76

** $p < 0.01$.

Statistics are presented as mean(standard deviation) unless otherwise noted. Age in years. Education in years. PPA refers to primary progressive aphasia.

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Table 2:

Mean percent correct MorGen performance by group

Morpheme	Controls (N=52)	PPA (N=44)	Acute Stroke (N=21)	Chronic Stroke (N=51)	Clinical Total (N=116)
Plura-s	99.9(0.9)	69.7(39.3)	85.7(26.8)	77.9(31.5)	76.2(34.2)
Possessive ‘s	99.8(1.1)	40.8(43.6)	63.0(41.7)	65.2(42.1)	55.5(43.8)
Noun	100.0(0)	71.5(39.5)	87.0(27.0)	85.6(28.7)	80.5(33.4)
Name	99.9(0.8)	69.0(35.3)	68.4(40.9)	87.0 (27.5)	76.8(34.2)
Numeral	95.9(10.1)	65.6(38.3)	78.0(32.8)	86.0(26.1)	76.8(33.4)
Size	97.4(5.4)	57.7(36.5)	57.4(37.4)	70.5(32.7)	63.3(35.3)
Color	99.0(3.8)	65.1(37.8)	70.4(38.5)	78.2(30.1)	71.8(35.0)
Total	98.8(1.9)	62.8(33.2)	72.8(27.3)	78.6(26.0)	71.6(29.8)

Statistics are presented as mean (standard deviation). PPA refers to primary progressive aphasia.

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Table 3:

Mean percent correct MorGen performance by PPA variant

Morpheme	lvPPA (N = 16)	nfavPPA (N = 9)	svPPA (N = 15)	unclassifiable (N = 4)
Plura-s	71.2(41.3)	79.9(38.1)	59.8(40.0)	78.2(37.2)
Possessive ‘s	41.2(46.5)	64.1(47.2)	25.5(35.9)	44.1(40.0)
Noun	75.5(40.1)	85.0(30.3)	57.6(42.6)	77.1(42.5)
Name	66.2(37.7)	90.9(16.7)	58.0(40.0)	72.1(22.2)
Numeral	72.7(39.1)	61.1(39.3)	53.3(38.8)	93.8(12.5)
Size	60.9(36.2)	75.0(35.2)	43.3(36.9)	59.4(29.1)
Color	65.8(39.0)	94.2(13.8)	48.1(40.0)	60.5(30.5)

Statistics are presented as mean (standard deviation). Variants of primary progressive aphasia (PPA) include semantic variant (svPPA), logopenic variant (lvPPA), and non-fluent agrammatic variant (navPPA). Those who showed characteristics of multiple subtypes resulting in unclear classification at the time of testing are labeled with “unclassifiable PPA.”

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Table 4:

Proportion of participants demonstrating the plural and possessive dissociation by group

	Controls		PPA		Acute Stroke		Chronic Stroke		Clinical Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Plural > possessive	0	0%	20	45.5%	9	42.9%	13	25.5%	42	36.2%
Plural = possessive	52	100%	24	54.5%	11	52.4%	35	68.6%	70	60.3%
Plural < possessive	0	0%	0	0%	1	4.8%	3	5.9%	4	3.5%

Data are presented as participant count; percent of group. “Plural > possessive” refers to participants whose plural performance was significantly greater than their possessive performance. “Plural < possessive” refers to participants whose plural performance was significantly less than their possessive performance. “Plural = possessive” refers to those who did not demonstrate a statistical difference in plural and possessive performance. Statistical significance was determined by Fisher’s exact tests. PPA refers to primary progressive aphasia.

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Table 5:

Mean percent correct MorGen performance by dissociation profile

	Incidence	Total MorGen % correct	Plural-s	Possessive ’s	Difference in Accuracy–s vs ’s
Plural > possessive	42; 25.0%	66.7(19.2)	83.3(19.9)	22.4(28.1)	60.9(25.4)
Plural = possessive	122; 72.6%	74.6(34.7)	73.7(39.9)	72.4(41.5)	1.3(8.2)
Plural < possessive	4; 2.4%	67.8(26.6)	44.4(23.6)	86.8(19.4)	−42.4(20.8)

Incidence is presented as participant count; percent of total sample (N = 168). Statistics are presented as mean (standard deviation). “Plural > possessive” refers to participants whose plural performance was significantly greater than their possessive performance. “Plural < possessive” refers to participants whose plural performance was significantly less than their possessive performance. “Plural = possessive” refers to those who did not demonstrate a statistical difference in plural and possessive performance. Statistical significance was determined by Fisher’s exact tests.

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Table 6:

Clinical characteristics and performance of those participants who demonstrated a significant difference between the plural-s and possessive ‘s

Participant	Group	Variant	MorGen	-s	’s	Δ
NBN	PPA	lvPPA	86.6	100.0	82.4	17.7*
LST	PPA	lvPPA	94.9	100.0	82.4	17.7*
WSH	PPA	lvPPA	90.5	96.8	76.5	20.3*
SAD	PPA	lvPPA	61.6	67.7	0.0	67.7**
JBK	PPA	lvPPA	63.6	87.1	0.0	87.1**
MBN	PPA	lvPPA	82.4	93.6	5.9	87.7**
MAT	PPA	lvPPA	56.2	93.6	0.0	93.6**
KGE	PPA	lvPPA	78.9	100.0	0.0	100.0**
RLR	PPA	nfavPPA	96.6	100.0	76.5	23.5*
WTN	PPA	nfavPPA	67.0	100.0	0.0	100.0**
JSR	PPA	svPPA	73.5	100.0	76.5	23.5*
MJE	PPA	svPPA	7.6	48.4	0.0	48.4**
MSH	PPA	svPPA	45.7	74.2	17.7	56.6**
AJN	PPA	svPPA	60.3	93.6	29.4	64.1**
MHN	PPA	svPPA	59.7	80.7	0.0	80.7**
TFD	PPA	svPPA	78.5	83.9	0.0	83.9**
JSE	PPA	svPPA	75.5	93.6	0.0	93.6**
WGH	PPA	svPPA	83.2	96.8	0.0	96.8**
BOY	PPA	unclassifiable PPA	64.5	93.6	41.2	52.4**
LGN	PPA	unclassifiable PPA	70.7	96.8	29.4	67.4**
LST	Acute	None	91.6	100.0	70.6	29.4**
CLA	Acute	None	80.0	96.8	58.8	38.0**
GRN	Acute	Anomic	73.7	83.9	41.2	42.7**
SHT	Acute	Anomic	43.3	71.0	0.0	71.0**
WWS	Acute	Anomic	66.3	100.0	23.5	76.5**
WBR	Acute	Wernicke’s	36.1	74.2	17.7	56.6**
DJN	Acute	Conduction	47.0	58.1	0.0	58.1**
CHH	Acute	Transcortical Motor	50.7	96.8	23.5	73.2**
GWR	Acute	Broca’s	73.1	90.3	5.9	84.4**
CCE	Chronic	Anomic	70.2	90.3	47.1	43.3**
LPL	Chronic	Anomic	57.7	83.9	11.8	72.1**
JZZ	Chronic	Wernicke’s	24.1	22.6	0.0	22.6*

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Participant	Group	Variant	MorGen	-s	’s	Δ
MW	Chronic	Wernicke’s	61.0	58.1	5.9	52.2 **
DOL	Chronic	Broca’s	55.5	38.7	0.0	38.7 **
MH	Chronic	Broca’s	54.2	45.2	5.9	39.3 **
CAM	Chronic	Broca’s	89.7	100.0	58.8	41.2 **
TG	Chronic	Broca’s	39.6	48.4	0.0	48.4 **
SA	Chronic	Broca’s	82.1	71.0	11.8	59.2 **
LBK	Chronic	Broca’s	75.3	77.4	11.8	65.7 **
DPE	Chronic	Broca’s	69.8	93.6	0.0	93.6 **
YBN	Chronic	Broca’s	74.2	100.0	0.0	100.0 **
GDS	Chronic	Global	88.0	96.8	29.4	67.4 **
KBN	**Acute**	**Broca’s**	**41.6**	**29.0**	**100.0**	**−71.0** **
JH	**Chronic**	**Anomic**	**96.8**	**77.4**	**100.0**	**−22.6** *
AWR	**Chronic**	**Broca’s**	**83.5**	**45.2**	**88.2**	**−43.1** **
VCLM	**Chronic**	**Broca’s**	**49.3**	**25.8**	**58.8**	**−33.0** *

* $p < 0.05$,

** $p < 0.01$ by Fisher’s exact test.

MorGen refers to the individual’s overall performance on the assessment (overall % correct). Individuals demonstrating the possessive-preserved pattern are bolded. Variants of primary progressive aphasia (PPA) include semantic variant (svPPA), logopenic variant (lvPPA), and non-fluent agrammatic variant (navPPA). Those who showed characteristics of multiple subtypes resulting in unclear classification at the time of testing are labeled with “unclassifiable PPA.” Aphasia variants for post-stroke participants are listed by the aphasia subtype established most closely to the administration of the MorGen using the Western Aphasia Battery.