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Selective impairment of morphosyntactic production in a neurological patient

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Abstract

In this paper we describe the impaired morphosyntactic production of a neurological patient (R.B.). The patient's production of almost all freestanding morphological material (e.g. subjects, verbs, and function words) is unimpaired, while production of bound inflectional morphology is impaired. We show that this impairment involves featural information on both verbs and nouns and discuss it in the context of the Distributed Morphology model of morphosyntactic processing. We conclude that her error pattern is consistent with impaired ability to convert featural information to morphological material after sentence formation is complete.

Keywords

Morphosyntactic production; Selective impairment

The study of disrupted language production subsequent to neurological damage provides a unique opportunity to examine the ways in which the linguistic faculty may fractionate and specific elements of the language faculty may be dissociated. Evidence from language impairments can thus provide important information about both the neural instantiation and the organization of language. Examination of the syntactic production of agrammatic Broca's ashasic patients has been especially useful in this regard. The speech of agrammatic patients is generally characterized by omission of closed-class or function words, a high noun-to-verb ratio, omission or substitution of inflectional affixes, and a lack of complex sentential structures. Recently, several authors have presented unified accounts of agrammatic production, which describe impairments of functional morphology and lack of complex sentential forms in terms of selective syntactic deficits.

There are different ways in which syntactic production may fractionate, and some accounts of dissociations between certain aspects of morphological and syntactic processing have been presented in the neurolinguistic literature (Badecker, 1997; Bastiaanse, 1995; Caramazza & Hillis, 1989; Miceli, Mazzucchi, Menn, & Goodglass, 1983; Miceli, Silveri, Romani, & Caramazza, 1989; Nespoulous, Dordain, Perron, Ska, Bub, Caplan, Mehler & Lecours et al., 1988). For example, Miceli et al. (1989), in a review of 20 Italian agrammatic aphasic patients, found that while a relationship between errors on freestanding and bound

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grammatical morphemes was apparent when the subjects were considered as a group, some patients showed selective impairments of freestanding versus bound morphological material. Such impairments can be described as syntactic in nature as they involve only material, such as (in English) affixes, which convey syntactic information. Based on this observation, Miceli et al. suggested that "production of freestanding and bound grammatical morphemes…are largely independent—damage to separate mechanisms is responsible for the two types of grammatical morphemes" (p. 466).

Miceli and Caramazza (1988) also described a patient who had difficulty producing inflectional, but not derivational or freestanding, morphology. In addition, the patient had difficulties with single word processing. The authors, therefore, accounted for the deficit in terms of impaired lexical representation rather than impaired syntactic processing. However, the impairment, at least in part, could also be considered syntactic.

Bastiaanse (1995) provided an account of a Dutch speaker who showed two patterns of speech deficit which she spontaneously shifted between. One pattern was confined to tense and agreement errors on verbs, with lexical retrieval, verb argument production, and phrase structure intact. In the second, the patient's production was telegraphic, with numerous errors involving production of closed class morphology and verb omission. Bastiaanse proposed that the patient had a deficit localized within the grammatical encoder in Levelt's (1989) model of syntactic production and that the differential production patterns noted were a result of an adaptation strategy (Kolk & Heeschen, 1990). This case study demonstrates that an underlying syntactic deficit may be manifested as a disorder involving both phrase structure and morphosyntactic affixation or that it may be restricted solely to the latter.

Hagiwara (1995) proposed that agrammatic production may be accounted for by considering the syntactic tree. She presented data from Japanese-, French-, and Italian-speaking agrammatic patients who demonstrated impairments at lower levels of the tree. In addition, the patients showed difficulty with structures higher in the tree. Based on these data Hagiwara suggested that without successful projection of the Inflection Phrase [IP] (situated at lower nodes of the tree), material in the Complementizer Phrase [CP] (situated at higher nodes) could not be projected.

Friedmann and Grodzinsky (1997) presented a similar account of syntactic deficits noted in a Hebrew-speaking agrammatic patient. In this case, the locus of the impairment was within IP. Following Pollock's (1989) *split inflection* (Split-Infl) hypothesis, subdividing IP to include projections for a Tense Phrase (TP), Negative Phrase (NegP), and Agreement Phrase (AgrP), they showed that their aphasic subject presented with intact representation of AgrP, but selective impairment in TP. In addition, their subject showed difficulty with complementizers and embeddings, indicating impaired CP as well.

On the basis of these data, and drawing on the ideas of Hagiwara, Friedmann and Grodzinsky posed the *Tree Pruning Hypothesis*, which holds that impairment may be localized to a specific, underspecified node in the syntactic tree; once such a node is underspecified, it cannot project any higher (Friedmann & Grodzinsky, 1997). Thus, production of material in higher nodes is prevented while material below the under-specified node is preserved. In Friedmann & Grodzinsky's patient, TP was underspecified and, therefore, the phrase structure could not project higher.

One problem with this account, however, concerns the lack of agreement on the ordering of nodes within IP. For example, Fig. 1 shows that in contrast to Pollock (1989),Ouhalla (1990) places AgrP above TP, with NegP taking even a lower position in the tree. On Chomsky's (1993) account, the inflectional nodes are ordered Agr_sP-TP-NegP-Agr_0P, where Agr_sP checks the features of the subject, and Agr_0P checks the features of the object. (Chomsky

(1995) later dispensed with agreement phrases altogether, allowing TP to check subject agreement.) Because Friedmann & Grodzinsky's patient showed completely intact subject agreement, her deficit pattern could not be attributed to Tree Pruning using either Ouhalla's (1990) or Chomsky's (1993) hierarchy.

The process of attaching inflectional material to free morphology has been discussed extensively within linguistic theory. The concept of syntactic features dates back to Chomsky's early theories (1965). According to later theories, i.e., Government and Binding (Chomsky, 1981), verbs and nouns are generated in base position without inflection and they move to higher locations within the syntactic structure in order to gain inflectional material. The more recent Minimalist Program (Chomsky, 1993, 1995) holds instead that verbs and nouns are retrieved from the lexicon fully inflected and move to higher locations in order to check the inflectional features on the retrieved lexeme against the inflectional features present on higher nodes. Other recent accounts (Halle & Marantz, 1993; Harley & Noyer, 1999; Halle, 1997) have proposed that attachment of inflectional morphology occurs after sentence formation is complete.

In this report we describe the production pattern of a patient presenting with a deficit which can be described as morphosyntactic, suggesting that attachment of inflection may be a poststructural process. Our patient's production impairment is almost entirely restricted to bound inflectional morphology. Her deficit pattern, however, is not completely consistent with a tree-pruning account. We claim that her construction of sentence structure is intact, but her conversion of features to inflectional morphemes is compromised.

A summary of the evaluations administered to our patient and an analysis of her morphosyntactic errors follows. We then present our account of her impairment pattern.

1. Method

1.1. Subject

R.B., a right handed, 37-year-old, college-educated, monolingual (native English speaking) white female, suffered a closed head injury resulting in a seizure disorder. MRI and SPECT scans administered following her injury were normal; however, EEG showed frequent episodes of left fronto-temporal high-voltage rhythmic delta slowing with spikes or sharp waves at the onset lasting up to 2 s. Theta slowing with sharp features was also seen in the left. The remainder of the neurological exam was normal. Behaviorally, she presented with grammatical impairments in both spoken and written language, and palallalia. She also showed mild word finding difficulties in conversation. No deficits in confrontation naming, auditory comprehension, or memory were noted. She was treated with anticonvulsants to control her seizure disorder. This resulted in a reduction in her palallalia; however, the grammatical impairment persisted. She did not receive treatment for grammatical difficulties. At the time of the present study she was 45 months post injury.

1.1.1. Standardized tests for aphasia

Language testing using the *Boston Diagnostic Aphasia Examination* (Goodglass & Kaplan, 1983) showed mild impairments in spoken and written language only. Language and reading comprehension were within normal limits.

1.1.2. Measures of language comprehension—Further testing of language comprehension using the *Philadelphia Comprehension Battery for Aphasia* (Saffran, Schwartz, Linebarger, Martin, & Bochetto, undated) and the *Northwestern University*

Sentence Comprehension Test for Aphasia (Thompson, undated) showed 100% correct lexical (single word) and 96% correct sentence comprehension.

1.1.3. Grammatically judgment—Grammaticality judgment also was tested; both grammatically correct and incorrect sentences were presented under headphones and the patient was required to indicate whether they were 'good sentences' or 'bad sentences'. Grammatically incorrect test sentences contained a variety of violations including agreement, determiner-noun, phrase structure, and movement errors. R.B.'s overall performance on this test was 89% correct; she had no problem identifying errors of phrase structure or movement. However, she showed difficulty detecting verb tense, agreement, aspect and number errors. For example, she judged the following sentences to be grammatically correct:

1. *They can suggested a restaurant.
2. *The farmer should planting corn.
3. *Many boy watched the game.
4. *That tables will be sold.

1.2. Productive language samples

The patient's production was tested in three spoken narrative tasks and one written narrative task. The patient completed two free narrative tasks in which she told the fairy tales of Cinderella and Little Red Riding Hood after having been shown pictures detailing the events in the stories. A third free narrative task elicited a description of action taking place in the Cookie Theft picture (Goodglass & Kaplan, 1983). Finally, the patient provided a written discourse sample regarding her personal and medical history.

1.3. Data analysis

Productive language samples were transcribed and segmented into utterances based on semantic, syntactic, and prosodic criteria, as per the coding method developed by Thompson, Shapiro, Tait, Jacobs, Schneider and Ballard (1995). Verbs and nouns were separated into regular and irregular groups and further analyzed with regard to functional categories.

2. Results

We present the results of our analysis of R.B.'s production abilities across tasks with reference to the syntactic tree structure shown in Fig. 2, which illustrates the major phrasal geometry of sentences and the relations among elements. Shown here are the local trees headed by the Complementizer Phrase (CP), Inflectional Phrase (IP), and Verb Phrase (VP). Going from top to bottom, the Specifier position of CP [Spec, CP] is the landing site for *wh*-morphemes in complex sentences with *wh*-movement. The head of CP, COMP, may be filled with complementizers such as *that* and *if*. The next level down is the local tree headed by IP. Its Specifier position [Spec, IP] is the subject position. The head of IP, INFL, is filled by auxiliary verbs as well as verb tense and agreement markers. Within the VP are contained complements of the verb such as the Determiner Phrase (DP, which dominates the noun phrase (NP)) or sentential complements (also CP structures). Possessive markers are located either at the head of DP, D, (Abney, 1987) or at the head of a Case Phrase above D (Valois, 1991). The head D contains determiners such as *a* and *the*; a Number Phrase below DP but above NP contains plural markers (Valois, 1991;Ritter, 1992).

For the purposes of our analysis we expand IP after Ouhalla (1990). From top to bottom on the syntactic tree we consider the Agreement Phrase (AgrP), Tense Phrase (TP), and Negation Phrase (NegP). We also include a projection for Aspect Phrase (AspP), which we locate below AgrP (after Hendrick (1991)). As shown in Fig. 3, the head positions of AgrP, TP, NegP, and AspP serve as sites for agreement endings, verb tense endings, negators, and aspectual morphology, respectively.

Following Fig. 2, we first present data regarding utterances containing material located in CP, followed by data relevant to material in IP, including sentential subjects and auxiliary verbs. We also show R.B.'s ability to produce main verbs, verb objects, and determiners.

We then present data on verb morphology, following Fig. 3, including agreement (i.e., third person -*s*), tense (i.e., -*ed*), aspect (i.e., -*ing*) and negation (i.e., -*n't* or *not*). We also discuss noun morphology on both subjects and objects.

2.1. Complex sentences

Results of our analysis indicated that although R.B. showed an overall reduction in the proportion of grammatical sentences produced, she had no difficulty producing complex sentential structures. As is shown in Table 1, the proportion of complex versus simple sentences produced was similar to that of normal subjects under similar conditions. Although her mean length of utterance (MLU) was slightly reduced as compared to normal subjects, open-to closed-class word and noun-to-verb ratios were within normal limits. Production of verb argument structures in sentences also was largely unimpaired.

Examples taken from her data indicate that she freely produced utterances containing material located in CP in all discourse conditions. These constructions included sentences containing moved *wh*-elements in the matrix clause such as in (5–8).

5 wolf want **what** in her basket (spoken narrative)

6 **how'**s that (spoken narrative)

7 **how** are you (written sample)

8 **how** do you likes Chicago (written sample)

In addition, she produced complex sentences containing relative pronouns as in (9–10) and embedded clauses with subordinating conjunctions and complementizers as in (11) and (12).

9 grandma **who'**s sick in bed and **who** live out in the woods (spoken narrative)

10 boy **who** stalk her (written sample)

11 she tell him no **because** they're for her grandmother (spoken narrative)

12 **if** you gets time to write (written sample)

2.2. Free morphology

Table 2 presents data concerning R.B.'s production of free morphology, including sentential subjects, auxiliary verbs, main verbs, verb objects, and determiners. These data show that R.B. produced few omissions of free morphological material.

2.2.1. Sentential subjects—R.B. showed relatively spared ability to produce sentential subjects. She omitted only two out of 60 subjects in the entire corpus. These included:

13 Ø see the yard (spoken narrative)

14 Ø can't tell (spoken narrative)

2.2.2. Auxiliary verbs—R.B. produced auxiliaries where appropriate, with few exceptions. For example, two omissions occurred with the use of the aspectual marker *-ing* (15, 16).

15 stool look like Ø going to fall over (spoken narrative)

16 she Ø not looking out the window (spoken narrative)

2.2.3. Main verbs—R.B. omitted five main verbs; in all cases, the missing verb was the copula. In (17) she omitted both the relative pronoun who and the copula; in (18–19) she omitted only the copula.

17 for her grandmother sick in bed (spoken narrative)[1] (cf. For her grandmother *who is* sick in bed)

18 wolf want what Ø in her basket (spoken narrative)

19 but their feets Ø too big (spoken narrative)

2.2.4. Verbal objects—During the spoken narrative tasks, R.B. produced all verbal objects, with two exceptions. She omitted an object in a postverbal prepositional phrase (20) and a verb object (21).

20 the look out the Ø (spoken narrative)

21 they killed Ø (spoken narrative)

2.2.5. Determiners—R.B. omitted articles on only two occasions. An example of such is provided in (22).

22 the fairy godmother turn Ø pumpkin into a carriage (spoken narrative)

2.3. Inflectional morphology and negation

2.3.1. Verb morphology—Data delineating the proportion of correctly supplied inflectional morphology across tasks for verbs are shown in Table 3. Specifically, percent correct production of the regular third person agreement morpheme *-s* (e.g. *he sleeps*), irregular agreement (e.g. *Cinderella is*), the regular past tense morpheme *-ed* (e.g. *she baked*), irregular past tense (e.g. *he slept*), and the present progressive aspectual morpheme *-ing* are shown (e.g. *The play is starting*). In addition, R.B.'s production of negation across tasks is shown.

2.3.2. Agreement—Results indicated that production of the regular third person agreement morpheme -s was impaired in all conditions. R.B. correctly supplied *-s* only 7% (4/56) of the time in the spoken narrative and written samples. Most of her errors were omissions as in (23–24).

23 she **continue** on (spoken narrative)

24 that too **keep** me busy (writing sample)

R.B. also produced extraneous *-s* with first person singular (as in 25), second person singular (as in 26), and third person plural pronouns (as in 27), as well as in contexts requiring the uninfected form (as in 27) or the infinitival form (as in 28).

[1]One reviewer of this manuscript found utterance (17) acceptable as a reduced relative clause, similar to *the people happy with the proposal* (cf. discussion in Sag (1997)). We agree; however, we point out that such judgment is entirely a matter of intuition. Further, judging (17) acceptable strengthens our claim that free morphology (main verb production) and complex sentence structures are not compromised in the patient's grammar.

25 I **thinks** about you all the time and **I misses** you (writing sample)

26 if you **gets** time to write (writing sample)

27 they **makes** her **helps** them (spoken narrative)

28 the better to **hears** you with (spoken narrative)

Errors also were noted in R.B.'s production of irregular agreement. She correctly produced irregular agreement forms for main verbs 45% (10/22) of the time in spoken narratives and in writing. Errors usually consisted of use of the citation form of the verb (as in 29–30), although on two occasions she affixed the regular suffix -s to the citation form (as in 31).[2]

29 Cinderella **have** a beautiful dress (spoken narrative)

30 it **be** such a beautiful city (spoken narrative)

31 she **bes** beautiful (spoken sample)

2.3.3. Tense—In the spoken narrative tasks, the patient primarily used present tense; when she did use past tense, she produced 33% (3/9) of regular forms correctly (no irregular past forms were used in the spoken narrative tasks). In the written sample, she used no past tense forms correctly (0/8 regular, 0/13 irregular).

The patient's errors in producing regular past tense verbs substituted the citation form for the infected form as in (32–33).

32 her mother **bake** some things (spoken narrative)

33 she **encounter** a lot of antisemitism in school… for several month (written sample)

For irregular verbs, R.B.'s errors were, for the most part, similar to those with regular verbs (34), but on three occasions she produced a regular tense marker *-ed* with an irregular verb, resulting in production of a novel form as in (35–36).

34 this past March **I get** (written sample)

35 we **haved** a rough year (written sample)

36 **haved** a disease (written sample)

2.3.4. Aspect—Production of the present progressive aspectual morpheme *-ing* also showed impairment. In the free narrative tasks, R.B. produced *-ing* correctly only 2 of 4 times (50%). One error created a novel form by suffixing *-ing* to a noun in(37); in the other error she substituted simple (habitual) present for present progressive in a context where the latter is clearly appropriate (38). The correct usages are given in (39) and (40); note that they lack auxiliaries preceding the progressive verb.

37 Cinderella's wicked stepmother and stepsister**ing** (spoken narrative)

38 the girl look like she **start** to laugh (spoken narrative) (cf. the girl looks like she is starting to laugh)

39 stool look like it go**ing** to fall over (spoken narrative)

40 she not look**ing** out the window (spoken narrative)

[2]One reviewer pointed out that utterances (29–31) could be coded as tense errors instead of agreement errors. We agree; however, we note that when R.B.'s narrative samples were considered as a whole she used almost no past tense forms, but consistently used present tense throughout (this was evidenced by the correct and incorrect use of the agreement suffix *-s*). (Such usage is common when patients retell fairy tales as they page through a book, using the pictures for narrative cues.) Therefore, we considered utterances such as *Cinderella have a beautiful dress* to be present tense attempts with agreement errors.

In the writing task, R.B. did not produce *-ing* at all, although context showed that it was necessary in several instances. When progressive aspect was called for, R.B. substituted the infinitive form (as in (41) below) or used the simple (habitual) present in contexts where it was not appropriate, as in (42).

41 last summer lend up **to go** off Felbatol (written sample) (cf. Last summer I ended up going off Felbatol)

42 my life finally **start** to feel more normal (written sample) (cf. My life finally is starting to feel more normal)

2.3.5. Negation—An account of R.B.'s production of negative morphology is necessary in order to understand the nature of her impairment because negation is closely related to agreement and tense. In contrast to her difficulties with agreement and tense, R.B. correctly produced 100% of negative morphology, including *-n't* and not, across all three task types—6/6 in spoken narrative tasks, 5/5 in the written sample.

2.4. Noun morphology

Data concerning R.B.'s production of noun morphology also are shown in Table 3. Percent correct production of both regular and irregular plural forms is shown. We also show data regarding production of possessive morphology.

2.4.1. Plurals—The patient correctly produced the regular plural morpheme *-s* on 13 of 24 occasions (54%). Notably, errors were produced in both subject and object noun phrases. She did not produce any correct irregular plural forms in spoken or written samples (0/9 and 0/5, respectively).

R.B.'s erroneous regular plural forms (as in 43) consist of omitted *-s*; she did not produce any extraneous *-s* suffixes (that is, she did not produce the suffix *-s* on singular forms).

43 she drop one of her **shoe** (spoken narrative)

R.B.'s erroneous productions of irregular plural forms differed notably from her other errors: in all cases the regular plural inflectional suffix *-s* was added to the irregular plural form as in (44–46).

44 the stepsister try to fit their **feets** into the shoe (spoken narrative)

45 I likes it quite a lot and have meet some very nice **peoples** (written sample)

46 so much **peoples** really (written sample)

2.4.2. Possessive morphology—In contrast to R.B.'s difficulty producing the plural morpheme *-s*, she showed good ability to produce the possessive marker *-'s* on nouns in both subject and object noun phrases. Our patient correctly produced the possessive suffix *-'s* 17 of 18 times (94%) across tasks (see 47, 48).

47 Cinderella's wicked stepmother (spoken narrative)

48 he come to Cinderella's house (spoken narrative)

3. Discussion

To summarize, R.B. presented no difficulty producing complex sentential structures. She freely produced utterances containing material located in the Complementizer Phrase (CP), including complex sentences with subordinating conjunctions and embedded clauses, sentences containing relative pronouns, and sentences containing moved *wh*-elements. She

also produced other free morphological elements without difficulty, including sentential subjects, auxiliary verbs, main verbs, and determiners. In contrast, R.B.'s production errors were restricted to certain morphosyntactic affixes. The Tree Pruning Hypothesis is, therefore, not an adequate description of R.B.'s error pattern. Indeed, she presented with intact ability to project CP structures that are high in the syntactic tree. Conversely, elements within IP that are lower in the syntactic tree presented difficulty for her.

Considering only elements within IP, Tree Pruning could be used to describe our patient's deficit pattern if we consider only tense, agreement, and negation and use Chomsky's (1993) or Ouhalla's (1990) ordering of nodes—with NegP placed below Agr_sP and TP. Indeed, our patient showed difficulty with tense and agreement, but not negation. However, per Pollock's analysis of IP (that used by Friedmann and Grodzinsky (1997)), negation takes a position between tense and agreement. Using this ordering of nodes within IP, our patient's deficits are inconsistent with a Tree Pruning account. Further, our patient showed impairment in aspect (i.e., *-ing*). While AspP is not discussed by Chomsky (1993) or Ouhalla (1990) in the context of phrases exploded in IP, Hendrick (1991) postulates the presence of AspP and places it at the bottom of IP (in order to explain why certain Welsh verbs cannot raise out of VP). Using Hendrick's ordering of elements in IP, a Tree Pruning account would predict no impairment in AspP, a prediction that is not supported by the present data.

Let us consider, instead, the possibility that R.B.'s deficit is morphological, resulting from faulty application of morphological rules, rather than syntactic, resulting from impaired syntactic projections. Two patterns of production evinced by R.B. suggest that her deficit is not purely morphological: (a) over-production of affixation and (b) use of doubly infected forms. As noted above, R.B. showed the ability to suffix morphological material to lexical items, however, she applied suffixation rules inappropriately. For example, she often affixed the third person agreement marker *-s* to verbs with first or second person subjects (e.g. *I thinks*). This production pattern shows that morphological attachment is not the source of R.B.'s deficit. Further, R.B.'s impairment pattern is not typical of agrammatic aphasic patients (speaking a zero-morphology language such as English), whose deficits have been characterized as morphological. Agrammatic patients generally omit inflectional affixes (Grodzinsky, 1984; 1998) and their errors do not involve overuse of affixation (Jarema, 1998).

Additionally, R.B. evinced difficulty with irregular suppletive forms when producing irregular plurals, i.e., she consistently produced novel forms, in which a regular inflectional marker was affixed to an irregular suppletive form (e.g. *feets*). The fact that she appends an affix to such words is curious, since forms such as *feet* should be associated with the feature [+PLURAL]. However, while faulty, the fact that this affixation occurs suggests that attachment of regular inflectional suffixes is not her primary deficit.

One possible explanation is that R.B.'s impairment is related to the checking or representation of features (e.g.[+ PLURAL], [+ TENSE]), as specified in Minimalist syntax, rather than to the application of regular morphology (e.g. *-s*,*-ed*.). Perhaps R.B. is unable to perform feature-checking. For example, it could be the case that when retrieving an infected form like *talk* + *s*[3SG] from the lexicon she inserts it into a sentence with a first-person subject; in this case, the features on the verb and the AGR node would not match. While correct feature-checking is required in intact grammars to prevent the derivation from crashing, perhaps R.B. simply skips this process, allowing incorrect derivations. However, impaired feature checking would also result in impaired word order, because Minimalist syntax holds that head movement occurs because of the need to check features. R.B. evinces no word order problems; therefore, we rule out the possibility that she evinces a feature

checking deficit. Alternatively, R.B. could have numerous incorrect lexical entries, such as -*s*[+ 1SG] or -*s*[+ 2SG]. Checking such forms against a first- or second-person subject would result in a match, and the derivation would proceed. However, R.B.'s production includes both correct and incorrect usage, so her lexicon would have to have both correct and incorrect lexical entries. That is, she would have to have the entries -*s*[+1SG] -Ø [1SG], -*s*[2SG], -Ø [2SG], and so on. This sort of augmentation of the lexicon seems highly unlikely following neurological damage. Additionally, it provides no straightforward account of how R.B. would produce doubly inflected forms like feets, where one or both [+PLURAL] features on the noun would correctly check against the [+ PLURAL] feature on the head of the Number Phrase.

Instead, R.B.'s deficit appears to involve the morphological instantiation of syntactic features. An account of her error pattern would require a model of grammar in which morphology was handled neither in the lexicon nor in the phrase structure, but at a later time in the derivation. The recently developed theory of Distributed Morphology (DM; Halle & Marantz, 1993; Harley & Noyer, 1999; Halle, 1997) posits a level of derivation, Morphological Structure (MS), that maps syntactic features onto morphemes after the syntactic derivation is complete.

In the Government and Binding model discussed above, lexical heads incorporate inflectional morphemes at S-structure. This occurs when lexical heads raise to functional heads housing inflection (as with English auxiliaries or finite verbs in Germanic languages) or when inflection lowers from functional heads onto lexical heads (as with English main verbs). The incorporation process is identical in DM, except that no actual morphology is present. Instead, features are incorporated onto unfilled slots for open-class items. The derivation thus leaves S-structure containing such incorporated forms as [VERB][+PAST] or [NOUN][+PLURAL].[3]

After leaving S-structure, the derivation enters MS. At MS, the process of Vocabulary Insertion (VI) replaces features with actual morphemes. In the VI process, lexical categories are inserted first, and then syntactic features are converted to morphology. For example, the regular past tense form *talked* is generated as follows: *talk* is inserted to fill the [VERB] slot; then the suffix *-ed* is inserted to replace the feature [+PAST]. Generation of irregular forms involves both VI and phonological readjustment rules. After an irregular verb is inserted in the [VERB] slot, replacement of the [+ PAST] feature with *-ed* is blocked by a rule that attaches a zero affix to irregular forms; this more specific rule prevents the application of the general (regular) rule. Finally, phonological readjustment rules complete production of irregular forms. These readjustment rules apply to specified sets of forms: a rule changes the vowel in *sit* and *sing* to /æ/ to form *sat* and *sang*, and a different rule changes the vowel in *drive* and *ride* to /o/ to form *drove* and *rode*.

The output from MS, a morphologically complete representation, goes to Phonological Form (PF), where it receives a phonological interpretation. MS thus serves as the interface between featural information and morphology. A flawed feature-to-morpheme mapping process of Vocabulary Insertion could result in both omission and overuse of inflection. On this account, R.B.'s association of features and morphemes would be disrupted so that, for example, the subject agreement features [+ 1SG] and [+ 3SG] could be associated with both

[3]Much recent DM work (Marantz, 1997) holds that open-class categories such as noun and verb are in fact a single underspecified category that is further distinguished only by its configuration in the phrase structure. When this category appears below the Number Phrase or Determiner Phrase, it will be regarded as a noun; when it appears below the Aspect Phrase, it will be regarded as a verb. Because this aspect of DM is largely irrelevant to this paper, we ignore it.

a zero affix and the suffix *-s*. This would explain R.B.'s omissions of *-s*, as well as superfluous use of *-s* with non-third-person subjects.

Incorrect application of feature-to-morpheme mapping rules would also explain R.B.'s unusual production of forms such as *feets* and *peoples* (utterances 44–46 above) that have been inflected twice, once by suppletion and once by affixation. (*Peoples* is, of course, a licit form denoting ethnic or cultural groups, but its existence is irrelevant to our analysis because *people*, plural of *person*, is still generated by zero affixation and application of a readjustment rule). On our account, R.B.'s production of these forms would proceed as follows: At D-structure, [NOUN] is located at the head of the Noun Phrase, and the feature [+PLURAL] is at the head of the Number Phrase. At S-structure, the plural feature lowers to the lexical head, or the lexical head raises to the head of the Number Phrase to incorporate the plural feature. The incorporated form [NOUN][+PLURAL] enters MS, where VI inserts foot to fill the [NOUN] slot. After inserting the noun, VI replaces the [+PLURAL] feature with an actual morpheme, and here R.B. applies both the narrow zero-affix rule and the regular *-s* affix rule.[4] Finally, R.B. applies a readjustment rule changing the vowel in *foot* to /i/. The readjustment rule is triggered by the presence of the root lexeme and the zero affix (Halle & Marantz, 1993); application of the rule is thus unaffected by the presence of the *-s* affix. Finally, a disruption of VI leaves R.B.'s word order unaffected, as VI operates in MS, after clauses emerge from S-structure.

While it appears that R.B.'s deficit pattern fits well into the Distributed Morphology model of morphosyntax, we show that two morphemes are notably intact in R.B.'s grammar: negation and possession. We relate her preserved production of negation and possession to the fact that these morphemes are expressed in only one form. That is, there is no zero affix for them as there is for other forms in English, e.g. zero affixes are possible for morphemes for agreement (*I talk* ± Ø), tense (*Bill hurt* ± Ø *John yesterday*), and plural (*two sheep* ± Ø).

Let us consider negation. R.B. showed no impairment in production of not or *-n't* forms. It could be argued that this is the case because not and *-n't*, considered a cliticized form of *not*, are free morphemes which are preserved for R.B. However, on more recent linguistic accounts *-n't* is treated as an inflectional suffix heading the Negative Phrase (Zwicky & Pullum, 1983; Haegeman, 1995). Accordingly, we should expect *-n't* to pattern with other impaired bound morphemes such as *-s*, which it does not. However, we suggest that omission of morphemes such as *-s* results from incorrect application of a zero affix; for example, in production of verbs with third person subjects zero affixation is used even though the affix *-s* should be applied, as in utterance (23), *she continue on*. For negation, there is no zero affix; therefore, there is only one possible VI rule to apply, so R.B. produces the suffixes correctly and negation is preserved.

Similar reasoning can be offered for possession. Like negation, there is no zero affix for possession. The only possession affix is *-'s*. Therefore, possessive forms are preserved. Initially, it appears that this explanation fails to account for R.B.'s impaired production of *-ing*, which also has no zero affix allomorph. However, closer examination of R.B.'s *-ing*

[4]There are two ways in which R.B.'s VI system could be disrupted so as to allow this sort of double inflection. As noted above, in an intact VI system, narrower rules apply first, and block application of more general rules; Halle (1997) refers to this as the Subset Principle. If this principle were disrupted in R.B.'s grammar, doubly inflected forms would be possible. However, the Subset Principle is identical to phonology's Elsewhere Condition, and if the two are different aspects of the same grammatical principle, R.B.'s phonological production would be expected to be impaired (it is not). On the other hand, if the Subset Principle and the Elsewhere Condition are parallel devices within the morphological and phonological components of the grammar, phonological disruption would not be seen, as in R.B.'s case. Alternatively, the DM mechanism of Fission allows multiple morphemes to be inserted for a given feature, in order to produce forms in languages in which multiple affixes instantiate certain syntactic features. R.B. could be using the Fission mechanism to produce doubly inflected forms. However, Fission is not an option in English grammar, and conjecturing that a previously unavailable grammatical device becomes available as a result of neurological damage seems untenable.

errors suggests that she is substituting a different verb form for *-ing* and incorrectly producing the morphology associated with the substituted form. Utterances (38), (41), and (42), repeated below, show such substitution errors. In (38) and (42), R.B. substitutes the present tense verb *starts* but then fails to produce the *-s* suffix. In (41), the error is again one of substitution, as the infinitival form *to go* is substituted for going. The infinitival form, however, is correctly produced.

38 the girl look like she **start** to laugh (spoken narrative)

41 last summer I end up **to go** off Felbatol (written sample) (cf. Last summer I ended up *going* off Felbatol)

42 my life finally **start** to feel more normal (written sample) (cf. My life finally *is starting* to feel more normal)

Finally, we discuss another model of grammar in which some morphological processes occur after syntactic structure is complete: the Word-and-Paradigm (WP) approach to morphology (Anderson, 1992; Matthews, 1991), which can also be considered in describing R.B.'s deficit. WP models agree with DM that S-structure contains only features without actual inflectional morphology (unlike DM, however, WP retains the traditional assumption that nouns and verbs are present in the D-structure). The main difference is that, in WP theories, all inflection is generated by rule application at PF rather than via a feature-morpheme interface. In addition, it is at PF that irregular forms are generated by specific rules that prevent the application of general rules. A WP account, thus, could explain some of R.B.'s patterns. A WP account could explain her use of doubly inflected forms the same way that the DM account does. However, R.B.'s overuse of the agreement suffix *-s* is less easily accounted for on this theory. According to WP, an intact grammar has a rule that adds *-s* only to verbs with the [+3SG] feature; no rule applies when verbs have other number features. To explain R.B.'s overuse of *-s*, a WP account would have to posit a broadening of the *-s* suffixation rule to apply to verbs with any number feature.

While this could explain overproduction, it does not predict R.B.'s omission of *-s* on verbs with the [+ 3SG] feature or the occasional (correct) absence of *-s* on verbs specified for other agreement features. To explain these omissions, we would need a rule adding a zero affix to verbs with any agreement feature. As in our DM account, the variability in R.B.'s use of *-s* would result from inconsistent choice between this rule and the *-s* suffixation rule. Zero affixes, however, are not used in Word-and-Paradigm theories (Stump, 1998), so this option is not available. Even if it were, the addition of a novel morphological rule allowing zero affixes to attach to verbs with any agreement feature is undesirable when explaining a deficit resulting from neurological damage. Indeed, while the use of zero affixes is often cited as a shortcoming of Distributed Morphology (Stump, 1998; Zwicky & Pullum, 1992) in this case it provides a much more parsimonious explanation for R.B.'s impairment, since the alternative to a disrupted feature-morpheme interface would be the existence of incorrectly specified lexical entries or additional morphological rules.

4. Conclusions

We have presented evidence from a patient who demonstrates that representation or processing of morphosyntactic features may be impaired while leaving other aspects of syntactic production largely unaffected. One benefit to studying acquired language deficits is that it can potentially lead to discovery about which aspects of syntactic processing may be dissociable in impaired populations, and thus may be separate processes. Indeed, such data suggest that constructs developed by linguists to account for structures and patterns found in languages have cognitive status. In the present case, our patient's deficit patterns can be considered reflective of difficulty associated with replacement of featural information

with morphological material. This selective impairment meshes well with the Distributed Morphology model of morphosyntactic production, which regards the translation of feature information into morphological material as a process that occurs after, as opposed to concurrently with, the realization of sentence structure.

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References

Abney, S. PhD dissertation. MIT; 1987. The English Noun Phrase in its sentential aspect.

Anderson, S. A-morphous Morphology. Cambridge, UK: Cambridge University Press; 1992.

Badecker W. Levels of morphological deficit: indications from inflectional regularity. Brain and Language 1997;60:360–80. [PubMed: 9398389]

Bastiaanse R. Broca's aphasia: A syntactic and/or morphological disorder? A case study. Brain and Language 1995;48:1–32. [PubMed: 7712146]

Caramazza A, Hillis AE. The disruption of sentence production: some dissociations. Brain and Language 1989;36:625–50. [PubMed: 2470464]

Chomsky, N. Aspects of the Theory of Syntax. Cambridge, MA: MIT Press; 1965.

Chomsky, N. Lectures on Government and Binding. Dordrecht: Foris; 1981.

Chomsky, N. A minimalist program for linguistic theory. In: Hale, K.; Keyser, SJ., editors. The View From Building 20: Essays in Honor of Sylvain Bromberger. Cambridge, MA: MIT Press; 1993. p. 1-52.

Chomsky, N. The Minimalist Program. Cambridge, MA: MIT Press; 1995.

Friedmann N, Grodzinsky Y. Pruning the syntactic tree: Tense and agreement in agrammatism. Brain and Language 1997;56:397–425. [PubMed: 9070419]

Goodglass, H.; Kaplan, E. The Assessment of Aphasia and Related Disorders. Philadelphia, PA: Lea & Febiger; 1983.

Grodzinsky Y. The syntactic characterization of agrammatism. Cognition 1984;16:99–120. [PubMed: 6205816]

Grodzinsky, Y. Comparative aphasiology: some preliminary notes. In: Visch-Brink, E.; Bastiaanse, R., editors. Linguistic Levels in Aphasia. San Diego: Singular Publishing Group; 1998.

Haegeman, L. The Syntax of Negation. Cambridge, UK: Cambridge University Press; 1995.

Hagiwara H. The breakdown of functional categories and the economy of derivation. Brain and Language 1995;50:92–116. [PubMed: 7552231]

Halle M. Distributed Morphology: Improverishment and Fission. MIT Working Papers in Linguistics 1997;30:425–49.

Halle, M.; Marantz, A. Distributed morphology and the pieces of inflection. In: Hale, K.; Keyser, SJ., editors. The View from Building 20: Essays in Honor of Sylvain Bromberger. Cambridge, MA: MIT Press; 1993. p. 111-76.

Harley H, Noyer R. State-of-the-article: distributed morphology. Glot International 1999;4.4:3–9.

Hendrick R. The morphosyntax of aspect. Lingua 1991;85:171–210.

Jarema, G. The breakdown of morphology in aphasia: A cross-language perspective. In: Stemmer, B.; Whitaker, H., editors. Handbook of Neurolinguistics. San Diego: Academic Press; 1998. p. 222-48.

Kolk HH, Heeschen C. Adaptation symptoms and impairment symptoms in Broca's aphasia. Aphasiology 1990;4:221–32.

Levelt, W. Speaking: from Intention to Articulation. Cambridge, MA: MIT Press; 1989.

Marantz A. No escape from syntax: Don't try morphological analysis in the privacy of your own Lexicon. University of Pennsylvania Working Papers in Linguistics 1997;4:201–25.

Matthews, P. Morphology: An Introduction to the Theory of Word Structure. 2. Cambridge, UK: Cambridge University Press; 1991.

Miceli G, Caramazza A. Dissociation of inflectional and derivational morphology. Brain and Language 1988;35:24–65. [PubMed: 2460185]

Miceli G, Mazzucchi A, Menn L, Goodglass H. Contrasting cases of Italian agrammatic aphasia without comprehension disorders. Brain and Language 1983;19:65–97. [PubMed: 6860936]

Miceli G, Silveri MC, Romani C, Caramazza A. Variation in the pattern of omissions and substitutions of grammatical morphemes in the spontaneous speech of so-called agrammatic patients. Brain and Language 1989;36:447–92. [PubMed: 2706449]

Nespoulous JL, Dordain M, Perron C, Ska B, Bub D, Caplan D, Mehler J, Lecours AR. Agrammatism in sentence production without comprehension deficits: Reduced availability of syntactic structures and/or of grammatical morphemes: A case study. Brain and Language 1988;33:273–95. [PubMed: 3359172]

Ouhalla J. Sentential negation, relativised minimality and the aspectual status of auxiliaries. The Linguistic Review 1990;7:183–231.

Pollock J-Y. Verb movement, Universal Grammar, and the structure of IP. Linguistic Inquiry 1989;20:365–424.

Ritter E. Cross-linguistic evidence for Number Phrase. Canadian Journal of Linguistics 1992;37:192–218.

Saffran, EM.; Schwartz, MF.; Linebarger, M.; Martin, N.; Bochetto, P. The Philadelphia comprehension battery for aphasia. undated.

Sag I. English relative clause constructions. Journal of Linguistics 1997;33:431–84.

Stump, G. Inflection. In: Spencer, A.; Zwicky, A., editors. Handbook of Morphology. Oxford: Blackwell; 1998. p. 13-43.

Thompson, CK. Northwestern University sentence comprehension test. undated.

Thompson CK, Shapiro LP, Tait ME, Jacobs B, Schneider S, Ballard K. A system for the linguistic analysis of agrammatic language production. Brain and Language 1995;51:124–7.

Valois, D. PhD dissertation. UCLA; 1991. The internal syntax of DP.

Zwicky A, Pullum G. Cliticization vs. inflection: English *n't*. Language 1983;59:502–13.

Zwicky A, Pullum G. A misconceived approach to morphology. Proceedings of the West Coast Conference on Formal Linguistics 1992;10:387–98.

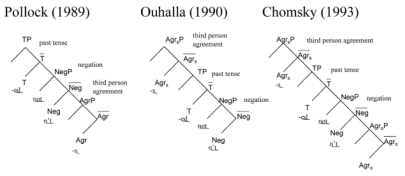

Fig. 1.
Several proposed structures for the split Inflectional Phrase (IP) in English.

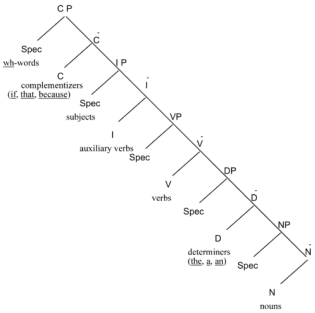

Fig. 2.
A syntactic tree structure (see text for details).

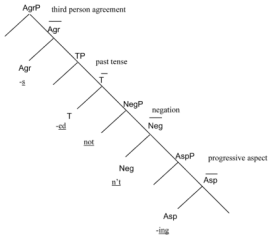

Fig. 3.
Split Inflectional Phrase (IP) used to analyze our patient's data (after Ouhalla (1990) and Hendrick (1991)).

Table 1

Complex sentence production and other data
(*Note*: Normal data for narrative discourse condition from Thompson et al. (1995))

Language Variable	Spoken discourse	Written discourse	Normal data *M* (SD)
MLU	9.23		14.47 (2.20)
% Grammatical sentences	24	22	88 (09)
% Simple sentences	48	49	43 (17)
% Complex sentences	52	51	58 (17)
% Verbs with correct arguments	98	90	98 (03)
Open-class:closed-class ratio	92	93	91 (.08)
Noun:verb ratio	1.08	1.05	1.21 (.25)

Table 2

Percentages of omitted free morphemes by morpheme type and task type

	Spoken narratives	Written sample
Subjects (pleonastic excluded)	3% (2/60)	0% (0/57)
Auxiliary verbs	20% (2/10)	0% (0/29)
Main verbs	4% (3/78)	0% (0/71)
Verb objects	4% (1/26)	0% (0/36)
Determiners	3% (1/29)	0% (0/25)

Table 3

Percentages of correctly supplied elements of 'exploded' Inflectional Phrase (IP), including inflectional morphology and negation by task and morpheme type

	Spoken narratives	Written sample	Total spoken and written production
Verb morphology			
Agreement—regular (-*s*)	10% (4/39)	0% (0/17)	7% (4/56)
Agreement—irregular	33% (4/12)	60% (6/10)	45% (10/22)
Tense—regular (-*ed*)	33% (3/9)	0% (0/8)	18% (3/17)
Tense—irregular	NA	0% (0/13)	0% (0/13)
Aspect (-*ing*)	50% (2/4)	0% (0/7)	18% (2/11)
Negation	100% (6/6)	100% (5/5)	100% (11/11)
Noun morphology			
Plural—regular (-*s*)	56% (10/18))	50% (3/6)	54% (13/24)
Plural—irregular	0% (0/9)	0% (0/5)	0% (0/14)
Possessive (-' *s*)	94% (17/18)	NA	94% (17/18)