Unaccusative verb production in agrammatic aphasia: the argument structure complexity hypothesis

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Abstract

This study examined patterns of verb production in narrative samples of eight individuals with agrammatic aphasia and seven education- and age-matched normal subjects. Comprehension and constrained production of two types of intransitive verbs—unaccusatives whose argument structure triggers a complex syntactic derivation and unergatives that are considered syntactically simple— was also tested. Results showed that in narrative tasks a hierarchy of verb production difficulty as seen in previous studies [Aphasiology 11 (1997) 473; Brain and Language 74 (2000) 1] emerged for the aphasic participants, with a preference noted for production of verbs with a fewer number of arguments. Both normal and agrammatic subjects also showed fewer productions of unaccusative intransitive verbs in their narrative samples as compared to other verb types (supporting findings reported by Kegl [Brain and Language 50 (1995) 151]. In contrast to relatively spared comprehension of both unaccusative and unergative intransitives, the aphasic participants showed significantly greater difficulty producing unaccusatives as compared to unergatives in the constrained task. These findings suggest that deficits in accessing verbs for production are influenced by the verb's argument structure entry and led to what is referred to as the 'argument structure complexity hypothesis'. When verbs become more complex in terms of the number of associated arguments or when the argument structure entry of the verb does not directly map to its s-structure representation, production difficulty increases.

Keywords

Verb production; Unaccusatives; Syntactic deficits; Agrammatism

It has been well documented in the literature that some individuals with aphasia, particularly those showing deficit patterns consistent with a diagnosis of Broca's aphasia with agrammatism, evince greater difficulty producing verbs as compared to nouns (Berndt, Mitchum, Haendiges, & Sandson, 1997; Miceli, Silveri, Nocentini, & Caramazza, 1988; Miceli, Silveri, Villa, & Caramazza, 1984; Thompson et al., l995b; Zingeser & Berndt, 1990). While recent research focused on determining the nature of verb production deficits has shown that several factors may play a role in this production difficulty, including frequency and familiarity (Kemmerer & Tranel, 2000), imageability (Bird, Howard, & Franklin, 2000), and semantic factors (Breedin, Saffran, & Schwartz, 1998), the number of syntactic arguments associated with the verb and corresponding participant roles has been shown to influence verb production in several studies (Jonkers & Bastiaanse, 1996, 1998; Kegl, 1995; Kemmerer & Tranel, 2000; Kim & Thompson, 2000; Kiss, 2000; Thompson,

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Lange, Schneider, & Shapiro, 1997; Thompson, Shapiro, Li, & Schendel, 1995a). For example, Thompson et al. (1995a, 1997) found that agrammatic aphasic subjects with verb retrieval difficulty in both verb naming and in sentence production showed a pattern of verb production deficit in both tasks related to the number of arguments associated with the verb. That is, verb retrieval difficulty increased as the number of arguments increased. Verbs requiring one argument (i.e. intransitive verbs such *laugh* as in *Zack laughed*) were produced with higher levels of accuracy than those requiring two or three arguments, respectively (e.g. the transitive verb *fix*, as in *Zack fixed the computer*; the ditransitive verb *put* as in *Zack put the shirt in the closet*). Comparing production of transitive and ditransitive verbs, transitives were found to be easier.

The question of the relationship between verb production difficulty and verb argument structure properties was further investigated by Kim and Thompson (2000) in seven agrammatic aphasic patients. Subjects first were tested for comprehension of nouns (organized by semantic category) and verbs (organized by the number of arguments represented in their lexical entry). Access to the verb's lexicon also was tested using a grammaticality judgment task involving verb argument structure violations. Finally, subjects' noun and verb naming and categorization were tested. Results showed that comprehension of both nouns and verbs, noun naming and noun categorization, and grammaticality judgment were relatively unimpaired. However, deficits were observed in verb naming and verb categorization, which required that participants sort verbs by their argument structure properties.[1] In both verb tasks, a hierarchy like that reported by Thompson et al. (1995a, 1997) was found, with verbs requiring more arguments more difficult than verbs requiring fewer. These findings suggested that verb production is influenced by the syntactically relevant argument-taking properties of verbs (Levin & Rappaport-Hovav, 1995).

Kim and Thompson (2000) further considered the locus of breakdown in the process of verb retrieval based on models of lexical representation which suggest that verbs are stored in the lexicon according to form class and their argument structure properties (Bock, 1995; Bock & Levelt, 1994; Levelt, 1989, 1993, 1999; Trueswell & Kim, 1998; Trueswell, Tanenhaus, & Kello, 1993 for evidence from sentence processing). In the process of verb retrieval, a lemma is selected, which matches the meaning and communicative perspective of the speaker and associated grammatical information is signaled. In the next stage, the phonological form of the selected lemma (lexeme) is activated. Although issues regarding the discreteness of processing at each level are controversial among theorists (e.g. Dell, 1986; Dell & O'Seaghdha, 1991; Levelt et al., 1991a,b), Levelt's (1999) model suggests that verb retrieval failure can occur at either the lemma or the lexeme level. Based on their data, Kim and Thompson (2000) speculated that verb production deficits in agrammatic aphasia result, at least in part, from difficulties at the level of lemma selection. The finding that verbs with a greater number of arguments are more difficult to retrieve than those with fewer arguments suggests that verb selection, like noun selection, involves automatic access to lexical entries, which for verbs, includes information about their argument structure characteristics. As the number of syntactic arguments increases, so too does verb selection difficulty.

Kegl (1995) also found that the argument structure properties of verbs influence production. Based on linguistic analysis of an agrammatic aphasic patient's (FOK) narrative production, Kegl suggested not only that verb arguments and other lexically related material are part of the lexical representation of verbs, but also that the verb's representation includes d-

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[1] We considered the categorization task to be production-like, requiring participants to generate a rudimentary syntactic structure either verbally or non-verbally in order to correctly categorize verbs by the number of obligatory arguments.

structure information (Chomsky, 1981, and subsequent work). The patient's narrative samples, collected by asking him to recount six video-taped movie excerpts, were analyzed for verb and verb argument structure production. Results showed that the patient produced a wide array of verbs with various argument structures. For example, of a total of 102 coded utterances, 41% contained verbs with external arguments. Although these verbs were not broken down by type (e.g. intransitive, transitive, dative), a striking finding was that, in comparison to three normal control subjects and a patient with anomic aphasia (JMD), FOK produced no *unaccusative*, intransitive verbs. Kegl's (1995) finding that unaccusative, intransitive type verbs present difficulty for agrammatic aphasic individuals led her to suggest that the lexical entry for verbs includes the d-structure representation of the configuration of verbs.

There are two syntactic classes of intransitive verbs: unergatives, such as laugh, and unaccusative verbs, such as *melt*, each associated with a different underlying syntactic representation (Perlmutter, 1978).[2] Within a Government-binding (GB) framework (Chomsky, 1981), unergative verbs take a d-structure subject and no object, whereas an unaccusative verb takes a d-structure object and no subject. Thus, the members of the two classes are associated with d-structure configurations as in (1) and (2).

1. Unergative verb: NP [$_{VP}$V]

2. Unaccusative verb:____[$_{VP}$V NP].

In argument structure terms, an unergative verb has an external argument, but no direct internal argument, whereas an unaccusative verb has a direct internal argument, but no external argument. Unaccusative verbs theta-mark the theme in the d-structure; formulation of the s-structure involves movement of the theme (raising) from the post-verbal position in d-structure to the subject position in s-structure (see Grimshaw, 1990; Levin & Rappaport-Hovav, 1995), leaving behind a trace (t). This movement is required in order for case to be assigned. Unergative verbs theta-mark the agent in the d-structure and nominative case is assigned, thus, no movement is required. See (3) and (4) below.

1. Unergative: The man$_{AGENT}$ laughs

2. Unaccusative: The ice$_{i\ THEME}$ melts t_i.

The purpose of the present study was to further examine verb comprehension and production of unaccusative and unergative verbs in agrammatic aphasic individuals. While both types of verbs are intransitive, which are less difficult to produce than transitive and ditransitive verbs, the d-structure representation of unaccusatives renders them more syntactically complex than unergatives. Therefore, it was predicted that access to unaccusatives would present more difficulty than unergatives for agrammatic aphasic patients in production tasks, because their argument structure properties create an environment in which movement is required. Production was examined in both narrative discourse and picture-naming tasks.

1. Method

1.1. Subjects

Eight individuals (seven Caucasian and one African American) (five males; *M* age = 50.7 years) presenting with language production (and comprehension) patterns consistent with a diagnosis of agrammatic aphasia, and seven age-matched, neurologically unimpaired

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[2]Chomsky's more recent theories (i.e. Minimalist Program (Chomsky, 1993)) eliminate d-structure and sstructure, however, specified lexical representations (here of verbs and their argument structure) continue to serve as input to the syntax by the structure building operations 'Move' and 'Merge'. Movement also is not encompassed in minimalism, however, it is combined with X-rules and lexical insertion in Move and Merge operations.

individuals (five males; *M* age = 56.9) participated in the study. All subjects had at least a high-school education (*M* = 14 years) and all but one aphasic participant were right-handed. None of the subjects had a history of prior neurological disease, drug or alcohol abuse, psychiatric disorders, developmental speech/language, or learning disabilities. All subjects were monolingual, native speakers of English and they demonstrated good visual and hearing acuity.

Aphasic subjects were recruited from the subject pool of the Northwestern University Aphasia and Neurolinguistic Research Laboratory. All subjects suffered a single, left hemisphere, thromboembolic stroke, involving Broca's area and adjacent white matter, extending posteriorly to the temporal lobe in one subject (MR), and were between one and six years post-stroke at the time of the study.

1.2. Language testing

Results of administration of the Western Aphasia Battery (WAB; Kertesz, 1982), the Northwestern Sentence Comprehension Test (NSCT; Thompson, unpublished), a sentence production priming task, the Northwestern Verb Production Battery (Thompson et al., 1997), and narrative discourse analysis led to a diagnosis of agrammatic aphasia for all subjects. (See Table 1 for results of testing.) Aphasia quotients (AQs) derived from the WAB ranged from 59.0 to 86.7 (*M* = 78). All subjects' spontaneous speech was slow and effortful and they produced primarily short, simple sentences. Auditory-verbal comprehension, while impaired, particularly for complex, non-canonical sentences, was superior to verbal expressive ability. Performance on the NSCT showed that comprehension of object relatives and passive sentences was more impaired than subject relatives and actives. The sentence production priming task in which production was tested by modeling target sentence types with a non-target sentence indicated good production of actives, but poor production of passive, subject-raising, and object cleft structures. Finally, noun naming as measured by performance on the WAB, while impaired, was superior to verb naming as measured by the Northwestern Verb Production Battery.

Formal analysis of spontaneous language showed production patterns consistent with a diagnosis of agrammatic aphasia for all subjects, including reduced mean length of utterance (MLU) (*M* = 5.37, SD = 2.12) and production of few grammatical sentences (*M* = 0.30, SD = 0.18). The subjects produced more open-class as compared to closed-class words (*M* open/closed class ratio = 1.94, range = 1.06–6.75), and, within the open class, they produced more nouns than verbs (*M* noun/verb ratio = 2.93, range = 1.30–3.94). The proportion of verbs produced with correct arguments ranged from 0.31 to 0.78 with a mean of 0.59.

1.3. Stimuli

For verb comprehension and production tasks, 25 monosyllabic, intransitive verbs (13 unaccusative and 12 unergative) were selected based on their written frequency of occurrence (*M* frequency = 79 per million, range = 23–239 for unaccusatives; *M* frequency = 91, range = 1–432 for unergatives) (Francis & Kucera, 1982). Selected verbs did not have a listing of noun usage greater than 25%, with the exception of *fall* (unaccusative) and *run* (unergative). Unaccusatives were differentiated from unergatives using diagnostics as discussed by Grimshaw (1987) and Levin and Rappaport Hovav (1995) and by two linguists who confirmed verb type designations. Selected verbs are listed in Appendix A.

Black and white line drawings were prepared for each verb on 5 × 7 in. paper (see Appendix B for examples of pictures of each verb type). Norms for naming the pictured verbs were obtained from a group of eight healthy normal subjects, who were tested individually. All normal subjects (five male and three female) were native speakers of English, and matched

for education and age with the aphasic subjects (*M* education = 15 years; *M* age = 48.9 years). Only pictures that elicited targets from all normal subjects were used in the experiment. The same stimuli were used for both the comprehension and naming tasks.

2. Procedures

2.1. Narrative elicitation

Narrative language samples were collected by asking subjects to tell the story of *Cinderella* after reviewing a picture book detailing the story and to describe a short Charlie Chaplin film after viewing it. All samples were audio-recorded, transcribed, and segmented into utterances for later analysis of verb production patterns.

2.2. Verb comprehension and production

For comprehension and production tasks, two practice items were used to establish that subjects understood the task. The order of presentation of target items within a task was randomized and held the same for all subjects. Since both comprehension and production tests employed the same targets, naming testing preceded comprehension testing for all participants.

All responses were scored as correct or incorrect. Self-corrections occurring within a 10 s response time were accepted. Feedback on the accuracy of response was provided for practice items only. All testing was completed in one session.

Naming conditions—To test verb naming, pictures of the verb targets were presented one at a time and subjects were instructed to name the action, i.e. the examiner said: "What's happening in this picture?" If an incorrect response was produced, subjects were further prompted by the examiner asking: "What's happening to the (pictured noun)?" If an incorrect verb was produced, the examiner said: "Can you think of another word?" No attempt was made to elicit a particular verb form. Semantically appropriate responses with the same argument structure as the target verb type were accepted as correct (e.g. production of *sleep* instead of *snore*—both unergatives).

Comprehension conditions—Verb comprehension testing involved spoken word-to-picture matching. Three distractors, randomly selected from the set of target verbs were presented together with the target verb, with the position of the target item randomized. Verb labels were presented auditorily by the examiner and participants chose the appropriate picture by a pointing response.

2.3. Reliability

Narrative transcription and utterance segmentation reliability involved two independent transcribers. Disagreements were discussed and resolved by the two transcribers listening to the audio-taped samples together. Verb codes were checked for reliability on seven on the nine narrative samples by an independent coder and point-to-point reliability was calculated for each verb type. Overall agreement ranged from 82 to 100% with an overall mean of 93.8%.

An independent observer scored 40% of subject responses to the comprehension and naming tasks on-line as correct vs. incorrect, based on the criteria presented earlier. Point-to-point agreement between the primary examiner's and the independent observer's scores ranged from 98 to 100% with overall agreement of 99.9%.

2.4. Data analysis

For analysis of verb production in spontaneous language, narrative samples from the Cinderella story and Charlie Chaplin movie were combined to form one large sample. Each verb produced in a verb-containing clause was assigned one of the following verb type codes: obligatory one-place (intransitive), obligatory two-place (transitive), optional two-place (transitives with legally omitted internal argument), obligatory three-place (datives and ditransitives), optional three-place (datives and ditransitives with omission of one internal argument), complement verbs, and copulas. Each verb produced also was coded as correct versus incorrect, according to its argument structure. The proportion of verbs produced by type was tallied as was the proportion of verbs of each type produced with correct arguments. Differences in production patterns for the two subject groups were analyzed using a repeated measures analysis of variance (ANOVA). The proportion of verbs produced with correct arguments by the aphasic and normal subjects was analyzed statistically using a paired t-test. Finally, differences in production of unaccusatives and unergatives were analyzed using a 2×2 ANOVA.

For verb comprehension and naming tests the percentage of correct unaccusative and unergative responses was calculated for each participant and means were computed for each verb type. Differences between comprehension and production, and differences between the production of unaccusative and unergative verbs were analyzed using paired t-tests. All statistical analyses were performed using DataDesk, version 6.0 (Data Description Inc., Ithaca, NY (1997)). An alpha level of p, 0.05 was set for all statistical tests.

3. Results

3.1. Narrative production

The proportion of verbs produced by type in the narrative samples of aphasic and normal participants is shown in Table 2 and Fig. 1. Statistical analysis showed a main effect for verb type ($F(1,8) = 56.12$, $p < 0.0001$), but not for group ($F(1,1) = 0.077$, $p = 0.078$), indicating differences in production of the various verb types for both groups of subjects. ANOVAs comparing verbs by type were significant for both the aphasic ($F(1,4) = 45.06$, $p < 0.0001$) and normal participant group ($F(1,4) = 78.54$, $p < 0.0001$). For the aphasic participants, a hierarchy of verb production was noted with one-place verbs produced more frequently than two- or three-place verbs. Post hoc tests (Bonferroni) indicated significant differences between one- and three-place verbs ($p = 0.000$) and between two-and three place verbs ($p = 0.000$); however, the difference between one- and two-place verbs was not significant ($p = 0.13$): The aphasic participants also produced significantly more copulas than three-place ($p = 0.000$) or complement verbs ($p = 0.000$); however, copular production was not significantly different than one-place ($p = 0.999$) or two-place verbs ($p = 0.410$): For the normal subjects, the hierarchy of verb production as seen in the aphasic participants' data was not apparent. Two-place verbs were produced significantly more frequently than one-place ($p = 0.000$) and three-place verbs ($p = 0.000$); and there was no significant difference between production of one-place and three place verbs ($p = 0.836$): The normal participants also produced significantly more complement verbs than any of the other verb types ($p = 0000$ for all comparisons), whereas they produced significantly fewer copulas as compared to two-place verbs (0.012) with no significant difference between copular and one-place or three-place verbs ($p = 0.83$; $p = 0.07$; respectively).

Analysis of the proportion of verbs produced with correct arguments showed that only 35% of verbs produced in the narrative samples by aphasic subjects were produced with correct arguments, whereas normal subjects produced 94% of verbs with correspondingly correct argument structure. Not surprisingly, the difference in the proportion of verbs produced with

correct arguments by the two subject groups was statistically significant ($t(9)$ = 18.18, $p <$ 0.0001).

When the narrative data were analyzed for intransitive verb production (see Fig. 2), both groups were found to produce fewer unaccusatives as compared to unergatives, however, the normal subjects produced more unaccusatives than did the aphasic individuals. Statistical analysis showed these differences to be significant with a main effect noted for both group ($F(1,1)$ = 355.78, $p <$ 0.0001) and verb type ($F(1,1)$ = 17.048, p = 0.054).

3.2. Intransitive verb comprehension and naming

Data derived from comprehension and naming tasks involving unaccusative and unergative intransitive verbs are shown in Fig. 3. These data indicate that the aphasic subjects evinced little difficulty comprehending either verb type. Mean comprehension of unaccusatives ranged from 83 to 100% correct with a mean of 96.9% (SD = 6.26); comprehension of unergatives ranged from 83 to 100% with a mean of 97.9% (SD = 6.01). Statistical analysis showed no significant differences between comprehension of the two verb types ($t(7)$ = −1, p = 0.350).

When the data were examined with regard to comprehension vs. production of intransitive verbs, a significant difference was noted ($t(15)$ = −4.277, p = 0.0007), indicating poorer naming, as compared to comprehension. However, naming of unaccusative verbs was poorer than naming of unergatives, with mean correct naming of unaccusative verbs at 60% (SD = 17.7; range = 31–84%) and mean correct production of unergatives at 92.62 (SD = 9.02; range = 75–100%). The difference in production of the two verb types was statistically significant ($t(7)$ = −32.50, p = 0.0003). Further, as shown in Fig. 4, this production pattern was seen for all subjects.

4. Discussion

Results of this study examining verb production in agrammatic aphasia showed a distribution in narrative tasks similar to that noted in previous studies. As compared to normal subjects, our agrammatic participants produced a greater proportion of one- and two-place verbs and copulas and fewer three-place and complement verbs. Further, as noted by Kim and Thompson (2000) and Thompson et al. (1995a,b, 1997), a hierarchy of difficulty in verb production based on argument structure was found. One-place verbs were produced most frequently, followed by two-place and three-place verbs.

Differences in verb production patterns based on the number of associated arguments or participant roles has been noted by several other researchers, including Kiss (2000) in Hungarian and De Bleser and Kauschke (2000) in German agrammatic aphasic patients. Kemmerer and Tranel (2000) also found this pattern in a large study examining factors that might influence verb production in English speaking aphasic patients. Of a total of 19 'impaired' participants, three showed more difficulty producing verbs involving two participant roles than those involving just one. While the proportion of their subjects showing this pattern appears low, Kemmerer and Tranel did not classify their patients with regard to linguistic impairment. Thus, it is not surprising that all subjects in their sample did not show the same verb production pattern.

Within the class of one-place, intransitive verbs, unaccusative verbs with more complex syntactic representations were produced less frequently in narrative samples, for both subject groups, than unergative verbs with less complex syntactic representations. These data support those reported by Kegl (1995). Like Kegl's aphasic subject (FOK), the agrammatic patients studied here produced very few unaccusatives. These data suggest that

agrammatic aphasic patients show impairments in production of verbs in which the argument structure entries do not directly map onto the s-structure. That is, verbs with argument structure properties that force movement from d- to s-structure are problematic.

The findings from constrained tasks examining comprehension and production of intransitive verbs provided additional evidence supporting the deficit pattern found in narrative samples. As expected, comprehension of both unaccusative and unergative verbs was superior to production. These data indicate, as noted in previous studies, that agrammatic aphasic subjects have relatively intact access to the lexicon of verbs in comprehension (Kim & Thompson, 2000; Pinango, 2000). Notably, Pinango (2000) studied comprehension of unergatives versus unaccusatives that allow causative alternation (e.g. *break: The cup broke; The girl broke the cup*) and those that do not (e.g. *fall*) and found above-chance comprehension of all three intransitive verb types in two Broca's aphasic patients. Kim and Thompson (2000) also found that agrammatic aphasic individuals show spared access to the argument structure of verbs in grammaticality judgement tasks involving argument structure violations, and previous work by Shapiro and colleagues showed that agrammatic aphasic individuals evince normal patterns of access to verb argument structure during on-line sentence processing (Shapiro, Gordon, Hack, & Killackey, 1993; Shapiro & Levine, 1990).

In contrast, the agrammatic aphasic patients examined in this study showed a disruption in production of verbs. Notably, within the class of intransitives, unaccusative verbs presented more difficulty than unergatives. As discussed previously, these verb types are distinct in terms of their d-structure representation. Unaccusative verbs, unlike unergatives, are associated with an underlying syntactic configuration in which there is no d-structure subject, only a d-structure object. In argument structure terms, this means that unaccusatives have no external argument (e.g. agent); they have only a direct internal argument (e.g. theme). Using a single simple linking generalization that covers transitive and intransitive (i.e. unergatives) verbs alike, agent arguments are d-structure subjects and patient/theme arguments are d-structure objects (Marantz, 1984; Rosen, 1984). Unaccusatives are an exception to this generalization. The verb theta-marks the theme in d-structure; formulation of the s-structure, then, involves movement of the theme to the subject position. The underlying argument structure configuration of unaccusatives, therefore, renders them more syntactically complex than unergatives.

It is also possible, however, that unergative verbs are easier than unaccusatives for aphasic patients simply because unergatives have animate subjects, and unaccusative verbs sometimes do not. However, our unaccusative verb set included verbs like fall that take an animate subject (e.g. *the man fell*) as well as verbs like *break* and *bounce* that do not. Our subjects erred on both *fall*-type and *break*-type verbs.

The finding that unaccusative verbs present difficulty for agrammatic aphasic patients supports Kegl's Syntactically Enriched Verb Entry Hypothesis, which predicts difficulty with production of any construction requiring movement of a noun phrase from one argument position to another between d- and s-structure (A-movement) in order to permute the lexically specified arrangement of arguments. While not directly tested by Kegl, the agrammatic patients tested here showed that, in addition to difficulty with production of unaccusative verbs, they also showed difficulty producing passives and subject-raising structures (which involve A-movement) on the sentence production priming pre-test. In contrast to active sentence production (produced with a mean of 87%), our subjects produced only 10–20% of passives and 5–10% of subject raising structures correctly. Both of these structures involve verbs whose lexical entry does not have an external argument

(i.e. a d-structure subject) as shown below in sample sentences of these constructions followed by their d-structure representation.

The boy was tickled by the girl. [*e* was tickled *the boy* by the girl]

The girl seems to have tickled the boy. [*e* seems *the girl* to have tickled the boy].

Notably, in d-structure, the subject position is empty (*e*), therefore, the displaced d-structure object moves to the subject position since in English, all surface sentences must have subjects.

The Syntactically Enriched Verb Entry Hypothesis also predicts that *amuse*-type, as opposed to *admire*-type psych verbs, should present difficulty for agrammatic production once again because the lexical entry of *amuse*-type verbs does not include an external argument (Belletti & Rizzi, 1988). Rather, the d-structure representation of *amuse*-type psych verbs entails an internal argument (theme).

The clown$_{THEME}$ amused the children$_{EXPERIENCER}$ [*e* amused *the clown* the children]

The children$_{EXPERIENCER}$ admired the clown$_{THEME}$ [the children admired the clown].

Like unaccusative verbs, *amuse*-type psych verbs involve movement of the theta-marked theme from the post-verbal position in d-structure to the subject position in s-structure. Psych verbs like *admire* do not involve such movement. Interestingly, our preliminary work examining production of these verb types in sentences in agrammatic aphasia (Lee & Thompson, in preparation) indicates that indeed *amuse*-type verbs are more difficult to produce than *admire*-type verbs.

Kegl's Syntactically Enriched Verb Entry Hypothesis, however, does not completely account for the pattern of verb production deficits noted so far. That is, we find that difficulty in production increases not only when the argument structure entry of the verb does not map directly onto its s-structure representation, rendering it syntactically complex, but also when verbs become more complex in terms of the number of associated arguments. It appears, then, that control over selection of verbs breaks down relative to both the number of arguments and type of argument structure information associated with the verb. These observations lead to what is referred to as the argument structure complexity hypothesis.

The argument structure complexity hypothesis

1. Verbs whose argument structures entail greater complexity are more difficult for agrammatic aphasic individuals to produce.

2. Complexity encompasses both the number of arguments and the type of argument structure information contained within the verb's lexical entry, i.e. verbs with a greater number of arguments or with argument structures that trigger movement operations render them more complex.

The data from this study taken together with those derived from others examining the source of verb production deficits in agrammatic aphasia suggest that difficulties in accessing verbs for production is influenced by the verb's lexical entry. Models of lexical processing suggest that access to conceptually determined items entails a lexical search, which involves automatic activation of lexically specified material of both the target and related items. Noun selection (lemma selection) involves activation of items sharing similar semantic properties (Levelt, 1999; Levelt, Roelofs, & Meyer, 1999). Variables such as frequency of occurrence, familiarity, imageability, and age of acquisition also have been shown to influence production; for example, items with greater frequency of occurrence or greater imageability are easier to produce likely because they are activated more strongly than those with lower frequency and imageability. Although not as well studied, verb production

appears to be influenced by many of the same variables (Bird et al., 2000; Breedin et al., 1998; Kemmerer & Tranel, 2000). One additional feature of the lexical representation of verbs, that is not relevant to nouns, concerns their argument structure properties. Verb selection then entails activation of the verb together with its arguments. The finding that verbs with a more complex argument structure either in terms of the number or d-structure configuration of arguments present difficulty for production suggests that verb production deficits in agrammatic aphasic individuals are tied to problems accessing verbs with complex lexical entries.

5. Conclusion

Agrammatic speakers with putatively spared lexical entries for verbs show production patterns indicating impoverished access to verbs with complex syntactically relevant argument structure properties. This finding is in keeping with the claim that agrammatism is a syntactic deficit which results, at least in part, from faulty access to verbs with complex lexical entries.

Acknowledgments

Appendix A. Verb targets by type

See Table A1.

Appendix B. Sample stimuli

See Figs. B1 and B2.

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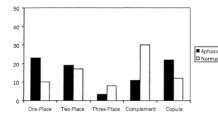
Fig. 1.
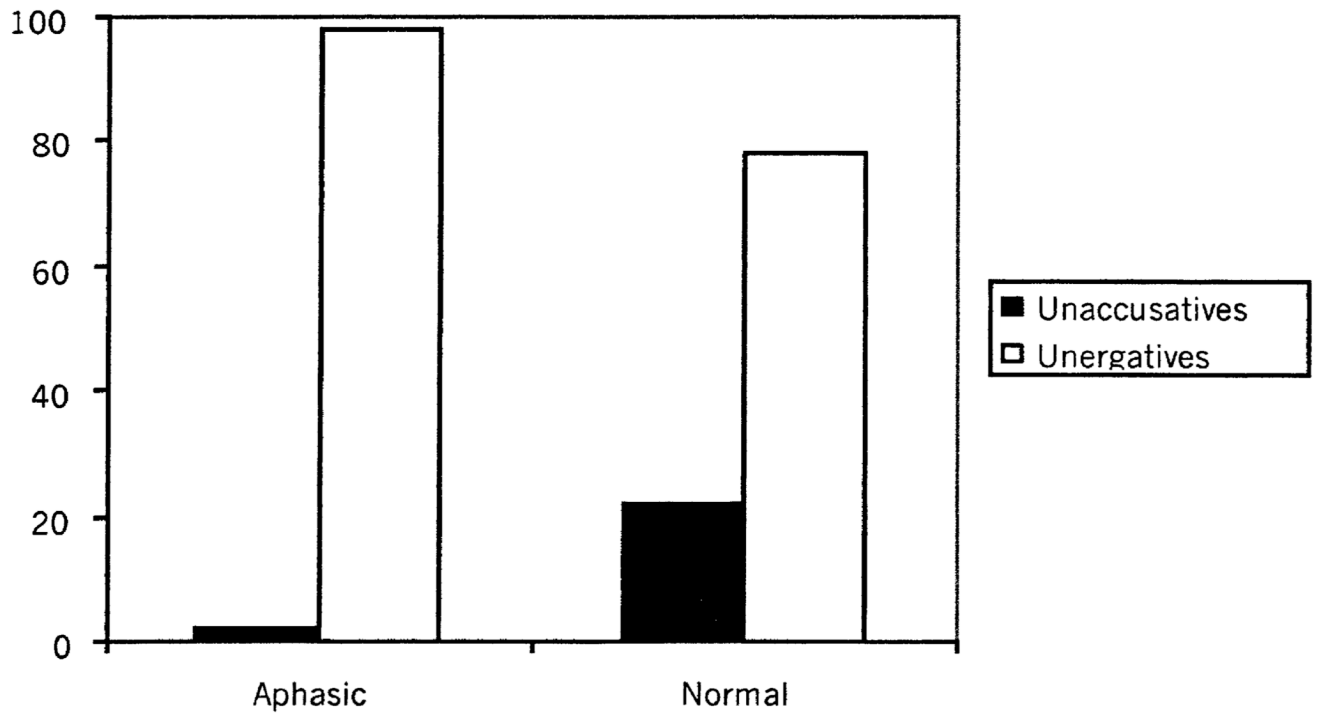Proportion of verbs produced by type by normal and aphasic participant groups in narrative samples.

Fig. 2.
Proportion of unaccusative and unergative verbs produced by normal and aphasic participant groups in narrative samples.
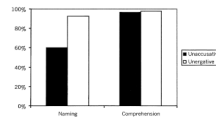
Fig. 3.
Percent correct naming and comprehension of unaccusative and unergative verbs by agrammatic aphasic subjects.
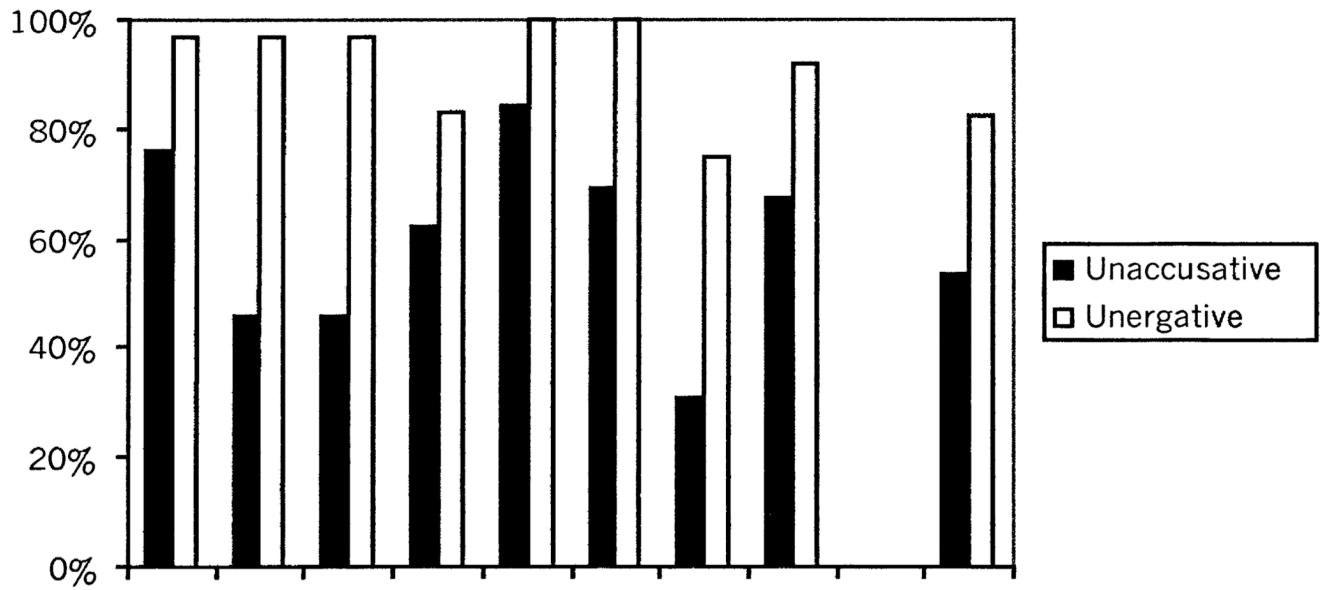
Fig. 4.
Percent correct naming of unaccusative and unergative verbs across agrammatic
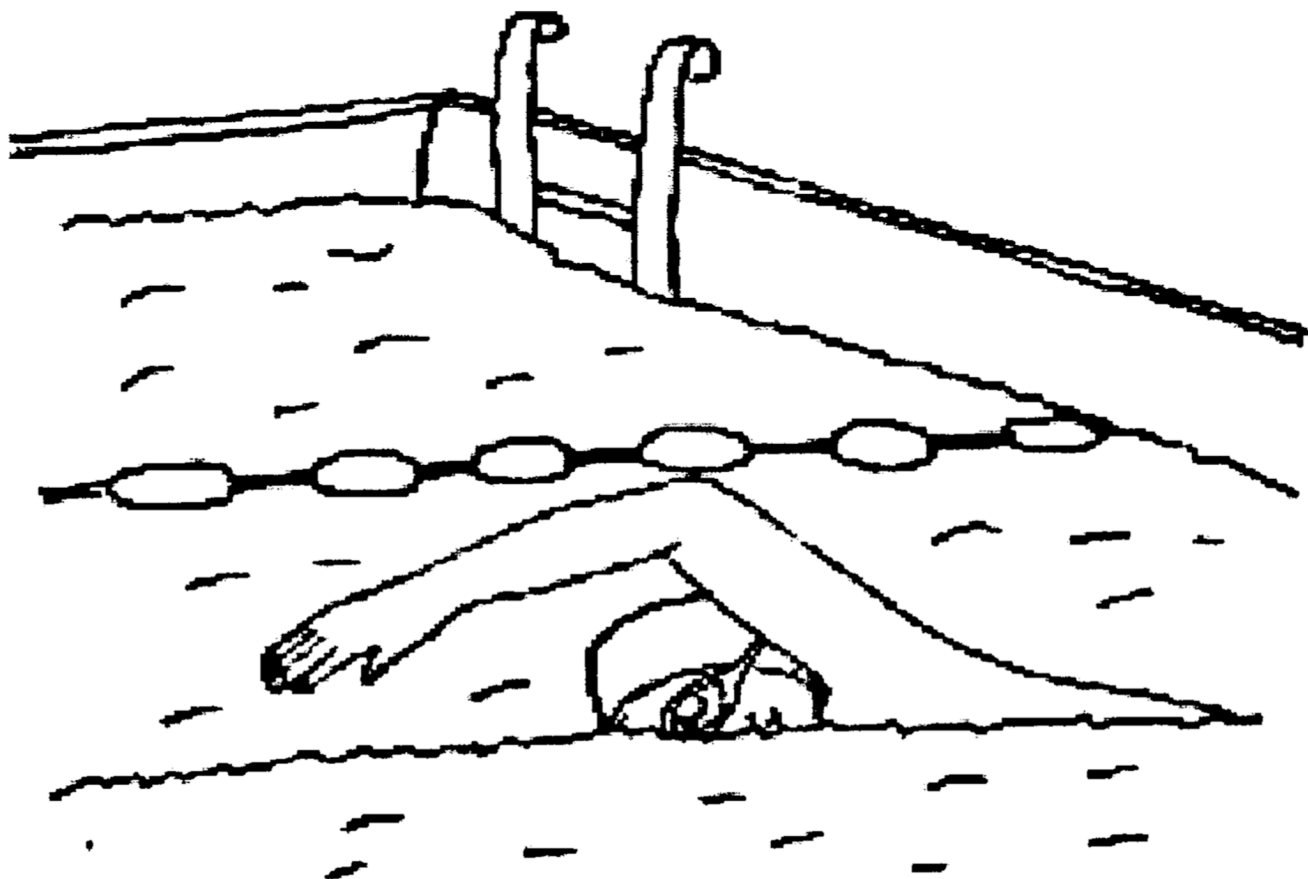participants.

Fig. B1.
Unaccusative: fall.

Fig. B2.
Unergative: *swim*.

Table 1

Aphasia test data

	S1	S2	S3	S4	S5	S6	S7	S8
WAB								
Aphasia quotient	88.5	75.4	76.8	78.3	81.6	78.0	59.0	86.7
Auditory								
Comprehension	7.9/10	9.1	10.0	9.3	7.9	9.6	6.1	9.3
Naming	8.5	8.2	8.5	8.4	8.9	8.7	6.0	8.4
NSCT								
Object relatives (%)	85	20	80	60	70	80	15	55
Subject relatives (%)	95	70	100	75	80	100	75	90
Passives (%)	70	80	75	65	45	75	15	70
Actives (%)	90	95	100	85	80	100	65	95
Northwestern Verb Production Battery								
Verb naming (%)	77	71	63	78	59	82	36	77

Table 2

Verbs produced by type in narrative samples for aphasic and normal, non-brain-damaged subjects

Verb type	Mean (SD)	
	Aphasic subjects	**Normal subjects**
Obligatory one-place	0.23 (0.08)	0.10 (0.04)
Unaccusative	0.01 (0.007)	0.22 (0.07)
Unergative	0.99 (0.01)	0.81 (0.11)
Obligatory two-place	0.19 (0.06)	0.17 (0.03)
Optional two-place	0.18 (0.13)	0.17 (0.04)
Obligatory three-place	0.0 (0.0)	0.03 (0.01)
Optional three-place	0.07 (0.03)	0.13 (0.03)
Complement	0.11 (0.07)	0.30 (0.06)
Copula	0.22 (0.12)	0.12 (0.03)
Verbs with correct arguments	0.35 (0.13)	0.94 (0.37)

Table A1

Unaccusative (*N*= 13)	Unergatives (*n* = 12)
Bounce	Crawl
Break	Cry
Crack	Jump
Crash	Laugh
Drop	Pray
Fall	Run
Float	Sit
Flow	Sneeze
Melt	Snore
Roll	Swim
Sink	Wink
Tear	