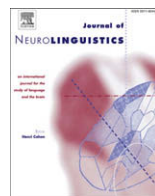




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Psych verb production and comprehension in agrammatic Broca's aphasia

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ABSTRACT

This study examined the factors that affect agrammatic sentence production by testing eight agrammatic aphasic participants' comprehension and production of active and passive sentences using two types of English psych verbs, those with an Experiencer-marked subject (Subject-Experiencer (SubExp)) and those with an Experiencer-marked object (Object-Experiencer (ObjExp)). The Argument Structure Complexity Hypothesis (ASCH, [J. Neuroling. 16 (2003) 151]) posits that the verb (and sentence) production difficulties observed in agrammatic aphasia can be attributed, at least in part, to the argument structure properties of verbs, with verbs that are marked for more complex argument structure (in terms of the number and type of arguments) presenting greater difficulty than those with less complex argument structure entries. Based on previous linguistic analyses of psych verbs, ObjExp psych verbs are more complex than SubjExp verbs. Therefore, we predicted that the former would present greater production (but not comprehension) difficulty than the latter. Results showed above chance comprehension of all sentence types, with the exception of SubjExp passive constructions, in which the subject position is occupied by a non-Experiencer argument. In active sentence production, ObjExp verbs were more impaired than SubjExp verbs. However, the opposite pattern was noted for passive sentence production. While all participants had difficulty producing passive sentences of both types, they showed better performance on ObjExp verbs, as compared to SubjExp verbs, in which the Experiencer is in the subject position. Further,

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agrammatic aphasic speakers showed a preference for producing actives for SubjExp verbs and passives for ObjExp verbs, indicating that the thematic role requirements of selected verbs (e.g., Experiencer, Theme) influence production patterns, as they do in normal speakers. These data, as well as the error patterns seen in our patients, support the ASCH and suggest that sentence production, disrupted in agrammatic aphasia, is impaired to a greater extent when the argument structure properties of the verb increase in complexity.

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1. Introduction

Several researchers have shown that verb production is more impaired than noun production in individuals with agrammatic aphasia (Kim & Thompson, 2000; Luzzatti et al., 2002; Miceli, Silveri, Nocentini, & Caramazza, 1988; Miceli, Silveri, Villa, & Caramazza, 1984; Thompson, Lange, Schneider, & Shapiro, 1997; Zingeser & Berndt, 1990). Thompson (2003) argued that this verb-production difficulty is influenced by the complexity of the argument structure entry of the verb; that is, verbs with more complex argument structures are more difficult for agrammatic aphasic patients to produce. For example, Kim and Thompson (2000) and Thompson et al. (1997) showed a hierarchy of verb-production deficits in English-speaking agrammatic aphasic patients based on the number of arguments associated with verbs, with 1-argument verbs such as *laugh* as in *Chris laughed* easier to produce than 2-argument verbs such as *hit* as in *Chris hit the ball*, which in turn are easier than 3-place verbs such as *give* as in *Chris gave the ball to Tommy*. This effect has been replicated in English (Kemmerer & Tranel, 2000)¹ as well as other languages, including Hungarian (Kiss, 1999), Italian (Luzzatti et al., 2002), German (De Bleser & Kauschke, 2003), Korean (Kim, 2006), and Russian (Dragoy & Bastiaanse, in press).

In addition to the number of verb arguments, the argument type also influences production (Bastiaanse & van Zonneveld, 2005; Kegl, 1995; Lee & Thompson, 2004; Thompson, 2003). For example, studies have shown that for agrammatic aphasic individuals unergative verbs (as in 1a below) are easier to produce than unaccusative verbs (as in 1b below).

(1a) Unergative verb: The boy_{AGENT} runs

(1b) Unaccusative verb: The rain_i _{THEME} falls *t_i*

Although the sentences in (1a) and (1b) appear identical, with an NP-V surface form, the verbs in the two examples are different from one another. Syntactic accounts suggest that the single argument of the verb *run* is an external Agent-marked argument subject, whereas for the verb *fall*, its one argument is an internal Theme-marked object, which moves to the subject position (Burzio, 1986; Grimshaw, 1990; Levin & Rappaport Hovav, 1995; Perlmutter, 1978), leaving behind a trace or copy of the moved argument. Movement is required because, lacking an external argument, unaccusative verbs fail to assign Accusative Case to their internal argument in the object position (Burzio, 1986).² Unergative verbs (as in 1a) do not require argument movement except that required to bring the subject out of the VP per the VP-Internal Subject Hypothesis (Koopman & Sportiche, 1991; Sportiche, 1988).³ This situation renders unaccusatives to be syntactically more complex than unergatives.

Theories that allow for only one level of syntactic structure, that is, those that espouse no movement, suggest that unergatives and unaccusatives differ primarily on semantic/functional grounds

¹ Only three of Kemmerer and Tranel's patients showed this pattern.

² Burzio's Generalization states that "all and only the verbs that can assign a theta-role to the subject can assign Case to an object" (Burzio, 1986: 178).

³ The VP-internal subject hypothesis (Koopman & Sportiche, 1991) posits that the single argument of both unergatives and unaccusatives is generated within the VP (i.e., Spec of VP) and moves to Spec of IP to receive Case from the head of IP. The argument of unaccusative verbs, however, transits first from its base-generated post-verbal position to Spec of VP and then lands in Spec of IP, leaving a longer chain between the original and moved positions.

(e.g., Role & Grammar (Van Valin, 1990, 2005; Van Valin & LaPolla, 1997), Construction Grammar (Goldberg, 1995, 2006), and Functional Syntax (Kuno & Takami, 2004)). Among the semantic characteristics of the two verb classes are agentivity and telicity: unergative verbs involve an agent and universally describe atelic events (i.e., without an inherent endpoint), whereas unaccusatives are non-agentive and telic (Van Valin, 1990). Also, unaccusative verbs inherently have causative meaning while unergatives do not (i.e., do'(x) CAUSE [BECOME (y)] versus do'(x), respectively) (Kuno & Takami, 2004; Van Valin, 1990; Van Valin & LaPolla, 1997). These differences in meaning show that unaccusative verbs are semantically more complex than unergatives. The complexity of unaccusatives further increases by the fact that these verbs alternate in two different constructions (i.e., intransitive and transitive constructions), which yield different meanings (Goldberg, 1995). Notably, studies with agrammatic aphasic speakers show that unaccusative verbs present more difficulty for production than unergatives both as singletons (Thompson, 2003) and in sentences (Lee & Thompson, 2004). Production difficulty, thus, increases not only when verbs become more difficult in terms of the number of associated arguments, but also by the complexity of arguments selected. To accommodate these verb-production patterns, Thompson (2003) proposed the Argument Structure Complexity Hypothesis (ASCH), as in (2) below.

(2) Argument Structure Complexity Hypothesis (ASCH, Thompson, 2003)

- a. Verbs with more complex argument structures are more difficult for agrammatic aphasic individuals to produce.
- b. Complexity encompasses both the number and the type of arguments associated with the verb.

In the present study, we investigated other factors that affect complexity by examining agrammatic aphasic patients' production and comprehension of psychological verbs (hereafter, psych verbs), such as the verbs *fear*, *admire*, *frighten*, and *amuse* (Belletti & Rizzi, 1988; Jackendoff, 1972; Postal, 1971). These verbs involve two arguments; and since they denote mental states, one of the arguments is always marked as Experiencer. Interestingly, there are two types of psych verbs – those in which the Experiencer is in the subject position (i.e., subject-Experiencer; hereafter, SubjExp) and those in which the Experiencer is realized in the object position (object-Experiencer; hereafter, ObjExp). For example, verbs like *admire* and *fear* are SubjExp verbs; verbs like *amuse* and *frighten* are ObjExp verbs.

The thematic role of the second argument in psych verbs is somewhat controversial. On some accounts, it is Theme-marked (Belletti & Rizzi, 1988) as in (3).

(3a) SubjExp: Mary admired Janet [EXPERIENCER, THEME]

(3b) ObjExp: Janet_i amused t_i Mary [THEME, EXPERIENCER]

Accordingly, SubjExp-type verbs as in (3a) involve a direct mapping of arguments onto the syntax because they involve only vacuous movement. However, ObjExp verbs as in (3b) lack an external argument and, therefore, license movement of the Theme-marked argument to the subject position. Like syntactic accounts of unaccusatives, movement is obligatory since all NPs must be assigned Case. On this movement-based account, ObjExp psych verbs are more complex than SubjExp verbs because of the extra NP movement.

Alternatively, non-movement accounts of psych verbs suggest that both types of psych verbs have external arguments (Arad, 1998; Baker, 1997; Pesetsky, 1995; see also Bouchard, 1995; Iwata, 1995; Pylkkänen, 2000; Tenny, 1998). On these views, ObjExp verbs are more complex than SubjExp psych verbs, but their complexity does not arise from movement. Arad (1998) suggested that the first argument in ObjExp psych verbs is not assigned the thematic role of Theme; rather, it may have three interpretations: agentive (*Janet amused Mary deliberately to distract her from her work*); eventive/causer, but not agentive (*The party amused Mary*); and stative (*Funky dressers amuse Mary*). On Arad's account, none of these involve movement as proposed by Belletti and Rizzi (1988). Rather, ObjExp psych verbs are more complex because they, unlike SubjExp verbs, allow for multiple semantic interpretations. Even though only one is appropriate in a given context, the verbs' potential to have more interpretations exerts additional complexity.

On Baker's (1997) account, both SubjExp and ObjExp psych verbs have proto-agents (see Dowty, 1991) as subjects. On this view, however, ObjExp psych verbs are fundamentally ditransitive, with the object being a Goal rather than an Experiencer: *The noise frightened John* has roughly the underlying structure of *The noise*_{PROTO-AGENT} gives *fright*_{THEME} to *John*_{GOAL}. Because they are fundamentally ditransitive, ObjExp psych verbs are more complex than SubjExp psych verbs.

Pesetsky (1995) provided yet another account. Based on a fine-grained semantic analysis, the external argument for SubjExp verbs is Experiencer as in (4a); whereas that for ObjExp psych verbs is Causer as shown in (4b).

(4a) SubjExp: Mary admired Janet [_{EXPERIENCER, OBJECT OF EMOTION}⁴]

(4b) ObjExp: Janet amused Mary [_{CAUSER, EXPERIENCER}]

In both (4a) and (4b), the external argument maps onto the subject position and the internal argument (i.e., an Object of Emotion in 4a, an Experiencer in 4b) takes the object position. Pesetsky (1995) provided linguistic evidence for this analysis based, among other things, on the passivization properties of psych verbs. That is, he noted that both SubjExp and ObjExp psych verbs in English form verbal passives as shown in (5), which is not possible for unaccusatives (Perlmutter & Postal, 1984).⁵

(5a) The clown_i OBJECT OF EMOTION was admired _{t_i} by the boy_{EXPERIENCER}

(5b) The boy_i EXPERIENCER was amused _{t_i} by the clown_{CAUSER}

Because an external argument is required to form a verbal passive (see e.g., Baker, Johnsen, & Roberts 1989; or Jaeggli, 1986), he argued that ObjExp verbs must have both an external and an internal argument.⁶ On this analysis, the two verb types are not syntactically different: no NP movement is required. However, there are other distinctions between the two: ObjExp verbs are semantically causative, whereas SubjExp verbs are not. ObjExp verbs describe the bringing about of a change in psychological or emotional state (Levin, 1993: 191). This causative meaning is generated because ObjExp verbs involve two subevents, which are associated with the two arguments of the verbs: the causing subevent is associated with the Causer argument and the changing subevent with the Experiencer (Dowty, 1979; Grimshaw & Vikner, 1993; Hale & Keyser, 1987; Levin & Rappaport Hovav, 1995; Parsons, 1990; Pustejovsky, 1991; Van Valin, 1990).

What is noteworthy is that in the passive form of SubjExp verbs the Experiencer-marked NP occupies the post-verbal position while passivized ObjExp verbs have the Experiencer-marked NP in the subject position. Interestingly, Ferreira (1994) found that unimpaired subjects show a preference for producing Experiencer-marked arguments in the sentential subject position. Thus, SubjExp verbs are produced more often in active form (e.g., *The boy admired the clown* rather than *The clown was admired by the boy*), compared to ObjExp-type verbs, in which the passive is preferred (e.g., *The boy was amused by the clown* rather than *The clown amused the boy*). Ferreira argued that speakers' choices between the two possible syntactic forms are affected by the prominence of thematic roles on the thematic hierarchy (Grimshaw, 1990; Gruber, 1965; Jackendoff, 1972, 1987).

We note that on both movement and non-movement analyses ObjExp verbs are more complex than SubjExp verbs – either syntactically or semantically. We, therefore, predicted that ObjExp psych verbs will present greater production difficulty for agrammatic aphasic patients than SubjExp psych verbs. We also predicted that agrammatic participants would show greater difficulty producing passive, as compared to active, sentences as has been shown in previous research (Ansell & Flowers, 1982; Balogh

⁴ Object of Emotion can be further broken down into Target of Emotion and Subject Matter of Emotion. We use Object of Emotion for both.

⁵ Belletti and Rizzi (1988) claimed that passive morphology is possible for unaccusatives; however, it is adjectival, not verbal, as in *elapsed time*, and *fallen leaf*. But consider **died celebrity* and **twinkled star*. Belletti and Rizzi also claimed that passivization in psych verbs also is adjectival, rather than verbal, e.g., *frightened rabbit*, *satisfied customer*.

⁶ Some (very few) psych verbs are underlyingly unaccusative, and thus cannot be passivized; e.g., *appeal* (to): **I was appealed to by John.*; *elude*: **I was eluded by the answer.*; *escape*: **I was escaped by the name* (Pesetsky, 1995).

& Grodzinsky, 1996; Caplan, Baker, & Dehaut, 1985; Caplan & Futter, 1986; Schwartz, Linebarger, Saffran, & Pate, 1987; Schwartz, Saffran, & Marin, 1980; Thompson & Shapiro, 2005), because formation of verbal passives always involves syntactic movement of an argument. However, because ObjExp-type verbs accommodate the Experiencer as subject in the passive form, we expected better passive sentence production for ObjExp-type as compared to SubjExp verbs, in keeping with normal English speakers' Experiencer as subject preference (Ferreira, 1994).

2. Method

2.1. Participants

2.1.1. Aphasic participants

Eight monolingual, English-speaking agrammatic aphasic subjects (six males; mean age = 58.8 years) participated in the study. They were recruited from the subject pool of the Northwestern University Aphasia and Neurolinguistics Research Laboratory. All subjects were right-handed, with the exception of two males, and were educated at least to grade 12 (mean = 17 years). None of the subjects had a history of prior neurological disease, drug or alcohol abuse, psychiatric disorders, developmental speech/language disorders, or learning disabilities. All subjects had a single lesion in the left hemisphere resulting from a thromboembolic stroke in the distribution of the middle cerebral artery; one subject (subject 4) also had a small old infarct in the right frontoparietal area. All subjects were between two and twelve years post-stroke at the time of the study. Testing of visual and hearing acuity showed abilities adequate for test performance.

2.1.2. Language testing

The diagnosis of aphasia was based on administration of the *Western Aphasia Battery* (WAB; Kertesz, 1982) and the *Northwestern Assessment of Verbs and Sentences* (NAVS; Thompson, unpublished). Aphasia quotients (AQs) derived from the WAB ranged from 62.2 to 82.3 (mean = 76.5), with auditory verbal comprehension, while impaired, superior to verbal expressive ability. Results from the NAVS did not reveal a single pattern of sentence comprehension by agrammatic participants: five participants understood active and subject-relative structures better than passive and object-relative sentences; a mixed pattern of sentence comprehension was noted for the other three. These results are in accordance with the findings by Caramazza, Capassob, Capitanic, and Miceli (2005) and Caplan, Waters, DeDe, Michaud, and Reddy (2007). Testing of sentence production, using a sentence production priming task, indicated good production of actives, but poor production of passive, object-relative, and subject-relative structures for all participants (see Table 1).

2.1.3. Control participants

Five unimpaired, monolingual, native speakers of English also participated in the study to provide a baseline of normal performance. They were undergraduate students at Northwestern University (mean age = 19.7 years). None had a history of neurological, psychiatric, or developmental speech, language, or hearing problems. All study participants (both aphasic and control) provided written informed consent prior to the study.

2.2. Materials

Twelve SubjExp and 12 ObjExp psych verbs were selected based on their written frequency of occurrence from the CELEX database (mean frequency = 69.1 per million, range 3–326 for SubjExp verbs; mean frequency = 64 per million, range 8–427 for ObjExp verbs). These verbs then were placed in semantically reversible sentence frames, resulting in 24 stimulus sentences, and corresponding black-and-white line drawings were prepared (see Appendix A). The position of the sentential object was placed on the right side in half of the pictures and on the left for the other half. Two sample stimuli involving each sentence type are shown in Appendix B. The stimuli were pre-tested with five unimpaired participants, one male and four females, all native speakers of English and graduate students at Northwestern University. Only pictures that elicited target sentences without any difficulty from all unimpaired subjects

Table 1
Language testing scores.

	S1	S2	S3	S4	S5	S6	S7	S8	Mean
Western Aphasia Battery									
Aphasia Quotient	76.8	69.3	77.5	62.2	82.3	80	82.1	81.6	76.5
Fluency	4	5	5	5	5	5	6	6	5.1
Auditory Comprehension	10	7.9	9.5	6.8	9.8	9.4	9.9	7.9	8.9
Repetition	6.9	7.9	7.4	5.4	7.0	10	8.3	9.0	7.7
Naming	8.5	5.9	7.9	6.9	9.4	7.6	7.9	8.9	7.9
Northwestern Assessment of Verbs and Sentences (percentage correct)									
Sentence Comprehension									
Subject relatives	85	40	95	75	70	90	80	80	77.1
Object relatives	85	65	80	50	40	65	95	70	71.4
Actives	90	55	80	80	80	85	100	80	81.4
Passives	100	45	85	30	65	70	90	45	71.4
Sentence Production (Production-Priming)									
Subject relatives	40	40	50	45	65	55	55	60	51.25
Object relatives	0	0	10	0	10	0	0	10	3.75
Actives	80	70	90	80	85	80	75	90	81.25
Passives	0	0	10	0	0	10	0	20	5.0

were used in the experiment. The same stimuli were used for both the comprehension and production tasks. For the production task, however, target verbs were printed below each picture.

2.3. Procedures

For both comprehension and production tasks, three practice items were provided to establish that subjects understood each task. Since both tasks employed the same target sentences and pictures, the production task preceded the comprehension task. The two tasks were completed in two sessions both occurring within a two-week period. All testing sessions were audio-tape-recorded.

2.3.1. Elicited production task

Both active and passive sentences were elicited using the picture stimuli, presented one at a time, in random order. For each picture, participants were instructed to describe the picture in a single complete sentence using the given verb. No instructions were provided as to whether to produce an active or a passive sentence. Following this, the sentence form that was not produced on the first attempt was elicited by the examiner pointing to the desired sentential subject and asking the subject to produce a sentence beginning with that item. For a picture depicting a girl adoring a boy, for example, when the participant produced an active sentence (i.e., *The girl adores the boy*) on the first attempt, the examiner pointed to the boy and prompted the participant to describe the picture again beginning with 'the boy' to elicit a passive sentence (i.e., *The boy is adored by the girl*).

2.3.2. Comprehension task

Sentence comprehension was tested using a sentence-verification task. In this task, the 24-picture set was used twice to test both active and passive forms of the target verbs. Subjects were presented with one picture at a time, which was accompanied by a spoken test sentence. They were then asked to indicate whether the sentence correctly described the picture by responding "Yes" or "No". Unmatched sentences were created by reversing the meaning of the target sentence (e.g., *The boy adores the girl* for *The girl adores the boy*). The experimental stimuli were pseudo-randomly ordered for presentation such that the same voice was not presented more than three times consecutively.

2.4. Response scoring

All responses were scored as correct or incorrect on-line. Self-corrections occurring within the given time frame (10 s for comprehension, 30 s for production) were accepted.

Spoken responses were coded based on the voice of the sentence (i.e., active, passive) and scored for accuracy based on word order and verb form. The voice of a sentence was determined by the relationship between the target picture and the first NP produced. For example, for the picture of a girl [EXPERIENCER] adoring a boy [THEME], if *the girl* was produced in the subject position the sentence was considered active (e.g., *The girl adores the boy*)⁷; if *the boy* was produced in the subject position, the sentence was coded as a passive (e.g., *The boy adores the girl*). Responses with correct word order in which the verb form matched the selected voice were scored as correct. For active sentences, any active verb form was accepted as correct (e.g., *adoring*, *adore*, and *adores*). For passives, infinitives and past participles, those accompanied by *by* were counted as correct (e.g., *is adored by*, *adored by*, *is adore by*, *adore by*). Following these criteria, for example, the responses *The boy adores the girl* and *The boy adored by girl* for a picture of a girl adoring a boy were scored as incorrect and correct passive sentence productions, respectively.

2.4.1. Voice preference

The preference for actives or passives was calculated by coding the proportion of each voice produced on the first attempt.

2.5. Reliability

An independent research assistant scored all participant responses for both the comprehension and production tasks. Point-to-point agreement between the primary examiner and the independent scorer was 100% for the comprehension task and 97.8% for the production task. Disagreements were resolved by scorer consultation.

2.6. Data analysis

Percentage correct comprehension and production of each verb type in active and passive sentences was calculated for each subject. Group means were then computed for each verb type and voice and for voice preference as well. Differences between tasks, between verb types, between voices, and between groups were analyzed using a series of repeated measures analyses of variance (ANOVAs) and paired-samples *t*-tests. An alpha level of $p < .05$ was set for all statistical tests.

2.7. Results

Mean percentage correct comprehension and production of active and passive sentences using ObjExp and SubjExp verbs for the unimpaired and aphasic participants is shown in Figs. 1 and 2, respectively. Overall, the aphasic participants performed better on the comprehension task than on the production task ($F(1, 7) = 11.753$, $p = .011$), while there was no significant difference between comprehension and production for our unimpaired participants ($F(1, 4) = 1.200$, $p = .335$).

A repeated measures three-way ANOVA revealed significant differences between the participant groups and sentence types: unimpaired subjects performed better, in general, than aphasic subjects ($F(1, 11) = 7.121$, $p = .022$), and scores on active sentences were better than on passive sentences ($F(1, 11) = 7.511$, $p = .019$). There was also a significant interaction effect between subject groups and sentence type ($F(1, 11) = 8.815$, $p = .013$), reflecting the fact that sentence voice had an effect only on aphasic subjects' performance. Unimpaired participants were not affected by this factor, performing equally well on both actives and passives. Another significant interaction effect was found between tasks and sentence type ($F(1, 11) = 7.432$, $p = .020$), which indicates that sentence voice influenced only the production task.

⁷ We use the theory-free term Theme to refer to non-Experiencer arguments of psych verbs hereafter in this paper.

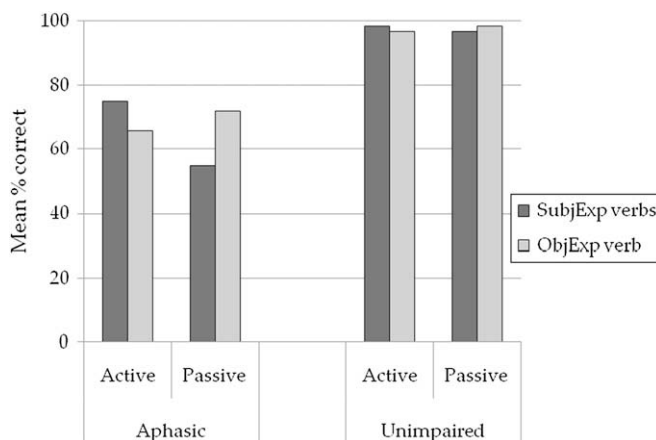


Fig. 1. Unimpaired and aphasic participants' comprehension of SubjExp and ObjExp psych verbs in active and passive sentence conditions.

2.7.1. Comprehension

The percentage of accurate comprehension of SubjExp and ObjExp verbs in each voice for the unimpaired and aphasic participants is shown in Fig. 1 and in Table 2. As can be seen, unimpaired subjects showed little difficulty understanding either sentence type with SubjExp verbs or ObjExp verbs. For aphasic participants, a two-way repeated measures ANOVA revealed a significant effect of sentence type ($F(1, 7) = 6.080, p = .043$), with active sentence comprehension superior to passives, while no main effect of verb type was found ($F(1, 7) = .584, p > .05$). Aphasic participants' performance was above chance for all ($p < .05$) except for passive SubjExp verbs ($t(7) = .456, p = .662$).⁸ There was a marginal interaction effect of verb type and sentence type ($F(1, 7) = 4.575, p < .10$): for SubjExp verbs, comprehension of passive sentences was more impaired than comprehension of actives; whereas, for ObjExp verbs, better performance on passives than actives was noted.

2.7.2. Production

The proportion of accurate productions of ObjExp and SubjExp verbs in each voice for the unimpaired and aphasic participants is shown in Fig. 2. As can be seen, unimpaired subjects showed little difficulty producing either sentence type with SubjExp verbs or ObjExp verbs.⁹ The aphasic subjects' performance, however, was significantly different than the unimpaired subjects' in all conditions ($F(1, 11) = 101.728, p = .000$). For aphasic participants, a two-way repeated measures ANOVA showed a significant effect of sentence voice ($F(1, 7) = 12.068, p = .010$), with actives produced with better accuracy than passive sentences. There was also an interaction effect between sentence type and verb type ($F(1, 7) = 23.450, p = .002$): when producing active sentences, the agrammatic individuals produced SubjExp verbs significantly more successfully than ObjExp verbs. Mean percentage correct production of the former was 85.4% ($SD = 17.68$; range = 50–100%), while mean percentage correct production of the latter was 47.9% ($SD = 18.77$; range 25–75%). On the other hand, production of passives was impaired for both verb types: mean percentage correct production of SubjExp verbs was 15.7% ($SD = 19.92$; range = 0–58%), and mean percentage correct production of ObjExp-type verbs was 36.5% ($SD = 31.48$; range 0–92%). However, passive SubjExp verbs were produced significantly less accurately than passive ObjExp verbs ($t(7) = -2.517, p = .040$), indicating

⁸ One-sample *t*-tests were run to determine if the performance on comprehension tasks was above chance.

⁹ Unimpaired subjects did not score 100% correct on all types of sentences as shown in Fig. 2. However, their errors consisted of grammatically correct productions of non-target structures. See below for examples.

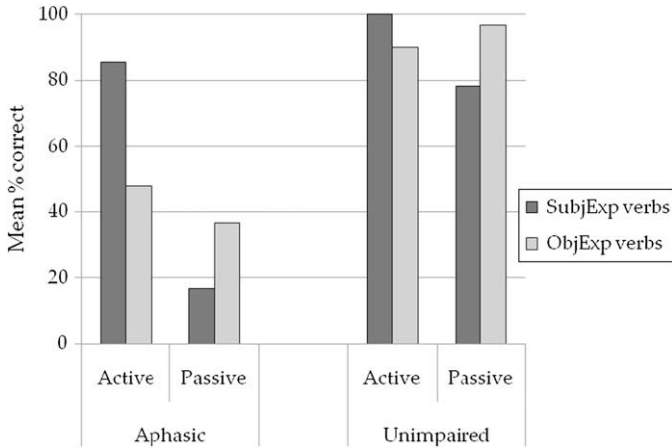


Fig. 2. Unimpaired and aphasic participants' production of SubjExp and ObjExp psych verbs in active and passive sentence conditions.

that although passive sentences were difficult for agrammatic aphasic patients to produce, they evinced greater success with ObjExp verbs which, in their passive form, required an Experiencer as subject. These results were significantly different from those obtained from unimpaired subjects ($F(1, 11) = 101.728, p = .000$).

We also examined voice preference (active versus passive) by coding the proportion of each voice produced on the first attempt, since the task allowed subjects to choose between actives and passives in describing the pictures. As shown in Fig. 3, both unimpaired and aphasic subjects preferred actives for SubjExp verbs: that is, 79% of aphasic subjects' first attempts were active sentences whereas 21% were passives ($t(7) = 7.603, p = .000$).¹⁰ Unimpaired controls also produced actives in 98% of their first attempts and only 2% were passives. Conversely, both subject groups preferred passives for ObjExp verbs: 78% of the normals' first productions were passivised, as compared to 22% of actives. Aphasic subjects also passivised 62% of ObjExp verbs on their first attempts while 38% were actives. One-sample *t*-tests showed that the preferences for SubjExp actives and ObjExp passives were all above chance for both groups ($p < .05$). A two-way ANOVA on the proportion of passive responses for SubjExp and ObjExp verbs revealed a main effect of verb type ($F(1, 11) = 140.638, p = .000$), with no group difference ($F(1, 11) = 1.986, p > .10$).

2.7.3. Error analyses

The primary error type produced by aphasic participants in their sentence production attempts was reversal errors. For instance, *Man shock the girl* was produced for the picture of a girl shocking a man and *Man is admiring woman* for the picture of a woman admiring a priest. This type of error involved production of passive sentences for active targets as in (6a) and (7a) as well as production of active sentences for passive targets as in (6b) and (7b) below. The remainder of the errors, which comprised 15% of the total, was primarily incomplete productions (e.g., lacking an obligatory argument or verb).

(6) SubjExp psych verbs

a. Passive for active:

The man *was pitied* by the girl. [target: The man pities the girl.]

¹⁰ The high percentage of passive voice choices for SubjExp verbs by aphasic participants (21%), as compared to only 2% by unimpaired controls, includes role-reversal errors made by the aphasic speakers.

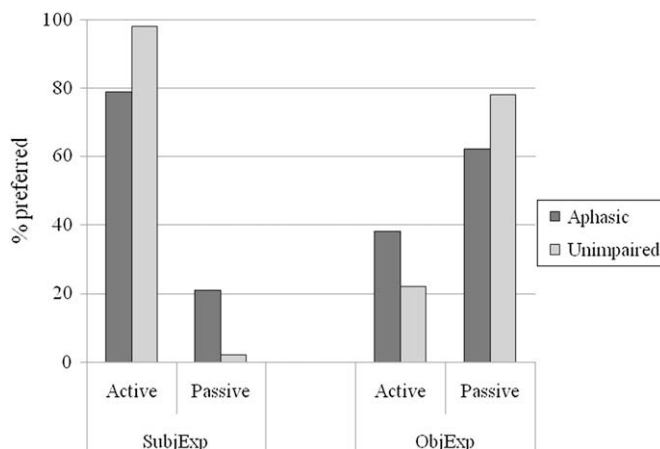


Fig. 3. Voice preference for aphasic and unimpaired speakers.

b. Active for passive:

Woman *despised* man. [target: The woman is despised by the man.]

(7) ObjExp psych verbs

a. Passive for active:

The boy *is bothered* by the girl. [target: The boy bothers the girl.]

b. Active for passive:

The man *frighten* the girl. [target: The man is frightened by the girl.]

The number of errors of each type is summarized in Table 3. Interestingly, for SubjExp psych verbs, all errors consisted of production of actives for passive targets as in (6b): only one error in (6a) involved production of a passive sentence for an active target. On the other hand, for ObjExp-type verbs, the errors involved production of passives for active targets as in (7a) as well as production of actives for passive targets as in (7b).

Although normal subjects had little difficulty producing target sentences, they did make some production errors, mostly with passive SubjExp verbs (see Fig. 2). However, their errors consisted of production of alternative sentences, rather than ungrammatical ones. For example, for *The clown is admired by the boy*, one subject produced *The clown is certainly something that the boy admires*. Another subject produced *The man was the one that the woman respected* for the target *The man was respected by the woman*.

Table 2

Percent correct sentence comprehension by aphasic participant (out of 12 for each sentence type).

Participants	SubjExp psych verbs		ObjExp psych verbs	
	Active	Passive	Active	Passive
S1	83	75	83	83
S2	75	42	92	83
S3	67	33	50	58
S4	58	50	50	50
S5	92	83	67	75
S6	92	33	50	92
S7	58	42	50	58
S8	75	67	83	75
Mean	75%	52%	65%	72%

Table 3

Percent thematic role errors made in sentence production attempts by aphasic subjects (out of 12 each).

Participants	SubjExp psych verbs		ObjExp psych verbs	
	Passive substitution	Active substitution	Passive substitution	Active substitution
S1	0	75	0	66
S2	8	25	8	8
S3	0	75	0	66
S4	0	8	42	0
S5	0	75	58	25
S6	0	75	42	60
S7	0	92	0	75
S8	0	33	0	33
Mean	1%	57%	19%	42%

3. Discussion

One of the main findings of this study is that ObjExp psych verbs were more difficult for agrammatic aphasic patients to produce than SubjExp psych verbs in active sentences. This is likely related to the fact that the argument structure representation differs for the two verb types, even though they both have the same number of arguments. As discussed earlier, the type of arguments associated with the verb appears to have important consequences for production in agrammatic aphasia. Unaccusative verbs are more difficult to produce than unergatives, both in action naming and in sentence production tasks and, on both syntactic and semantic grounds, unaccusatives can be considered to be more complex than unergatives. The present findings show that argument structure characteristics also play a role in production of sentences with psych verbs. Following *Belletti and Rizzi's (1988)* analysis, the difference between ObjExp psych verbs and SubjExp psych verbs is similar to that for syntactic accounts of unaccusative and unergative verb differences. Whereas both types of psych verbs select for an Experiencer and a Theme, ObjExp verbs, like unaccusatives, do not have an external argument. Rather, both arguments are verb internal and the Theme-marked argument moves from the post-verbal object position to the subject position to satisfy case requirements in English. These verbs are, therefore, syntactically more complex than SubjExp psych verbs which, like unergatives, have an external argument (Experiencer) that is base-generated in the subject position and no syntactic movement is required.

As noted earlier, however, not all researchers agree with *Belletti and Rizzi's (1988)* analysis of psych verbs. *Pesetsky (1995)* argues that both psych verb types have an external argument and an internal argument and both select for Experiencer, but that the thematic role of the other argument differs for the two. In particular, SubjExp verbs select for an internal Object of Emotion, while ObjExp verbs select an external Causer. On this analysis, ObjExp verbs are semantically causative, which renders them more difficult for agrammatic patients than SubjExp verbs. *Arad (1998)* and *Baker (1997)* also attribute the relative complexity of ObjExp verbs to their semantic characteristics: that is, the multiple interpretations of their first argument (i.e., agentive, eventive/causer and stative) and their ditransitivity, respectively. Thus, although for different reasons from *Belletti and Rizzi (1988)*, on all accounts ObjExp verbs are more difficult to process in active sentences.

Another finding of the study is that production of passive sentences was impaired for our agrammatic speakers, as expected, since these structures involve NP movement, which in and of itself is difficult for aphasic people with agrammatism (*Grodzinsky, 1990*). Interestingly, however, passivized ObjExp verbs were actually produced better than passivized SubjExp verbs (36.5% and 15.7% correct, respectively). This finding likely relates to the surface form arrangement of arguments in the two verb types. According to the syntactic analyses discussed earlier (by *Belletti & Rizzi, Arad, & Pesetsky*), in ObjExp verbs, the Experiencer-marked argument takes the subject position in the passivized form;

whereas, for passivised SubjExp verbs, the subject position is filled with a non-Experiencer argument. This finding suggests that aphasic speakers, like unimpaired speakers, are influenced by the prominence of arguments on the thematic hierarchy and thus prefer to produce Experiencer argument in the subject position.¹¹

Support for this interpretation was also apparent in our voice-preference data (for active versus passive sentence productions). Both unimpaired and aphasic participants produced more active sentences for SubjExp verbs on their first picture description attempt and more passives for ObjExp verbs on their first attempt. These data indicate a preference for production of Experiencer, rather than Theme, in the subject position, regardless of the active versus passive status of the sentence produced.

The aphasic error data also reflect this pattern. Our agrammatic speakers produced more errors on sentences with a non-Experiencer sentential subject. All but one error for SubjExp verbs was made in attempt to produce passive sentence forms, which have a Theme-marked argument as subject. Conversely, a great number of errors for ObjExp verbs were made in attempts to produce active sentences, where the subject is a Theme. These error patterns, once again, can be explained by the prominence of the theta-role of the sentential subject.

It also could be argued that the morphological material required for passive structures underlies the error pattern noted. For example, errors as shown in (8) were made for SubjExp verbs. That is, in attempts to produce the passive form, aphasic speakers produced the base form of the verb, failing to attach the proper verb morphology for the passive verb form (e.g., *is despised*). This interpretation, however, is countered by inspection of the errors produced for ObjExp verbs as in (9), where the same participants showed ability to produce passive verb morphology.

(8) Subject-Experiencer errors:

Target (passive): The woman_{THEME} is despised by the man_{EXPERIENCER}

Response (active substitution): Woman *despise* man

(9) Object-Experiencer errors:

Target (active): The boy_{THEME} bothers the girl_{EXPERIENCER}

Response (passive substitution): The boy *is bothered by* girl.

These findings are in keeping with those derived from previous studies, which indicate that verb argument structure complexity influences sentence production in individuals with agrammatic aphasia, and thus provide additional evidence supporting the ASCH (Thompson, 2003). In particular, the data conform to the notion that the type of argument entailed within the verb representation impacts production. The arguments of ObjExp verbs are more complex than those of SubjExp verbs, regardless of which theoretical framework is considered, that is, whether or not NP movement, multiple interpretations, or causative meanings are involved. The ASCH also explains the finding that passivised ObjExp verbs are easier for agrammatic patients to produce than passivised SubjExp verbs. Although both involve NP movement, which is involved in formation of passive sentences, this movement yields an Experiencer-marked subject for ObjExp verbs but a non-Experiencer subject for SubjExp, making passivised ObjExp verbs easier to produce than passivised SubjExp verbs.

The noticeable differences between SubjExp and ObjExp verbs found in comprehension, production and voice-preference patterns provide interesting evidence that agrammatic verb-production deficits are actually due to grammatical factors, not to other psycholinguistic factors. Previous research has attributed grammatical impairments observed in agrammatic verb production to frequency (e.g., Bird, Howard, & Franklin, 2000), imageability and concreteness (e.g., Bird, Lambon Ralph, Patterson, & Hodges, 2000; Bird et al., 2003), or transitivity bias (e.g., Gahl, 2002; Menn et al., 1998). However, given that SubjExp and ObjExp verbs are equally frequent, similarly low in imageability and concreteness,

¹¹ In this regard, Baker's (1997) analysis does not explain this result because it posits the Goal-marked argument in the subject position.

and similarly strong in transitivity bias, these psychological factors do not explain the observed differences between the two verb classes.

Our findings have further implications for theories pertaining to the source of agrammatic production deficits, that is, whether they reflect impaired representation or limited processing. The comprehension data showed that lexical representation was relatively intact, in that the agrammatic participants' comprehension of psych verbs was above chance for all sentences tested, except for passive constructions with SubjExp psych verbs. The chance level comprehension of SubjExp passive verbs likely reflects patients' difficulty with argument movement that is required for passivization, which for ObjExp verbs is less impaired (i.e., above chance) due to the advantage of having an Experiencer-marked argument in the subject position, as discussed earlier. This pattern nicely parallels observed production pattern: our aphasic participants performed better with the Experiencer in subject position both in production and comprehension. Moreover, this comprehension pattern is consistent with Piñango's (2000) finding, which also showed that agrammatic, Broca's patients perform better on psych verbs with the Experiencer subject, regardless of whether the sentence was passive or active.

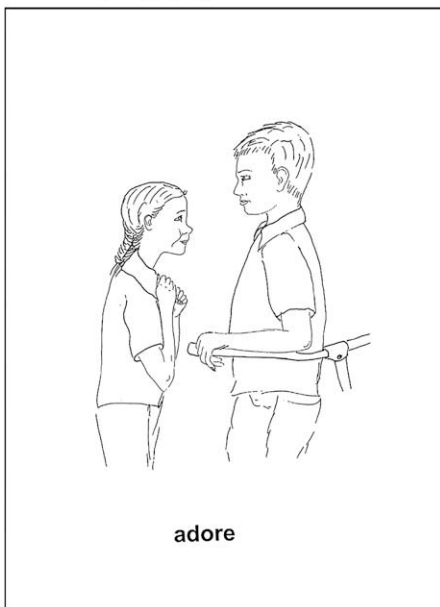
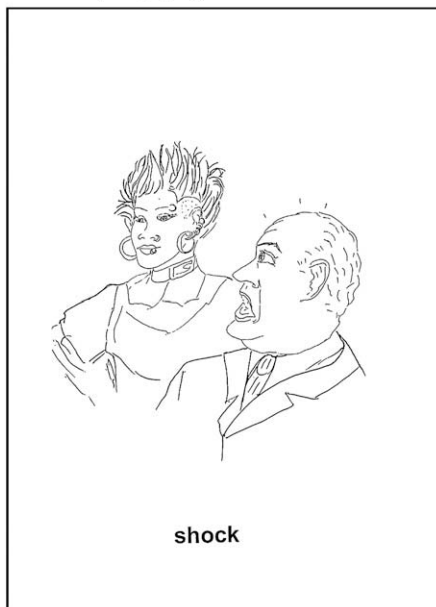
Access to this, relatively intact, representation, however, is required for sentence production. According to models of sentence production (Bock, 1995; Bock & Levelt, 1994; also see Thompson & Faroqi-Shah, 2002), verbs are accessed together with their entire lexical representation, including the subcategorization frame, argument structure, theta-role assignment, and other morphosyntactic features. Thus it may be that flawed sentence production reflects a deficit in accessing this material. In fact, we engaged this interpretation to explain agrammatic aphasic individuals' less impaired production of one-argument verbs as compared to verbs with two or three arguments (Kim & Thompson, 2000). However, Lee and Thompson (2004) rejected this analysis in their study of unaccusative and unergative verb production in agrammatism in that their patients produced all required arguments, but in the wrong sentence position. We, therefore, suggested that sentence production deficits derive from faulty sentence building operations that become more difficult as the complexity of the material encoded by the verb increases. The present data support this latter analysis in that our aphasic participants produced sentences with the correct number of arguments associated with target verbs, indicating successful accessing of lemma level material; however, they incorrectly mapped these arguments onto the syntactic structure. Bock and Levelt's (1994) sentence production model suggests that errors of this type reflect post-lemma problems. We interpret our findings as such and suggest that this mapping is particularly impaired in sentences with verbs with complex argument structure representations.

4. Conclusions

Results of this study provide further evidence that verb production is impaired in agrammatic aphasic individuals and that verb argument structure complexity, related to the thematic roles of arguments as well as to the number and/or type of arguments, is linked to sentence production ability. We suggest that impaired sentence production, which relies at least in part on the argument structure properties of the verb, underlies the impoverished sentence production patterns seen in agrammatic aphasia. Sentence production is, thus, more impaired when the selected verb entails greater argument structure complexity.

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Appendix A. Sample stimuli (for production task).**SubjExp psych verb: *adore*****ObjExp psych verb: *shock*****Appendix B. List of target sentences.**

Active voice sentences	Passive voice sentences
SubjExp psych verb sentences 1. The woman admires the priest. 2. The man fears the woman. 3. The mother cherishes the baby. 4. The man despises the woman. 5. The woman distrusts the man. 6. The man dislikes the woman. 7. The man likes the woman. 8. The woman respects the priest. 9. The man pities the girl. 10. The mother loves the baby. 11. The man trusts the girl. 12. The girl adores the boy.	The priest was admired by the woman. The woman was feared by the man. The baby was cherished by the mother. The woman was despised by the man. The man was distrusted by the woman. The woman was disliked by the man. The woman was liked by the man. The priest was respected by the woman. The girl was pitied by the man. The baby was loved by the mother. The girl was trusted by the man. The boy was adored by the girl.
ObjExp psych verb sentences 1. The woman angers the man. 2. The girl intrigues the boy. 3. The girl frightens the boy. 4. The boy bothers the girl. 5. The man hurts the woman. 6. The woman concerns the man. 7. The man moves the woman. 8. The girl satisfies the father. 9. The man surprises the woman. 10. The girl shocks the man. 11. The boy upsets the mother. 12. The man wounds the girl.	The man was angered by the woman. The boy was intrigued by the girl. The boy was frightened by the girl. The girl was bothered by the boy. The woman was hurt by the man. The man was concerned by the woman. The woman was moved by the man. The father was satisfied by the girl. The woman was surprised by the man. The man was shocked by the girl. The mother was upset by the boy. The girl was wounded by the man.

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