

Towards an Agrammatic Grammatical Theory: Evidence from Research on Aphasic Patients

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Abstract

Research on agrammatism (i.e. a phenomenon commonly known as language loss of aphasic patients whose particular area(s) of brain accidentally get damaged resulting in language impairment) has revealed that the nature of language impairment is systematic and interpretable. This paper summarizes some of the representative studies on agrammatism. All these investigations support that agrammatism has a distinctive linguistic pattern(s) i.e. special grammaticality of its own. I hypothesize that agrammatics have a special kind of grammar of their own that is different from normal speakers' language patterns. In the following, I elucidate such special patterns of agrammatism. I also speculate that developing such distinctive pattern(s) of agrammatic speech will help administer both diagnoses of and therapies for aphasic patients in more effective ways.

Keywords: Aphasia, morphological deficit, representational/processing deficit, feature interpretability etc.

1. Introduction:

Broca's patients, (who are diagnosed having injury or damage due to either accident or stroke in the brain,) have various kinds of language production impairments depending on the severity and specific region(s) of damage(s). French physician Paul Broca first identified lesion(s) in the left hemisphere of patients who had speech impairment(s). An area in the left hemisphere is named after him. Though Broca's area is usually considered to be the language production area, production of linguistic items is not exclusively confined to this region.

Then followed the identification of Wernicke's area, which is commonly held to be responsible for language comprehension. Till date, there have been many studies focusing on the functions of the different parts of the brain, and the severity of language impairments based on the damages in different parts of the brain. This language impairment is commonly known as aphasia. Usually, if the impairment is related to Broca's region (left-hemisphere) and patients have problems in language production, it is called Broca's aphasia, and if the impairment relates to Wernicke's area (right-hemisphere) resulting in difficulty in comprehension, it is commonly known as Wernicke's aphasia. Even within these two broad modalities of impairment, there are minor categorizations of the types of language impairments. Such as, impairments of complementizer phrases, wh-phrases, Tense- (or Agreement) phrase, difficulties in producing interpretable features, comprehension difficulty of reversible and passive sentences, etc.

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There are a lot of studies on the comprehension difficulty of non-canonical sentences in natural languages, especially in Japanese, German, and English agrammatism. Production impairment of non-canonical sentences has received considerable attention from linguists and clinicians worldwide. The agrammatic patients' finding difficulty in producing non-canonical sentences conforms to the involvement of extra-computational loads of sentences that deviate from the basic (canonical) word order of any particular languages. Such findings again lead to debate whether the linguistic impairments are results of representational (also known as structural or grammatical) deficits or processing (or limitations in application of grammatical rules) deficiency of the aphasic patients.

Broca and Wernecke at first focused on the linguistic pattern(s) of agrammatic patients. Avrutin (2001) has introduced some recent studies in aphasiology to relate theoretical linguistics to psycholinguistics. He considers the relations between theoretical linguistics and psycholinguistics as that of mutual enrichment and somewhat dependent on each other. Theoretical linguistics provides researchers with linguistic models and systems for analyzing its various phonemic, morphological and syntactic components as well as the connection of the human brain with linguistic behavior. Psycholinguistics deals with how the linguistic structures yield meaning in some specific ways. For example, by analyzing the agrammatic speech, we get a theory-based account of the functional localization of language in brain and the aspects of language that are impaired more than the others. Broca's aphasia is usually caused by a brain damage in Broca's area and its vicinity (Brodmann's area 44 and 45) in the left hemisphere, but damages in other parts of the left hemisphere may also cause this type of aphasia.

In both Broca's and Wernicke's cases, patients had damage in their brains. The damages were in two different areas and the speeches of both types of patients were different—in Broca's study the speech was effortful, laborious, slow and telegraphic, but in Wernicke's study, the speech was effortless, sentences with many functional categories, but comprehension was impaired. These studies also point to the neurological association in determining the cortical localization of some linguistic functions as external evidence of a grammatical theory. These extra-linguistic factors for linguistic impairment provide the psycholinguistic basis and the theoretical linguistics helps characterize the linguistic function(s) related to particular areas of human brain. Therefore, both psycholinguistic findings and theoretical research help each other for enhanced understanding of the both.

Psycholinguistic research on aphasia or linguistic disorders so far has supported the view of language being an independent system governed by its own rules and principles. The independent linguistic system helps psycholinguistics researchers find possible source of linguistic impairment. For example, studies of Trace Deletion Hypothesis (TDH) (Grodzinsky, 1984), Wh-questions, Reversible and non-reversible sentences, (Hickok & Avrutin, 1995) and (Tait et al., 1995), d-linked and non-d-linked questions, (Pesetsky, 1987), Tree Pruning Hypothesis (TPH) (Friedmann and Grodzinsky, 1997 & Friedmann, 1998), Tense Underspecification Hypothesis, (Wenzlaff & Clahsen, 2004, cited in Kok et al., 2007) etc. have contributed to identifying the linguistic structures of agrammatism—as a system having its own grammatical patterns though agrammatism appears to be ungrammatical.

By applying the findings of theoretical linguistics, studies in aphasiology have discovered some features such as overt movements and TDH, double agent sentences, pronouns, non-finite forms, null subject sentences, omissions of functional categories such as determiners, tenses and complements etc. Without the application of linguistic theory, such observations on linguistic disorders would not be possible, and there would not have been good understanding of the nature of agrammatism as well. Agrammatic patients reduce functional elements of language significantly, such as, producing only NP instead of full DP (omitting determiners), even null subjects, and/or only VP in lieu of CP or IP. Additionally, they usually have more problems in producing verbals than nominals. Investigations carried on agrammatic patients so far have revealed that aphasia is not a random phenomenon; rather the nature of mistakes, and production difficulties are very systematic and related to other extra-linguistic features i.e. discourse, interpretability features etc. Additionally, studies in priming with normal and aphasic speakers suggest that agrammatics' deficit may have roots in external sources, such as, neurons, brain activities, hormone secretion, stage of language loss etc.

Studies on non-canonical sentences i.e. object relative clauses, passive sentences, wh-interrogatives, etc. report that the sentence constructions that deviate from the basic word order are more difficult to be processed for agrammatic patients. As adult speakers over-learn the structures of canonical sentences, they can produce the canonical sentences comparatively easily. So far the previous research on agrammatism has insinuated that agrammatic speech has a specific type of grammar or patterns of its own.

Coupled with these, studies on agrammatic language patterns provide us with windows to better understand the cognitive-neurobiological foundations of human languages. Results of eye-tracking studies, online-offline language processing studies, fMRI, voxel-based studies, etc. instantiate such contributions to the field of general linguistics too.

2. Features of Agrammatic Speech:

The patients who are diagnosed with Broca's aphasia have difficulty in producing grammatical sentences in most cases, though they may have the comprehension capacity relatively intact. This impairment in producing grammatical structures is commonly known as agrammatism in the literature. Broca's patients usually produce short utterances, and it is laborious for such patients to produce right sounds or find the right words. Broca's aphasia is usually caused by a brain damage in Broca's area and its vicinity (Brodmann's area 44 and 45) in the left hemisphere, but damages in other parts of the left hemisphere may cause this type of aphasia too. Broca's and Wernicke's aphasia are differently characterized depending on the damaged area(s) of the brain.

3. Evidence from Research:

For agrammatic patients, both comprehension and production of language appears to be difficult or totally impaired depending on the nature and extent of the damage in different areas of the brain. Researchers report language impairment in both cases though it is generally the production of language that is more impaired than comprehension for agrammatic patients. Moreover, researchers usually found that damage to Wernicke's area of the brain leads to comprehension difficulty, while damage to Broca's area is

responsible for production impairment. The following sections (3.1,3.2) discuss both the comprehension and production impairments of language of agrammatic patients.

3.1. Agrammatic Comprehension:

It is generally found that linguistic comprehension is less, or not at all impaired compared to linguistic production in agrammatic patients.

3.1.1. Reversible & Non-Reversible Sentences:

Researches (Hickok & Avrutin,1995; and Tait et al., 1995) reported that for agrammatic patients, reversible sentences are more difficult to comprehend than non-reversible sentences due to the absence and presence of the semantic cues for understanding the meaning. In non-reversible sentences, semantic cues for correct interpretation are available alongside the syntactic ones, and hence, patients face less difficulty in comprehension. Contrarily, in reversible sentences, the comprehension is entirely dependent on the syntactic cues only, and the absence or ambiguity (arising out of trace identification) of semantic cues makes comprehension difficult (Hickok & Avrutin (1995) and Tait et al. (1995), such as:

1.a. The man_i who cut the tree was guilty_i. 1.a.' *The tree_i *who/that cut the man was guilty_i.

1.b. The tiger_i that the man killed was innocent_i. 1.b'. The man_i that the tiger killed was innocent_i.

Here sentence 1.a. is a non-reversible one, because semantically it is possible that only the man can cut a tree, not the vice-versa, and sentence 1.a'. is unacceptable. On the other hand, sentences 1.b. and 1.b'. are reversible and both the tiger and the man can interchange the subject-object positions, and hence these types of sentences can create comprehension difficulty for the agrammatic patients. Since both tiger and man can be used semantically and syntactically either as nominative or accusative, it makes comprehension difficult for Broca's patients.

3.1.2. Trace Deletion Hypothesis & Agrammatic Comprehension:

Grodzinsky (1984) proposed Trace Deletion Hypothesis (TDH) that holds aphasic patients cannot represent the traces of NP in passives or other sentences involving movements. For example:

2.a. The tiger chased the man. 2.b. The man was chased by the tiger.

In 2.b. sentence, the NP 'the man' though receives an accusative theta-role and then moves to the subject position due to getting passivization. Agrammatic patients cannot identify this NP as the receiver of the chasing event, rather they opt for double agent interpretation of the sentence—one by default strategy to assign the subject NP as agent and the other by 'by' phrase. By doing so, they develop the idea of two agents and perform by chance for the interpretation of the sentence. Grodzinsky's (1999) study reported Broca's aphasics showing "better performance on comprehension of subject relative clauses, subject clefts and adjectival passives" than regular passives, object relative clauses and object clefts.

3.1.3. *Passivization & Agrammatic Comprehension:*

Hagiwara (1993) reported similar results from studies with Japanese aphasics involving active and passive sentences: the patients showed chance performance in sentences having movement operations and traces.

Hartsuiker, Kolk & Huinck (1999) suggested that agrammatic patients passive-construction-problem is related to processing limitation rather than structural deficit.

Pinango & Burkhardt (2001) demonstrated agrammatic patients performing on chance level when the thematic roles are reversed due to syntactic movement i.e. passivization.

3.1.4. *Agrammatic Comprehension of d-linked & non-d-linked wh-phrases:*

Pesetsky, (1987) showed that difficulties lie in the discourse marking property of language. The d-linked wh-questions are more difficult to the patients and they perform on chance with d-linked wh-questions. On the other hand, non-d-linked wh-questions, which are not marked for discourse, are easier to answer and they perform above chance. It is because the d-linked wh-questions require extra processing effort, while non-d-linked wh-questions lack such discourse presuppositions. Agrammatic patients' having more difficulty in processing D-linked wh-phrase than non-D-linked ones is also well documented in Hickok & Avrutin (1995) and Tait et al. (1995) such as:

- 3.a. Which man did the police arrest?
- b. Who arrested the man?

The patients have to consider the discourse-referent clue of 'which man' in addition to the syntactic clue to interpret sentence 3.a. that causes more processing demand, whereas, only the syntactic clue is enough to get the meaning of sentence 3.b. for 'who' having practically no discourse reference.

3.1.5. *Agrammatic Comprehension of Scrambled Sentences:*

Tamanna (2017) reported that Bengali agrammatic speakers showed more difficulty than normal speakers in comprehension tasks involving different word orders and syntactic movements. It is to be noted that Bangla is a relatively free word order language e.g. constituents can move to any place clause internally without affecting semantics, but not the pragmatics. She used five sentence types: active (SOV), scrambled (OSV), passive, object relative clause and subject relative clause; each of which was constructed with 3 different semantically reversible verbs and also had a picture-matching task (29). Results show that only the active, canonical SOV sentence comprehension was intact, while the others were impaired which were ordered in scrambled ways.

3.2. Previous Studies and Theorization on Agrammatic Production:

Almost in all studies (Avrutin (2001), Agnew et al. (2014), Lee et al.,(2005), Arabatzi & Edwards (2002), Kok & kolk (2007), Fyndanis et al. (2012), Rispens et al., (2001), Kemmerer (2012) and Engel et al. (2018) on agrammatic production, results showed that agrammatic production is more impaired than comprehension. Moreover, impairment in linguistic production also holds for the theory of processing deficits, rather than representational account for agrammatism. Now we discuss some salient hypotheses that focus on the nature of agrammatic production deficits in the following sections.

Cho-Reyes & Thompson (2012) reported agrammatic groups producing overall more incorrect responses with their studies on 35 individuals with agrammatic aphasia, and 24 with anomic aphasia using the Western Agrammatic Battery (WAB). The study reported that the more the number of arguments was, the less sentence accuracy was found, while prepositional impairments were the severest. Schwartz et al. (1987) suggest that patients with agrammatism have difficulty mapping relations between the abstract functional level and the surface syntax at the positional level. Next, we focus on Tree Pruning Hypothesis and its currency in agrammatic research.

3.2.1. Tree Pruning Hypothesis (TPH) and Refuting Tree Pruning Hypothesis:

Now we turn to the production impairment of agrammatic patients with The Tree Pruning Hypothesis (TPH), as is phrased by Friedmann and Grodzinsky (1997), that simply refers to the fact that some parts of the syntactic tree become inaccessible to the agrammatic patients i.e. some parts are ‘pruned’/impaired resulting in omission of certain grammatical items in language production. The impairment may be caused at the higher or lower nodes of the tree depending on the severity of aphasia. It also predicts that usually the higher nodes are more impaired than the lower nodes and the impairment is selective. To be more specific, the predictions of TPH are as follows:

- 4.i. the highest node, CP, is always impaired to some degree.
- ii. material at higher nodes should be more impaired than material at lower nodes, but not vice versa.
- iii. tense inflection being higher is more difficult to produce than agreement inflection.

Friedmann and Grodzinsky (1997) and Friedmann (1998) reported that their Hebrew and Arabic speaking patients produced more tense than agreement errors. The predictions of TPH are not supported by the experiments that Lee, Thompson & Cynthia (2005) conducted on production of (in Experiment 1) complementizers (*if*, *whether*, and *that*) and (in Experiment 2) verb inflections (3rd person singular *-s*, present plural bare stem- \emptyset and past tense *-ed*). They reported that CP remains intact while the TP and AgrP are impaired. Their experiments with FG and LC reported that FG and LC produced 19 and 20 correct responses respectively out of 20 complementizer task items. They report tense to be more impaired than any other nodes (contra the predictions that CP would be mostly impaired) while AgrP is reported to be the least impaired node (both patients performed better in agreement than tense). As there is no unanimity about the position of AgrP in IP, the results are yet inconclusive for syntactic-tree-based account. Pollock posited AgrP below tense phrase in split IP, while both Ouhalla (1993), and Chomsky (1995) placed subject agreement above, and object agreement below tense phrase in GB/Principles and Parameters Framework. Chomsky (1995) also differentiated between subject agreement and object agreement and put tense phrase in between these two, while Ouhalla opined for a common agreement phrase situated above tense phrase. Moreover, Bobaljik and Thrainsson (1998) claimed English having an unsplit IP—agreement and tense being expressed under I(Infl). With regard to the debate of split or unsplit IP (whether tense and agree being separately projected or collated under Infl) unanimity awaits further research. Interesting are the more substitution errors than omission errors made by both patients, and within substitution errors, occurrence of more *-s* for *-ed* in this

study. Even FG overused the *-s* morpheme across 3rd person singular number *-s*, present plural bare inflection, and past tense *-ed* in the second experiment.

3.2.2. Morphological Deficit Hypothesis:

Lee et al., (2005) proposed that there might be morphological deficits rather than syntactic deficits in agrammatic language production. As both FG and LC show functional categories i.e. complementizers, *-s*, *-ed* etc. but they make faulty selection(s) of the inflectional morphemes. They used at least one of the three functional/grammatical categories but the problem is deficits in selecting the correct inflectional marker. Both FG and LC's error patterns showed that, a) affixation is intact and inflectional rules are present, but b) the patients are unable to apply rules correctly, that resulted in faulty selection of an inflectional morpheme. However, the proposal requires further research.

The 2nd experiment is only with 3rd person singular *-s*, present plural bare inflection, and past tense *-ed*. Other inflectional varieties such as, *to* infinitive, present/past progressive *-ing*, perfective, future indicative etc. should be undertaken for understanding the nature of tense and agreement phrases. Moreover, English *-s*, that marks both tense and agree, may be counter-balanced with studies in languages that distinguish agreement and tense morphologies to identify relations between the two inflections.

3.2.3. Derived Order Problem Hypothesis:

Another interesting theory i.e. the Derived Order Problem Hypothesis (DOP-H) holds that all languages have a base word order such as English has SVO, Bangla, Dutch and German have SOV as base word order, and when agrammatic patients encounter sentences with the word order in derived position i.e. moved from original position, they find the sentences more difficult to produce and comprehend than the sentences in the base word order. Bastiaanse et al. (2002a) reported, "Dutch patients have more problems with (finite) verb inflection and/or word order in main clauses than in embedded clauses. (Cited in Duman, 2009: 11). Duman (2009) also pointed, "Note that the DOP-H is restricted to word order" (11).

3.2.4. Tense Underspecification Hypothesis (TUH):

Tense Underspecification Hypothesis (TUH) was proposed by Wenzlaff & Clahsen (2004) as an alternative to Tree Pruning Hypothesis to account for the dissociation between tense and agreement inflection in agrammatic speech. TUH assumes tense and agreement as an unsplit T/INFL (Tense/Inflection) node where Tense represents an interpretable feature due to its semantic interpretation (i.e. referring to time in real world), and agreement represents an uninterpretable feature for the finiteness marker being purely syntactic indicating only subject-verb agreement and having no semantic interpretation (i.e. having no discourse reference that indicates anything in real world). They regard tense marking as an anaphoric phenomenon too. And this anaphoric phenomenon is found to be affected mostly in agrammatism by a number of studies (Grodzinsky et al., 1993; Ruigendijk & Avrutin, 2006), since the interpretation of tense requires external information processing; whereas, agreement marking is much less susceptible to underspecification as it requires only clause-internal feature checking. TUH also holds that the T/INFL node is unspecified for tense, but other features such as agreement, moods remain intact in agrammatic production.

3.2.5. *Tense-Agreement Underspecification Hypothesis:*

Burchert et al. (2005) came up with Tense-Agreement Underspecification Hypothesis (TAUH) claiming that agrammatic underspecification is unsystematic, and not only the interpretable tense feature but also the uninterpretable agreement feature can be underspecified resulting in agrammatic patients having problems with either in tense or agreement or in both cases. But Kok's et al. (2007) findings were not in line with those of Burchert et al. (2005) as they (i.e. Burchert et al., 2005) did not employ real production task.

3.2.6. *Extralinguistic Factors for Processing Limitations:*

Kok et al. (2007) accounted for whether the representational models or the current processing limitations (e.g. limited working memory capacity) are responsible for agrammatic production. Their findings match with that of the account of the processing limitations hypothesis as was proposed by Avrutin (2001). The processing hypothesis assumes that tense inflection is comparatively difficult to produce for its being computationally complex that requires "integration of information at grammatical and conceptual level" (Avrutin 2001). This becomes problematic for agrammatic patients. Integration of grammatical and discourse level representations makes it difficult for the patients to process information. Kok et al. (2007) commented that their findings imply that the difficulties in producing verb/tense inflection cannot be explained by a structural representational account. Hartsuiker, Kolk, and Huinick (1999) recorded agrammatics' as well as normal speakers' approach to complete the following sentences with singular verb inflections:

5. a. The baby on the blankets
- b. The label on the bottles

As sentence 5.a. contains an NP that is singular both at grammatical and conceptual level, normal speakers take both accounts to complete agreement inflection but made more agreement errors in sentence 5.b. which is grammatically singular but conceptually plural as opposed to the agrammatic speakers who do not account for conceptual meaning, while agrammatic speakers take only grammatical account to avoid extra computational difficulty for integrating conceptual information. So, the findings do not support the representational account which focuses on only grammatical aspects, but subscribes to the processing account that integrates both grammatical and discourse information. Kok et al. (2007) showed patients making more errors (both in tense and agreement inflections) when (computational) performance load are double in the *Order and Inflection Test* than single (computational) performance load in the *Inflection Test*.

Not all the studies yielded consistent data as many hypotheses and results are found to be refuted in later studies. Shapiro et al. (1987) reported normal speakers' taking longer for processing verbs that have more possible argument structures (e.g. alternating datives such as 'send' takes more resources than a transitive verb such as 'fix'). In this regard, Broca's aphasics show their sensitivity to a verb's representational complexity, while Wernicke's failed to do the same.

3.2.7. Feature Interpretability & Minimalist Program in Agrammatism:

Fyndanis et al. (2012) reported selective impairment in verb inflection based on feature interpretability and aligned the findings with the Minimalist Program (Chomsky, 1995). Elements that have conceptual/discourse representation alongside the grammatical one are interpretable, while elements that have only grammatical representation are uninterpretable features. Not any of the previous hypotheses i.e. TPH, TUH, TAUH are proved to be responsible for linguistic impairment. Nanousi et al. (2006) and Varlokosta et al. (2006) reported Aspect being more impaired than Agreement in Greek agrammatism, though Aspect is lower than Tense and Agreement in Greek.

3.2.7.1. Interpretable Feature Impairment Hypothesis:

Fyndanis et al. (2012) proposed *Interpretable Features' Impairment Hypothesis* (IFIH) claiming that interpretable features, such as Tense and Aspect are more impaired than Agreement which is not an independent functional category but an operation by which certain uninterpretable features of Tense are checked against certain interpretable features of the subject. They proposed that the syntactic-phonological process that assigns phonological values to interpretable features is impaired in their agrammatic speakers.

Bastiaanse (2008), Duman and Bastiaanse (2009) and Bastiaanse et al. (2011) reported that reference to the past is more impaired than present or future. But Fyndanis et al. (2012) found no difference in difficulty regarding reference to past, future or present. Their results also did not support TPH, rather the proposal of Nanousi et al. (2006) and Varlokosta et al. (2006) of interpretable such as Tense's and Aspect's being more impaired in agrammatism than uninterpretable features such as Agreement. Their results are also at par with the proposal of Faroqi-Shah and Thompson (2004, 2007) that claim agrammatic speakers have more impairment in encoding T related diacritical features and retrieving corresponding verb forms as well as TUH and TAUH as Tense is more impaired than Agreement.

Fyndanis (2012) reported Aspect to be the most impaired functional category that carries interpretable feature, followed by Tense; and Agreement the least impaired functional category carrying uninterpretable feature. Tense and Aspect require construction of complex conceptual representation as well as grammatical operations and are considered interpretable features. But Agreement does not require any conceptual representation and carries uninterpretable feature. Hence, Agreement is better preserved than Tense in agrammatism. The syntactic category T/INFL that hosts morpheme marking Tense, Mood and Agreement on the verb is underspecified for Tense, but not for Mood and Agreement. (Wenzlaff & Clahsen, 2004) Hence, interpretable features are more difficult than uninterpretable features for agrammatic speakers to process and produce. Between the elements of interpretable features i.e. Tense and Aspect, surprisingly Aspect is reported to be more impaired for it being more subjective, and intentional that requires more processing load and extensional/extralinguistic information. The findings with control group's (normal speakers') Agreement being better preserved than Tense/Aspect support the processing hypothesis too. Both control and agrammatic groups show similar pattern of performance. No dissociation between past and present, or perfective or imperfective aspect is observed. Both subjects have morphological deficits, one has an additional lexical deficit too.

3.2.8. *Negation in Agrammatic Speech:*

Rispens et al. (2001) showed that although NegP occupies different positions in syntactic tree in different languages, the comprehension does not differ between negative and affirmative sentences among English, Norwegian and Dutch agrammatic patients, but they had minor individual variation(s). For production, English agrammatics' negation is reported to be impaired more than Dutch and Norwegian, though for affirmative sentences, no difference is recorded. For negation, no difference between Dutch and Norwegian is found.

Using grammaticality judgement task in English agrammatics, Gdozinsky and Finkel (1998) found comprehension of negation intact as it is not involved in any theta-role assignment. Rispens et al. (2001) find no difference in comprehending both affirmative and negative sentences by their Dutch aphasic patients. But Ouhalla's (1993) predictions of patients from all three languages performing equally as sentential negation is functional projection is not borne out by present findings; nor is Hagiwara's claim of English and Norwegian patients' performing worse than Dutch (as NegP is higher in English and in Norwegian than in Dutch syntactic tree) is supported, because it is not the position of NegP in tree, rather the internal structure of NegP that influences negation production. (Neg being functional head of NegP and the mutual dependency of Neg with verb and AgrS in English influencing V-movement makes agrammatics' difficulty in producing negative sentences but in Dutch and Norwegian, Neg does not influence V-movement, and Neg is not head of NegP, but specifier). So, negation is more problematic for agrammatics when Neg is functional head, and easier when Neg is specifier. Moreover, all patients resorting to constituent negation when making errors resembles one phenomenon of child language acquisition—a parallel that deserves further research.

3.2.9. *Agrammatics' and Children's Linguistic Patterns:*

Arabatzi et al. (2002) experimented whether agrammatic speakers' errors resemble the errors made by children at the Optional Infinitive Stage (OIS) that accepts both root infinitive and the inflected form and report that agrammatic errors made in tense and verb phrases resemble partly children's errors at OIS though, they also differ from those of children at OIS that requires a different explanation for agrammatic inflectional errors. Both omission and substitution errors are observed among the eight monolingual English-speaking subjects. In *Verb Inflection in the Sentence Completion Task*, agrammatic speakers have marked inflection deficit of 57.5%; in Tense Omission (33.8%); auxiliary omission 28.1%. The other category errors are tense substitution errors of 17.5%. The omission of progressive 'be' is the most frequent types of errors (31.6%) in *Verb Inflection in Declarative Sentences in Narrative Speech Data*. In *Verb Inflection in Negative Sentences*, the agrammatic patients omitted verb in 10% and substituted in 30.8% of the sentences. In 7.5% of the sentences, the patients produced bare stems (like children at OIS) following negation and the omission of *do* such as: *He not shave*; while in 17.5% of the sentences they inflected the verbs (unlike children at OIS) following negation and omission of *do* such as: *He not shaves*. 71.7% errors are reported in *Verb Inflection in Negative Sentences*, while 8.3% attempts were unsuccessful, and only 20% of the sentences were correct. In *Grammaticality Judgment Task*, aphasic speakers' recognition of inflectional errors was unreliable.

3.2.9.1. Children's Optional Infinitive Stage and Agrammatic Production:

Agrammatic speakers' errors do not match that of children at OIS in the sense that children's knowledge of grammatical rules and processes, i.e. Head Movement Constraint (HMC), and feature-checking restrict the child from using an optional infinitive which is not the case with most aphasic speakers. Harris and Wexler (1996) showed that children at OIS omit inflections, leave bare stem or root more than they substitute incorrect inflections. In negation task, aphasic speakers inflect verb forms more than the children in Harris and Wexler (1996) study and violate HMC to inflect verbs incorrectly. The frequency and distribution and pattern of aphasic inflectional errors differ from that of children at OIS. Children's grammar is not completely represented at this stage, while there is no 'loss' of grammar in aphasic patients though, they cannot properly access some rules, functional categories and certain grammatical processes that are impaired and faulty.

3.2.10. Agrammatic Production and Prototypical Neurolinguistic Action:

Kemmerer (2012) discussed how the prototypical transitive action i.e. an animate agent acting forcefully on an inanimate patient to induce a change of state cognitively influences the typological generalization of the vast majority of human languages' basic word order(s) being either SOV (about 48%) or SVO (about 41%). The potential connections between typology and neuroscience are explored from two iconic principles: a. subject salience principle i.e. the subject (agent) being the head of causal chain affects the object (patient) and usually precedes objects (energy flowing from agent to patient); b. verb-object adjacency principle i.e. the agent's action, rather not the agent itself, changes the state of the patient (mirroring tight causal relation between agent's action and its effect on patient). Research suggests that Broca's area schematically represents the sequential and hierarchical organization of goal-directed body movements—both in real world and symbolically conceptualized world are expressed as transitive clauses. Tettamanti et al. (2005) influential fMRI study showed that psychological sentences (i.e. *I appreciate sincerity*.) differ semantically from the other body-part action sentences (i.e. *I kick the ball. I grasp a knife* etc.) as an animate agent induces a change of state in an inanimate patient that proves BA44's sensitivity to the schematic structure of goal-directed action. Fazio et al. (2009) experimented on six brain-damaged patients whose lesions overlapped maximally in BA44 reports that the patients were significantly impaired in the human action condition, but not in the nonhuman event condition compared to the healthy control group. Clerget et al. (2009) study reported similar results. Most of the available data suggest this tendency of canonical mappings between syntax and semantics i.e. syntactic subject > object prominence hierarchy corresponding isomorphically to the agent > patient semantic prominence hierarchy. Grewe's et al. (2006) fMRI study for grammaticality of German sentences revealed that subjects markedly activated the left posterior superior temporal sulcus (pSTS) (part of Wernicke's area) and surrounding temporoparietal territory activation in conditions when both arguments (agent, patient) being animate ($S_A > O_A$, $O_A > S_A$) compared to subject only animate conditions ($S_A > O_I$, $O_I > S_A$). BA44 was found to be activated significantly when object preceded subject conditions ($O_I > S_A$, $O_A > S_A$) compared to the conditions when

subjects preceded object (($S_A > O_A$, $S_A > O_I$). This accounts for the processor's response to the violation of basic linearization principle of subject/agent preceding object/patient and resembles the subject salience principle. The present study supports the views that the left temporoparietal cortex represents linguistically goal-directed actions and BA44 captures the sequential and hierarchical organization of such actions as well as other domains i.e. music, visuospatial stimuli, artificial grammars, natural grammars. This natural grammar, original specialization of BA44, provides the neurocognitive platform for the cross-linguistic preference for SOV and SVO word order, and the prototypical transitive action scenario of animate agents transmitting energy to inanimate patients to change state from the subject salience and verb-object contiguity principles.

3.2.11. Pronoun Resolution and Agrammatic Production:

Engel et al. (2018) using eye-tracking-while-listening paradigm evaluated processing and comprehension of pronouns and reflexives with agrammatic aphasia and age-matched control groups from the Intervener Hypothesis point of view that predicts that if any NP/DP intervenes between pronouns and reflexives agrammatic patients commit more mistakes in identifying pronouns than reflexives. The results show that both agrammatic and control participants have longer eye gaze at the correct options and have advantage for sentences with reflexives relative to pronouns. Two reasons come up for this trend— a. reflexives have uninterpretable features i.e. themselves having no discourse reference except grammatical representation and hence less demanding for processing; whereas, pronouns have interpretable features i.e. they refer to discourse elements as well as grammatical representation and are more demanding for processing; b. according to Principle A, the antecedent NPs/DPs of reflexives can be reached within the verb phrase i.e. the antecedents and reflexives remain in the same clause, but pronouns have to cross the clause boundary or similar NP structure to reach the correct referents. In offline sentence-picture matching task, the agrammatic patients showed above chance performance and better comprehension of sentences with reflexives, while for sentences with pronouns, performance was on chance level and comprehension suffered. When in the long distance condition an intervening NP appeared between antecedent and reflexive, comprehension was numerically lower in the long relative to the short distance conditions, though not significantly. But for age-matched control group, comprehension of all sentence types was highest. Agrammatic patients looked more at the most recent NP (NP2) picture in long distance pronoun condition, and at NP1 in long distance reflexive condition resulting in more gazes to incorrect NP in long distance pronoun and to correct NP in long distance reflexive conditions. They also gazed more to first NP (NP1) in both short distance pronouns and reflexive conditions resulting more gazes to the correct NP in short distance reflexive and to incorrect NP in short distance pronoun conditions. Based on the results of presence of *intervenes* in sentences containing overt and covert sentence element dependencies and subject relative constructions, the authors refine the *Intervening Hypothesis* characterizing an intervener as a sentence element of similar structure to a target referent that intervenes between two elements of a dependency chain and intervenes exclusively refer to the underlying syntactic structure of the sentence and not linear/temporal order.

3.2.10. Production of Non-Canonical Sentences:

Whether production impairments are results of representational deficits or processing deficits are yet an ongoing debate. Burchert et al. (2008) studied the production of non-canonical sentences in German. They experimented to know whether Tree Pruning Hypothesis (TPH) and Derived Order Problem (DOP) hypothesis account for agrammatic sentence production. TPH refers to the fact that certain parts of the sentential tree (usually CP or any node above TP or at any position) are deleted or pruned in agrammatic production. When a node of the tree is impaired, the upper nodes from that node are also necessarily impaired. On the other hand, DOP looks upon the impairment as limitations in the application of movement rules (Burchert et al. 2008). When there occurs any movement in the syntactic tree, aphasic patients find the processing of the moved object difficult, and the more is the distance between the moved object (filler) and the place from where the NP has been moved (gap or trace), the more difficult is the production for agrammatic speakers. For this reason, certain sentences that involve movement (i.e. non-canonical sentences) are more difficult to produce by agrammatic patients than the sentences that do not involve movement (i.e. canonical sentences). In this regard, passive sentences and object-relative clauses, interrogatives, etc. best exemplify non-canonicity in any particular languages, as such constructions involve derived word order.

Burchert et al. (2008) found that Broca's agrammatic patients had greater difficulty and more error problems with the production of scrambled (non-canonical) sentences. Additionally, object-relatives, wh-interrogatives, passives are reported to be generally more difficult to produce for agrammatics. Their findings support the DOP-H rather than the TPH. Their discussion does not shed light on the distinction between Movement and Scrambling and considers both phenomena in the same spirit i.e. non-canonical. The comparison between canonical and non-canonical sentence production shows that group performance of agrammatic speakers was more difficult for non-canonical sentences than the canonical ones. Additionally, the main source of errors was descrambling sentences (error type 1) when scrambling was required. Their results of non-canonical object-adverb order are in line with Bastiaanse et al.'s (2002) study with Dutch-speaking agrammatic patients. Their results support the DOP hypothesis as they noticed problems with sentences involving movement, not with sentences with CP or higher node impairment. Makuuchi et al. (2013) focused on the processing of non-canonical sentences in the left hemisphere in Broca's area in their fMRI study and found that —the longer the filler-gap distance, the greater the difficulty in reaccessing the filler from the lexicon (Makuuchi et al., 2013). The distance between the filler and the gap increases the processing demands from both syntactic and semantic points of views as both syntactic-semantic features of the filler need to be maintained until the gap is met. In the case of Scrambling in German, a linear increase of activation is well-documented and results that are reported maintain consistency. (Makuuchi et al. 2013; Friederichi et al. 2006). Additionally, Makuuchi et al.'s (2013) study found the —nonlinear increase in the Movement construction in German as a new phenomenon. Their findings also show that —neural network consisting of the PO, IFS, mMTG, and IPS is —involved in the processing of filler-gap relations in non-canonical sentences constructed either by Movement or Scrambling operations (Makuuchi et al. 2013). While the neural basis for

the filler-gap is same for both conditions, there is a slight quantitative difference in the linear effect of distance (Makuuchi et al. 2013).

4. Conclusion:

Concerning the question whether agrammatics' language patterns have similarities with those of children, findings report positively based on "children's difficulties with interpreting pronouns" (Koster, 1993), "comprehension problems with D-linked-wh-questions" (Avrutin, 2001) "erroneous interpretation of sentences with universal quantifiers" (Philip, 1995), "presence of non-finite verb" and Optional Infinitive Stage (Wexler, 1994) etc. Contrarily, "Children's knowledge is claimed to be incomplete, and aphasics knowledge is claimed to be lost" (Avrutin, 2001). Though the lack of knowledge hypothesis remains an empirical question, that of the lack of processing resources in both populations is agreed upon (Kolk's, 1998) argument in line with Adaptation Theory. "It is worth noting, however, that agrammatic errors are not 'random': they seem to follow certain patterns depending on the ambient language" (Avrutin, 2001:91). Grodzinsky (1990, 2000) found that agrammatic performance can be of omission or substitution errors: In English or Japanese the bare stems functioning as independent lexical items, patients omit bound morphemes, whereas in Russian or Italian no bare occurring independently, patients substitute items with the incorrect ones. All the experimental study data advocate the existence of a kind of underlying representational grammar in agrammatic speakers that are adequately discussed here. Though on surface level some forms of impairment do not conform to the representation of natural grammar, agrammatic speech retains a kind of distinct grammar. So, it is evident that agrammatism has a kind of special grammaticality on its own patterns. Further studies may focus on analyzing this agrammatic grammaticality in terms of the Minimalism Program (Chomsky, 1995). The nature of such distinctive agrammatic grammar should be studied more and more to reach a level that can contribute to the treatment of agrammatic patients, especially, with regard to designing speech therapy for such patients.

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