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Resource Limitations in Aphasiac Sentence Production Based on Temporal Window Hypothesis

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Abstract
The main purpose of the study was to find the resource limitations as underlying agrammatism and its symptoms. The only participant of the study was an Iranian American biology teacher, fluent both in Persian and English, and 54 years old when hospitalized for a right hemiplegia and a verbal suppression following a stroke. After the administration of some tests, the outcome of the study related to the research questions revealed that there were two types of difficulties. The first was abnormally fast decay of information and the second one was abnormally long delay in the retrieval of other information put forward by the temporal window hypothesis. Also the results from the present study showed abnormal patterns of grammatical activation for aphasic subject and it showed that the grammatical errors appeared more than sentential and lexical errors. The results also revealed that treatment could mitigate the patients suffering from agrammatism and accelerate his language learning process.
Keywords: Aphasia, Broca's area, Temporal window hypothesis

INTRODUCTION

Language is not just combination of words. It reveals our ability to detect, recognize and apply words to produce sentences. Almost for most people, left hemisphere of the brain is responsible for maintaining this capability. If a damage or stroke affects the left side of the brain, this capability of the brain to use language will be disrupted. This disruption may lead to aphasia, a language impairment that makes it difficult to use language in those ways. Aphasia can have awful and terrible consequences.

Recovery from a severe and serious aphasia is a difficult and unpredictable difficulty for patients. Nowadays techniques used in speech therapy do not seem successful with the most severely aphasic patients (Basso, Capitani & Vignolo, 1979). It is a distinct event that aphasic patients showing all major syndrome types have a problem with the comprehension of sentences, especially if the meaning interpretation is based on

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structural signs rather than on the meanings of the individual lexical items (Caplan & Hildebrandt, 1988; Naeseretal.1987).

Those who suffer from aphasia usually have a language impairment and difficulties thoroughly devoting attention to resources necessary for language processing. This restriction of resources and tools is normally regarded a significant contributor to deficits in language comprehension (LaPointe & Erickson, 1991; McNeil et al., 2004; McNeil et al., 2005; Murray, Holland & Beeson, 1997).

According to Menn and Obler (1990) there are three main forms of symptoms of spontaneous speech as follow: A) Reduced and limited variation of grammatical form; produced sentences contain little subordination or phrasal details. Since this type of symptom is concerned with sentence form, it is called syntactic symptoms. B) Deletion and elimination of function words such as articles, pronouns, auxiliaries, prepositions, inflections and so on. These symptoms are related to grammatical morphology and are called the morphological symptoms. C) Slow and dull rate of speech or non-fluent speech which is referred to rate symptoms is the third type of symptoms. These symptoms are established for English speaking patients, and similar symptoms occur in many other languages.

Grammatical errors appear more than lexical and sentential errors in patients suffering from agrammatic Broca‘s aphasics under temporal window hypothesis. The temporal window hypothesis is one influential hypothesis about the symptoms of agrammatic Broca‘s aphasia which explicitly invokes problems with the temporal coordination of sentence elements (Kolk and Van Grunseven, 1985; Kolk, 2005). In addition to that the role of processing support in the treatment of aphasic language production disorders (Marshal, Pring, & Chiat, 1998) is closely examined in this work to reach a conclusive set of parameters to face probable problems of this minority of language learners who are in need of support. The temporal window hypothesis is one influential hypothesis about the symptoms of agrammatic Broca‘s aphasia which explicitly invokes problems with the temporal coordination of sentence elements (Kolk, 2005; Kolk & Van Grunseven, 1985).

Generally, to assess agrammatism in aphasia, researchers administer a standardized aphasia test battery like the Western Aphasia Battery (Kertesz, 1982) or the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983). In assessment of the grammar, Standard tests with three areas including testing sentence comprehension, testing verbs and verb arguments, testing sentence production and examining spontaneous discourse are used.

This work is an attempt to alleviate resource limitations among patients suffering from agrammatic Broca‘s aphasia under temporal window hypothesis. Needless to say, it is far beyond the space limitation, and researcher capacity to present all works carried out in the field of language impairment, even during the last decade. The goal of this work is more modest: researcher will attempt to demonstrate how classic symptoms of agrammatic Broca‘s aphasia –fragmented sentences and omissions of grammatical

markers are accounted for and mitigated using (Kolk, 2005) temporal window hypothesis. To this end, the following questions were formulated.

Q1- Do grammatical errors appear more than lexical and sentential errors in patients suffering from agrammatic Broca‘s aphasia?

Q2- What scientific measures could be taken to both mitigate their sufferings and to accelerate their language learning process?

LITERATURE REVIEW

Agrammatism

Agrammatism is a case of a more general linguistic impairment known as Broca's aphasia (Spreen and Risser, 1998: 1123-31). It is manifested by the presence of ungrammatical utterances in the speech of patients with a particular brain damage as well as in abnormal (ungrammatical) comprehension of certain constructions. This disorder usually results from a brain damage such as trauma or stroke. It should be noted here that agrammatic comprehension of sentences with reflexive pronouns and tag questions has received scrutiny in Linebarger et al.’s (1983) study.

Agrammatic aphasia, furthermore, is characterized by repeatedly elimination of functional categories, such as determiners, tense, complementizers. Patients' comprehension appears to be normal, at least the intuitive feeling is that they understand what they hear, and struggle to reply appropriately (Isserlin, 1922). As discussed, however, recent psycholinguistic research has shown that comprehension in agrammatism is also impaired. Broca's aphasia is usually contrasted with another language impairment known as Wernicke's aphasia (Caramazza & Zurif, 1976). The comprehension pattern of Wernicke's aphasics is usually characterized as poor. However, they appear to have undisturbed computational capacity in speech production: their speech is effortless, functional categories are, for the most part, present and used correctly and the intonation pattern seems to be normal. Yet, the semantic content of their speech is often empty and sentences may contain some jargon thus making it hardly comprehensible. The speech of Wernicke's aphasics may sometimes contain non-words, most often semantic substitution.

Related empirical study

A particular feature of agrammatic speech is the frequent omission of functional categories, such as determiners, Tense, and complementizers. This omission is common for agrammatic speech and is often taken as the diagnosis of agrammatism (Marshall, 1986; Goodglass, 1993; 16 among others). It is worth noting, however, that agrammatic errors are not `random': they seem to follow certain patterns depending on the ambient language.

As Grodzinsky (1990, 1999: 281-292) argues, patients' performance can be characterized either as omission or substitution: In languages like English or Japanese, where bare stems can function as independent lexical items, agrammatics tend to omit bound morphemes. In languages like Hebrew, Russian or Italian, where bare stems are not allowed, subjects do not produce bare stems, but may use an incorrect one.

Resource Reduction Hypothesis

In a recent article (Miyake, Carpenter & Just, 1994), it was shown that comprehension breakdown in aphasic patients arises, in part, from reduced working memory resources for 18 languages. They assumed to improve the capacity theory of normal sentence comprehension into the domain of aphasic sentence comprehension. They asserted that the sequence of working memory capacity ranging from high span normal to low span normal, could be promoted further to involve moderately and strictly impaired aphasic patients whose working memory capacity for language may have been pathologically decreased as a result of brain damage such as that caused by Cerebral Vascular Accident (CVA). While through testing a normal subject performance on the reading span task, working memory capacity for language can be measured, difficulty in an aphasic patient can be measured by the overall score on an aphasia battery.

Temporal Window Hypothesis

Temporal window hypothesis is the context within which sentence production is carried out (The oxford handbook of psycholinguistics, 2010: 434-35). Hartsuiker, Kolk & Huinck (1999) stated the idea that the adopted strategies by patients to overcome their temporal processing limitations may result in an exchange between structure and speech rate can be developed to other kinds of tradeoffs. The temporal window hypothesis reveals an exchange between structural and semantic/conceptual information as a function of task demands. The studies on agrammatism consist of a great deal of reports of restricted sensitivity to semantic aspects when the task requires the integration of syntactic information with semantic or conceptual information, both in production. Aphasic patients able to produce complete sentences when talking about a single picture, however they produce more fragmented and ill-formed sentences when they try to have multi-sentence productions (Lesser, 1989; Mitchum & Berndt, 1994; Weinrich, Shelton, McCall & Cox, 1997).

How to help aphasic people

About 25% of all patients with a stroke have aphasia in the first week post onset (Wade, Hewer, David & Enderby, 1986; Pedersen, Jorgensen, Nakayama, Raaschou & Olsen, 1995) it is about 5000 new cases per year occur in the Netherlands. Most spontaneous recovery occurs in the first three months (Pedersen et al., 1995). Indeed, there is little information about the aspects and features of language disorder that cannot be cured. A few number of studies attempted to investigate aphasic symptoms like auditory comprehension and expression and some of these studies revealed that auditory comprehension recovered sooner and more complete than expression (Kertesz, 1984).

Yet, the recovery and treatment of the underlying linguistic deficits has not been studied.

Treatment of Aphasia

In fact, a number of treatment studies and approaches have revealed the advantages of treating sentence production in patients with aphasia (Ballard & Thompson, 1999; Marshall, Pring & Chiat, 1998; Thompson & Shapiro, 1994; Thompson, Shapiro, & Roberts, 1993; Thompson etal., 1997; Wambaugh & Thompson, 1989). Recovery from severe aphasia remains a suffering and unpredictable painful effort for patients. New techniques in speech therapy are least successful with the most severely aphasic patients (Basso, Capitani, &Vignolo, 1979).

Language recovery of aphasic patients is relying on the amount of brain damage. If it is mild, so there is no need to treatment. But for a large number of people with aphasia it is necessary to have language therapy to rehabilitate their language skills and improve their communication experiences. However, the process of recovery of language impairment is relatively a slow process, and few people regain their previous conditions. A complete recovery is almost impossible, if the symptoms of aphasia last more than two or three months after the damage. The first step in aphasia treatment is speech therapy with the focus on learning and practicing language skills and using different or complementary communication methods and techniques. The natural tendency of family members to minimize the patient's communication impairment especially in the early stages of recovery requires understanding and tactful management (Sarno, 1998). Those aphasic patients who do not recover completely most of the time experience many problems during their everyday communication with others that really affects the quality of their life. The main and ultimate objective of aphasia treatment is improving the patients' communicative ability in daily life. This improvement can be done in many ways with noticing at the "impairment level" or " activities limitations level".

In a study carried out by Kelly (2009), there was an investigation to find out whether people with aphasia, following stroke, could learn new words or not. The sample of the study consisted of 12 people under 65 years old with a range of severities of aphasia. Over 4 successive days the participants were taught 20 words in sessions lasting from 30 minutes to 1 hour. All of the participants made an attempt to learn some of the words. Testing of 10 of the participants 3 to 5 days after the end of the therapy found that they retained some of the new vocabularies showing that there were been retained in their long-term memory. The findings of this study revealed that people with aphasia are potentially able to learn new words and therapy to teach lost language could actually teach these words as new. Participants indicated variety of learning styles when learning the words demonstrating the significance of individually tailored therapy.

Another study done by Caute (2013), the effect on communication skills of 15 hours of gesture and naming therapy compared with 15 hours of strategic therapy. In this study there were 14 participants who had severe aphasia. 2 new measures were used to evaluate the effect of the intervention on the participant's communication skills. Through message task the participants were required to convey a message to their conversation partner and the narrative task consisted of participants watching a silent video and then tried to convey the narrative of the video to their conversation partner. Communication skills developed on both tasks after the treatment with participants that had the additional therapy making further gains on the message task. The results of this study were promising and a larger study with more robust methodology could be beneficial.

There are many different types of treatment for people who suffer from aphasia. Following is a summary of these treatments. The most common type is *language therapy* that is impressive in treating and curing aphasia when provided intensely; less intensive therapy given over a longer period of time does not provide a statistically noticeable advantage, although clinical benefits can be achieved. *Computer-Based Treatment* of Aphasia is another form of treatment that can improve language skills measured at the impairment level; but it is not obvious that improvements made by means of computer-based intervention generalize to functional communication. There is another treatment by use of drugs that is *drug therapy in aphasia*.

METHOD

Participant

The case history in this work was an Iranian American biology teacher who spoke fluently both Persian and English. He was 54 years old when hospitalized for a right hemiplegia and a verbal suppression following a stroke. Sam was right-handed without a family history of left-handedness. It should be noted that, about 1 year ago, he had suffered from a first Transient Ischemic Attack (TIA), a short interruption of blood flow to part of the brain that makes temporary stroke-like symptoms, with right hemiparesis and verbal suppression which lasted only a few minutes, all medical and linguistic examinations carried out the following day being normal. On admission to Hospital, the patient was conscious. His routine neurological examination showed a right hemiparesis, mainly affecting the right upper limb. This case was not an American native, and had learned English at age15 through formal education and spoke English fluently, and now because of this disease, has faced dysfunction and the researcher intended to retrain the second language too.

Instruments

To accomplish the task, the following instruments were employed: a CT SCANs, a 10-minute interview, The short version of the Token Test short version, The Boston Diagnostic Aphasia Examination (BDAE).

Procedure

The experiment consisted of an interview and administration of two experimental sessions that were separated by at least 2 weeks. Sam's brain CT scans showed infarction in the posterior left frontal lobe extending into the left anterior temporal lobe. He suffered from a non-fluent aphasia and right hemiparesis. From the linguistic point of view, Sam, during the first week post onset, showed a verbal suppression in the absence of any comprehension deficits for both auditory and visual stimuli. At the early stage, his spontaneous speech was restricted to a few stereotyped phrases, and he characteristically responded to questions by writing a single word. He couldn't read the words that he had written. At the single word level, Sam had a mild auditory comprehension deficit, he was able to repeat single words easily, and could match orally and written presented words to pictures with greater than70% accuracy. His performance in naming pictures orally was noticeably inferior to his performance in written naming. These results revealed that Sam couldn't support his reading and writing by grapheme-to-phoneme conversion at the single word level. On leaving the hospital, his oral production was limited to a stereotype (/ke/ . . . /ke/ . . . /ke/) and to a few verbal automatisms ("How are you?" . . .); as for his written production, it was limited to a few words, written with his left hand. A free conversation as an interview was conducted in order to elicit as much conversation as possible. It was started with a familiar topic, such as his job, illness and so on.

Administration of the Token Test short version

The test was conducted in the subject‘s home, in the absence of auditory and/or visual distraction. The researcher used the short version of the Token Test to see if the patient‘s deficit is central or syntactic at the level of knowledge, and whether disrupts specifically those processes responsible for both retrieval and production of free-standing grammatical morphemes whenever they have been inserted into phrases and sentences or not.

The patient was required to respond to 36 commands divided in six parts: part 1 consists of 7 commands, parts 2–5 consists of 4 commands each, and part 6 has 13instructions. Parts2, 4, and F use big tokens only. The test had an increasing difficulty level, but within each part, the complexity level was designed to be equivalent.

Administration of the Boston Diagnostic Aphasia Examination (BDAE)

At the beginning of BDAE administration, Sam was asked to complete the demographic part of the test through introducing himself. Then he was required to participate in a conversational and expository speech. In this part the researcher asked some simple social questions in order to elicit as many of the desired responses as possible. This part consisted of 7 social questions and each question had one point.

The next step involved with free conversation. In order to elicit as much conversation as possible, the researcher started with a familiar topic, such as "What kind of word were you doing before you became ill?" or "Tell me what happened to bring you here?" Sam was encouraged at least 7 minutes of conversation. There were not questions that required "Yes" or "No" responses. Sam's evaluation using BDAE indicated non-fluent output with occasional agrammatisms. Comprehension was good for simple sentences and commands but declines for more complex sentences and ideational material. Sam‘s profile on the BDAE (Goodglass & Kaplan, 1983) is presented in Table 1No unilateral primary sensory disorders were noted. The visual fields were full.

In order to test Sam‘s verbal and written production of past tense morphology isolated from sentence construction and lexical retrieval, a sentence completion task was designed. Earlier studies had indicated that the semantic and syntactic information contained in sentence completion tasks improved word retrieval for most aphasic patients (McCall, Cox, Shelton & Weinrich, 1997). The aim of examiner was to elicit only the verb form in the past tense and thus provided Sam with the target verb in the present progressive, also a sentence frame that dictated which tense to produce. For example, the experimenter would say "Today the man is driving the car. Yesterday the man … ."Or "Today the girl is watching TV. Tomorrow the girl … .", asking Sam to complete the second sentence appropriately. Model sentences were of the form Subject–Verb–Object (SVO) or Subject–Verb–Prepositional Phrase (SVPP).

When Sam showed that he could not produce the target e.g., stated ‗‗I don‘t know‘‘ or fell silent for several second, the stimulus was repeated by the examiner. If the repetition did not elicit a response, the examiner provided either a phonological (for verbal production) or orthographic (for written production) cue. These cues provided information only about the first phoneme of the target verb. Verbal responses were recorded and scored. After this experiment was completed, the assessment was repeated in a separate session using printed sentences as stimuli. The entire task was administered a second time and the data were combined, since Sam responded similarly on both administrations.

This helped us to examine the following issues:

a) Omission of obligatory items

b) Substitution of obligatory items

c) Reduced production of non-obligatory items

d) Spared morpho-syntactic items

BDAE Scoring

The manual provides clear statements and rules for scoring protocols. Once the scores are collected, the examiner completes the Summary of Scores and inserts them in to the Summary Profile of Standard Subtests in the Boston Diagnostic Aphasia Examination Record Booklet to get percentiles. The percentiles are listed as 0, 10, 20, 30, 40, 50, 60,

70, 80, 90, and 100 only. The scores that are collected are a tally of the number of correct responses, the number of cues given, number of phonemic cues, etc.

RESULTS AND DISCUSSION

The administration of psycholinguistic tests and interview and CT SCANs, an interpretation of the data collected from the early and the late taken CT SCANS of the patient, the Token Test and the Boston Diagnostic Aphasia Test (BDAE) helped us to prepare the required raw material to be used in the tables and see if the patient's deficit is central or syntactic at the level of knowledge, and whether disrupts specifically those processes responsible for both retrieval and production of free-standing grammatical morphemes whenever they have to be inserted into phrases and sentences or not.

Interview

The interviewer (I) asked some questions and Sam(S) answered.

I: How are you today? S: Not bad, I sleepy.

I: Have you ever been here before? S: No. No think so.

I: Do you think we can help you? S: No one can't help.

I: Do you think you can make any more progress? S: I hope.

I: When are you going to be leaving here? S: Donno.

I: What is your full name? S: SAMIAR.

I: What is your full address? S: hmmmmm.

Free Conversation

I: What were you teaching?

S: bio ….logy

I: What happened to you?

S: mmmmshokin, no, mmmmstuking, very exetin (exciting).

I: what kind of work were you doing before you become ill?

S: me was a teacher (long pause), teach bio….logy (pause), go school every day (pause). (He continues with difficulty). I am many student, me teached many years.

I: ok, if you get improved, would you like to go back to work?

S: sure, I loves seeing me student and (paused) talk their.

I: so, what about your writing and reading? Do you think they have changed?

S: mmme think bad (pause) myself hard can write text (paused) reading has little good.

I: can you read fluently?

S: none always, and has interrupt.

Reading Part:

1. The weather was…

Cool sunny crisp rainy

2. Mary and Jim rode in a …..

Train boat car plane

3. The trip took about …..

Half a day five minutes 45 minutes two hours

4. The water was……

Rough warm chilly crowded

5. They forgot to bring a ….

Towel umbrella lunch swim suit Comprehension

Score: Short Form -/3 Standard Form -/5

Results of the Token Test short version

The test was administered. An error on any part speech yielded an incorrect response for the entire sentence. One point was awarded for each fully correct sentence with a maximum score of 36. This test was administered in approximately 15 minutes. The items within a section had the same level of complexity. The scores were calculated by assigning 1 point for each item answered completely correct, ranging from 0 to 36 points. According to Artmed (2010) the pieces are arranged in a specific order and the subject must answer exactly as the item requests. In this test Sam's score was 29 out of 36. He answered correctly to 29 commands. The results of this test, revealed comprehension level was at a near normal state.

Results of the Boston Diagnostic Aphasia Test (BDAE)

After the administration of BDAE, Sam‘s profile on the BDAE is presented in Table 1.Note that performance is expressed in percentage of items correct in each subtest. The results obtained from this test showed Sam's impairment production.

Table 1. Sam's Performance on the Boston Diagnostic Aphasia Test

Comprehension	
Word discrimination	83%
Body parts	58%
Commands	63%
Complex	55%
Verbal expression	
Nonverbal oral	98%
Verbal agility	20%
Automatic sequence	30%
Word repetition	40%
Phrase repetition	
High	25%
Low	0
Word reading	30%
Responsive naming	40%
Confrontation naming	27%
Animal naming	—
Oral sentence reading	0
Reading	
Symbol/word discrimination	20%
Word recognition	50%
Oral Spelling	5%
Word–picture matching	90%
Sentences/paragraphs	10%
Writing	
Mechanics	0%
Recall of writing	28%
Primer level dictation	10%
Written word finding	0
Oral word finding	0
Written naming	10%

Note that performance is expressed in percentage of items correct in each subtest.

The purpose of this study was to investigate the resource limitations as underlying agrammatism and its symptoms. Thus, the study aimed to prove the hypotheses:

1. Grammatical errors do not appear more than lexical and sentential errors in patients suffering from agrammatic Broca's aphasics under temporal window hypothesis.

2. Scientific measures could not be taken to both mitigate their sufferings and to accelerate their language learning process.

A thorough-going analysis of agrammatic speech has always been difficult because agrammatic speakers tend to say very little. Review of articles reveals that the researcher of the present study has used a variety of tasks or tests to evaluate of sentence production. These tasks include sentence completion, sentence repetition, making the sentence with the words given and sentence production priming. The few

studies have used the combination and a package of tasks in order to accurately speech analyze.

The findings reported here replicate earlier findings (Prather, Zurif & Love, 1992) that a non-fluent Broca‘s aphasic patient activates lexical information in a slower-than-normal fashion. Sam showed a slow rise time in automatic activation. The results of the current study would be arguable that whether the fundamental problem was to be described in terms of a dimension of time or a dimension of strength or alternatively some combination of the two. The hypothesis of delayed lexical activation represents a position with increasingly strong support. Based on these results a main conclusion could be drawn. That is agrammatism was neither a complete loss of syntax, nor a complete loss of grammatical morphemes or functional classification.

The results also demonstrated abnormal patterns of grammatical activation for our non-fluent patient. Through the analysis of Sam's free conversation and writing, it was discovered that, he made different mistakes using appropriate pronouns and also in subject/verb agreement. The researcher found out that grammatical errors appeared more than lexical and sentential errors. Therefore, the first null hypothesis, grammatical errors do not appear more than lexical and sentential errors in patients suffering from agrammatic Broca‘s aphasics, was rejected.

Recovery from severe aphasia remains a difficult and unpredictable problem for patients. Current techniques in speech therapy are least successful with the most severely aphasic patients (Basso, Capitani & Vignolo, 1979). In spite of many years of research into the linguistic mechanisms of aphasia, few new therapeutic modalities are available, particularly for the most severely afflicted patients. Complicated language systems, while effective for patients with motor or speech disorders, have generally not been successful with severely aphasic patients (Weinrich, 1997).

Accordingly, in a study carried out by Hartsuiker and Kolk (1998), they reported that patients with Broca‘s aphasia show enhanced syntactic priming of verbal output, even for relatively syntactically complex sentences, like passives. They discuss that their data provide evidence that the limitations in Broca‘s aphasic patients verbal production are related to a resource limitation brought about by a temporally constrained processing capacity, since the limitation can be brought under control by an automatic process that facilitates syntactic priming. However, Hartsuiker and Kolk can only reveal this facilitation over a short period of time, either directly after the prime or after several intervening items. Regardless of the ethical explanation, some studies such as Weinrich, et al. (1999) have shown that training with an alternative communication interface can result in sustained progress in some aspects of natural language production and generalization to untrained items and domains.

In another study done by Rochon, Laird, a Bose, and Scofield (2005), they investigated a new way of treatment in which sentence production abilities were trained in a small group of individuals and nonfluent aphasia. The study was based on a mapping therapy approach which holds that sentence production and comprehension impairments are

due to difficulties in mapping between the meaning form (thematic roles) and the syntactic form of sentences. The obtained results were discussed with reference to the heterogeneity of underlying impairments in sentence production impairments in nonfluent patients, and the possible mechanisms by which improvement in sentence production might have been achieved in treatment.

Considering the above mentioned studies rejected the second null hypothesis and revealed that scientific measures could be taken to both mitigate their sufferings and to accelerate their language learning process. The results from the present study demonstrated abnormal patterns of grammatical activation for our non-fluent patient. Through the analysis of Sam's free conversation and writing, the researcher found out that grammatical errors appeared more than lexical and sentential errors.

CONCLUSION

The main findings of this study can be summarized as follows. Our first conclusion has to do with Tense. Sam, our patient, made more tense errors in the past than in the present tense. He did not make more agreement errors with plural than with singular. He made significantly more tense errors than agreement errors, but only in the past tense. Our second conclusion relates to word order. SVPP orders elicited more word-order errors than either SVO or SOV, but this difference was not significant. SVPP production was significantly slower, however. With respect to complexity, the following could be concluded. As compared to single clause sentences, two clause sentences (a) elicit more word order errors, (b) elicit more infinitive use, (c) take longer to produce but (d) do not lead to more tense or agreement errors. Finally, regular past tense inflections appear to be somewhat easier than irregular ones, although the difference was not significant.

The outcome of the presented study related to the research question revealed that there were two types of difficulties. The first was abnormally fast decay of information and the second one was abnormally long delay in the retrieval of other information put forward by the temporal window hypothesis. In fact the results of this study revealed that grammatical errors appear more than lexical and sentential errors in patients suffering from agrammatic Broca‘s aphasics under temporal window hypothesis. This study suggests that the reduced sentence production capacity in agrammatism relates to the processing of syntactic and conceptual information. In fact, in the production of sentences, agrammatic speakers cannot simultaneously keep the necessary representations – both conceptual and syntactic – in mind. As a result, sentence production is hindered and morphological errors, such as subject-verb agreement errors, are likely to occur. Also the results from the present study show abnormal patterns of lexical activation for aphasic subject. This delayed rise time is consistent with findings of only partially successful activation during real-time sentence processing but preserved activation and comprehension when sufficient processing time is allowed.

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