

## **CORRECT INFORMATION UNIT (CIU) AS A MEASURE OF COMMUNICATIVE INFORMATIVENESS AND EFFICIENCY IN PERSONS WITH APHASIA**

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### **Abstract**

*Correct information unit (CIU) assesses the language performance in persons with aphasia. It is a rule based scoring system for measuring the communicative performance of persons with aphasia in connected speech and language which has two important aspects i.e. Communicative informativeness and Communicative efficiency (Nicholas and Brookshire, 1993). The present study aimed at identification of CIU in connected speech and language of three persons with aphasia as a measure of communicative informativeness and efficiency in the Indian context. It was found that there was a difference between the neuro-typical participants and person with aphasia in words per minute (WPM) and percent CIU per minute (% CIU). It was observed that both the groups performed better in the measure of % CIU per minute than the measure of WPM. Clinical application of the CIU analysis is certainly warranted for assessment of connected speech. Qualitative and quantitative analysis of CIU will help professionals to differentially diagnose fluent from non-fluent types of aphasia. It may also yield a stable base line performance against which, changes in connected speech with treatment can be measured.*

**Key Words:** Words per minute, Communication, Assessment

Portrayal of language abilities in persons with aphasia has always been a matter of debate. This debate has been overcome primarily through the use of standardized testing instruments (Goodglass & Kaplan, 1972). However, language abilities of persons with aphasia are usually better than the scores obtained by standardized language tests. Such formal tests may not be appropriate tools for the assessment of every day language performance in persons with aphasia. This observation led the researchers to develop other tools that better reflect the communicative abilities of aphasics (Bloemert, Koster 1987). Among such tools correct information unit is also an important aspect which does provide information about the language performances of an aphasic

Correct information unit (CIU) is a rule based scoring system for measuring the communicative performance of persons with aphasia in connected speech. Communicative informativeness (CI) and communicative efficiency (CE) are the two important aspects of CIU as reported by Nicholas and Brookshire (1993). CI refers to the degree to which the speech of an individual imparts the intended message, while CE is the rate at which the message is produced for language use. The CIU analysis may yield stable baseline performance against which changes in connected speech with treatment or manipulation of experimental variables can be measured. The CIU analysis of

connected speech involves measuring the rate at which the speaker produced speech and combining it with a derived measure i.e. the percentage CIU. The percentage CIU measures the combined total word count which meets the specific criteria necessary to be called as a correct information unit (CIU).

Yorkston and Beukelman (1980) reported that it is imperative to know the insight of communicative performance in persons with aphasia. Thus, the content units in the utterances of a person with aphasia should be measured. Measurement of such content units or correct information units in speech of persons with aphasia will facilitate the speech language pathologist to have an idea of the person's performance in daily language abilities, before and after treatment. Also, it will help the professionals to set the goals which are relevant to the person's communicative performance than just focusing on the language goals.

Linguistics and pragmatics are the two main aspects of CIU which have been reported in the literature by different researchers such as Shewan (1980), Saffran, Berndt and Schwartz (1989), Byng and Black (1989) Thompson (1995) have extensively studied the linguistic aspects in person with aphasia. Shewan (1988) described a more comprehensive system, the Shewan Spontaneous Language Analysis (SSLA) for the analysis of language samples generated in a picture description task. They used twelve

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variables viz. number of utterances, time, rate, length, melody, articulation, complex sentences, errors, content units, paraphasias, repetitions, and communicative efficiency. The SSLA samples performances in three components of the language system which included phonology, syntax, and semantics.

Saffran, Berndt and Schwartz, (1989) introduced the quantitative production analysis (QPA) to study the agrammatic production in persons with aphasia (same was used by Byng and Black 1989). The QPA analyzes the syntax in a finer grained manner.

Menn, Ramsberger and Helm Estabrooks (1994) gave linguistic communication measure (LCM) for analysis of transcription of aphasic and other disordered narratives. It measures the narrative output in terms of three dimensions- amount of information that is presented in words, proportion of informative to non- informative words and grammatically acceptable words in the expression. They reported that these aspects can be applied to evaluate the progress or deterioration either in research or clinical settings in a person with aphasia.

Yorkston and Beukelman (1980) Nicholas and Brookshire (1993) focused on pragmatic aspects for analyzing aphasic discourse. Yorkston and Beukelman (1980) studied 78 non brain damaged adults using "cookie theft" picture from Boston Diagnostic Aphasia Examination (BDAE, Goodglass and Kaplan, 1983), and reported that content units per minute can differentiate the speech of a person with aphasia that of non-brain damaged participants. Also, the two measures i.e. number of content units and content units per minute were found to be potentially sensitive measures of change in connected speech as a consequence of treatment.

Nicholas and Brookshire (1993) studied 20 non brain damaged persons (10 male and 10 female) and 20 persons with aphasia (18 male and 2 female) who were native speakers of English. The results of the study showed that the informativeness of the connected speech of adults with aphasia can reliably be scored, using the three measures (WPM, CIUs per min, and % CIUs) as there was a significant difference found on these three measures between the persons with aphasia and the non-brain damaged participants.

The percentage CIU of conversational samples was compared with that of connected speech by Doyle, Goda and Spencer (1995). The results indicated that although persons with aphasia spoke with a higher percentage of CIU rate in conversational samples than in the connected speech, their performance in the conversation

samples could be predicted from their connected speech performance. They noted that measuring communicative informativeness and efficiency under conversational discourse condition is perhaps the most ecologically valid means of determining the interpersonal verbal communication abilities of persons with aphasia.

Oelschlaeger and Thorne (1999) studied a 50 year old right handed male, six years post stroke with a history of a single left hemisphere cerebrovascular accident (CVA) with residual moderate aphasia and mild right hemiparesis. They studied the reliability and stability of CIU analysis for measuring communicative informativeness and efficiency of connected speech across time and across conversational contexts. Results suggested that reliability of CIU analysis was less than 73% for intra-rater and was less than 56% for inter-rater. The stability of the communicative efficiency and informativeness was precluded by the reliability findings, although speech rate was noted to be stable across conversations.

To conclude, two aspects i.e. linguistic and pragmatic were discussed in the literature with reference to correct information unit (CIU). Studies on Linguistic aspects done by Shewan (1980), Shewan (1988), Saffran et. al. (1989), Byng and Black (1989) Thompson (1995) stated the analysis of three components i.e. phonology, semantics and syntax can be done using tools such as SSLA, QPA, LCM. On the other hand, findings on pragmatic aspects such as Yorkston and Beukelman (1980) Nicholas and Brookshire (1993) suggested that informativeness of the connected speech of adult with aphasia can reliably score Aphasics' performance in the conversation samples.

#### **Need for the study**

CIU can be assessed using linguistic and pragmatic aspects of the language. Among all this, discourse appears to be an important aspect which can give a better perspective of CIU in persons with aphasia. Studies have reported that, analyzing the connected speech of persons with aphasia in natural conditions is preferred over standardized aphasia test, as it offers greater potential for determining their communication abilities and deficits (Larfeuli & Le Dorze, 1997; Ross & Wertz, 1999). There have been very limited research reports in this area, especially in the Indian context; hence a need was observed to provide further corroborative evidence to the existing research findings and also to measure CIUs in persons with aphasia.

#### **Aim of the study**

The aim of the present study was to identify the Correct Information Unit (CIU) in connected

speech of persons with aphasia as a measure of communicative informativeness and efficiency.

**Method**

A total six number of persons participated in the present study, they were further divided into two groups. Group -1 consisted of three male persons with aphasia (PWA) i.e. conduction aphasia (CA), trans-cortical aphasia (TCS) and Broca’s aphasia(BA) with the mean age of 59 years, diagnosed by a qualified Speech language pathologist using Western Aphasia Battery (WAB, Kerstesz & Poole, 1982). All the participants were native speakers of Kannada. (*Kannada is a language spoken in south India predominantly in the state of Karnataka*). The demographic details of persons with aphasia are shown in Table-1. Group-2 included three neuro-typical persons (NTP) i.e. N1, N2, N3 who were matched for age, gender, language, laterality and education with group-1 participants. These participants were ruled out for any obvious history of speech, language, motor and /or sensory impairment (participant N1, N2 and N3 matched with CA, TCS and BA respectively).

Table 1: *Demographic details of the persons with aphasia*

Partici- pants	Age	Type of aphasia	Cause	Educa- tional status	Hand- edness
CA	55 yrs	Conduct ion	Stroke	Illiterate	Right
TCS	66 yrs	Trans- cortical sensory	Stroke	MBBS	Right
BA	56 yrs	Broca’s	Stroke	VII std	Right

**Tasks and stimulus materials**

To elicit the speech-language samples with a reasonable amount and consistency of content across speakers, the three types of task stimuli were selected. Task I as *personal information*-requests for personal information included participants name, age, occupation, family members and description of his problem. Task II as *Procedural information*, this included questions such as “Tell me how would you make tea”? and “How would you go about shaving your beard?”. Task III was *picture description*-for this task, “cookie theft” picture from the Boston Diagnostic Aphasia Examination, BDAE (Goodglass & Kaplan, 1983) and “picnic” picture from the Western Aphasia Battery, WAB (Kertesz & Poole, 1982) were the two single pictures stimuli. Verbal instructions for the first two tasks (personal information and procedural information) were given to all the participants before the recording began. The two pictures for the picture description tasks were presented one

after the other in the vicinity of the participants. They were instructed to describe the picture.

**Procedure**

All testing sessions were conducted in a quiet room, free from distractions. The subject and the examiner sat side-by-side at a table that held a laptop with the Wavesurfer software and a microphone. The entire verbal interaction with each participant was audio recorded on the Wavesurfer software.

**Scoring and Analysis**

The obtained connected speech samples were orthographically transcribed and the total number of words and CIUs were counted using the scoring system given by Nicholas and Brookshire (1993). The rules used to score words and CIUs are provided in Appendix-I. Word and CIU counts were used to calculate two measures i.e. words per minute (WPM) which refers to the total number of words / total time taken (in minutes) and the percentage of correct information unit per minute (%CIU pm), which is the total number of CIU per minutes / total number of words per minutes × 100. In order to be included in the word count, the words had to be intelligible in context but need not be accurate, relevant or informative in relation to the elicited stimulus. For including in the CIU count, words had to be accurate, relevant and informative in relation to the elicited stimulus. Words need not be grammatically accurate to be counted as CIUs. Each CIU consisted of a single word, and only those words that were included in word count were considered for CIU count.

All the recorded speech-language samples obtained from the participants were given to three post-graduate students of Speech Language Pathology (SLP) for the analysis and calculation of the two measures i.e. WPM and % CIU pm. A mean score obtained from the three judges was used to compare the performance of both the groups across three tasks i.e. task I, II, and III using ‘Mann Whitney U- test’. A descriptive analysis was done to compare the performance of each participant for both the measures across three tasks.

**Results and discussion**

The present study was aimed to identify the Correct Information Unit (CIU) in connected speech and language of persons with aphasia as a measure of communicative informativeness and efficiency. A total of six persons participated in the study (three persons with aphasia (PWA) and three neuro-typical persons (NTP)). Results of the participants in all three tasks for both the measures are depicted in Table 2. Two fold analyses of the samples were done to find and

compare all participants for each of the two measures i.e. WPM and % CIU pm across two groups and three tasks. The first group included person with conduction (CA) vs. trans-cortical sensory (TCS) vs. Broca’s aphasia (BA); and

second group included neuro-typical persons (NTP) vs. persons with aphasia (PWA). Personal information, procedural information and picture description were the three tasks as task given to the participants of the study.

Table 2: Results of participants in three tasks for both measures

Tasks	TASK I		TASK II		TASK III	
	WPM	%CIU pm	WPM	%CIU pm	WPM	%CIU pm
Participants						
CA	45	73%	50	64%	47	57%
N 1	78	81%	92	69%	80	88%
TCS	91	84.8%	85.2	43.5%	78.3	16%
N 2	60	86%	107	100%	97	85%
BA	39	51%	56	45.5%	16.5	75.5%
N 3	75	85%	90	75%	64	75%

**1. Performance of the participants for words per minute (WPM)**

**A. Across group:**

**(a) Neuro-typical persons (NTP) vs. Persons with aphasia (PWA)**

Mann Whitney-U test was used to compare the mean WPM scores of persons with aphasia

(PWA) and neuro-typical persons (NTP). As shown in Table. 3, a significant difference ( $p < 0.05$ ) was found between PWA and NTP for the task II (procedural information) and there was no significant difference ( $p > 0.05$ ) found between both the groups for the task I (personal information) and task III (picture description).

Table 3: Showing mean (%) of WPM pm between PWA and NTP across tasks

Tasks	TASK I				TASK II				TASK III			
	Mn	SD	z	Sig	Mn	SD	z	Sig	Mn	SD	Z	sig
Participants												
PWA	58.3	28.4	0.65	>0.05	63.7	18.8	1.95	<0.05	47.2	30.9	1.52	>0.05
NTP	71.0	9.64			96.3	9.2			80.3	16.5		

**b.) Person with Conduction (CA) vs. Transcortical sensory (TCS) vs. Broca’s aphasia (BA)**

Results (as depicted in Table 2) showed that the performance of person with trans-cortical sensory aphasia (TCS) was comparatively better than person with conduction aphasia (CA) and Broca’s aphasia (BA). Among all the persons with aphasia, person with BA showed the poorest scores (Trans-cortical sensory (91) > Conduction (45) > Broca’s (39)).

The above difference can be explained by the fact that persons with trans-cortical sensory aphasia (TCS) do not get feedback about their verbal output and also are fluent in nature, thus their overall vocabulary appears to be more. Also in the present study, it was noticed that the rate of speech of person with TCS was quite faster than the other two persons with aphasia i.e CA and BA.

As a consequence of brain damage in persons with aphasia, the verbal output is reduced in terms of quantity and this can be relate to the results shown by person with CA and BA in the present study who showed lower WPM due to their frequent pauses, effortful and slow rate of speech which can be attributed to their better feedback mechanism (Schuell & Jenkins, 1961).

Whereas, the person with TCS showed an effortless and continuous verbal output.

**B. Across Task**

A slight deterioration in performance of trans-cortical sensory aphasia was seen from the task I (personal information) to task III (picture description); same is also depicted in graph-1. The performance of TCS in task I i.e. personal information was found to be better than the other two tasks i.e. procedural and picture description .The WPM in speech of TCS for personal information was high (91) due to the egocentric nature of stimuli presented. In contrast lower performance in the other two tasks (procedural information, picture description) was due to the novelty of the stimuli (85.2 and 78.3 respectively). Similar findings were reported by Goswami 2004, with reference to comprehension deficits in aphasia. The performance of CA was observed to be consistent across all the three tasks (45, 50 and 47). However, in the present study BA showed much better performance in task II (56) followed by task I (39) and task III (16.5).

It was found that WPM for person with conduction aphasia (CA) and Broca’s aphasia (BA) was significantly lower (45, 39 respectively) than their neuro-typical

counterparts. However, WPM was significantly higher (91) in person with trans-cortical sensory aphasia (TCS) compared to all other participants of the study in task I. In task II and task III, he showed better scores (85.2 and 78.3 respectively) for WPM than the other two persons with aphasia but poorer than his neuro-typical counterpart.

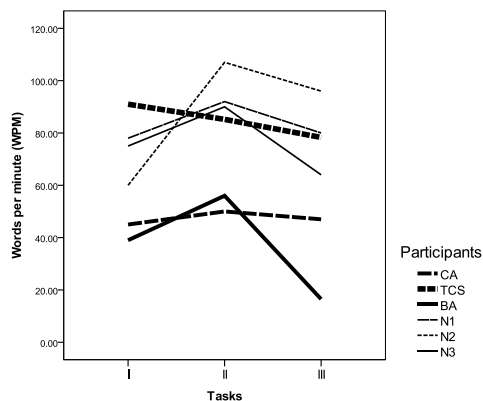


Figure 1. Words per minute (WPM) of all participants in three tasks

Overall, the performance of persons with aphasia (PWA) group was poorer as they scored a lower mean WPM in tasks I (58.3), II (63.7) and III (47.2) than the neuro-typical persons (NTP) group, who scored a higher mean WPM in task I (71.0), II (96.3), and III(80.3).

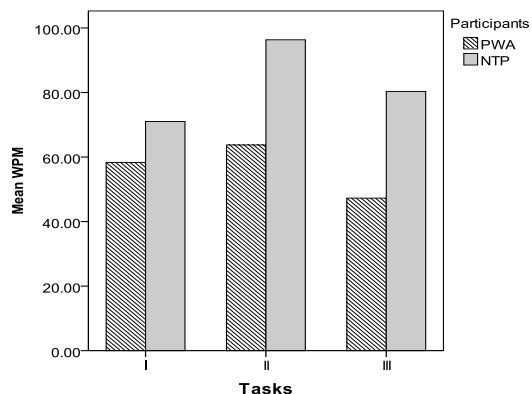


Figure 3. Mean values for Words per minute (WPM) of two groups across tasks

**2. Performance of the participants for percentage CIU per minute (% CIU pm)**

**A. Across group:**

**(a) Neuro-typical persons (NTP) vs. Persons with aphasia (PWA)**

Mann Whitney-U test was used to compare the mean scores of persons with aphasia (PWA) and neuro-typical persons (NTP) for % CIU pm. As shown in Table 4, a significant difference ( $p < 0.05$ ) found between PWA and NTP for the task II (procedural information) and there was no significant difference ( $p > 0.05$ ) found between both the groups for the task I (personal information) and task III (picture description).

Table 4.: Showing mean (%) of %CIUpm between PWA and NTP across tasks

Tasks	TASK I				TASK II				TASK III			
	Mn	SD	z	sig.(p)	Mn	SD	z	sig.(p)	Mn	SD	Z	sig.(p)
PWA	69.6	17.1	1.52	>0.05	51.0	11.3	1.95	<0.05	49.5	30.4	1.52	>0.05
NTP	84.0	2.6			81.3	16.4			82.6	6.8		

On % CIU per minute, persons with aphasia performed poorer than the neuro-typical persons across all the three tasks. This shows that brain damage does influence the person’s overall integrity of the brain, which in turn influences his /her linguistic activity and participation (ICFH-2001), thereby reducing the meaningful verbal output.

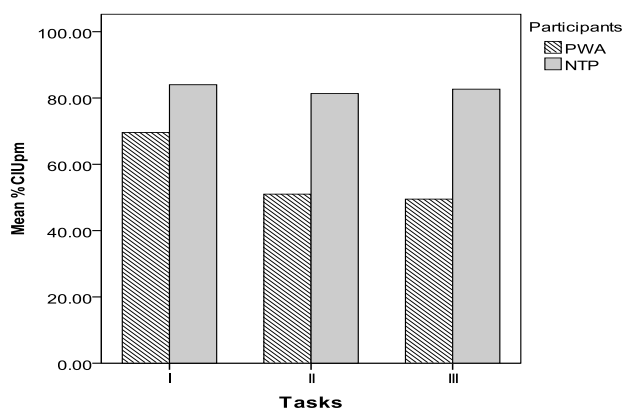


Figure 4. Mean values for percent correct information unit per minute (% CIU pm) of two groups across tasks.

PWA- Persons with aphasia, NTP- Neuro-typical persons, Task I-Personal information, Task II- Procedural information, Task III- Picture description.

**(b) Person with Conduction (CA) vs. Transcortical sensory (TCS) vs. Broca's aphasia (BA)**

Person with trans-cortical sensory aphasia (TCS) scored higher in task I i.e. 84.8% than person with Broca's aphasia (BA) and conduction aphasia (CA) i.e. 51% and 73% respectively. In task -II, performance of person with TCS and BA was approximately equal but lower than person with CA, who showed much better scores than the other two persons with aphasia. In task -III, person with BA scored highest followed by CA and the least was scored by TCS. This can be explained by the "Press of speech" (Goodglass & Kaplan, 1983) and "Jabberwocky" phenomenon found in persons with Trans-cortical sensory aphasia (Brookshire, 1997).

The content in speech of person with TCS for personal information (task I) was high, as he was able to explain about his problem appropriately without much circumlocutions due to egocentric nature of the presented stimuli which correlates with the findings of Goswami (2004) with reference to comprehension deficits in aphasia. On contrary, in the other two tasks (procedural information, picture description) which were novel to him, he showed more of jargon speech and neologism, resulting in reduced content of speech.

Further, obvious lack of topic termination, indicating pragmatic deficits was seen. The reduced content of speech in person with CA can be attributed to the presence of perseveratory behaviors, circumlocutions, self corrections, phonemic paraphasia and paraphrases in his verbal output (Kohn, 1992). Person with BA lacked initiation to respond appropriately for the targeted stimuli on his own and required frequent cueing which improved his performance in the present study.

**B. Across Task**

Person with CA showed slightly deteriorating performance from task I to task III, as evident from Figure 2. Person with TCS showed steeply deteriorating performance from task I to task III, which explains that the content reduces, as complexity of the task increases. Person with BA showed similar performance in task I and task II and comparatively better performance in task III. This could be attributed to his telegraphic speech which consisted of more content words (Schuell & Jenkins, 1961).

From the above findings, it can be stated that WPM and % CIU pm are the two important measures for assessing the overall quantity and quality of speech in persons with aphasia which in turn reflects the verbal communication skills.

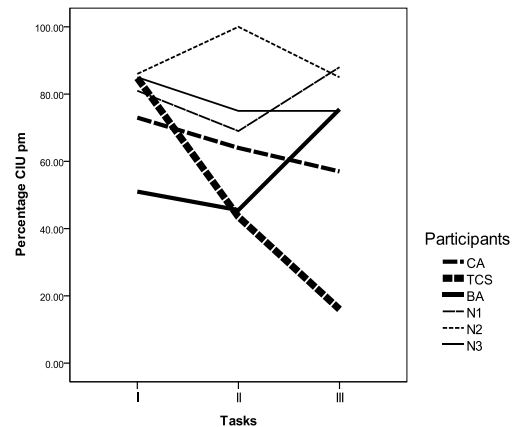


Figure 2. Percentage CIU per minute of the participants in all three tasks

CA- Person with conduction aphasia, TCS- Person with trans-cortical sensory aphasia, BA- Person with Broca's aphasia; N1,N2,N3- Neuro-typical counterparts of persons with CA,TCS and BA respectively; Task I- personal information, Task II- Procedural information, Task III- Picture description.

**Conclusion**

The present study was aimed to identify the Correct Information Unit (CIU) in connected speech of adults with aphasia as a measure of communicative informativeness and efficiency. The study consisted of three persons with aphasia (CA, TCS and BA) and three age, gender and education matched neuro-typical counterparts (N1, N2 and N3 respectively). Connected speech and language samples of all the participants were elicited using three types of stimuli such as Personal information (Task I), Procedural information (Task II) and Picture description (Task III) and were analyzed for two measures i.e. Words per Minute (WPM) and Percent CIU per minute (% CIU). Results revealed that the persons with aphasia performed significantly poorer than the neuro-typical participants for both the measures with an exception of person with TCS who performed better than all the other participants of the study for WPM in task I (personal information). Person with CA performed consistently on all the three tasks for both the measures. Person with BA showed poorest WPM than all the participants in task III (picture description) task and showed a comparable % CIU pm to the matched neuro-typical participant (N3) in the task III.

Although there was a significant difference between neuro-typical (NTP) and persons with aphasia (PWA) on both the measures, the % CIU pm discriminated normals from aphasics better than the WPM count, as none of the aphasic's performance was above the score obtained by normals for % CIU pm count.

Similar results were reported by Yorkston & Beukelman (1980), authors reported that the mean syllable per minute was related inversely to severity of aphasia, however speaking rate of the persons with aphasia group were all slower than either of the normal speakers group. In their second measure of efficiency i.e. content units per minute, reported that there was an inverse relationship between this measure of efficiency and severity of aphasia. Further none of the aphasic group achieved a rate as rapid as normal speaker. However, both normal groups produced significantly more content per minute than any of the aphasic group. To conclude, CIU is a simple and a language free tool for profiling the language components such as semantics, syntax and pragmatics. With the %CIU pm analysis the accuracy, relevance and informativeness of the words produced by an individual can be evaluated. Clinical application of the CIU analysis is certainly warranted for assessment of connected speech. Qualitative and quantitative analysis of CIU will help the professionals to differentially diagnose fluent from non-fluent types of aphasia. It may also yield a stable base line performance against which, changes in connected speech with treatment can be measured.

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**Appendix I****Rules for counting words per minute (WPM) and correct information units (CIUs).**

(Nicholas & Brookshire, 1993)

Prior to determining which words should be included in the count of words and CIU, delete statements that are made before or after the speaker performs the task. e.g. 'I'll start by saying' this or 'That's about it'

**Rules for counting words:**

- Words or partial words that are not intelligible in context e.g. he had a st..sn...stick or non word fillers (u, er, uh) should not be included.
- All the words those are intelligible in context. Count words that contain sound substitutions, omissions, distortion, or additions if the word is intelligible in context. If the incorrect production results in another real word that does not appear to be the target word, it is still included in the word count.
- Filler words and phrases, Interjection and informal terms, common contractions or simplifications of words, contraction standard and colloquial as two words.

**Rules for counting correct information units (CIU):**

- Words that do not see accurate in relation to the topic being discuss such as incorrect names, pronouns, numbers, actions, should not be counted as CIU.
- Repeated words, phrases and ideas are not counted in CIU.
- Conjunctive terms if used as fillers and non-specific terms (there, here, somehow) will not be counted as CIU.
- All words (nouns, adjectives, verbs, pronouns, adverbs, articles, prepositions, and conjunctions) that are intelligible in context should be counted.
- The final attempt in a series of attempts to correct sound errors and the informal terms that convey meaning to the information about the content of picture (nope, yep) should be counted as CIU.