The recovery of fluency, MLU and verb production in spontaneous speech of fluent and non-fluent aphasics during the first half year after stroke.

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Abstract

Background: Data about aphasia recovery gives insight into the (re)organization of language in the brain, or more in general, into the structure of language (Niewold, 2006). Most studies of aphasia recovery use language data of chronic aphasics (Lazar et al., 2008), have not investigated spontaneous speech or do not make a distinction between fluent and non-fluent aphasics. Besides, different results on recovery of fluency, MLU and verb production are described, which are important factors in the typology of agrammatism and paragrammatism.

Aims: **(a)** To investigate whether fluent and non-fluent aphasics differ in the recovery of fluency, MLU and verb production in spontaneous speech during the first half year after stroke; and to explore the general hypothesis that the typology agrammatism-paragrammatism is a useful classification. **(b)** To investigate whether the recovery of fluency, MLU and verb production is related in spontaneous speech in fluent and non-fluent aphasics.

Methods & Procedures: From two groups; fluent and non-fluent aphasics, spontaneous speech samples from two weeks and six months after stroke were analyzed by fluency, MLU, Verb Type and Mean Frequency of produced verbs. A paired-samples T-test and a Wilcoxon Signed Rank Test were used to determine the recovery in each group. The difference between groups was analyzed with an independent samples T-test and a Mann Whitney *U* test. Finally, with a Spearman's *rho* a possible relation between variables was established.

Outcomes & Results: Results showed a significant difference between fluent and non-fluent aphasics for fluency, MLU, Verb Type, Type/Token ratio of verbs and the Adjusted Mean Frequency, caused by overall higher scores in the fluent group. Non-fluent patients improved significantly considering fluency, MLU and Verb Type, which was not the case for fluent patients. In the fluent group fluency and MLU and, Verb Type and Mean Frequency were correlated. In the non-fluent group fluency and Verb Type were highly correlated.

Conclusions: Fluency, MLU and Verb Type are good measures of recovery in spontaneous speech, which can be used by speech-language therapists. The difference in recovery between fluent and non-fluent aphasics is due to a difference in language disorders after stroke. The findings in this study confirm the usefulness of the classification in agrammatism and paragrammatism.

Introduction

Recovery of aphasia is of major importance for aphasic patients. Aphasia recovery can take place as a consequence of spontaneous recovery and/or due to intervention (Lendrem & Lincoln, 1985). Separating these processes remains a great challenge, but the ability to do this is important for speech-language therapists. Therefore, detailed information on the recovery of aphasia is needed (Lendrem & Lincoln).

Research on aphasia demonstrates that most patients make at least some recovery and the majority makes substantial recovery (Hillis, 2007). This takes mostly place during the first six months after stroke, but the greatest improvement is usually observed during the first three months (Demeurisse et al., 1980). Besides that it is said that the types of aphasia, like Broca's or Wernicke's aphasia recover differently, which is also the case for the various components of language (Kertesz & McCabe, 1977).

Conversation is part of everyday life and often highly problematic for aphasics (Wilkinson, 1999). It is therefore important to measure certain aspects of spontaneous speech during conversation at different periods after stroke, once determining recovery. According to Visch-Brink et al. (1999), measuring recovery in spontaneous speech is a useful method to objectively asses spontaneous recovery in functional language, but also the efficacy of aphasia therapy. Functional language encloses sending and receiving a message, where spontaneous speech plays an important role. Studies investigating spontaneous speech of aphasics measure different aspects.

For example, Prins, Snow & Wagenaar (1978) measured the recovery of spontaneous speech in 74 aphasic patients for 28 variables (e.g. MLU, complex utterances). Patients were divided in four groups; a severely non-fluent group, a non-fluent group, a mixed group and a fluent group. All patients had become aphasic at least three months prior to the beginning of the study and were tested three times; at the start of the study, six months after start and twelve months after start. Twelve of the 28 variables showed significant time effects; five of improvement, five of decrease and two were too difficult to interpret. The five variables showing improvement were: speech tempo, utterances ≤ five words, MLU, function-word substitutions and unclassified mistakes. Prins et al. found no qualitative or quantitative differences among the groups in the course of recovery, despite the fact that the groups differed in the severity of aphasia as well as on the fluency dimension.

Grande et al. (2008) analyzed spontaneous speech samples of 28 aphasic patients, of which half was fluent and half was non-fluent. Both groups contained post-acute and chronic patients and the mean duration of aphasia was 18;4 months. All patients received therapy for seven weeks for at least eight hours per week. The analysis focused on the following parameters: percentage words, percentage open class words, syntactic completeness, complexity, and MLU. Their results revealed that 13 patients showed improvement in at least one parameter, while six showed a possible deterioration in one or more parameters. One patient showed improvement in the parameter syntactic completeness, but at the same time a possible deterioration in complexity. Grande et al. concluded that analysis of basic parameters of spontaneous speech might be a clinically applicable instrument to measure even small changes in spontaneous speech. Another conclusion was that fluent and non-fluent aphasia should be investigated separately, because of the difference in recovery in these types of aphasia.

Three measures, which are (highly) important for the quality of speech and for the classification in agrammatic and paragrammatic aphasia, are fluency, MLU and verb production. According to Lorch (1989) agrammatism is characterized by a difficulty with function words and inflections with few substantive words. Speech production is typically made up of short declarative sentences composed primarily of nouns, verbs and adjectives. In contrast, paragrammatism is typically described with empty word strings of semantic content, but with a structural richness and variety of sentences (Lorch). Since fluency, MLU and verb production play an important role in this classification and in spontaneous speech, for each of these factors, background information considering recovery is provided.

Fluency

Basso, Capitani & Zanobio (1982) performed a study on 388 aphasic patients; 198 were classified as fluent and 190 as non-fluent. They investigated the patients at six months after stroke and approximately one year after stroke. In this period, none of their patients developed from a non-fluent to a fluent form of aphasia or vice versa. Therefore, Basso et al. state that the dichotomy between fluent and non-fluent aphasia seems to be more than useful to classify aphasic patients.

In the study of Prins, Snow & Wagenaar (1978) four patients of the 20 severely non-

fluent patients showed sufficient increase in speech production to become non-fluent instead of severely non-fluent. However, the increase in fluency did not correlate with an increase in functional language (Prins et al.).

Measuring fluency is important because it is used to differentiate patients in to fluent and non-fluent aphasics (Wagenaar, Snow & Prins, 1975). With regard to the typology of aphasia, non-fluent aphasics are characterized with agrammatism and fluent aphasics are associated with paragrammatism (Lorch, 1989).

Mean Length of Utterances (MLU)

In the study of Grande et al. (2008) a significant improvement of the MLU was found in three patients; two fluent patients and one non-fluent patient. Another non-fluent patient with a decreased MLU was considered as an outlier because he had severe apraxia of speech.

Schneider and Thompson (2003) investigated the MLU in seven agrammatic patients after treatment, who were between 39-132 months after stroke. Schneider and Thompson observed a decrease of the MLU, though this was not statistically significant.

In 1964 Goodglass, Quadfasel and Timberlake discovered that in 90% of the cases the aphasic patients with a short MLU were clinically classified as Broca's aphasics, whereas the patients with a long MLU were considered either Wernicke's or anomic type of aphasia. Therefore, Goodglass et al. concluded that the MLU was a factor of major significance in considering the typology of aphasia. Besides, like fluency, MLU is a factor that can be used to divide patients in to agrammatic or paragrammatic aphasia, which makes the MLU an important factor in the analysis of spontaneous speech.

Verb production

Considering the recovery of verb production, Schneider and Thompson (2003) discovered that verb retrieval significantly improved in aphasia after therapy. Unfortunately they do not make a distinction between fluent and non-fluent aphasics.

With regard to frequency of verbs, Ellis and Young (1988) claim that lexical activation is faster with frequent verbs because they have been activated more often. Therefore one might expect that aphasic patients use more frequent verbs than infrequent verbs in their spontaneous speech (Ellis & Young). However, Jonkers (1998) found that verb retrieval is not influenced by the frequency of the verb. He investigated verb retrieval amongst Broca's and

anomic aphasics at word and sentence level in an object and action naming task. In these tasks a patient has to name an object (noun) or an action (verb) which is shown on a picture. Anomics (fluent patients) appeared to be better in retrieving verbs at the sentence level than the Broca's aphasics (non-fluent patients) (Jonkers). However, these results are based on naming tasks and therefore might differ from verb retrieval in spontaneous speech.

The study of verb processing in aphasia has attracted a smaller number of researchers than what could be expected. However, with regard to sentence processing and the classification in agrammatic and paragrammatic aphasia (Jonkers, 1998), the verb plays an important role in spontaneous speech.

Current study

Former research on aphasia recovery often does not include analysis of spontaneous speech. Next to it, only few studies on recovery of aphasia use acute patients and make a distinction between fluent and non-fluent aphasics. Hence, the current study included acute fluent and non-fluent aphasics, and analyzed different aspects of spontaneous speech in order to measure recovery.

The present research was designed to study the following: **(a)** To investigate whether fluent and non-fluent aphasics differ in the recovery of fluency, MLU and verb production in spontaneous speech during the first half year after stroke; and to explore the general hypothesis that the typology agrammatism-paragrammatism is a useful classification. **(b)** To investigate whether the recovery of fluency, MLU and verb production is related in spontaneous speech during the first half year after stroke in fluent and non-fluent aphasics.

With regard to the first aim of this study the succeeding was expected: **(a)** Recovery in fluent and non-fluent aphasic patients occurs in a different course. This concurs with the prospect that once non-fluent aphasics recover, sentences become longer and more complex, which means the MLU increases and the variety of verbs probably will become larger. The reasoning behind this expectation is that non-fluent aphasic patients are associated with agrammatism, like Lorch (1989) described.

Because paragrammatism is associated with fluent aphasics (Lorch, 1989), these patients presumably have problems with sentence structure, but not with sentence length or variety of verbs. Hence, it was expected that fluency, MLU and verb production remain

stable once fluent aphasics recover. The use of words with semantic content will probably improve, but that is beyond the scope of this research.

Considering the second aim of this study the following was expected: **(b)** The recovery of fluency, MLU and verb production is related in both groups. This was expected because an aphasic patient that becomes more fluent, will be able to create longer utterances which results in a longer MLU. When utterances become longer the patient is probably using more different kind of verbs, which will be used more often. Presumably, this will especially be the case for non-fluent aphasics because they experience more difficulty with verb retrieval (Jonkers, 1998). Even though the fluent group was not expected to recover with regard to fluency, MLU and verb production, still the expectation was that these factors would be related in this group.

	Male/Female	Age		Tokentest	
		Mean	*25'/75' Percentile*	*Mean score*	*Maximum score*
Fluent group	8 / 7	66;10	62;0 / 79;4	19,77	23
Non-fluent group	6 / 9	60;8	49;9 / 74;9	11,50	22
Total	*14 / 16*	*63;9*	*56;0 / 77;1*	*15,64*	*22,50*

Table 1 Demographic characteristics including the mean scores and maximum scores on the Tokentest at two weeks after stroke.

Methods

Participants

Two groups of aphasic patients are selected from the SPEAK Study (Sequential Prognostic Evaluation of Aphasia after stroKe; El Hachioui, 2006) where all patients were followed for one year after stroke. Both groups are created by determining the fluency (speech rate) which resulted in one group with 15 fluent patients and one group with 15 non-fluent patients. To determine the fluency, of each patient the produced words were counted during one minute of spontaneous speech at two weeks after stroke. A patient who produced between 0 and 50 words per minute was classified as a non-fluent patient, whereas a patient with >90 words was classified as a fluent patient (rate of speaking derived from Kerschensteiner, Poeck and Brunner, 1972). The samples were categorized in a consecutive order. The third minute of the speech sample was used to determine the

fluency to avoid possible starting problems in the spontaneous speech in the first minutes, which might lower the speech rate unnecessary. The fluent group consisted of patients with Wernicke's, anomic, conduction and transcortical sensory aphasia, whereas the non-fluent group was represented by patients with Broca's, global and transcortical motor aphasia (Poeck, 1989). The demographic characteristics of both groups are displayed in Table 1.

Spontaneous speech samples were derived from the SPEAK study through which the patients had to meet the following inclusion criteria. The patients had to be aphasic after a single stroke which was not caused by a subarachnoidal bleeding. They were all 18 years or older, native Dutch speakers and in none of the cases a patient was analphabetic. No aphasic participant had a recent psychiatric history or an already existing dementia. Further, they had no severe dysarthria, development dyslexia or severe visual, perceptual or hearing disorder. A last criterion of the SPEAK Study was that patients had to be able to perform the ScreeLing (Doesborgh et al., 2002) within 6 days after stroke.

For the current study it was required that patients possessed of a spontaneous speech sample at two weeks and six months after stroke. Second, they received therapy after stroke to guarantee a difference in recovery was not due to the fact whether the patients had therapy. Third, they had a score of <29 on the Tokentest (De Renzi and Faglioni, 1978) at two weeks after stroke to make sure patients were still aphasic. And last, all spontaneous speech samples had a minimum duration of four minutes.

Unfortunately, from four patients of the non-fluent group one speech sample lasted shorter than four minutes. In two cases this resulted in a shorter 'starting up' time and in the other cases the sample was less than three minutes of speech and therefore was extended. Still, this data of participants was included which made it possible to make two equal numbered groups.

Materials

Spontaneous speech samples

The spontaneous speech samples were obtained by asking the participants several questions according to the procedure of the Aachen Aphasia Test (Graetz, De Bleser & Willmes, 1992). Amongst others, the following questions were used: Can you tell me in detail how you have

become ill?; What is your profession?; Please tell me something about your family?; Can you tell me about your hobbies?

ASTA

ASTA (Boxum & Zwaga, 2007) was used for the calculation of the MLU to define which words had to be included in a sentence. ASTA stands for 'Analyse voor Spontane Taal bij Afasie' and contains a manual that can be used for analyzing spontaneous speech of aphasic patients.

CLAN programs

The CLAN programs (MacWhinney, 2000) were utilized for calculating the MLU and selecting all verbs produced by the patients. CLAN stands for 'Computerized Language Analysis' which is mainly used for transcribing and analyzing language of children.

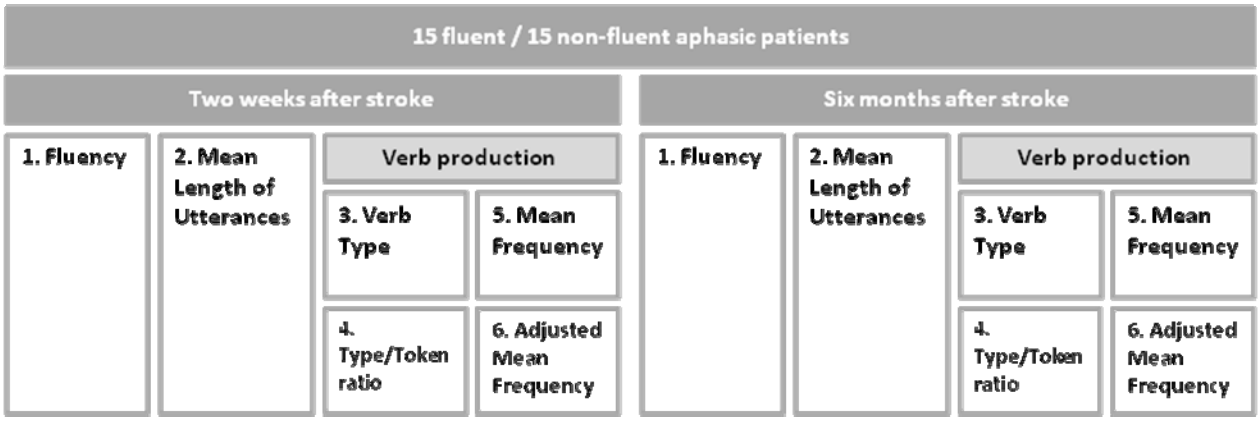

Figure 1 Research design. Two groups are included; 15 fluent and 15 non-fluent aphasics. At two weeks and six months after stroke the fluency, MLU, Verb Type, Type/Token ratio, Mean Frequency and the Adjusted Mean Frequency of verbs is measured for each group.

Procedure

The design of this research is illustrated in Figure 1. First, spontaneous speech samples of both groups were transcribed with the CLAN programs. Because non-fluent aphasics were included, of each sample three minutes of speech were transcribed instead of 300 words like is described in the ASTA (Boxum & Zwaga, 2007).

Second, in each sample six variables were analyzed of which the first one was fluency **(1)**. Fluency was measured at six months after stroke in able to compare this with the fluency at two weeks after stroke. Similar to the speech samples at two weeks after stroke, produced words during one minute were counted for the samples at six months after stroke, to determine the fluency.

Third, the MLU **(2)** of each speech sample was determined for both groups. Like described in the ASTA (Boxum & Zwaga, 2007) amongst others, repeatings and echolalia were excluded. As follow the MLU was calculated with the CLAN programs (MacWhinney, 2000).

Fourth, all independent verbs produced by the patients were filtered from the samples. The verb tenses which belonged to the same verb were summed, for example, 'ging', 'gegaan' and 'ga' all belonged to the Verb Type 'gaan'. For each sample was counted how many Verb Types the patient produced, which resulted in the variable Verb Type **(3)**. Next was counted how many times this Verb Type was used, which was mentioned as the variable Type/Token ratio of verbs **(4)**.

Finally, for each Verb Type, the frequency was looked up in a study by Tabak in 2010 and in the CELEX database (Max Planck Institute for Psycholinguistics, 2001). As follows, the Mean Frequency of produced verbs **(5)** was calculated. Besides the Mean Frequency the amount of times a verb was used by a patient in a speech sample was counted. This was called the Adjusted Mean Frequency **(6)**.

Statistics

To determine whether both groups significantly differed between two weeks and six months after stroke a paired-samples T-test was used for the MLU and Verb Type. For the remaining variables a Wilcoxon Signed Rank Test was conducted because this data was non-parametric. To determine whether there was a significant difference between the fluent and non-fluent group with regard to recovery an independent samples T-test was used for the MLU and Verb type. A Mann Whitney *U* test was conducted for the fluency, Type/Token ratio, Mean Frequency and Adjusted Mean Frequency of verbs.

With a Spearman's *rho* a possible relation was established between the effect sizes of each variable. The Type/Token ratio and the Adjusted Mean Frequency of verbs were not included in the correlation matrix, since these two variables were combined by two factors.

Results

The first aim of this study was to determine whether fluent and non-fluent aphasics differ in recovery of spontaneous speech. In order to achieve this aim several factors of spontaneous

speech were measured at two weeks and six months after stroke, namely; fluency, MLU, Verb Type, Type/Token ratio of verbs, Mean Frequency and Adjusted Mean Frequency of Verbs. The second aim of this study was to determine whether these factors were related in recovery. To be able to accomplish these aims, first for each factor the change over time was measured.

Figure 2 to 7 illustrate the recovery for all variables for the fluent and non-fluent group. In the non-fluent group fluency, MLU and Verb Type showed an increase at six months after stroke, whereas the fluent group remained stable. With regard to Type/Token ratio, Mean Frequency and the Adjusted Mean Frequency both groups did not change at the second measuring moment.

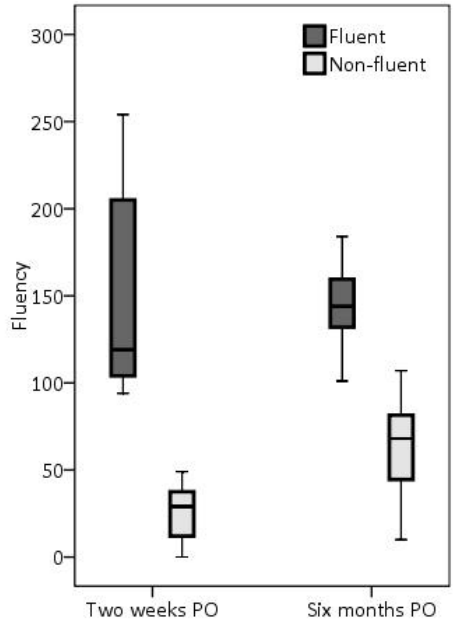

Figure 2 Representation of fluency in both groups at two weeks and six months after stroke.

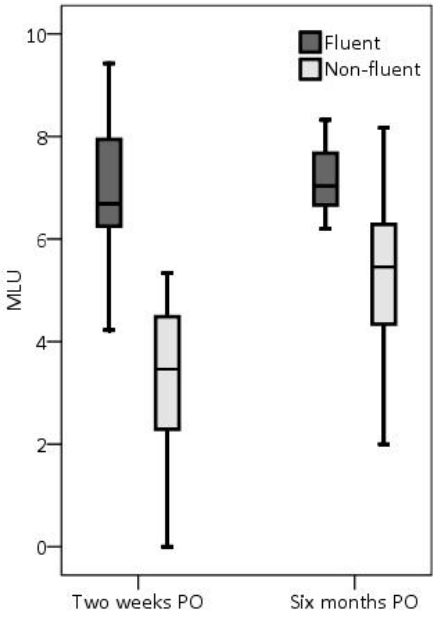

Figure 3 Representation of the MLU in both groups at two weeks and six months after stroke.

Statistical analysis showed there was no significant (p<0.05) recovery for one of the variables in the fluent group (Table 2). With regard to fluency, six out of the fifteen aphasics of the fluent group improved and five were less fluent, but this change was not statistically significant. The MLU became longer for six aphasics and deteriorated for three aphasic patients, which was also not statistically significant.

		Fluency	MLU	Verb production			
				Verb Type	*Type/Token ratio*	*Mean Frequency*	Adjusted Mean Frequency
Fluent group	*Effect size*	-6	0,237	-0,53	0,03687	-9353,40	-16733,23
	p-value	0,670	0,501	0,806	0,191	0,281	0,307
Non-fluent group	*Effect size*	38,73	2,136	7,33	-0,00473	21991,03	28215,12
	p-value	0,001*	0,000*	0,000*	0,865	0,570	0,256

Table 2 Difference in recovery between two weeks and six months after stroke, presented in effect sizes and level of significance. * = *p*<0.05.

The non-fluent group showed a significant recovery for fluency, MLU and verb type during the first half year after stroke. With regard to fluency at six months after stroke four patients were characterized as fluent once compared with the rate of speaking derived from Kerschensteiner, Poeck and Brunner (1972). Seven patients improved with a speaking rate between 50 and 90 words per minute and therefore were classified as slow speakers. Three patients had approximately the same speaking rate and of one patient the speaking rate deteriorated. Considering the MLU 11 patients improved more than one point and four patients had approximately the same MLU. Besides, all non-fluent patients improved with regard to Verb Type. Out of the 15 patients 11 used five or more different verbs at six months after stroke, whereas the other four improved in a less degree. The Type/Token ratio, Mean Frequency and Adjusted Mean Frequency for verbs were approximately the same at two weeks and six months after stroke.

	Fluency	MLU	Verb production			
			Verb Type	*Type/Token ratio*	*Mean Frequency*	*Adjusted Mean Frequency*
Two weeks po	0,000*	0,000*	0,000*	0,032*	0,221	0,029*
Six months po	0,000*	0,000*	0,000*	0,000*	0,065	0,494

Table 3 Difference in recovery between the fluent and non-fluent group. *= *p*<0.05

Fluent versus non-fluent aphasics

Table 3 displays the statistical results with regard to the difference in recovery between the fluent and non-fluent aphasics. For almost all variables except the Mean Frequency of verbs, the fluent and non-fluent group were significantly (p<0.05) different at both measurement

intervals. The recovery in Adjusted Mean Frequency of verbs only differed significantly between groups at two weeks after stroke.

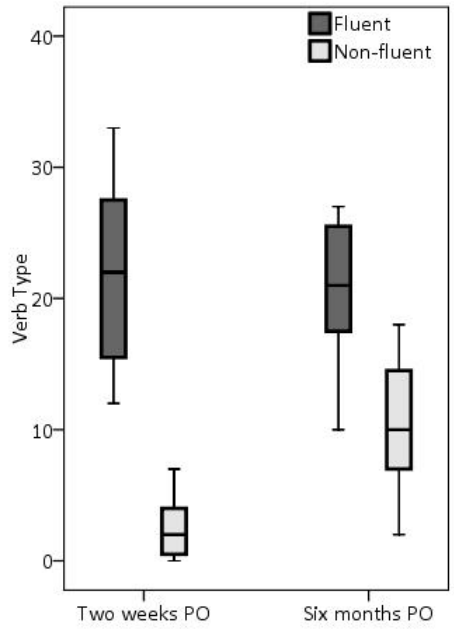

Figure 4 Representation of the different Verb Types produced by fluent and non-fluent aphasics at two weeks and six months after stroke.

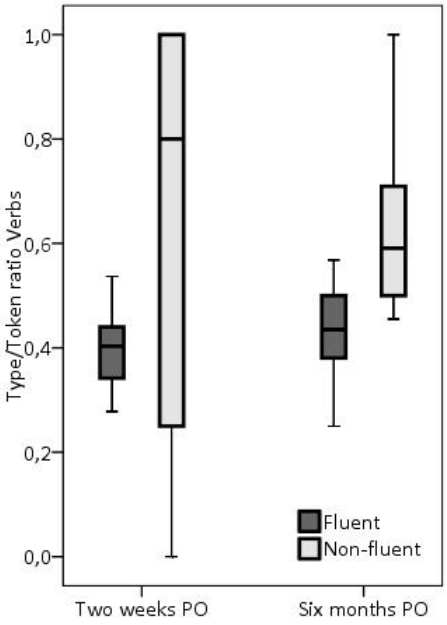

Figure 5 Representation of the Type/Token ratio for verbs in fluent and non-fluent aphasics at two weeks and six months after stroke.

Correlational analysis

The second aim of this study was to determine whether recovery in fluency, MLU and verb production is related. The correlation matrix showed a significant positive correlation (*r*=0,558) between fluency and MLU in the fluent group (Table 4). Verb Type and Mean Frequency of verbs were negatively correlated (*r*=-0,709). In the non-fluent group fluency and Verb Type were highly correlated (*r*=0,894).

Discussion

Before the difference between fluent and non-fluent aphasics is discussed, for each variable the change over time is described and compared with former results.

Fluency

In this study, 11 out of the 15 non-fluent patients became more fluent, which is more than was found in the study of Prins, Snow & Wagenaar (1978). In their study four patients of 20

severely non-fluent patients became non-fluent instead of severely non-fluent. In the study of Basso, Capitani & Zanobio (1982), none of the 190 non-fluent patients became fluent. However, they measured fluency at six months and twelve months after stroke. The patients possibly did not recover intensely any longer after this period, since recovery becomes less after six months (Demeurisse et al., 1980).

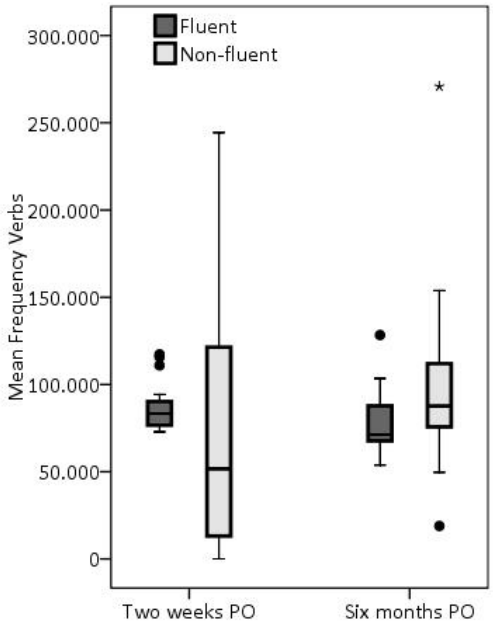

Figure 6 Representation of the Mean Frequency of verbs for fluent and non-fluent aphasics at two weeks and six months after stroke.

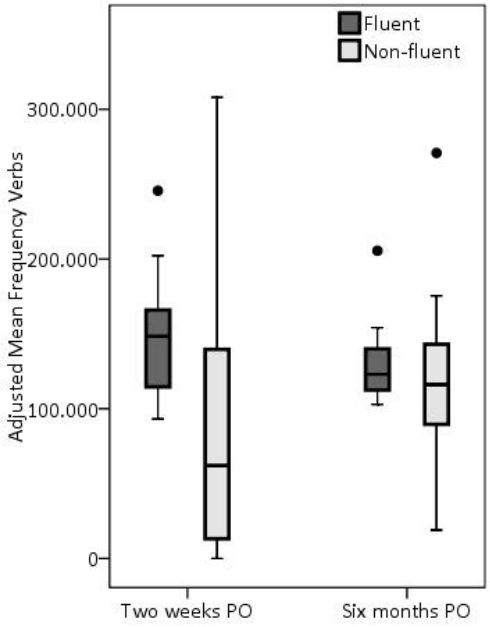

Figure 7 Representation of the Adjusted Mean Frequency of verbs for both groups at two weeks and six months after stroke.

MLU

The MLU of non-fluent patients improved significantly over time, however, the MLU of the fluent patients did not. Grande et al. (2008) found a significant improvement of the MLU in three patients; two fluent patients and one non-fluent patient. Schneider and Thompson (2003) observed a decrease of the MLU, though this was not statistically significant.

However, both studies used chronic aphasic patients instead of acute patients. Similar with fluency, this might be the reason why the results found in this current study differ with the results mentioned earlier.

The conclusion that the MLU is an important factor in the typology of aphasia (Goodglass, Quadfasel and Timberlake, 1964) concurs with the results in the current study;

at two weeks and six months after stroke the non-fluent patients had a significant shorter MLU than the fluent patients.

Verb Type

With regard to Verb Type non-fluent aphasics showed a significant improvement, in contrast with fluent aphasics. This means non-fluent aphasics produced more different type of verbs once they recovered over time, which was expected in the first place. This corresponds with the fact that the MLU of the non-fluent patients also improved. Schneider and Thompson (2003) discovered that verb retrieval significantly improved in aphasia after therapy. Although their results show similar results, it has to be taken into mind that they do not make a distinction between fluent and non-fluent aphasics, where the current study does.

Type/Token ratio verbs

Considering the Type/Token ratio for verbs, none of the fluent and non-fluent patients demonstrated a significant change. This stands out for the non-fluent group where Verb Type did improve. It means that, though Verb Type improved, Verb Token did not, which is against expectations. It is possible that because these patients are non-fluent they do not produce a lot of verbs. Another reason might be that the Type/Token ratio of verbs presents a relation between two factors, and is therefore not a good measure to determine recovery in spontaneous speech.

Mean Frequency

Considering the Mean Frequency of verbs, results showed that the fluent and non-fluent group did not change significantly over time. This means that both groups did not produce more frequent or infrequent verbs. There was also no significant difference between the two groups.

Adjusted Mean Frequency

Comparable with the Mean Frequency, there was no significant change for the Adjusted Mean Frequency in the fluent and non-fluent group. This indicates that even when the amount of times a verb was produced was included, the mean frequency remained the same. Since the Adjusted Mean Frequency is combined by two variables it is difficult and

maybe not suited to draw conclusions. One might conclude that aphasics activate verbs with approximately the same frequency at two weeks and six months after stroke. Hence, the theory of Ellis and Young (1988) that aphasics probably use more frequent verbs than infrequent verbs in spontaneous speech is not plausible. However, this is in contrast with the correlation that has been found between Verb Type and Mean Frequency. Therefore, it seems more reasonable that the Adjusted Mean Frequency does not change significantly because like the Type/Token ratio it gives an indication of a relation between two variables.

At two weeks after stroke there was a significant difference between the two groups for the Adjusted Mean Frequency, which was presented by a lower Adjusted Mean Frequency in the non-fluent group. This can be explained by the fact that some of the non-fluent aphasics did not produce verbs in spontaneous speech which resulted in a frequency of zero. At six months after stroke all non-fluent patients produced at least two different verbs, which resulted in a higher Adjusted Mean Frequency comparable with the level of the fluent patients.

Fluent versus non-fluent aphasics

The results demonstrated a significant difference between fluent and non-fluent aphasics at two weeks and six months after stroke, with regard to the majority of the factors of spontaneous speech; fluency, MLU, Verb Type and Type/Token ratio of verbs. Besides that, the Adjusted Mean Frequency differed significantly at two weeks after stroke. *These results confirm for the most part hypothesis **(a)** that fluent and non-fluent aphasic patients differ in the recovery of fluency, MLU and verb production in spontaneous speech during the first half year after stroke.*

Statistical analysis revealed that the difference between groups was caused by overall higher scores in the fluent group. However, the non-fluent group showed significant improvement for fluency, MLU and Verb Type, compared to the same four variables for the fluent group. This means that non-fluent aphasics became more fluent, used longer utterances and produced more different type of verbs at six months after stroke compared to two weeks after stroke. In contrast, the fluent patients showed no significant change, which indicates that even if the non-fluent group improved significantly over time, this group did not improve to a level that is comparable with the fluent group.

Given that patients in this study received therapy, one might suggest that the non-fluent aphasics improved because of this, but this explanation does not seem reasonable because the fluent aphasics also had therapy and did not improve.

The most plausible reason behind the difference in recovery between fluent and non-fluent aphasics is the difference in language disorders after stroke. The results found in this study concur with the expectations mentioned earlier. Like Lorch (1989) described non-fluent aphasics typically produce short sentences and according to Jonkers (1998) they experience more difficulty with verb retrieval. Fluent aphasics do not experience these problems or in a lesser way. *The demonstrated results agree with this difference between fluent and non-fluent aphasic patients, and confirms the hypothesis that the typology agrammatism-paragrammatism is a useful classification.*

Relation between factors of spontaneous speech

The second object of this study was to investigate whether recovery of fluency, MLU and verb production is related in spontaneous speech during the first half year after stroke in aphasic patients. *Three significant correlations were found, which means that the hypothesis* ***(b)*** *the recovery of fluency, MLU and verb production is related, is partially confirmed.*

The results by Spearman's correlation demonstrated a positive correlation between fluency and MLU in the fluent group. This means that when a patient became more fluent his utterances became longer and vice versa, which seems plausible. Also in the fluent group, a negative correlation between Verb Type and Mean Frequency was found. This indicates that a fluent patient used more infrequent verbs when he produced more different kind of verbs during speech. Patients that were not able to produce a larger diversity of verbs mainly used frequent verbs, which fits with the statement of Ellis and Young (1988) that lexical activation is faster with frequent words.

Correlations Spearman's rho

Groep			Effect Fluency	Effect MLU	Effect Mean Frequency	Effect Verb Type
Fluent	Effect Fluency	*Correlation Coefficient*	1,000	0,558*	-0,154	0,486
		Sig. (2-tailed)	-	0,031	0,584	0,066
		N	15	15	15	15
	Effect MLU	*Correlation Coefficient*	0,558*	1,000	-0,086	0,456
		Sig. (2-tailed)	0,031	-	0,761	0,088
		N	15	15	15	15
	Effect Mean Frequency	*Correlation Coefficient*	-0,154	-0,086	1,000	-0,709**
		Sig. (2-tailed)	0,584	0,761	-	0,003
		N	15	15	15	15
	Effect Verb Type	*Correlation Coefficient*	0,486	0,456	-0,709**	1,000
		Sig. (2-tailed)	0,066	0,088	0,003	-
		N	15	15	15	15
Non-Fluent	Effect Fluency	*Correlation Coefficient*	1,000	0,483	-0,352	0,894**
		Sig. (2-tailed)	-	0,068	0,198	0,000
		N	15	15	15	15
	Effect MLU	*Correlation Coefficient*	0,483	1,000	-0,357	0,423
		Sig. (2-tailed)	0,068	-	0,191	0,116
		N	15	15	15	15
	Effect Mean Frequency	*Correlation Coefficient*	-0,352	-0,357	1,000	-0,434
		Sig. (2-tailed)	0,198	0,191	-	0,106
		N	15	15	15	15
	Effect Verb Type	*Correlation Coefficient*	0,894**	0,423	-0,434	1,000
		Sig. (2-tailed)	0,000	0,116	0,106	-
		N	15	15	15	15

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 Correlation matrix of the effect sizes for each variable.

In the non-fluent group there was a highly positive correlation between fluency and Verb Type, which indicates that when a patient became more fluent his speech contained more different kind of verbs and the other way around. It appears that once patients recover, they are able to activate more language in general, which has a positive influence on retrieving different verbs. One might expect that fluency would correlate with MLU in the non-fluent group, which would be comparable with the fluent aphasics. However, this was not the case, which means that an improvement of fluency did not influence the length of utterances. Also the correlation between Verb Type and Mean Frequency, which was visible in the fluent group, was not present in the non-fluent group. This might be explained by the fact that the non-fluent patients possibly had problems with word finding, and therefore used frequent verbs at two weeks and six months after stroke.

Conclusion

In this study recovery in spontaneous speech during the first half year after stroke is determined in fluent and non-fluent aphasics. Fluency, MLU and Verb Type are good factors in measuring recovery, which is confirmed by the demonstrated correlations. These factors can be useful for speech-language therapists to determine recovery in aphasia. Verb frequency appears to be a factor that is less influenced by aphasia recovery.

Results show a clear difference in recovery between fluent and non-fluent aphasics, which might be due to therapy and/or a consequence of spontaneous recovery. In the current study difference in aphasia recovery is evidently due to a difference in language disorders after stroke, which means the typology of agrammatism and paragrammatism remains a useful method to classify aphasic patients.

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