Introduction

Distinction between "fluent" and "nonfluent" speech is of critical value when characterizing speech production. Fluency is often used as an effective "first cut" in diagnostic classification (Goodglass, 1993) because it is more practical and compelling than the use of more traditional clinical-anatomical sub-groupings (Kerschensteriner, Peock, & Brunner, 1972). For example, Goodglass and Kaplan (1972) categorized aphasic patients based on whether their speech was fluent or nonfluent. Although many studies have described characteristics of fluent and nonfluent speech (e.g., Benson, 1967; Goodglass & Kaplan, 1972; Yorkston & Beukelman, 1980), judging fluency is complex because all aspects of speech are combined while speaking, and listeners often rely solely on their perceptions in making these judgments. Some listeners may consider speech rate a main factor in judging fluency, while others may place more importance on sentence length. Although Benson (1967) designed a set of dimensions on which to judge fluency of speech, which variables contribute most to listener judgments of fluency is still unclear. A better characterization and understanding of the factors that affect listeners' judgments of speech fluency in aphasia may provide a means for more uniform ratings across listeners. The purpose of the current study was to investigate the variables of speech production that contribute most to judging fluency in neurologically healthy older adults and individuals with nonfluent aphasia. This study was funded in part by the National Institute on Deafness and Other Communication Disorders.

Participants and Materials

Twenty neurologically healthy older adult (OA) speakers and 27 nonfluent aphasic (NFA) speakers participated in this study. None of the OA speakers reported a history of neurological or psychiatric disorders. NFA speakers met the following criteria: unilateral left hemisphere stroke, lesions in the left posterior inferior frontal cortex and/or the left anterior insula, and at least six months post their most recent stroke. All participants were right-handed native English speakers. The age range for OA speakers was 55 to 81 years (mean=72.35 years, SD=6.16 years) while NFA speakers ranged between the ages of 42 and 92 years (mean=65.11 years, SD=12.19 years). Mean education level was similar in both groups (15.12 years for OA group, 13.78 years for NFA group). Mean score on the short form of the Boston Naming Test (BNT) (REF) for the OA group was 14.18 (SD=.95) out of 15, while mean score on the long form of the BNT for the NFA group was 25.70 (SD=10.69) out of 60. The mean WAB-AQ in the NFA group was 70.22 (SD=16.80).

All speakers were asked to describe the Cookie Theft picture from the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass and Kaplan, 1972). Examiners did not interrupt the speakers during their description. If a speaker provided only a brief response, the examiner prompted the speaker by asking, "Do you have anything more to add?"

Variables

We defined five variables of speech production deemed important to rating speech fluency: speech rate, audible struggle, syllable type token ratio (syllable TTR), speech productivity, and filler ratio. We defined speech rate as the number of discrete linguistic productions per second, omitting silences. Discrete linguistic productions were defined as separate discernable syllables. Discrete productions included fillers, neologisms, paraphasias, and repetitions of syllables or words. We derived speaking rate in syllables-per-second by dividing the total number of syllables by total speaking time. Audible struggle was defined as a degree of vocal tension and articulatory effort. To determine audible struggle, three clinicians who independently listened to the speech samples rated struggle using a 5-point interval scale (1=most struggle and 5=no struggle). Syllable TTR was calculated as a ratio of the total number of unique syllables divided by the total number of syllables. Speech productivity was derived by calculating a ratio of the total speaking time, with silences omitted, divided by the total time of the speech sample. We calculated a filler ratio by dividing total time producing fillers by total speaking time with silences omitted.

Statistical Analysis and Results

To compare whether the speech fluency of the two groups was significantly different, we performed independent *t*-tests with post-hoc Bonferroni corrections. Speech rate was significantly faster in the OA group [t=8.83, p<.01 (corrected)]. The NFA group was rated as having a significantly greater amount of audible struggle [t=6.60, p<.01 (corrected)]. Moreover, speech productivity was significantly greater in the OA group [t=3.59, p<.01 (corrected)]. Syllable TTR and filler ratio were not significantly different between the two groups, [t=.23, p>.01 (corrected)] and [t=-.78, p>.01 (corrected)], respectively. Table 1 shows the means and standard deviations for each of the five variables by group.

Discussion

Speech rate, audible struggle, and speech productivity were found to be defining variables in judging fluent vs. nonfluent speech in a sample of healthy and aphasic older adults. The lack of a significant difference in syllable TTR was unexpected. Since NFA speakers (e.g., Broca's aphasia, transcortical motor aphasia, etc.) produce repetitions, corrections, and have limited vocabulary (Goodglass, 1993), we anticipated them having a significantly lower syllable TTR than the OA speakers. One explanation for this unexpected finding is that our samples included a number of mildly nonfluent speakers, and it may be possible that syllable TTR will only characterize the more severe cases. Another possibility is that calculating the *syllable* TTR (which includes nonsense words and sounds), rather than the *word* TTR inflated the ratio in the NFA group. Perhaps calculating the word TTR would have yielded a significantly higher ratio in the OA group. Filler ratio was also not significantly different between the groups. It is well established that the speech of individuals with Broca's aphasia relative to healthy older adults is more effortful and contains a greater number of fillers and pauses (Goodglass, 1993). However, this study showed that filler ratio, which excluded pauses, did not affect fluency judgment, suggesting that pausing could be a more important variable than the use of fillers. Additional studies that include more speakers and different neurological populations are needed to further investigate how each of these five variables applies to the judgment of speech fluency. An extension of this investigation may also provide the basis for designing a scale for fluency prediction.

References

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Table 1. The means and standard deviations of variable in the two groups.

	Older adults group		Nonfluent aphasic group	
	Mean	SD	Mean	SD
Speech rate	4.07	.48	2.36	.76
Audible struggle	5.00	.00	3.77	.95
Syllable TTR	.58	.10	.57	.12
Speech productivity	.71	.16	.50	.21
Filler ratio	.06	.04	.07	.07