FINAL REPORT

for

Presentation Rate and Readability of Closed Captioned Television

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of Closed Caption Television

Final Report

Objective 1 – Establish Advisory Board

This project had several consultants and a formal Advisory Panel.

The consultants were:

Dr. Patricia Koskinen – Professor – University of Maryland
Dr. Jane Haugh – President – Center for Developing Learning Potentials
Dr. Robert Wilson – Professor Emeritus – University of Maryland
Jeff Hutchins – Vice President – VITAC

The Advisory Panel Members were:

Dr. Robert R. Davila – President – National Technical Institute for the Deaf
Martin Block – Vice President – VITAC
Mardi Loetermann – Research Director – National Center for Accessible Media (WGBH)
Brenda Battat – Deputy Executive Director – Self Help for the Hard of Hearing
Judith Johnson – Professor – Gallaudet University
Dr. Linda Gambrell – Associate Dean- University of Maryland

The consultants were brought in as needed. The Advisory Panel had full-day meetings at least annually.

Objective 2 – Establish Measurement System

Carl Jensema, with assistance from Drs. Koskinen, Wilson, and Haugh, investigated measurements of reading difficulty. Indices reviewed included Grammatik, Beta-Max's Reading Estimator software, Micro Power & Light Reading Estimator, and several other measures with which the consultants were familiar. In addition, attempts were made to establish our own reading scale based on caption word frequency. After months of work, the Advisory Panel advised us to abandon reading difficulty scales and focus on caption speed. Caption speed was simply defined as the number of words shown on a program during the specific times captions were shown. For example, a half-hour program may have captions on the screen only 17 minutes and 15 seconds. In calculating speed (in words per minute), the total number of words in all the captions was divided by 17.25.

Objective 3 – Obtain/Analyze Off-Air Data

Data were obtained from 183 programs and 22 music videos through the following procedure.

1. Tape television programs off air.

2. Run program through a HUBCAP decoder to strip captions from Line 21. Process the raw caption code to obtain meaningful captions, attach a time code, and store them on a computer file.

3. Import the file into Microsoft Excel, edit out commercials and other non-program material.

4. Run the file through a custom analysis program to calculate statistics for the program.

5. Enter program statistics in the master database.

The data collected in this manner was analyzed and a report was written. This report was published in the October 1996 issue of the American Annals of the Deaf.

The captions from all the programs were combined, sorted alphabetically, and collapsed into a frequency table. This frequency table became the basis for an article to be published in "Perspectives on Deafness and Education" in September, 1997.

Jeff Hutchins at VITAC sent us Spanish caption scripts. We put considerable work into analyzing the Spanish word frequency in the same way we did for the English caption data we had. There should be a good journal article in this. A new sorting program was written to handle the special Spanish characters and the Spanish sort was done. The one remaining problem was how to combine similar words. For example, in English we combined plural forms (e.g., goy and boys were counted as a single unique word), but in Spanish there are many more extensions and decisions on combining need to be made. Unfortunately, work on this was not completed by our Spanish expert, Joe Robison, before he left the project to accept another job. We will look for a Spanish language expert at one of the nearby universities and offer to give the data to them for development into a journal article.

Objective 4 – Develop Video Materials

Working with consultant Jeff Hutchins, three test videos were developed. The topics were "Nation's Capital", "Sailing", and "Space." Each video consisted of eight 30-second segments, each captioned at a different specific speed. The speeds used in this project were 96, 110, 126, 140, 156, 170, 186, and 200 words per minute. Each segment was separated from the next one by 10 seconds of blank screen. The blank screen allowed the respondents time to mark their score sheets.

The video material was created by selecting posters related to the topics and moving a video camera over them to give the illusion of motion. The videos had no audio. Each video was captioned with the exact number of words needed to create the desired caption speed. For example, a 30-second segment at 140 words per minute would have exactly 70 words in it.

Two additional segments on the topic of "Art" were made. These segments were for use as part of the instructions to the participants.

Participants were given a spoken and written introduction, asked to respond to a demographic questionnaire, filled out an eye chart, and responded to the two practice "Art" segments. They then watched a total of 24 video segments, responding to each one using a five-point scale.

Objective 5 – Obtain/Analyze Child Data
Objective 6 – Obtain/Analyze Adult Data

Objective 5 and 6 are combined because data collection from children and adults was done concurrently. Data was collected from residents of New York, Pennsylvania, New Jersey, West Virginia, Virginia, North Carolina, South Carolina, Florida, District of Columbia, and Maryland. A total of 578 subjects were used. Data analysis was done with a statistical package called Statview. The results were written up and have been submitted to the *American Annals of the Deaf* for publication.

Objective 7 – Final Report

This manuscript is the final report. The three journal articles produced by the project are in the appendix of the report.

Objective 8 – Dissemination

Several hundred copies of the off-air paper were mailed to interested professionals. The paper was accepted for publication by the *American Annals of the Deaf* and published in their October 1996 issue. A copy of the paper is attached to this report.

The paper on caption word frequency was submitted to *Perspectives on Education and Deafness* at Gallaudet University. It was accepted for publication and will be in the September 1997 issue. A copy of the paper is attached to this report.

The paper on caption speed was submitted to the *American Annals of the Deaf* in June 1997. We fully expect to have it accepted for publication after the journal's review process is completed. A copy of the paper is attached to this report.

The three journal articles will be made available on the IDRT web site.
HTTP:/WWW.IDRT.COM

The paper on the analysis of off-air captions was given at the CAID/CEASD convention in Minneapolis in June 1995 and at the TDI convention in Boston in July 1995.

The caption speed paper will be given at the Telecommunications for the Deaf, Incorporated convention in Kansas City, Missouri on July 15, 1997. Preparations for this have been made and all that remains is actually giving the paper.

Objective 9 – Administration

All monthly reports have been submitted. The final project report is being submitted.

APPENDIX

Presentation Speed and Vocabulary in Closed Captioned Television

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Presentation Speed and Vocabulary in Closed Captioned Television

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Introduction

In 1972, WGBH in Boston did a unique experiment in which they open-captioned a cooking program called "The French Chef" featuring Julia Child. The success of this first attempt at captioning led WGBH to rebroadcast daily an open captioned version of "ABC World News Tonight" for hearing impaired people. During the 1970's this was the only regularly broadcast television program in America designed to be accessible to deaf people. It was wildly popular in the deaf community because it was the only televised news program they could understand.

When WGBH began rebroadcasting the "ABC World News Tonight" there were no rules for captioning. Captioning policy was developed on a day to day basis as captioning problems arose. The guiding principle at that time was to make the program accessible to every deaf viewer, regardless of their individual reading ability. Since studies conducted by the Gallaudet University Office of Demographic Studies and others indicated that the average graduate from an educational program for hearing impaired students had about a third grade reading level, WGBH extensively edited the program dialogue. The number of words were cut by about a third and the reading level was cut from roughly the sixth grade level to the third grade level. All passive voice sentence construction was removed, nearly all idioms were removed, contractions were eliminated, clauses were converted into short declarative sentences, and even jokes and puns were changed if it was felt the hearing impaired audience would not understand them.

These captioning techniques, which almost everyone now considers over-editing, continued for many years. Part of the reason for this was that deaf people were so delighted to have captions that they accepted almost anything thrown on the screen. As captioned television became more entrenched as a standard part of television services in the late 1980's, deaf people began to examine the quality of captioning more closely. In general, deaf people indicated they wanted access to whatever was spoken on the audio and that captioners should not play the role of censors. Caption companies have tended to interpret this as meaning deaf people want straight verbatim captioning.

Counting both broadcast and cable, there are now roughly 100 hours of captioned television programs shown each day, yet we have no formal data on the characteristics of the captions on these programs. Are programs now captioned verbatim? How much editing is done? What is the caption presentation speed of programs currently being shown on television? How does this presentation speed vary with the type of program? These and other questions are addressed in the research study reported here.

Method

Recording

Caption data for this study was obtained from a sample of television programs recorded off-air. Based on the recommendations of an advisory panel of captioning experts, a sample of 183 programs stratified by program type was selected and recorded in late 1994. Table 1 gives a breakdown of the program types and number of programs selected for each. The programs varied from a half-hour to four hours, with the film "Gettysburg" being the longest. The programs represented a total of approximately 180 hours of air time. Recording was done using the cable television service in a number of different homes. The exception was for some movies shown over premium cable channels. It proved easier to rent the films from a local video store than to record them off the cable system. All recording was done on an ordinary consumer-quality 4-head videocassette recorder (VCR).

In addition, the project staff gained access to 22 captioned music videos, each of which was between two and five minutes in length. These were analyzed separately because they were so different from the regular programming.

Table 1
Sample of Programs

Regular Programs	**N**	**%**
Kids Animation	20	11
Kids Educational	11	6
Kids Action	6	3
Prime Time Drama	26	14
Situation Comedie	26	14
Films	21	11
News	20	11
Documentaries	17	9
Talk Shows	10	5
Soap Operas	9	5
Music Specials	6	3
Sports	6	3
Live Performances	5	3
Total Programs	**183**	**100**
Music Videos		
2 to 5 minute song	22	
Total	205	

Data Extraction

The videotapes which were obtained were replayed and the signal was run through a special closed caption decoder which read the captions from line-21 and fed them into a computer file. Special software was written to read the computer's clock and attach a start time and an end time to each line of caption data. This time-and-caption file was the basic raw data which was analyzed for each program.

Those programs which were recorded off commercial channels had advertisements, and even those on PBS or pay channels had station breaks or promotional material. All this non-program material had to be edited out of each data file. This was done by importing each data file into a spreadsheet and deleting the non-program parts, a lengthy and time consuming process. The result was a final "clean" data file for each program.

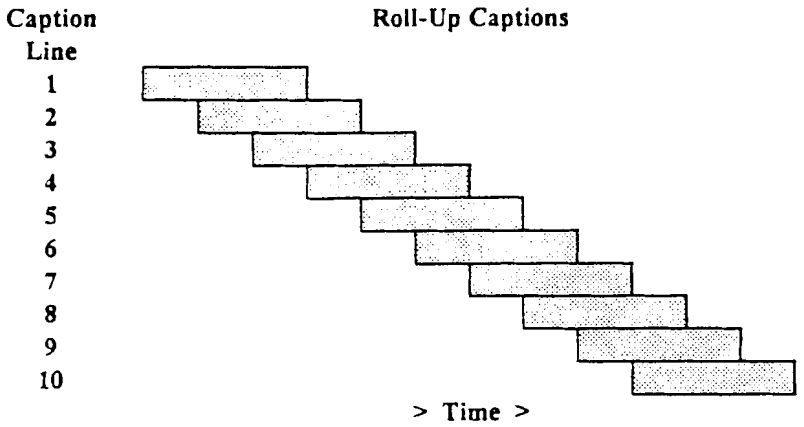
Time Analysis

Analysis of the time data was much more complex than it might seem. The captions and the control codes associated with them are transmitted in a steady binarily-coded stream in the television signal, but the actual appearance of captions on the screen is not necessarily exclusively sequential. There is a great deal of time overlap in the caption lines.

There are two kinds of captions, each with different characteristics. Roll-up captions scroll up the screen, usually in a three-line format. As one line rolls off, a new line rolls up. Although three lines are usually used, two line and four line captions are also possible. The roll usually has a steady speed, but the captioner can make it speed up or slow down as needed to keep up with the program audio. Pop on captions are blocks of words which may have anywhere from one to four lines. They pop onto the screen and pop off after a few seconds. There may be more than one block of pop on captions on the screen at one time. Figure 1 shows a schematic of how roll-up and pop on captions overlap in time. The words are transmitted as one long stream of data, but control codes in the data stream make the decoder divide the words into caption lines and these caption lines have an overlap in screen display time.

The "clean" data files in this study were analyzed with a custom computer software program. Table 2 gives a list of the information outputted by the computer program. "Total time of program" is the actual time from when the program begins to when it ends, including break time and commercial time. It does not include commercials or break time before and after the program. "Total time of captions on screen" is the time during which program captions are present on the screen. It does not include break time, commercial time, or program time during which no captions are shown. All of the analysis in this study is based on "total time of captions on screen".

Figure 1
Schematic Representation of
Caption Presentation Over Time



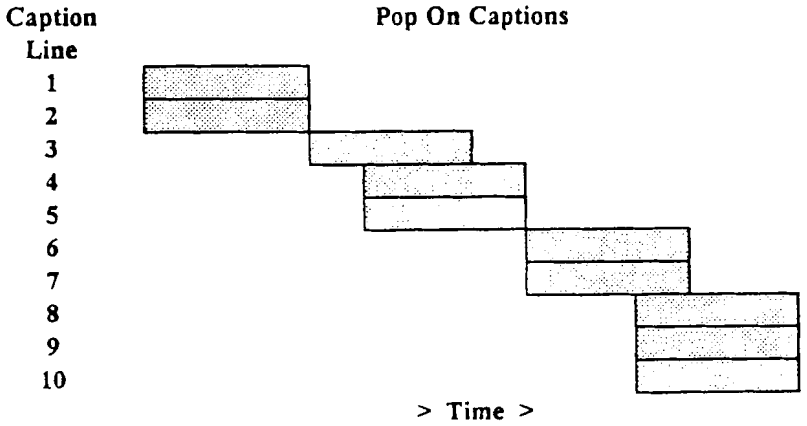


Table 2
Output from Caption Time Analysis Program

Total time of program
Total time of captions on screen
Total # of caption lines
Total # of words
Total # of characters
Mean caption lines per minute
Mean # of words per line
Mean # of characters per line
Mean # of words per minute
Mean characters per minute

Editing Level

Hearing impaired people have repeatedly indicated that they prefer verbatim captioning. They know they are not always getting perfect verbatim captioning because they sometimes see an actor speak a word or group of words for which there is no caption on the screen. The problem is that no one seems to know how much editing is done and how much is lost in the conversion from audio to captioning. In this study, 26 programs were randomly selected and for each program a sample of 10 minutes of audio was compared to the words which were captioned. The results were tabulated to give an indication of the percent of program audio which is usually captioned.

Word Analysis

What words are used in captioning? What is the frequency with which words appear in captions? To provide some insight into these questions, all the words in all the programs in this study were combined into one large computer file. This file, which contained 834,726 words, was sorted and the 16,102 unique words were arranged into a frequency table.

Results and Discussion

Program Characteristics

A total of 205 programs were analyzed, 183 regular programs and 22 short (2-5 minute) music videos. Table 3 provides a breakdown of the programs by length. Overall, there were roughly 180 hours of video.

Table 3
Program Length

Length	Number of Programs
5 minutes	22
.5 hour	78
1 to 1.5 hours	75
2 hours	25
over 2 hours	5
Total	205

Table 4 shows the number of programs in this study which were captioned by each of the major caption companies. However, it should not be assumed that the distribution of programs reflects the size of a caption company's business. For example, VITAC captions the one-hour Jay Leno program included in this study, but it captions that program five nights a week. This is about 10 times as much business as captioning a weekly half-hour sitcom.

Table 4
Caption Companies

	Number of Programs Captioned
Regular Programs	
NCI	113
WGBH	45
Captions, Inc.	9
Vitac	8
All Others	8
Music Videos	
NCI	3
WGBH	19
Total	205

Caption Speed

Table 5 gives various breakdowns of caption statistics for the 183 programs analyzed. (The 22 short music videos will be discussed separately.) For each program grouping, the mean, standard deviation, maximum value, minimum value, and range are given for words-per-minute (WPM), characters-per-minute (CPM), characters-per-word, caption-lines-per-minute, words-per-line, and characters-per-line. Over all programs, the mean values were 141 WPM, 736 CPM, 5.2 characters per word, 38.7 lines per minute, 3.7 words per line, and 19.2 characters per line. WPM and CPM are the two indexes usually used to measure caption speed. WPM has more intuitive meaning for most people, but it can be influenced by differences in word length. Figures 2 and 3 present the mean WPM and CPM in graphic form. The graphs for WPM and CPM are very similar in shape.

There are two kinds of captions, popping and rolling. In this study, it was found that rolling captions generally present more words over a given period of time as compared to popping captions (151 WPM vs. 138 WPM), but that rolling captions are used for a wide range of audio speeds, from very slow (74 WPM) to very fast (231 WPM).

Sports and music specials have the slowest caption rates. Sports tend to be visual in nature and most viewers are more interested in screen action than in the commentary. Music specials follow the pace of the music and the words to music are often sung more slowly than they would be spoken, resulting in a slower caption rate. Of course, there are exceptions, as will be seen in the discussion of music videos later.

Children's programming also has a slow captioning rate, but that rate was faster than expected. For children's educational, animation, and action programs, the rates were 124, 125, and 131 WPM, respectively. The overall mean for children's programs was 126 WPM. Program speed ranged from 87 WPM for "Sesame Street" to 154 WPM for "Bill Nye". There is clearly a trend toward faster caption rates for programs aimed at older children, but beyond that little is known about matching caption speed with the reading speed of children. Much more research is needed in this area.

In the mid range of caption speed are live performances (137 WPM), documentaries (139 WPM), films (140 WPM), prime time drama (146 WPM), and sitcoms (147 WPM). These kinds of programs tend to be clustered around the mean captioning speed of 141 WPM found over all 183 programs analyzed.

The categories of soaps (154 WPM), news (157 WPM), and talk shows (177 WPM) provided the fastest caption speeds. The mean speed for talk shows was increased by the presence of two late-night programs, "Later With Greg Kinnear" (231 WPM) and "Last Call" (229 WPM). Table 6 provides statistics for the programs with the five fastest and slowest caption speeds. The five fastest programs have more than twice the caption rate of the five slowest programs.

Table 5
Caption Speed Statistics

		Words Per Minute	Characters Per Minute	Characters Per Word	Caption Lines Per Min	Words Per Line	Characters Per Line
All Programs (n=183)	Mean	141	736	5.2	38.7	3.7	19.2
	St.Dev.	21	108	0.2	6.0	0.5	2.7
	Maximum	231	1,171	6.2	55.3	5.0	25.9
	Minimum	74	357	4.7	19.1	2.8	14.0
	Range	157	814	1.5	36.2	2.2	11.9
Rolling Captions (n=48)	Mean	151	781	5.2	34.8	4.4	22.5
	St.Dev.	31	165	0.2	7.2	0.3	1.8
	Maximum	231	1,171	5.6	55.3	5.0	25.9
	Minimum	74	357	4.8	19.1	3.4	16.3
	Range	157	814	0.8	36.2	1.6	9.6
Popping Captions (n=135)	Mean	138	719	5.2	40.0	3.5	18.1
	St.Dev.	15	73	0.2	4.9	0.3	2.0
	Maximum	177	832	6.2	49.6	4.4	22.9
	Minimum	87	463	4.7	24.4	2.8	14.0
	Range	89	369	1.5	25.2	1.6	8.9
Talk Shows (n=10)	Mean	177	897	5.1	40.4	4.4	22.2
	St.Dev.	30	151	0.1	6.4	0.3	1.3
	Maximum	231	1,171	5.3	55.3	5.0	24.6
	Minimum	142	713	4.9	33.2	4.1	20.7
	Range	89	458	0.4	22.1	0.9	4.0
Sports (n=6)	Mean	106	535	5.1	23.2	4.6	23.0
	St.Dev.	15	79	0.1	3.0	0.2	1.2
	Maximum	126	645	5.2	26.3	4.9	25.0
	Minimum	88	442	4.9	19.1	4.1	21.4
	Range	38	203	0.3	7.2	0.7	3.6
Soaps (n=9)	Mean	154	778	5.1	36.7	4.2	21.2
	St.Dev.	15	72	0.1	3.3	0.3	1.2
	Maximum	178	896	5.2	44.1	5.0	24.3
	Minimum	138	696	4.9	33.1	4.0	20.3
	Range	40	200	0.3	11.0	1.0	4.0

Table 5 (Continued)
Caption Speed Statistics

		Words Per Minute	Characters Per Minute	Characters Per Word	Caption Lines Per Min	Words Per Line	Characters Per Line
Sitcom (n=26)	Mean	147	758	5.2	43.1	3.4	17.7
	St.Dev.	10	51	0.1	3.8	0.3	1.3
	Maximum	162	825	5.4	49.6	4.0	20.3
	Minimum	119	593	5.0	35.3	3.0	15.5
	Range	43	232	0.4	14.3	1.1	4.8
Prime Time (n=24)	Mean	146	748	5.1	42.9	3.4	17.5
	St.Dev.	10	52	0.1	3.5	0.2	1.1
	Maximum	164	814	5.4	48.5	3.9	19.6
	Minimum	120	605	4.9	35.6	3.2	16.0
	Range	45	210	0.5	12.9	0.7	3.5
News (n=20)	Mean	157	835	5.3	36.2	4.3	23.1
	St.Dev.	15	86	0.2	4.1	0.3	1.5
	Maximum	183	978	5.7	43.2	4.9	25.9
	Minimum	123	652	4.9	28.7	3.9	20.7
	Range	60	326	0.7	14.5	1.0	5.2
Music Specials (n=6)	Mean	107	551	5.2	29.0	3.7	19.2
	St.Dev.	24	135	0.2	8.1	0.5	2.6
	Maximum	144	729	5.4	41.6	4.5	22.4
	Minimum	74	357	4.8	19.2	3.2	16.3
	Range	70	372	0.6	22.4	1.3	6.1
Live Performances (n=5)	Mean	137	725	5.3	36.5	3.7	19.8
	St.Dev.	19	88	0.1	2.6	0.4	1.9
	Maximum	156	808	5.4	39.3	4.4	22.5
	Minimum	115	623	5.2	34.4	3.3	17.8
	Range	41	185	0.3	4.9	1.1	4.7

Table 5 (Continued)
Caption Speed Statistics

		Words Per Minute	Characters Per Minute	Characters Per Word	Caption Lines Per Min	Words Per Line	Characters Per Line
Kids Educational (n=10)	Mean	124	667	5.4	34.6	3.5	18.7
	St.Dev.	18	99	0.2	4.9	0.3	1.7
	Maximum	154	791	5.7	38.8	4.1	21.7
	Minimum	87	463	5.0	24.4	3.1	16.8
	Range	66	328	0.7	14.4	1.0	4.9
Kids Animation (n=20)	Mean	125	660	5.3	39.4	3.2	16.8
	St.Dev.	13	61	0.2	3.9	0.2	1.0
	Maximum	148	784	5.7	46.3	3.5	19.0
	Minimum	105	574	4.9	33.4	2.9	15.2
	Range	43	210	0.8	12.9	0.6	3.9
Kids Action (n=6)	Mean	131	685	5.2	40.2	3.3	17.0
	St.Dev.	20	101	0.1	5.0	0.2	1.4
	Maximum	152	788	5.5	45.7	3.5	19.1
	Minimum	95	494	5.1	33.2	2.9	14.9
	Range	57	294	0.4	12.6	0.6	4.2
Film (n=22)	Mean	140	710	5.1	41.3	3.4	17.3
	St.Dev.	13	59	0.2	3.9	0.4	1.9
	Maximum	177	832	5.4	47.9	4.2	20.5
	Minimum	121	607	4.7	32.1	2.8	14.0
	Range	56	225	0.7	15.8	1.4	6.4
Documentary (n=17)	Mean	139	766	5.5	35.7	3.9	21.6
	St.Dev.	12	43	0.2	3.4	0.4	1.7
	Maximum	161	829	6.2	45.6	4.9	25.4
	Minimum	113	698	5.2	31.0	3.3	18.1
	Range	48	131	1.0	14.6	1.6	7.3

Table 6
Programs with Fastest and Slowest Caption Rates

	Type	Caption Type	Mean Words Per Minute	Mean Characters Per Minut	Mean Caption Lines Per Mi	Mean Words Per Line	Mean Characters Per Line	Mean Char Per Word
Fastest Programs								
Later w/Greg Kinnear	Talk show	roll 3	231	1171	55	4.2	21	5.1
Last Call	Talk show	roll 3	229	1134	46	5.0	25	5.0
Connie Chung	News	roll 3	183	920	38	4.8	24	5.0
Guiding Light	Soap	roll 3	178	870	36	5.0	24	4.9
Meet the Press	Talk show	roll 3	177	930	40	4.4	23	5.3
		Mean	**199**	**1005**	**43**	**4.7**	**24**	**5.0**
Slowest Programs								
ABC Sports: Golf	Sports	roll 2	94	463	20	4.7	23	4.9
TNT Basketball	Sports	roll 3	88	442	19	4.6	23	5.0
Sesame Street	Kids Educational	pop	87	463	27	3.2	17	5.3
Billboard Music Awards	Music Special	roll 3	87	430	19	4.5	22	5.0
Whitney Houston	Music Special	roll 3	74	357	22	3.4	16	4.8
		Mean	**86**	**431**	**22**	**4.1**	**20**	**5.0**

For comparison purposes, the mean WPM and CPM for various breakdown categories are presented in Figures 2 and 3. Since for most programs the number of characters per word does not vary greatly from the overall mean of 5.2 characters, the WPM and CPM graphs closely resemble each other in shape. The finding that word length does not vary greatly among programs is important. It had been suspected that programs considered more difficult to read might have a longer mean word length. This was not the case. For example, although "Sesame Street" is obviously easier to read than "Meet the Press", both have a mean word length of 5.3 characters.

The music videos were analyzed as a separate category. Music videos were included in this study mostly as a matter of curiosity because they represent a unique kind of caption material. Figure 4 presents the caption speed for each of the 22 music videos. The speed varies from 60 to 311 WPM, a much wider range than was found in the regular program categories. Many music videos flash images on the screen for a brief time. This makes captions harder to read because the viewer's attention is distracted. The fastest and most difficult to read captions were found in rap music. For example, the captions for the song "Freak It" proved impossible to understand without repeated viewing.

Caption Editing

For each of the program categories, two programs were selected and a 10-minute segment of each was carefully analyzed to see if there were any words spoken but not captioned. The results are given in Table 7. Several programs were 100% captioned. The most edited program was an ABC golf program where only 81% of the spoken words were captioned. This program was clearly an anomaly because it was captioned live and rolling captions were used, meaning that there were many times when captions could not be put on screen without covering up a player putting or a ball rolling toward a cup.

Among the 26 programs, the average was 94% captioned. When the golf program was excluded, the average was 95% captioned. To take a closer look at the material being edited, two programs were selected and a word-by-word inspection was made. "Hanging with Mr. Cooper" was selected as the most edited (87% captioned) program with pop on captions. The NBC "Today" show was selected as an example of a highly edited (91% captioned) program with roll-up captions.

Table 8 shows the changes made in a segment of the "Mr. Cooper" program. The first column gives the exact words which were spoken. The second column gives the words which were removed, the third column gives the words added, and the fourth column gives the actual captions which appeared on the screen. Most of the editing does not change the meaning of the text. The changes usually just provide a slight simplification of the sentence structure. The editing does not really seem necessary. Perhaps some of the changes were made because the captioner's supervisor gave instructions to caption at a certain WPM rate. For example, replacing "he likes to listen" with "he likes listening" changes the line from four words to three words, but it doesn't make the line shorter or easier to read. Another possibility is that the studio provided the captioner with a script and the captioner captioned the program verbatim, then the studio decided to go over the program again and "sweeten" the audio after it was captioned.

Figure 2
Mean Words Per Minute

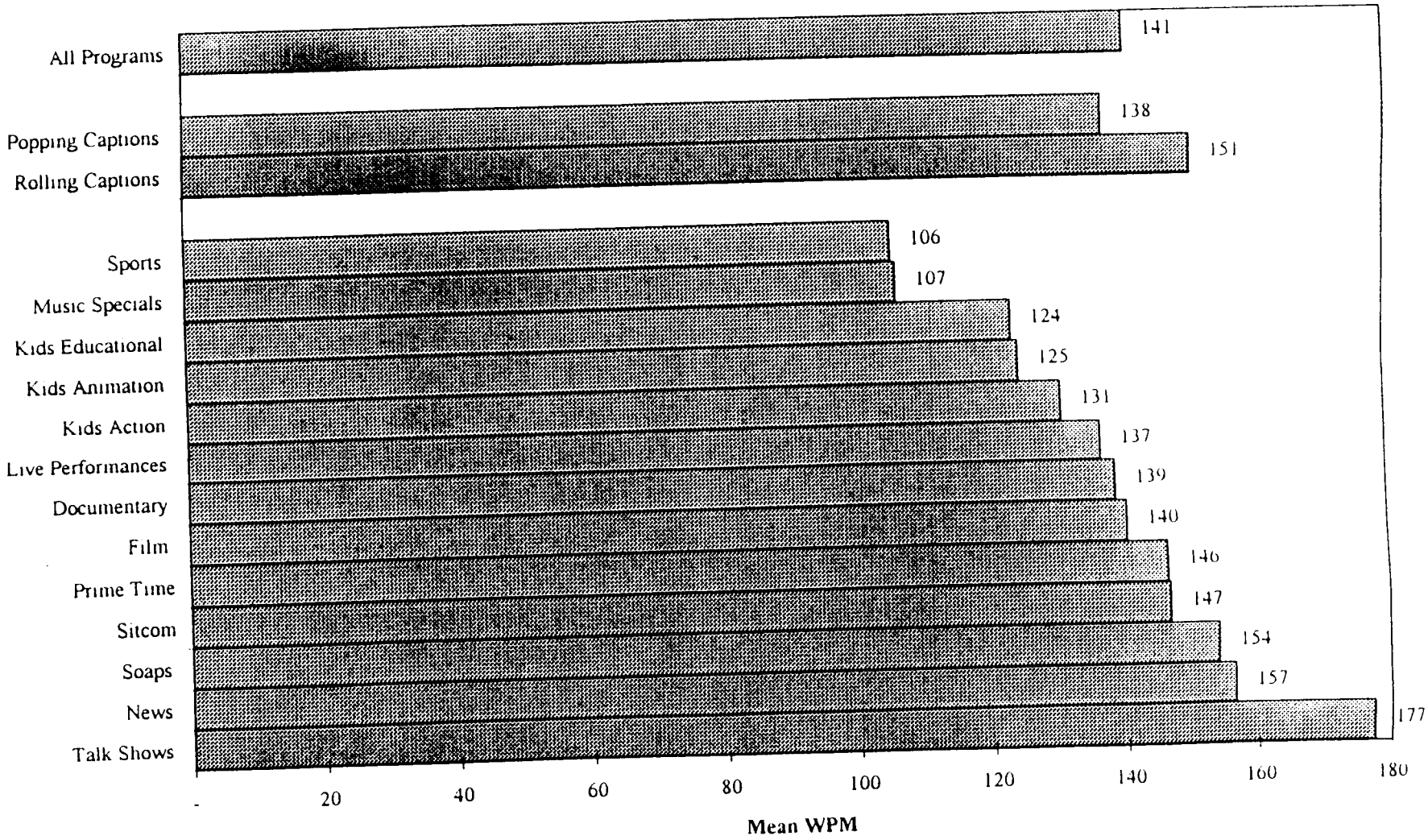


Figure 3
Mean Characters Per Minute

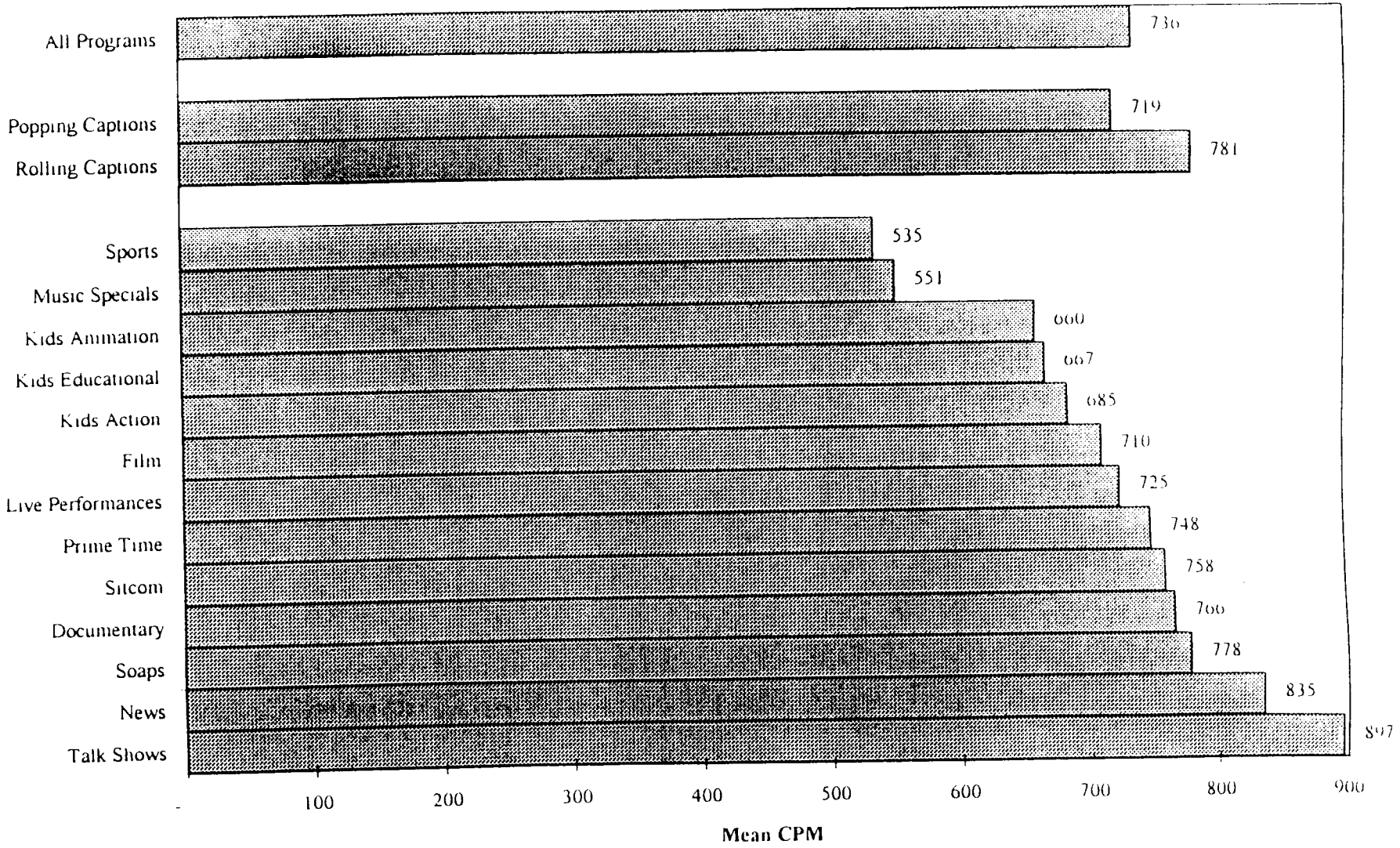


Figure 4
Music Video Words per Minute

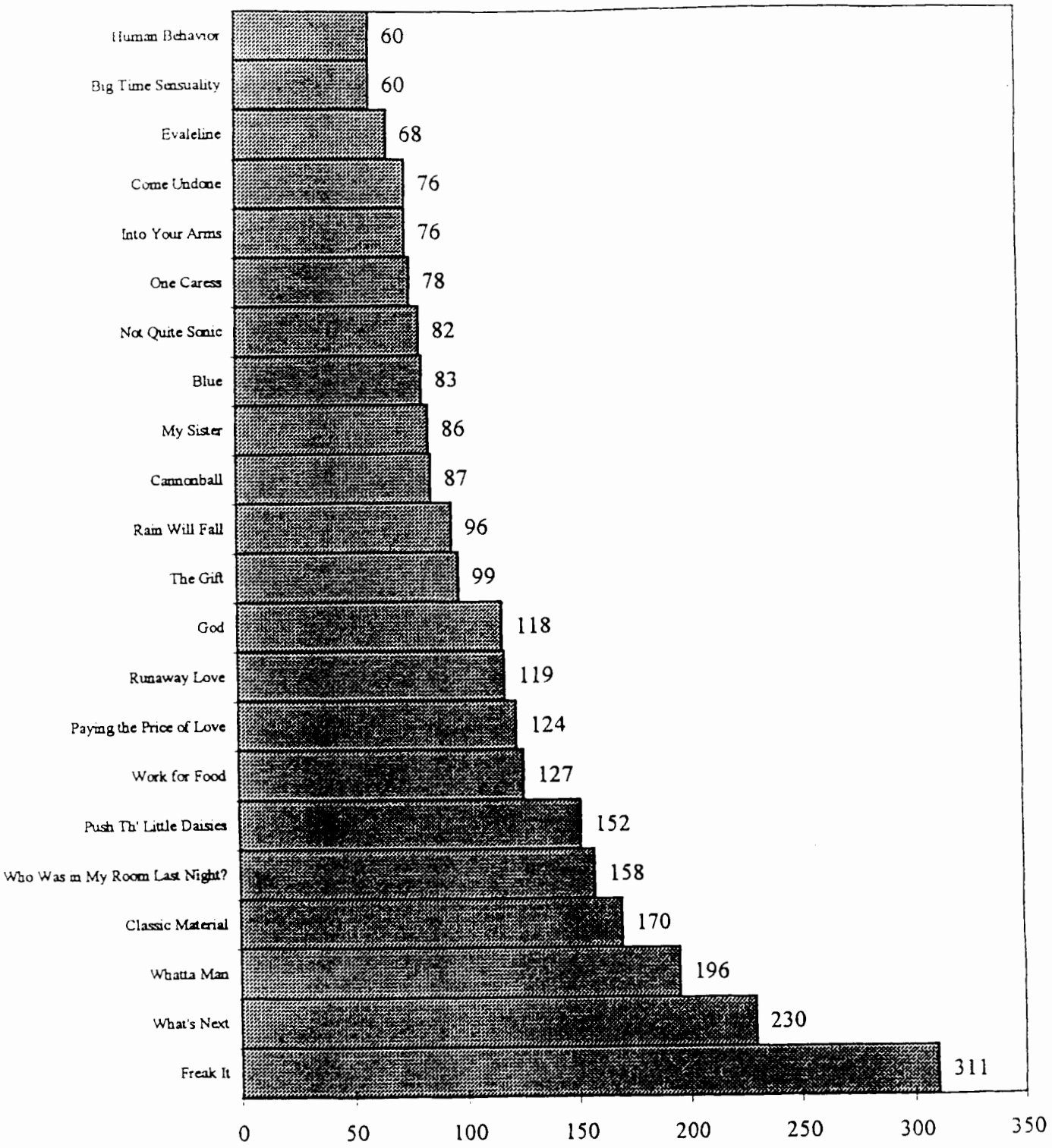


Table 7
Percentage of Audio Captioned

Program Type	Program Title	Percent Captioned
Soap	The Bold and the Beautiful	100
	Guiding Light	100
Documentary	Wild America	100
	Great Railroad Journey	99
Film	Ace Ventura	98
	Madame Butterfly	97
Talk Show	David Letterman	99
	Jay Leno	96
Live Performance	Clio Awards	97
	Seigfried and Roy	95
Prime Time	Arly Hanks	97
	ER	94
Music Special	Whitney Houston	100
	Billy Ray Cyrus Special	91
News	ABC News	98
	TODAY	91
Kids Action	Power Rangers	96
	California Dreams	90
Kids Animation	Animaniacs	97
	Batman - The Series	89
Kids Educational	Kids Songs	93
	Barney	88
Sitcom	In Living Color	91
	Hangin With Mr. Cooper	87
Sports	CBS Sports: Figure Skatin	90
	ABC Sports: Golf	81

Table 8
Changes in "Mr. Cooper"

Spoken	Remove	Add	Caption
TURN IT UP. I CAN'T HEAR ANYTHING	I CAN'T HEAR ANYTHING		TURN IT UP.
SHH' HE'S ON THE PHONE			SHH' HE'S ON THE PHONE
COME ON, BABY			COME ON, BABY
YOU KNOW YOU DON'T HAVE	YOU KNOW		YOU DON'T HAVE
TO GO SHOPPING			TO GO SHOPPING
YOU KNOW WHAT BIG DADDY			YOU KNOW WHAT BIG DADDY
WANT FOR HIS BIRTHDAY			WANT FOR HIS BIRTHDAY
HOLD ON			HOLD ON
LET ME CALL YOU BACK. ALL RIGHT	ALL RIGHT		LET ME CALL YOU BACK.
WHAT DOES HE WANT?			WHAT DOES HE WANT?
HEY, BIG DADDY.			HEY, BIG DADDY.
WE'RE SORRY COUSIN MARK.	COUSIN MARK		WE'RE SORRY
WE WERE JUST TRYING TO FIND OUT	WERE JUST TRYING	WANTED	WE WANTED TO FIND OUT
WHAT YOU WANTED			WHAT YOU WANTED
FOR YOUR BIRTHDAY.			FOR YOUR BIRTHDAY.
WELL YOU KNOW YOU TWO SHOULDN'T	WELL YOU KNOW TWO		YOU SHOULDN'T
BE EAVESDROPPING.			BE EAVESDROPPING.
'CAUSE YOU NEVER KNOW	CAUSE		YOU NEVER KNOW
WHAT YOU MIGHT HEAR,			WHAT YOU MIGHT HEAR,
LIKE HOW TYLER'S			LIKE HOW TYLER'S
PARENTS ARE SENDING HIM	PARENTS ARE SENDING HIM	BEING SENT	BEING SENT
TO MILITARY SCHOOL.			TO MILITARY SCHOOL.
THE FEW, THE PROUD,			THE FEW, THE PROUD,
THE BIG-HEADED			THE BIG-HEADED.
NOW WHERE'D YOU GET	NOW		WHERE'D YOU GET
THE WALKIE-TALKIE?			THE WALKIE-TALKIE?
IT'S A BABY MONITOR.			IT'S A BABY MONITOR.
MY DAD USES IT TO LISTEN IN	MY		DAD USES IT TO LISTEN IN
ON THE BABYSITTER.			ON THE BABYSITTER.
YOU MEAN YOUR BABY SISTER.	YOUR		YOU MEAN BABY SISTER.
NO. I MEAN THE BABYSITTER.			NO. I MEAN THE BABYSITTER.
HE LIKES TO LISTEN	TO	ING	HE LIKES LISTENING
TO HER READ BEDTIME STORIES,			TO HER READ BEDTIME STORIES
OR AT LEAST UNTIL	OR		AT LEAST UNTIL
MY MOTHER CAUGHT HIM.			MY MOTHER CAUGHT HIM.
MOM REALLY RAKED IT IN			MOM REALLY RAKED IT IN
THIS CHRISTMAS.			THIS CHRISTMAS.
WELL, ALL RIGHT, GOMER.			WELL, ALL RIGHT, GOMER.
GET OUT OF HERE			GET OUT OF HERE
AND TAKE PRIVATE BENJAMIN			AND TAKE PRIVATE BENJAMIN
WITH YOU. GET OUT.	GET OUT.		WITH YOU.
KIDS AND THEIR TOYS.			KIDS AND THEIR TOYS.
THIS IS A GOOD WAY			THIS IS A GOOD WAY
FOR ME TO FIND OUT			FOR ME TO FIND OUT
WHAT I'M GETTING			WHAT I'M GETTING
FOR MY BIRTHDAY THOUGH.			FOR MY BIRTHDAY THOUGH.
HI, MARK.			HI, MARK.
HEY! HEY	HEY	HA HA	HEY! HA HA.
WHAT'S IN THE BAGS, GIRLS?			WHAT'S IN THE BAGS, GIRLS?
UH, BIRTHDAY PLATES,			UH, BIRTHDAY PLATES,
PARTY CANDLES,			PARTY CANDLES,
60 OF MY CLOSEST			60 OF MY CLOSEST
FRIENDS, WHAT?			FRIENDS, WHAT?
GEE MARK, I DON'T KNOW WHAT YOU	I DON'T KNOW	ARE	GEE MARK, WHAT ARE YOU
TALKING ABOUT?			TALKING ABOUT?

Tables 9a, 9b, and 10 show two different kinds of editing for the "Today" program. This program is partly scripted and partly live. For the scripted part, the caption company is given a copy of the script before the show airs. They convert the script to captions and feed these captions into the broadcast at air time. The announcers on the screen see the same script on a teleprompter, but they do not always say exactly the same words that they read. The result is "editing" which is actually ad-libbing on the part of the announcers. Table 9a shows a scripted segment where several people are interacting. There is considerable ad-libbing. Table 9b shows a scripted segment which is straight news reporting. the announcer stays with the script and there is very little difference between the spoken and captioned versions. Table 10 shows a segment of "Today" which was captioned live by a stenocaptioner. There is a great deal of editing, but the essential information is still there.

Word Analysis

The caption scripts from all the programs in this study were combined into one large computer file. This file was edited to remove punctuation and anything else which was not a word. Certain non-standard "words", such as "uh", "mmmmm", and "ahhhh", were kept, since they are commonly used in captioning to indicate certain sounds in the audio. The resulting word list was sorted and arranged into a frequency table. The file had 843,726 words, of which 16,102 were unique. Just 10 words (the, you, to, a , I, and, of, in, it, that) accounted for 176,793 of the 834,726 words (21%). Half of all the words captioned were accounted for by just 79 unique words. Figure 5 gives a graph of the cumulative frequency of the 4,000 most frequent unique words. The horizontal axis gives the number of unique words and the vertical axis gives the percent of the entire word file accounted for by those unique words. Table 11 gives a list of the 250 most frequent unique words. These words account for more than 2/3 of all words used in the captions in this study.

For comparison, the frequency distributions of the words in about a dozen individual programs were examined. All the cumulative frequency graphs for these programs were very similar. Figure 6 provides a cumulative frequency graph for the 678 unique words used in an episode of "Wings", a typical situation comedy. For comparison purposes, the graph also includes the cumulative frequency curve for the 678 most frequently used words among all programs. The "All Programs" line provides a lower bound for the frequency curve of any individual program, since it represents all unique words available among all programs in this study.

In this instance, just 51 unique words accounted for half of all words used in the captions for this "Wings" episode and 174 words accounted for 75% of the words used. The important point is that captioned television (and by inference, the audio which the captions represent) use relatively few unique words. There are at least 500,000 words in the English language, but learning less than 500 words will cover most of the vocabulary in any television program shown in the United States today.

Table 9a
Changes in Scripted "Today"

Spoken	Remove	Add	Caption
AND WELCOME TO "TODAY"			>>> AND WELCOME TO "TODAY"
ON THIS THURSDAY MORNING			ON THIS THURSDAY MORNING
I'M KATIE COURIC			I'M KATIE COURIC
AND I'M MATT LAUER, FILLING IN FOR	FILLING IN FOR		>> AND I'M MATT LAUER.
BRYANT GUMBELL WHO IS ON	GUMBELL WHO		BRYANT IS ON
VACATION THIS WEEK			VACATION THIS WEEK
AND MATT AHEAD IN OUR FIRST HALF	AND MATT		>> AHEAD IN OUR FIRST HALF
HOUR THIS MORNING.	THIS MORNING		HOUR.
WE'RE GOING TO GET AN UPDATE	RE GOING TO	LL	WE'LL GET AN UPDATE
ON THE LATEST DEVELOPMENTS			ON THE LATEST DEVELOPMENTS
IN THE O J SIMPSON CASE			IN THE O J SIMPSON CASE
AND HEAR WHAT NICOLE BROWN			AND HEAR WHAT NICOLE BROWN
SIMPSON'S SISTER HAD TO SAY			SIMPSON'S SISTER HAD TO SAY
OUTSIDE THE COURTROOM.			OUTSIDE THE COURTROOM.
WE'LL ALSO LOOK			WE'LL ALSO LOOK
AT THE BIZARRE AND VERY TRAGIC	VERY		AT THE BIZARRE AND TRAGIC
STORY OUT OF SWITZERLAND,			STORY OUT OF SWITZERLAND,
WHERE 48 PEOPLE DIED			WHERE 48 PEOPLE DIED
IN A MASS SUICIDE.			IN A MASS SUICIDE.
MATT, AND ANOTHER SAD	MATT	VERY	>>AND ANOTHER VERY SAD
STORY THIS MORNING – KATIE	KATIE		STORY THIS MORNING
THE PARENTS OF A YOUNG AMERICAN BOY	AMERICAN		THE PARENTS OF A YOUNG BOY
KILLED BY BANDITS IN ITALY			KILLED BY BANDITS IN ITALY
A WEEK AGO TODAY			A WEEK AGO TODAY.
THEY DONATED HIS ORGANS		ALL	THEY DONATED ALL HIS ORGANS
SO ITALIANS MIGHT LIVE.			SO ITALIANS MIGHT LIVE.
ALSO AHEAD ACTOR JOHN TRAVOLTA IS	ALSO AHEAD IS	WILL BE	ACTOR JOHN TRAVOLTA WILL BE
HERE TO TALK ABOUT			HERE TO TALK ABOUT
HIS LATEST MOVIE, WHICH IS			HIS LATEST MOVIE, WHICH IS
GETTING A LOT OF CRITICAL			GETTING A LOT OF CRITICAL
ACCLAIM, IT'S CALLED "PULP FICTION."	IT'S CALLED		ACCLAIM, "PULP FICTION."
BASEBALL GREAT MICKEY MANTLE			BASEBALL GREAT MICKEY MANTLE
WILL BE ALONG AND WE'LL			WILL BE ALONG AND WE'LL
LEARN SOME HEALTHY AND TASTY			LEARN SOME HEALTHY AND TASTY
WAYS TO PREPARE SEAFOOD	SEAFOOD	FISH	WAYS TO PREPARE FISH.
WHAT KIND OF SEAFOOD?			>> WHAT KIND OF SEAFOOD?
I THINK TODAY WE'RE DOING			>> I THINK TODAY WE'RE DOING
STEAMED SHRIMP AND YOU'RE GO			STEAMED SHRIMP AND YOU'RE GO
TO HELP.			TO HELP.
I AM, I'M GONNA BE YOUR SOUS-CHEF	AM, I'M GONNA	WILL	>> I WILL BE YOUR SOUS-CHEF
YOU'RE THE STEAMER.	YOU'RE THE STEAMER.		
OK, BUT LET'S GET STARTED	OK, BUT GET STARTED	GO TO	LET'S GO TO
WITH THE MORNING'S	WITH THE MORNING'S		
TOP NEWS STORY OVER AT	TOP NEWS STORY OVER AT		
THE NEWSDESK			THE NEWSDESK
AND FOR THAT WE WILL TURN TO	FOR THAT		AND WE WILL TURN TO
ELIZABETH VARGAS			ELIZABETH VARGAS.
GOOD MORNING, KATIE AND MATT	KATIE AND MATT.		>> GOOD MORNING,
GOOD MORNING, EVERYONE	GOOD MORNING		EVERYONE.
JURY SELECTION WILL BE			>>> JURY SELECTION WILL BE
ON THE SIDELINES AGAIN TODAY			ON THE SIDELINES AGAIN TODAY
AT THE O J SIMPSON TRIAL			AT THE O J. SIMPSON TRIAL
IN THE CONTINUING DEBATE			IN THE CONTINUING DEBATE
OVER EVIDENCE TAKEN			OVER EVIDENCE TAKEN
FROM SIMPSON'S CAR.			FROM SIMPSON'S CAR.

Table 9b
Changes in Scripted "Today"

Spoken	Remove	Add	Caption
THE GRIM SEARCH			>>> THE GRIM SEARCH
CONTINUES THROUGH THE RUINS			CONTINUES THROUGH THE RUINS
OF BURNED-OUT HOMES	HOMES	HOUSES	OF BURNED-OUT HOUSES
IN SWITZERLAND			IN SWITZERLAND
IT'S THE AFTERMATH			IT'S THE AFTERMATH
OF AN APPARENT MASS SUICIDE			OF AN APPARENT MASS SUICIDE
BY MEMBERS OF A DOOMSDAY			BY MEMBERS OF A DOOMSDAY
CULT THAT HAS LEFT AT LEAST			CULT THAT HAS LEFT AT LEAST
50 PEOPLE DEAD			50 PEOPLE DEAD
IN SWITZERLAND AND IN CANADA.	IN		IN SWITZERLAND AND CANADA.
DETAILS NOW FROM NBC'S	NOW		DETAILS FROM NBC'S
KEITH MILLER.			KEITH MILLER.
THE POLICE SAY THE DEATH			>> THE POLICE SAY THE DEATH
TOLL COULD GO HIGHER.			TOLL COULD GO HIGHER.
INVESTIGATORS WAITED UNTIL			INVESTIGATORS WAITED UNTIL
THIS MORNING TO SEARCH			THIS MORNING TO SEARCH
A BURNT-OUT SKI CHALET	T	ED	A BURNED-OUT SKI CHALET
FEARING IT COULD BE			FEARING IT COULD BE
BOOBY-TRAPPED.			BOOBY-TRAPPED.
A RELIGIOUS SECT CALLED			A RELIGIOUS SECT CALLED
THE ORDER OF THE SOLAR			THE ORDER OF THE SOLAR
TEMPLE IS BEHIND, WHAT			TEMPLE IS BEHIND, WHAT
POLICE CALL, A BIZARRE			POLICE CALL, A BIZARRE
RITUAL SLAUGHTER.			RITUAL SLAUGHTER.
23 BODIES WERE FOUND IN THIS			23 BODIES WERE FOUND IN THIS
BURNED-OUT FARMHOUSE			BURNED-OUT FARMHOUSE
IN THE VILLAGE OF CHEIRY,			IN THE VILLAGE OF CHEIRY,
80 MILES NORTHEAST			80 MILES NORTHEAST
OF GENEVA.			OF GENEVA.
ANOTHER 25 BODIES WERE			ANOTHER 25 BODIES WERE
DISCOVERED IN THREE SKI			DISCOVERED IN THREE SKI
CHALETS 90 MILES AWAY.			CHALETS 90 MILES AWAY.
MASS SUICIDE IS POSSIBLE.			MASS SUICIDE IS POSSIBLE.
SO IS MURDER.			SO IS MURDER.
TWENTY OF THE VICTIMS			TWENTY OF THE VICTIMS
IN THE FARMHOUSE HAD BEEN			IN THE FARMHOUSE HAD BEEN
SHOT.			SHOT.
MOST OF THE BODIES WERE			MOST OF THE BODIES WERE
FOUND IN AN UNDERGROUND ROOM			FOUND IN AN UNDERGROUND ROOM
THAT MAY HAVE BEEN USED			THAT MAY HAVE BEEN USED
FOR RELIGIOUS RITUALS.			FOR RELIGIOUS RITUALS.
EVERYTHING LOOKED LIKE			>> EVERYTHING LOOKED LIKE
LIKE PEOPLE LIKE IN A WAX MUSEUM.	LIKE		PEOPLE LIKE IN A WAX MUSEUM.
SIMILAR CIRCUMSTANCES			>> SIMILAR CIRCUMSTANCES
SURROUNDED THE DEATHS OF TWO			SURROUNDED THE DEATHS OF TWO
PEOPLE NEAR MONTREAL			PEOPLE NEAR MONTREAL
ON TUESDAY.			ON TUESDAY.
THEY WERE DISCOVERED			THEY WERE DISCOVERED
IN THE BURNT-OUT DUPLEX			IN THE BURNT-OUT DUPLEX
ADJACENT TO THE ONE OWNED			ADJACENT TO THE ONE OWNED
BY THE SECT'S LEADER,			BY THE SECT'S LEADER,
LUC JOURET			LUC JOURET.

Table 10
Changes in Live "Today"

Spoken	Remove	Added	Caption
WHAT HAPPENED?			WHAT HAPPENED?
>>WELL UH INDIVIDUAL INVESTORS	WELL, UH		>> INDIVIDUAL INVESTORS
ACTUALLY HUNG IN THERE			ACTUALLY HUNG IN THERE
THE MARKET WAS DOWN THE			THE MARKET WAS DOWN THE
WORST WE'VE HAD ALL YEAR			WORST WE'VE HAD ALL YEAR
MOSTLY BECAUSE TECHNOLOGY STOCKS			BECAUSE TECHNOLOGY STOCKS
TOOK A REAL HIT			TOOK A REAL HIT
>>AND DO YOU NOW RECOMMEND THAT, UH, SMALL	AND, NOW, THAT, UH,		DO YOU RECOMMEND SMALL
INVESTORS GET BACK INTO			INVESTORS GET BACK INTO
TECHNOLOGY STOCKS?			TECHNOLOGY STOCKS?
>>YES	>>YES		
>>AS A LOT OF PEOPLE ARE DOING	AS		A LOT OF PEOPLE ARE DOING
RIGHT NOW	RIGHT NOW	THIS?	THIS?
>> THEY ARE. THEY ARE	THEY ARE.		>> THEY ARE
THEY HAVEN'T HAD MUCH CHANCE TO	MUCH		THEY HAVEN'T HAD A CHANCE TO
GET INTO THESE THINGS AT LOWER	THINGS		GET INTO THESE AT LOWER
PRICES.			PRICES
BUT THEY'VE DONE THAT AND ALREADY THEY'VE	BUT, ALREADY THEY'VE	HAVE	THEY'VE DONE THAT AND HAVE
COME BACK QUITE STRONGLY. SO I THINK	QUITE, SO I THINK		COME BACK STRONGLY
IT IS TIME TO GET BACK INTO	IS	S	IT'S TIME TO GET BACK INTO
TECHNOLOGY			TECHNOLOGY
THEY'RE GOING MUCH HIGHER.	MUCH		THEY'RE GOING HIGHER
>> SCARY TIMES ALSO SCARY THE ORANGE, UH	SCARY TIMES, UH		>> ALSO SCARY, THE ORANGE
COUNTY'S MUNICIPAL BOND	S		COUNTY MUNICIPAL BOND
DEFAULT UH	UH		DEFAULT
WHAT'S THE FALLOUT FROM THAT?	FROM THAT		WHAT'S THE FALLOUT?
>> WELL WHAT HAPPENED WAS THEY DEFAULTED JUST TWO	WELL, WHAT HAPPENED WAS		>> THEY DEFAULTED JUST TWO
WEEKS AGO, OR SO, ON 679 MILLION DOLLARS WORTH OF MUNICIPAL	679 MILLION DOLLARS WORTH OF		WEEKS OR SO AGO ON MUNICIPAL
BONDS.			BONDS
THAT'S REALLY PUT A FRIGHT INTO THE	REALLY		THAT'S PUT A FRIGHT INTO THE
MUNICIPAL BOND MARKET			MUNICIPAL BOND MARKET
WE HAVEN'T HAD ANYTHING LIKE			WE HAVEN'T HAD ANYTHING LIKE
THAT BEFORE, PARTICULARLY A VERY RICH	BEFORE, VERY		THAT, PARTICULARLY A RICH
COUNTY DEFAULTING ON IT'S BONDS SO	DEFAULTING ON IT'S BONDS, SO		COUNTY
PEOPLE ARE GETTING VERY SHY	VERY		PEOPLE ARE GETTING SHY
THEY'VE TAKEN $1 3 BILLION OUT OF	THEY'VE		TAKEN $1 3 BILLION OUT OF
MUNICIPAL BOND FUNDS IN THE			MUNICIPAL BOND FUNDS IN THE
LAST TWO OR THREE WEEKS			LAST TWO OR THREE WEEKS
>>THERE'S BEEN SOME DISCUSSION ABOUT A FLAT TAX	THERE'S BEEN SOME DISCUSSION ABOUT		>> A FLAT TAX
HOW WOULD THAT AFFECT THE			HOW WOULD THAT AFFECT THE
MUNICIPAL BOND MARKET?	MUNICIPAL		BOND MARKET?
>> DEVASTATING.	DEVASTATING.	TERRIBLE	>> TERRIBLE
THAT WOULD BE TERRIBLE FOR THE	THAT WOULD BE TERRIBLE FOR THE	DEVASTATING	DEVASTATING
MUNICIPAL BOND MARKET. BECAUSE, UH	MUNICIPAL BOND MARKET. BECAUSE, UH		
IT WOULD NO LONGER BE			IT WOULD NO LONGER BE
TAX-EXEMPT SO ON AN	SO ON AN		TAX-EXEMPT
AFTER TAX BASIS, YOU'D BE WAY BEHIND	YOU'D BE		AFTER TAX BASIS, WAY BEHIND

Figure 5
Cumulative Frequency Percentage for
4000 Most Frequent Unique Words

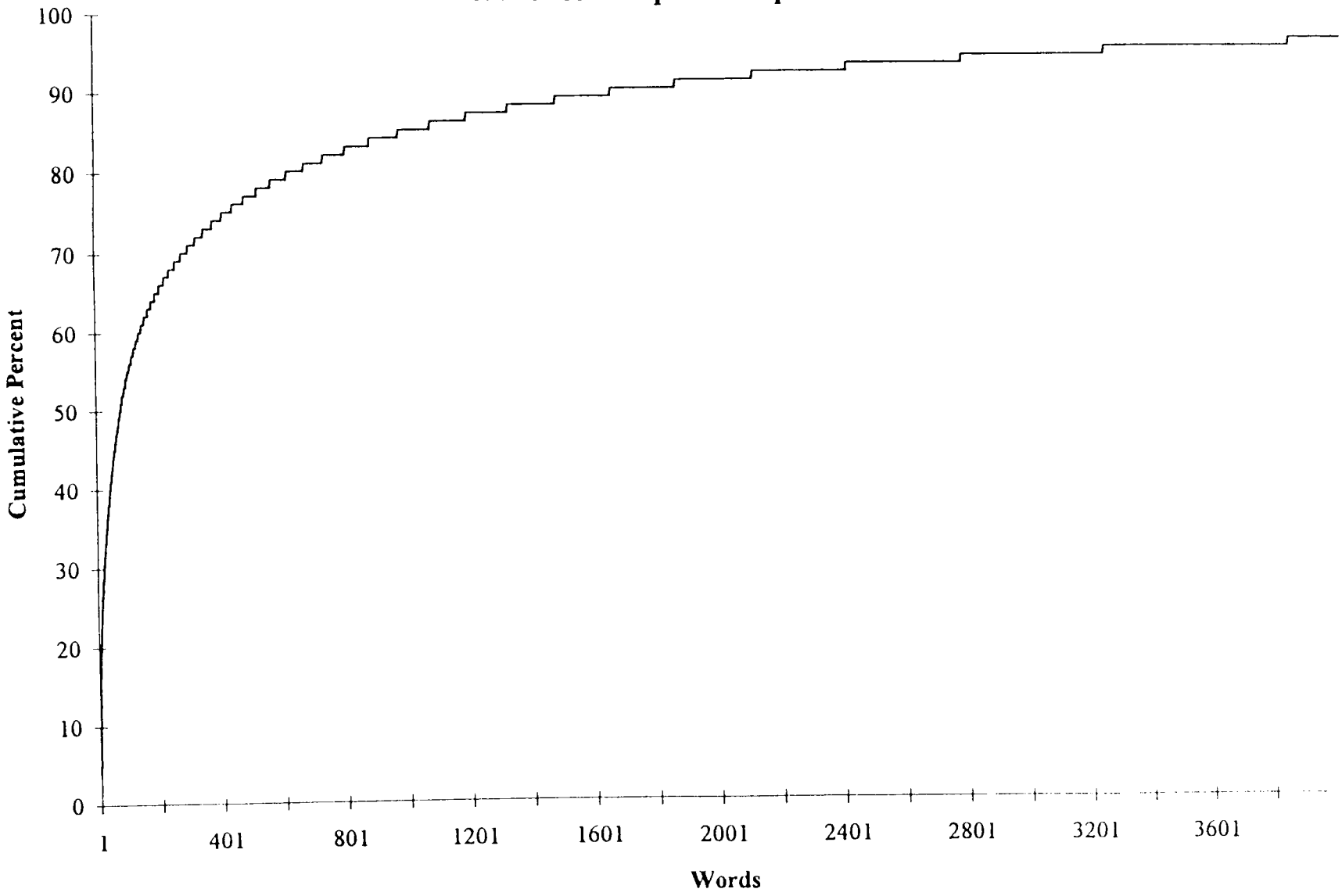
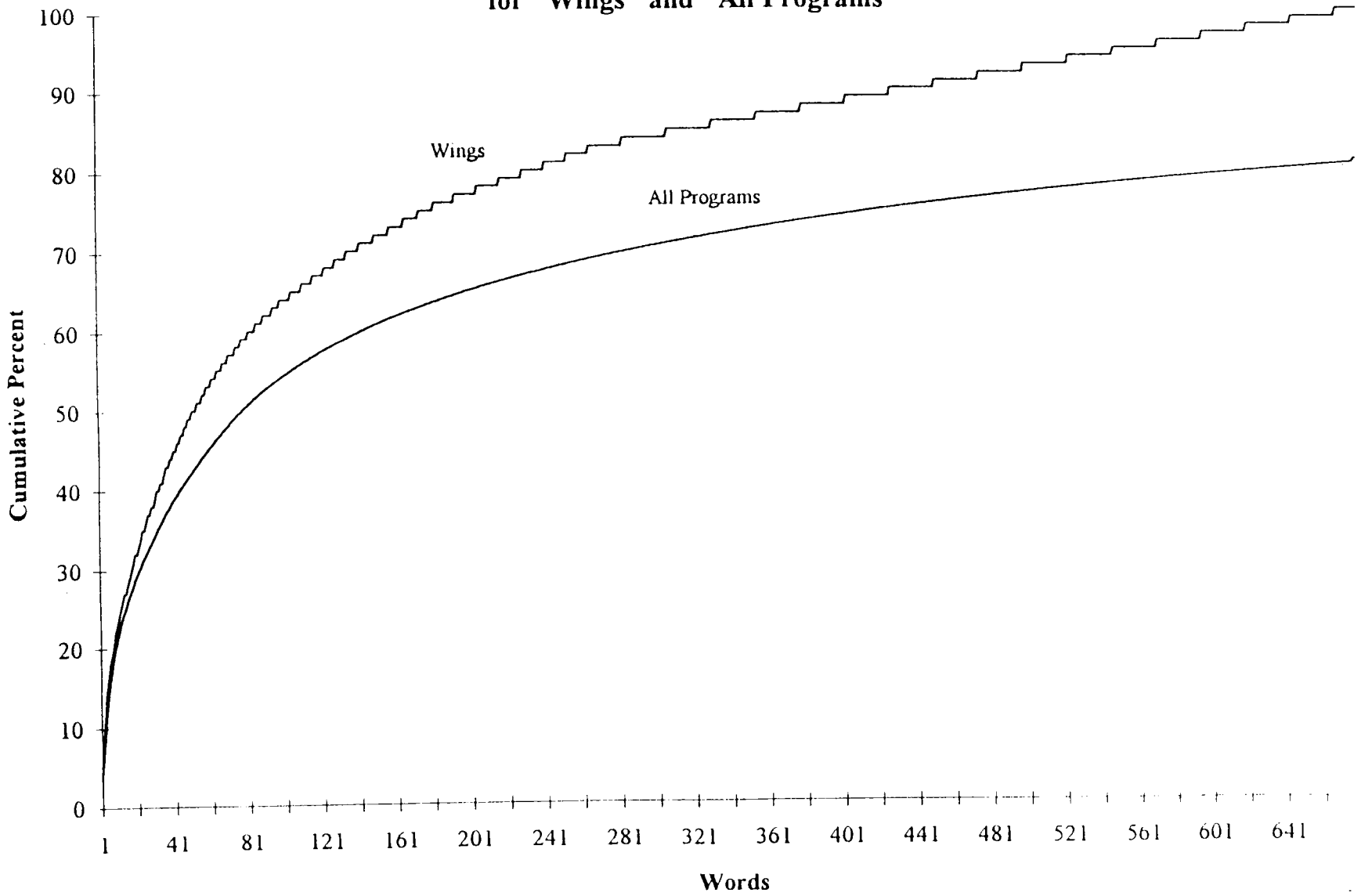
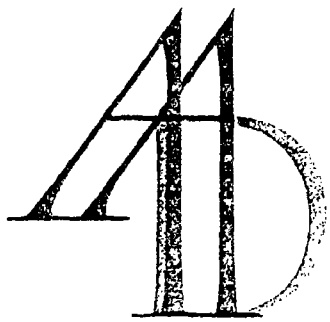


Table 11
Frequently Used Words

Word	Freq.	Percent	Word	Freq.	Percent	Word	Freq.	Percent	Word	Freq.	Percent
THE	30142	3.61	FROM	2373	46.27	TOO	1048	58.06	THOUGHT	652	64.23
YOU	22600	6.32	THAT'S	2343	46.55	DIDN'T	1040	58.18	BELIEVE	650	64.31
TO	22161	8.97	LOOK	2324	46.83	HA	1034	58.31	BOY	646	64.38
A	20023	11.37	HIM	2316	47.1	NEW	1023	58.43	THREE	644	64.46
I	19991	13.77	YOU'RE	2285	47.38	TALK	1020	58.55	EVERY	641	64.54
AND	16130	15.7	TIME	2243	47.65	INTO	1012	58.67	CAPTION	639	64.61
OF	13914	17.37	WHEN	2231	47.91	WORK	1007	58.79	EVER	639	64.69
IN	10941	18.68	SEE	2230	48.18	PLAY	1006	58.91	SHOW	636	64.77
IT	10496	19.93	HOW	2214	48.45	TRY	998	59.03	AWAY	635	64.84
THAT	10395	21.18	SAY	2200	48.71	MUCH	988	59.15	ALWAYS	626	64.92
IS	8764	22.23	GOOD	2155	48.97	GUY	987	59.27	ANYTHING	607	64.99
THIS	7116	23.08	BY	2115	49.22	I'VE	980	59.39	AM	598	65.06
FOR	6679	23.88	HAD	2041	49.47	UH	976	59.5	LONG	593	65.13
ON	6411	24.65	YEAH	1971	49.7	MEAN	954	59.62	ASK	587	65.2
WAS	5945	25.36	AN	1968	49.94	THERE'S	954	59.73	TODAY	587	65.27
HAVE	5804	26.06	WOULD	1899	50.17	ONLY	938	59.84	NAME	583	65.34
ME	5740	26.75	DID	1804	50.38	GIVE	924	59.96	RUN	583	65.41
WE	5521	27.41	TAKE	1794	50.6	OFF	920	60.07	PLACE	581	65.48
WHAT	5464	28.06	WERE	1765	50.81	ANY	917	60.18	STOP	580	65.55
BE	5449	28.71	MAKE	1757	51.02	FEEL	907	60.28	WHICH	570	65.62
HE	5218	29.34	BACK	1739	51.23	THESE	905	60.39	SORRY	566	65.69
WITH	4895	29.93	WHO	1719	51.43	GREAT	884	60.5	FRIEND	564	65.76
MY	4834	30.5	BEEN	1707	51.64	LET'S	884	60.6	BETTER	563	65.82
YOUR	4385	31.03	HAS	1697	51.84	PREPARE	871	60.71	THROUGH	562	65.89
DO	4375	31.55	THEM	1599	52.03	LET	863	60.81	HOUSE	559	65.96
I'M	4258	32.06	OR	1553	52.22	LIFE	859	60.91	DOES	558	66.02
ARE	4224	32.57	SOME	1547	52.4	OTHER	852	61.02	FAMILY	555	66.09
ALL	4129	33.07	MAN	1529	52.59	NIGHT	831	61.12	KIND	554	66.16
NOT	4117	33.56	VERY	1510	52.77	THEY'RE	829	61.22	MAY	551	66.22
IT'S	4111	34.05	OUR	1475	52.94	HELP	805	61.31	MOST	548	66.29
KNOW	3962	34.53	DOWN	1474	53.12	HAPPEN	802	61.41	GOD	530	66.35
NO	3890	34.99	THING	1456	53.3	WHAT'S	800	61.5	WOMAN	524	66.41
BUT	3885	35.46	WAY	1431	53.47	THOSE	784	61.6	MANY	512	66.48
DON'T	3859	35.92	YEAR	1420	53.64	THAN	782	61.69	HI	510	66.54
GET	3739	36.37	PEOPLE	1409	53.81	FIND	776	61.78	NOTHING	509	66.6
THEY	3612	36.8	COULD	1408	53.97	LAST	760	61.88	NEXT	508	66.66
LIKE	3436	37.21	MORE	1383	54.14	WORLD	760	61.97	MOVE	503	66.72
SO	3425	37.62	US	1381	54.31	AFTER	756	62.06	ANOTHER	499	66.78
JUST	3300	38.02	I'LL	1369	54.47	SHE'S	743	62.15	CAME	498	66.84
AT	3295	38.41	YES	1364	54.63	MR	741	62.24	TONIGHT	495	66.9
HERE	3197	38.8	HE'S	1359	54.8	EVEN	740	62.32	LEFT	493	66.96
OUT	3117	39.17	THANK	1352	54.96	HOME	735	62.41	TURN	484	67.02
UP	3074	39.54	LITTLE	1351	55.12	AGAIN	727	62.5	DOESN'T	483	67.07
ABOUT	3031	39.9	LOVE	1340	55.28	MADE	719	62.59	I'D	482	67.13
ONE	2998	40.26	WHY	1278	55.43	BIG	718	62.67	NEITHER	481	67.19
RIGHT	2906	40.61	REALLY	1263	55.58	DOING	718	62.76	MUST	476	67.25
COME	2904	40.95	TELL	1256	55.73	PLEASE	712	62.84	KILL	472	67.3
THERE	2886	41.3	OVER	1249	55.88	PUT	711	62.93	HAND	470	67.36
OH	2781	41.63	CALL	1241	56.03	LOT	709	63.01	STAY	468	67.41
CAN	2772	41.97	CAN'T	1192	56.18	SHOULD	700	63.1	WATCH	467	67.47
IF	2751	42.3	WHERE	1179	56.32	BEFORE	694	63.18	YOU'VE	467	67.53
WANT	2730	42.62	SAID	1169	56.46	AROUND	688	63.26	CHILDREN	465	67.58
AS	2714	42.95	DAY	1163	56.6	WAIT	688	63.34	HEAR	463	67.64
NOW	2696	43.27	NEVER	1158	56.74	STILL	687	63.43	HOPE	462	67.69
SHE	2686	43.59	SOMETHING	1158	56.87	START	684	63.51	MOTHER	455	67.75
THINK	2606	43.9	WE'RE	1155	57.01	LIVE	680	63.59	NICE	455	67.8
HER	2591	44.22	THEN	1140	57.15	USE	675	63.67	REMEMBER	454	67.86
GO	2584	44.52	TWO	1133	57.28	SURE	674	63.75	OWN	453	67.91
WILL	2522	44.83	BECAUSE	1115	57.42	KEEP	671	63.83	WON'T	451	67.96
WELL	2442	45.12	THEIR	1089	57.55	SIR	670	63.91	MORNING	449	68.02
GOING	2428	45.41	HEY	1087	57.68	OLD	667	63.99	EVERYTHING	446	68.07
HIS	2409	45.7	FIRST	1065	57.81	MAYBE	657	64.07			
GOT	2375	45.98	NEED	1049	57.93	WE'LL	653	64.15			

Figure 6
Cumulative Frequency Percentage
for "Wings" and "All Programs"





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CLOSED-CAPTIONED TELEVISION PRESENTATION SPEED AND VOCABULARY

This study summarizes an extensive research project on closed-captioned television. Caption data were recorded from 205 television programs. Both roll-up and pop-on captions were analyzed. In the first part of the study, captions were edited to remove commercials and then processed by computer to get caption speed data. Caption rates among program types varied considerably. The average caption speed for all programs was 141 words per minute, with program extremes of 74 and 231 words per minute. The second part of the study determined the amount of editing being done to program scripts. Ten-minute segments from two different shows in each of 13 program categories were analyzed by comparing the caption script to the program audio. The percentage of script edited out ranged from 0% (in instances of verbatim captioning) to 19%. In the third part of the study, commonly used words in captioning and their frequency of appearance were analyzed. All words from all the programs in the study were combined into one large computer file. This file, which contained 834,726 words, was sorted and found to contain 16,102 unique words.

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In 1972, public television station WGBH in Boston did a unique experiment in which *The French Chef*, a cooking program featuring Julia Child, was open-captioned. The success of this first attempt at captioning led WGBH to rebroadcast daily an open captioned version of *ABC World News Tonight* for deaf and hard of hearing people. During the 1970s, this was the only regularly broadcast television program in America designed to be accessible to deaf people. It was wildly popular in the deaf community because it was the only televised news program deaf people could understand.

When WGBH began rebroadcasting *ABC World News Tonight*, there were no rules for captioning. Captioning policy developed on a day-to-day basis as captioning problems arose. The guiding principle at that time was to make the program accessible to every deaf viewer regardless of reading ability. Because studies conducted by the Gallaudet University Office of Demographic Studies (Jensema, Schildroth, and O'Rourke, 1975; Trybus and Karchmer, 1977; Jensema and Trybus, 1978) indicated that the average graduate from an educational program for deaf and hard of hearing students read at about a third-grade level, WGBH extensively edited the program script. The word count was cut by about a third and the reading level was cut from roughly the sixth-grade level to the third-grade level. All passive-voice sentence construction was removed, nearly all idioms were removed, contractions were eliminated, clauses were converted into short declarative sentences, and even jokes and puns were changed if it was felt the deaf and hard of hearing audience would not understand them. These

captioning techniques, which almost everyone now considers overediting, continued for many years. Part of the reason for this was that deaf people were so delighted to have captions that they accepted almost anything thrown on the screen.

As captioned television became a standard part of television services in the late 1980s, deaf people began to examine the quality of captioning more closely. Deaf viewers wrote letters to caption companies indicating they wanted access to whatever was spoken on the audio and that captioners should not play the role of censors. According to conversations with captioning company officials, caption companies have tended to interpret this as meaning deaf people want straight verbatim captioning.

Counting both broadcast and cable, about 100 hours of captioned television programs are shown on national television in the United States each day, yet heretofore no formal data on the characteristics of the captions on these programs have been collected. Are programs now captioned verbatim? How much editing is done? What is the caption presentation speed of programs currently being shown on television? How does this presentation speed vary with the type of program? These and other questions are addressed in the research study reported here.

Table 1
Programs Selected for Study by Type and Number

Regular Programs Programs	N	%
Children's animation	20	11
Children's educational	11	6
Children's action	6	3
Prime-time dramas	26	14
Situation comedies	26	14
Films	21	11
News	20	11
Documentaries	17	9
Talk shows	10	5
Soap operas	9	5
Music specials	6	3
Sports	6	3
Live performances	5	3
Total Programs:	**183**	***98**
Music Videos		
2- to 5-minute songs	22	
Total number of programs:	**205**	

*Percentage sums to less than 100 because of rounding.

Method

Recording

Caption data for the present study were obtained from a sample of television programs recorded as they were telecast. A ten-member advisory panel met to select and analyze programs to be studied. This panel consisted of: Dr. Robert Davilla, New York School for the Deaf; Dr. Judy Johnson, Gallaudet University; Ellie Korres, Gallaudet University; Mardi Loetermen, WGBH; Beth Nubbe, NCI; Judith Brentano, The Caption Company; Martin Block, VITAC; Brenda Battat, SHHH; Dr. Linda Gambrell, University of Maryland; and JoAnn McCann, U.S. Department of Education. Jeff Hutchins of VITAC was the technical consultant for the project. Based on the recommendations of these captioning experts, a sample of 183 programs stratified by program type was selected and recorded in late 1994. Table 1 provides a breakdown of the program types and the number of programs selected for each type. The programs varied in length from a half-hour to about four hours, with the film Gettysburg being the longest. The programs represented a total of approximately 180 hours of airtime. Recording was done using the cable television service in a number of different homes. The exception was for some movies shown over premium cable channels. It proved easier to rent the films from a local video store than to record them from the cable system. All recording was done on a consumer-quality four-head videocassette recorder (VCR). In addition, the project staff gained access to 22 captioned music videos, each of which was between two and five minutes long. These were analyzed separately because they were so different from the regular programming.

Data Extraction

The videotapes were replayed with the signal being run through a special closed-caption decoder which read the closed-caption information from line 21 of the vertical blanking interval and fed that data into a computer file. Special software was written to read the computer's clock and attach a start time and an end time to each line of caption data. This time-and-caption file was the basic raw data analyzed for each program.

Programs recorded from the commercial networks and pay channels had advertisements, and even those on the PBS network were occasionally interrupted by station breaks or promotional material. All of this nonprogram material was edited out of each data file. This was done by importing each data file into a spreadsheet and deleting the nonprogram parts, a lengthy and time consuming process. The result was a final "clean" data file for each program.

Time Analysis

Analysis of the time data was much more complex than it might seem. Captions and the control codes associated with them are transmitted in a steady, binarily coded stream in the television signal, but the actual appearance of captions on the screen is not necessarily exclusively sequential. There is much time overlap in the caption lines.

There are two kinds of captions, each with different characteristics. Roll-up captions scroll up the screen, usually in a three-line format. As one line rolls off the top, a new line rolls up from the bottom. Although three lines are usually used, two-line and four-line captions also are possible. The roll usually has a steady speed, but the captioner can increase or decrease it as needed to keep up with the program audio. Pop-on captions are blocks of words consisting of one to four lines. These captions pop onto the screen and pop off after a few seconds. There may be more than one block of pop-on captions on the screen at one time. For both kinds of captions, the words are transmitted as one long stream of data, but control codes in the data stream make the decoder divide the words into caption lines, which sometimes have an overlap in screen display time.

The "clean" data files in this study were analyzed with a custom computer software program. Ten kinds of information were outputted by the computer program. The two most important were total time of program (the actual time from when a program begins to when it ends, including break time and commercial time; it does not include commercials or break time before and after a program) and total time of captions on screen (the time during which program captions are present on the screen; it does not include break time, commercial time, or program time during which no captions are shown). All of the analysis in this study is based on total time of captions on screen. Other kinds of information outputted by the computer program were total number of caption lines, total number of words, total number of characters, mean number of caption lines per minute, mean number of words per line, mean number of characters per line, mean number of words per minute, and mean number of characters per minute.

Editing Level

People who are deaf and hard of hearing have repeatedly indicated through letters to caption companies that they prefer verbatim captioning. They know they are not always getting perfect verbatim captioning because they sometimes see an actor speak a word or group of words for which there is no caption on the screen. The problem is that no one seems to know how much editing is done and how much is lost in the conversion from audio to captioning. In the present study, 26 programs (2 for each of 13 program types) were randomly selected, and for each program a sample of 10 minutes of audio was compared to the words that had been captioned. The results were tabulated to give an indication of the percentage of audio usually captioned for each program.

Word Analysis

What words are used in captioning? What is the frequency with which words appear in captions? To provide some insight into these questions, all the words in all the programs in the present study were combined into one large computer file. This file, which contained 834,726 words, was sorted and the 16,102 individual, unique words were arranged into a frequency distribution.

Results and Discussion

Program Characteristics

A total of 205 programs were analyzed: 183 regular programs and 22 short (two- to five-minute) music videos. Among the 183 regular programs, 78 ran a half-hour, 75 ran one hour to 90 minutes, 25 ran two hours, and 5 ran more than two hours. Overall, there were roughly 180 hours of video.

Caption Speed

In Table 2, data on caption speed are provided by category for the 183 programs analyzed for the present article. (We will discuss the 22 short music videos separately.) For each program grouping, the mean, standard deviation, maximum value, minimum value, and range are given for words per minute (WPM), characters per minute (CPM), characters per word, caption lines per minute, words per line, and characters per line. For all programs, the mean values were 141 WPM, 736 CPM, 5.2 characters per word, 38.7 caption lines per minute, 3.7 words per line, and 19.2 characters per line. WPM and CPM are the two indexes usually used to measure caption speed. WPM has more intuitive meaning for most people, even though it can be affected by differences in word length.

In the present study, we found that roll-up captions generally present more words over a given period than pop-up captions (151 WPM vs. 138 WPM), and that roll-up captions are used for a wider range of audio speeds, from very slow (74 WPM) to very fast (231 WPM).

Sports programs and music specials had the slowest caption speeds. Sports are visual in nature, and most viewers take more interest in screen action than in commentary. Music specials follow the pace of the music, and the lyrics often are sung more slowly than they

Table 2
Caption Speed Statistics

		Words/min.	Chars./min.	Chars./word	Lines/min.	Words/line	Chars./line
All programs (N = 183)	*M*	141	736	5.2	38.7	3.7	19.2
	SD	21	108	0.2	6.0	0.5	2.7
	Maximum	231	1,171	6.2	55.3	5.0	25.9
	Minimum	74	357	4.7	19.1	2.8	14.0
	Range	157	814	1.5	36.2	2.2	11.9
Roll-up captions (N = 46)	*M*	151	781	5.2	34.8	4.4	22.5
	SD	31	165	0.2	7.2	0.3	1.8
	Maximum	231	1,171	5.6	55.3	5.0	25.9
	Minimum	74	357	4.8	19.1	3.4	16.3
	Range	157	814	0.8	36.2	1.6	9.6
Pop-up captions (N = 135)	*M*	138	719	5.2	40.0	3.5	18.1
	SD	15	73	0.2	4.9	0.3	2.0
	Maximum	177	832	6.2	49.6	4.4	22.9
	Minimum	87	463	4.7	24.4	2.8	14.0
	Range	89	369	1.5	25.2	1.6	8.9
Talk shows (N = 10)	*M*	177	897	5.1	40.4	4.4	22.2
	SD	30	151	0.1	6.4	0.3	1.3
	Maximum	231	1,171	5.3	55.3	5.0	24.6
	Minimum	142	713	4.9	33.2	4.1	20.7
	Range	89	458	0.4	22.1	0.9	4.0
Sports (N = 6)	*M*	106	535	5.1	23.2	4.6	23.0
	SD	15	79	0.1	3.0	0.2	1.2
	Maximum	126	645	5.2	26.3	4.9	25.0
	Minimum	88	442	4.9	19.1	4.1	21.4
	Range	38	203	0.3	7.2	0.7	3.6
Soap operas (N = 9)	*M*	154	778	5.1	36.7	4.2	21.2
	SD	15	72	0.1	3.3	0.3	1.2
	Maximum	176	896	5.2	44.1	5.0	24.3
	Minimum	136	696	4.9	33.1	4.0	20.3
	Range	40	200	0.3	11.0	1.0	4.0
Situation comedies (N = 26)	*M*	147	758	5.2	43.1	3.4	17.7
	SD	10	51	0.1	3.8	0.3	1.3
	Maximum	162	825	5.4	49.6	4.0	20.3
	Minimum	119	593	5.0	35.3	3.0	15.5
	Range	43	232	0.4	14.3	1.1	4.8
Prime-time dramas (N = 26)	*M*	145	748	5.1	42.9	3.4	17.5
	SD	10	52	0.1	3.5	0.2	1.1
	Maximum	164	814	5.4	48.5	3.9	19.6
	Minimum	120	605	4.9	35.6	3.2	16.0
	Range	45	210	0.5	12.9	0.7	3.5
News (N = 20)	*M*	157	835	5.3	36.2	4.3	23.1
	SD	15	86	0.2	4.1	0.3	1.5
	Maximum	183	979	5.7	43.2	4.9	25.9
	Minimum	123	652	4.9	28.7	3.9	20.7
	Range	60	326	0.7	14.5	1.0	5.2
Music specials (N = 6)	*M*	107	551	5.2	29.0	3.7	19.2
	SD	24	135	0.2	8.1	0.5	2.6
	Maximum	144	729	5.4	41.6	4.5	22.4
	Minimum	74	357	4.8	19.2	3.2	16.3
	Range	70	372	0.6	22.4	1.3	6.1
Live performances (N = 5) (no music)	*M*	137	725	5.3	36.5	3.7	19.6
	SD	19	88	0.1	2.6	0.4	1.9
	Maximum	156	808	5.4	39.3	4.4	22.5
	Minimum	115	623	5.2	34.4	3.3	17.8
	Range	41	185	0.3	4.9	1.1	4.7
Children's educational (N = 10)	*M*	124	667	5.4	34.6	3.5	18.7
	SD	18	99	0.2	4.9	0.3	1.7
	Maximum	154	791	5.7	38.8	4.1	21.7
	Minimum	87	463	5.0	24.4	3.1	16.8
	Range	66	328	0.7	14.4	1.0	4.9
Children's animation (N = 20)	*M*	125	660	5.3	39.4	3.2	16.8
	SD	13	61	0.2	3.9	0.2	1.0
	Maximum	148	784	5.7	46.3	3.5	19.0
	Minimum	105	574	4.9	33.4	2.9	15.2
	Range	43	210	0.8	12.9	0.6	3.9
Children's action (N = 6)	*M*	131	685	5.2	40.2	3.3	17.0
	SD	20	101	0.1	5.0	0.2	1.4
	Maximum	152	788	5.5	45.7	3.5	19.1
	Minimum	95	494	5.1	33.2	2.9	14.9
	Range	57	294	0.4	12.6	0.6	4.2
Film (N = 22)	*M*	140	710	5.1	41.3	3.4	17.3
	SD	13	59	0.2	3.9	0.4	1.9
	Maximum	177	832	5.4	47.9	4.2	20.5
	Minimum	121	607	4.7	32.1	2.8	14.0
	Range	56	225	0.7	15.8	1.4	6.4
Documentary (N = 17)	*M*	139	766	5.5	35.7	3.9	21.6
	SD	12	43	0.2	3.4	0.4	1.7
	Maximum	161	829	6.2	45.6	4.9	25.4
	Minimum	113	698	5.2	31.0	3.3	18.1
	Range	48	131	1.0	14.6	1.6	7.3

Table 3
Speed Rates for Programs with Fastest and Slowest Captioning Captioning

	Program type	Caption type	Mean words/min.	Mean chars./min.	Mean caption lines/min.	Mean words/line	Mean chars./line	Mean chars./word
Programs with fastest captioning								
Later with Greg Kinnear	Talk show	roll-up 3-line	231	1171	55	4.2	21	5.1
Last Call	Talk show	roll-up 3-line	229	1134	46	5.0	25	5.0
Connie Chung	News	roll-up 3-line	183	920	38	4.8	24	5.0
Guiding Light	Soap opera	roll-up 3-line	178	870	36	5.0	24	4.9
Meet the Press	Talk show	roll-up 3-line	177	930	40	4.4	23	5.3
		M	**199**	**1005**	**43**	**4.7**	**24**	**5.0**
Programs with slowest captioning								
ABC Sports: Golf	Sports	roll-up 2-line	94	463	20	4.7	23	4.9
TNT Basketball	Sports	roll-up 3-line	86	442	19	4.6	23	5.0
Sesame Street	Children's Ed.	pop-on	87	463	27	3.2	17	5.3
Billboard Music Awards	Music special	roll-up 3-line	87	430	19	4.6	22	5.0
Whitney Houston	Music special	roll-up 3-line	74	357	22	3.4	16	4.8
		M	**86**	**431**	**22**	**4.1**	**20**	**5.0**

would be spoken. The result is a slower caption rate. There are exceptions, however, as we later show in the discussion of music videos.

Although we found children's programming to have a slow captioning rate, that rate was faster than expected. For children's educational, animation, and action programs, the rates were 124, 125, and 131 WPM, respectively. The overall mean for children's programs was 126 WPM. Program speed ranged from 87 WPM for *Sesame Street* to 154 WPM for *Bill Nye the Science Guy*. A trend toward faster caption rates for programs aimed at older children can be discerned; this initial finding, however, warrants more research.

In the middle range of caption speed were performances (137 WPM), documentaries (139 WPM), films (140 WPM), prime-time dramas (146 WPM), and situation comedies (147 WPM). These kinds of programs tended to cluster around the mean captioning speed of 141 WPM which was found for all 183 programs analyzed.

Soap operas (154 WPM), news programs (157 WPM), and talk shows (177 WPM) had the fastest caption speeds. The mean speed for talk shows was boosted by two late-night programs, *Later With Greg Kinnear* (231 WPM) and *Last Call* (229 WPM). Table 3 provides statistics on the programs with the five fastest and five slowest caption speeds. The five programs with the fastest speeds had a mean caption rate more than twice that of the five programs with the slowest speeds.

We had suspected that programs considered more difficult to read might have a longer mean word length. This was not the case. For example, although the captioning for *Sesame Street* was easier to read than for *Meet the Press*, the captions for both programs have a mean word length of 5.3 characters. More difficult material is not necessarily characterized by longer word length, and we cannot take word length as an indication of reading difficulty.

The music videos were analyzed as a separate category. Music videos were included in this study mostly as a matter of curiosity because they represent a unique kind of caption material. The caption speed for the 22 music videos varied from 60 to 311 WPM, a much wider range than was found in the regular program categories. In many music videos, images flash on the screen for a brief time. This makes captions harder to read because the viewer's attention is distracted. Rap music videos had the fastest and most difficult-to-read captions. For example, the captions for the song *Freak It* (311 WPM) proved impossible to understand without repeated viewing.

Caption Editing

For each of the program categories, two programs were randomly selected, and a 10-minute segment of each was analyzed to see if there were any words spoken but not captioned. The results are provided in Table 4. Several programs were 100% captioned. The most heavily edited program was a golf program on the ABC network for which only 81% of the spoken words were captioned. This program was clearly an anomaly because it was captioned live and roll-up captions were used, meaning that there were many times when captions could not be put on screen without obscuring a player in the act of putting or a ball rolling toward a cup.

Among the 26 programs examined, the average was 94% captioned. When the golf program was excluded, the average was 95% captioned. To take a closer look at the material being edited, we selected two programs and made a word-by-word inspection. A situation comedy, *Hangin' with Mr. Cooper*, was chosen because it was the most heavily edited program with pop-on captions (87% captioned). At 91%

captioned, the *Today* show was chosen as an example of a heavily edited program with roll-up captions.

Appendix Table 1 shows the changes made in a captioned segment of *Hangin' with Mr. Cooper*. The first column gives the exact words which were spoken. Most of the editing does not alter the meaning of the text. The changes usually do no more than provide a slight simplification of the sentence structure. Perhaps some of the changes were made because the captioner's supervisor gave instructions to caption at a certain WPM rate. For example, replacing "you know you don't have" with "you don't have" saves two words but has little effect on length or readability. Another possibility is that the studio provided the captioner with a script and the captioner captioned the program verbatim, but then the studio decided to go over the program again and "sweeten" the audio after it was captioned.

Appendix Tables 2, 3, and 4 illustrate two different kinds of editing applied to the *Today* show. Parts of this program, such as the opening segment and news updates, follow a script; other parts, such as interviews, do not. For the scripted segments, the caption company is given a copy of the script before the show airs. The company converts the script to captions and feeds these captions into the broadcast at airtime. The program's hosts and other on-air staff see the script on a TelePrompTer, but they do not always say exactly the same words that they read. The result is "editing" in the form of ad-libbing. Appendix Table 2 is an excerpt from a scripted segment in which several people are interacting. There is considerable ad-libbing. Appendix Table 3 is an excerpt from a scripted segment consisting of straight news reporting. The newscaster stays with the script, and there is very little difference between the spoken and captioned versions. Appendix Table 4 is an excerpt from an interview on *Today* that was captioned live by a stenocaptioner. There is much editing, but the essential information is still there.

Table 4
Percentage of Captioned Audio

Program type	Program title	Percent captioned
Soap opera	*The Bold and the Beautiful*	100
	Guiding Light	100
Documentary	*Wild America*	100
	Great Railroad Journey	99
Film	*Ace Ventura, Pet Detective*	98
	Madame Butterfly	97
Talk show	*Late Show with David Letterman*	99
	Tonight Show with Jay Leno	96
Live performance	*Clio Awards*	97
	Seigfried and Roy	95
Prime-time drama	*Arly Hanks*	97
	ER	94
Music special	*Whitney Houston*	100
	Billy Ray Cyrus Special	91
News	*ABC News*	98
	Today	91
Children's action	*Power Rangers*	96
	California Dreams	90
Children's animation	*Animaniacs*	97
	Batman - The Series	89
Children's educational	*Kids Songs*	93
	Barney	88
Situation comedy	*In Living Color*	91
	Hangin' with Mr. Cooper	87
Sports	*CBS Sports: Figure Skating*	90
	ABC Sports: Golf	81

Word Analysis

The caption scripts from all the programs in the present study were combined into one large computer file. This file was edited to remove punctuation and anything else that was not a word. Certain nonstandard utterances such as uh, mmm, and ahh were kept, since they are commonly used in captioning to indicate certain sounds in the audio. The resulting word list was sorted and arranged into a frequency distribution. The file had 843,726 words, of which 16,102 were unique. Just 10 words (the, you, to, a , I, and, of, in, it, that) accounted for 176,793 of the 834,726 words (21%). Half of all the words captioned were accounted for by 79 unique words. Just 250 words accounted for more than two-thirds of all the words used in the captions. The graph at Figure 1 depicts the cumulative frequency of the 4,000 most frequently occurring unique words.

For comparison, the frequency distributions of the words in about a dozen individual programs were examined. All the cumulative frequency graphs for these programs were very similar. Figure 2 provides a cumulative frequency graph for the 678 unique words used in an episode of *Wings*, a situation comedy typical of those currently shown on the air. For comparison purposes, the graph also includes the cumulative frequency curve for the 678 most frequently used words among all programs. The *All Programs* line provides a lower band for the frequency curve of any individual program, since it represents all unique words available among all programs in this study. In this *Wings* episode, just 51 unique words accounted for half of all words used in the captions and 174 words accounted for 75% of the words used. The important point is that captioned television (and, by inference, the

Figure 1
Cumulative Frequency Percentage for 4,000 Most Frequently Occuring Unique Words

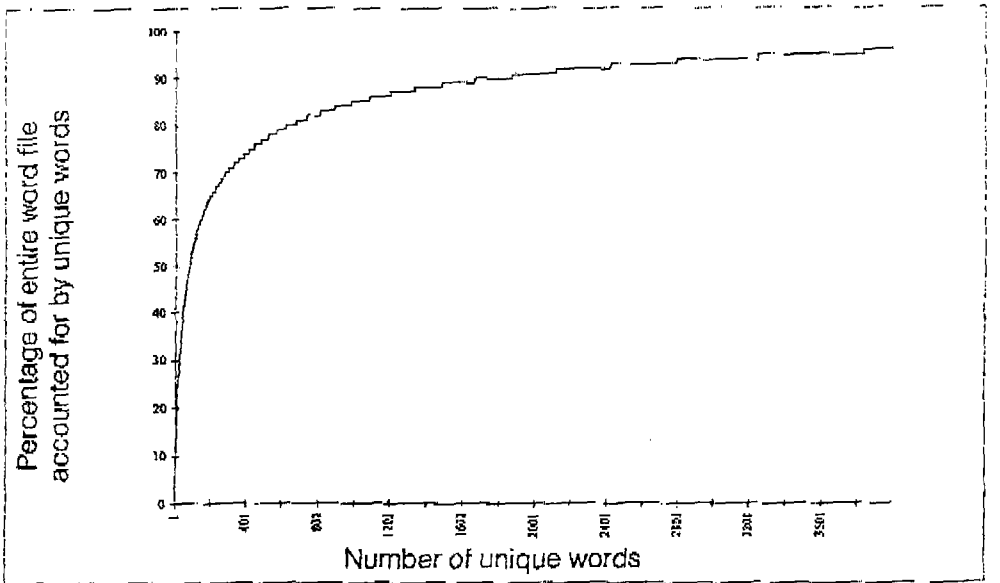
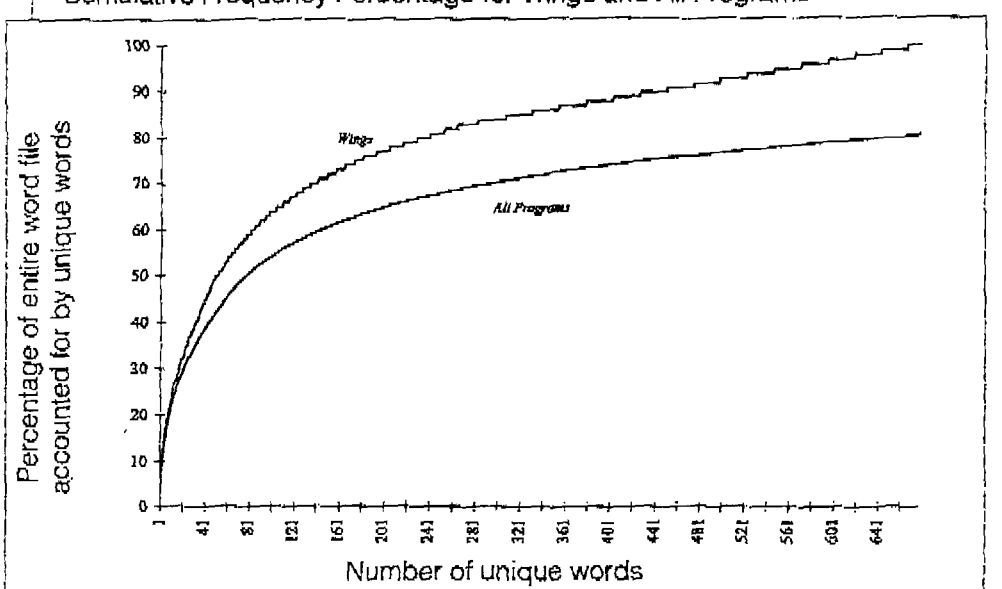


Figure 2
Cumulative Frequency Percentage for *Wings* and *All Programs*



audio that the captions represent) uses relatively few unique words. There are at least 500,000 words in the English language, but mastery of fewer than 500 words will help a viewer to understand most of the vocabulary in any television program shown in the United States today.

Conclusion

This research has examined the statistical characteristics of the closed captions in 205 television programs, a broad sampling of the material currently available over broadcast and cable television. The overall mean caption speed among all programs was 141 WPM, but this does not indicate the wide variation among television programs. The slowest program (a *Whitney Houston* music special) had only 74 WPM, while a late night talk show (*Later With Greg Kinnear*) had 231 WPM.

Most captioning shown today appears to be near-verbatim. Variance in caption speed is mostly a function of the audio speed rather than a function of captioning techniques or editing. For example, the slow captions (74 WPM) on the *Whitney Houston* program were compared to the program audio and were found to be straight verbatim captioning. In the cases where considerable caption editing was found, there were usually good reasons. A golf program was found to have the most editing (only 81% of the audio was captioned), but this editing was done because the roll-up captions would have obscured on-screen action and seriously detracted from the program. When editing was found on programs, much of it was attributable to program circumstances and technological limitations, rather than careless captioning or a deliberate editing policy. Overall, captions match program audio about 95% of the time.

Captions, and by extension the spoken language they represent, use relatively few unique words, but they use them often. Just 250 unique words represented two-thirds of all 834,736 captioned words in the programs. The captions on a typical half-hour program use about 700 unique words. It would seem that mastery of the use of just a relatively small number of words is important to understanding captioning.

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Appendix Tables

Appendix Table 1

Changes in a Captioned Segment from *Hangin' with Mr. Cooper*

Spoken	Removed	Added	Caption
TURN IT UP, I CAN'T HEAR ANYTHING.	I CAN'T HEAR ANYTHING.		TURN IT UP.
SHH! HE'S ON THE PHONE.			SHH! HE'S ON THE PHONE.
COME ON, BABY.			COME ON, BABY.
YOU KNOW YOU DON'T HAVE	YOU KNOW		YOU DON'T HAVE
TO GO SHOPPING.			TO GO SHOPPING.
YOU KNOW WHAT BIG DADDY			YOU KNOW WHAT BIG DADDY
WANT FOR HIS BIRTHDAY.			WANT FOR HIS BIRTHDAY.
HOLD ON			HOLD ON
LET ME CALL YOU BACK, ALL RIGHT.			LET ME CALL YOU BACK.
WHAT DOES HE WANT?			WHAT DOES HE WANT?
HEY, BIG DADDY.			HEY, BIG DADDY.
WE'RE SORRY COUSIN MARK.	COUSIN MARK		WE'RE SORRY
WE WERE JUST TRYING TO FIND OUT	WERE JUST TRYING	WANTED	WE WANTED TO FIND OUT
WHAT YOU WANTED			WHAT YOU WANTED
FOR YOUR BIRTHDAY.			FOR YOUR BIRTHDAY.
WELL YOU KNOW YOU TWO SHOULDN'T	WELL YOU KNOW...TWO		YOU SHOULD'NT
BE EAVESDROPPING.			BE EAVESDROPPING.
CAUSE YOU NEVER KNOW	CAUSE		YOU NEVER KNOW
WHAT YOU MIGHT HEAR,			WHAT YOU MIGHT HEAR,
LIKE HOW TYLER'S			LIKE HOW TYLER'S
PARENTS ARE SENDING HIM	PARENTS ARE SENDING HIM	BEING SENT	BEING SENT
TO MILITARY SCHOOL.			TO MILITARY SCHOOL.
THE FEW, THE PROUD,			THE FEW, THE PROUD,
THE BIG-HEADED.			THE BIG-HEADED.

Appendix Table 2

Changes in Scripted *Today* Show Segment: People Interacting

Spoken	Removed	Added	Caption
AND WELCOME TO TODAY			>>>AND WELCOME TO TODAY
ON THIS THURSDAY MORNING.			ON THIS THURSDAY MORNING.
I'M KATIE COURIC.			I'M KATIE COURIC.
AND I'M MATT LAUER, FILLING IN FOR	FILLING IN FOR		>>AND I'M MATT LAUER,
BRYANT GUMBELL WHO IS ON	GUMBELL WHO		BRYANT IS ON
VACATION THIS WEEK.			VACATION THIS WEEK.
AND MATT AHEAD IN OUR FIRST HALF	AND MATT		>>AHEAD IN OUR FIRST HALF
HOUR THIS MORNING,	THIS MORNING		HOUR,
WE'RE GOING TO GET AN UPDATE	RE GOING TO	LL	WE'LL GET AN UPDATE
ON THE LATEST DEVELOPMENTS			ON THE LATEST DEVELOPMENTS
IN THE O.J. SIMPSON CASE			IN THE O.J. SIMPSON CASE
AND HEAR WHAT NICOLE BROWN			AND HEAR WHAT NICOLE BROWN
SIMPSON'S SISTER HAD TO SAY			SIMPSON'S SISTER HAD TO SAY
OUTSIDE THE COURTROOM.			OUTSIDE THE COURTROOM.
WE'LL ALSO LOOK			WE'LL ALSO LOOK
AT THE BIZARRE AND VERY TRAGIC	VERY		AT THE BIZARRE AND TRAGIC
STORY OUT OF SWITZERLAND,			STORY OUT OF SWITZERLAND,
WHERE 48 PEOPLE DIED			WHERE 48 PEOPLE DIED
IN A MASS SUICIDE.			IN A MASS SUICIDE.
MATT, AND ANOTHER SAD	MATT	VERY	>>AND ANOTHER VERY SAD
STORY THIS MORNING — KATIE	KATIE		STORY THIS MORNING
THE PARENTS OF A YOUNG AMERICAN BOY	AMERICAN		THE PARENTS OF A YOUNG BOY
KILLED BY BANDITS IN ITALY			KILLED BY BANDITS IN ITALY
A WEEK AGO TODAY.			A WEEK AGO TODAY.

Appendix Tables

Appendix Table 3

Changes in Scripted *Today* Show Segment: Straight News Report

Spoken	Removed	Added	Caption
THE GRIM SEARCH			>>>THE GRIM SEARCH
CONTINUES THROUGH THE RUINS			CONTINUES THROUGH THE RUINS
OF BURNED-OUT HOMES	HOMES	HOUSES	OF BURNED-OUT HOUSES
IN SWITZERLAND.			IN SWITZERLAND.
IT'S THE AFTERMATH			IT'S THE AFTERMATH
OF AN APPARENT MASS SUICIDE			OF AN APPARENT MASS SUICIDE
BY MEMBERS OF A DOOMSDAY			BY MEMBERS OF A DOOMSDAY
CULT THAT HAS LEFT AT LEAST			CULT THAT HAS LEFT AT LEAST
50 PEOPLE DEAD			50 PEOPLE DEAD
IN SWITZERLAND AND IN CANADA.	IN		IN SWITZERLAND AND CANADA.
DETAILS NOW FROM NBC'S	NOW		DETAILS FROM NBC'S
KEITH MILLER.			KEITH MILLER.
THE POLICE SAY THE DEATH			>>THE POLICE SAY THE DEATH
TOLL COULD GO HIGHER.			TOLL COULD GO HIGHER.
INVESTIGATORS WAITED UNTIL			INVESTIGATORS WAITED UNTIL
THIS MORNING TO SEARCH			THIS MORNING TO SEARCH
A BURNT-OUT SKI CHALET	T	ED	A BURNED-OUT SKI CHALET
FEARING IT COULD BE			FEARING IT COULD BE
BOOBY-TRAPPED.			BOOBY-TRAPPED.

Appendix Table 4

Changes in Unscripted *Today* Show Segment: Captioned Live by Stenographer

Spoken	Removed	Added	Caption
WHAT HAPPENED?			WHAT HAPPENED?
>>WELL UH. INDIVIDUAL INVESTORS	WELL, UH		>>INDIVIDUAL INVESTORS
ACTUALLY HUNG IN THERE.			ACTUALLY HUNG IN THERE.
THE MARKET WAS DOWN THE			THE MARKET WAS DOWN THE
WORST WE'VE HAD ALL YEAR.			WORST WE'VE HAD ALL YEAR.
MOSTLY BECAUSE TECHNOLOGY STOCKS	MOSTLY		BECAUSE TECHNOLOGY STOCKS
TOOK A REAL HIT.			TOOK A REAL HIT.
>>AND DO YOU NOW RECOMMEND THAT, UH, SMALL	AND, NOW, THAT, UH,		DO YOU RECOMMEND SMALL
INVESTORS GET BACK INTO			INVESTORS GET BACK INTO
TECHNOLOGY STOCKS?			TECHNOLOGY STOCKS?
>>YES	>>YES		
>>AS A LOT OF PEOPLE ARE DOING	AS		A LOT OF PEOPLE ARE DOING
RIGHT NOW.	RIGHT NOW	THIS?	THIS?
>> THEY ARE. THEY ARE.	THEY ARE.		>>THEY ARE.
THEY HAVEN'T HAD MUCH CHANCE TO	MUCH		THEY HAVEN'T HAD A CHANCE TO
GET INTO THESE THINGS AT LOWER	THINGS		GET INTO THESE AT LOWER
PRICES.			PRICES.
BUT THEY'VE DONE THAT AND ALREADY THEY'VE	BUT, ALREADY THEY'VE	HAVE	THEY'VE DONE THAT AND HAVE
COME BACK QUITE STRONGLY. SO I THINK	QUITE, SO I THINK		COME BACK STRONGLY.
IT IS TIME TO GET BACK INTO	IS	'S	IT'S TIME TO GET BACK INTO
TECHNOLOGY.			TECHNOLOGY.

Viewer Reaction to Different Captioned Television Speeds

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Abstract

A series of 24 short, 30-second video segments captioned at different speeds were shown to 578 people. The subjects used a five-point scale (Too Fast, Fast, OK, Slow, Too Slow) to make an assessment of each segment's caption speed. The "OK" speed, defined as the speed at which "Caption speed is comfortable to me," was found to be about 145 Words Per Minute (WPM). Most subjects did not seem to have significant trouble with the captions until the rate was at least 170 WPM.

People who could hear wanted slightly slower captions. However, this seemed to relate to how often people watched captioned television. Frequent viewers were comfortable with somewhat faster captions. Age and sex were not related to the caption speeds people were comfortable with. Education had no relation to caption speed except that people who had attended graduate school might prefer slightly faster captions.

Introduction

Since it first appeared on television broadcasts on March 16, 1980, close captioned television has become an important factor in the education and entertainment of people who are deaf or hard of hearing. There are over 500 hours of closed captioned television programming shown each week and the number of hours is steadily increasing. By the turn of the century, most programs shown on television are expected to be closed captioned.

This outpouring of televised material for people who are deaf or hard of hearing has raised many questions concerning how well the captions fit their intended audience. One of the major issues is caption speed. When closed captions were first shown, they were usually edited down to 120 Words per minute (WPM) or less. Since then, most caption companies have adopted a policy of captioning every word spoken. This change was made partly in response to viewer comments and partly due to the cost of editing. Unfortunately, relatively little is known of the relationship between caption speed and the reading skills and preferences of the viewers. The author of this article has been working for several years to investigate this relationship.

This is the second in a series of research studies related to the speed with which captions are presented on television programs. The first study (Jensema, McCann, and Ramsey, 1996) examined over 200 closed captioned television programs and calculated the caption presentation speed of each. The mean caption speed among all programs was 141 WPM, with considerable variation for different types of programs.

The second study, the results of which are presented here, measured how comfortable people were with different caption speeds. This was done by showing them a series of captioned video segments and asking them how they liked the caption speed.

Procedure

Experimental Materials

The materials in this project were a series of 24 short, 30-second video segments, each captioned at a specific speed. Subjects watched each segment and made an assessment of the segment's caption speed. The video segments were developed specifically for this project.

Three topics were selected for the video tape materials: Sailing, Space, and the Nation's Capital. Posters were obtained for each topic, with care being taken to select posters which were relevant to the topic, but did not give information related to the captions. A 30-second video was shot of each poster, with the camera being moved around the poster to give the illusion of a moving picture. The idea was to create interesting video images related to the topic to distract the viewer without duplicating information given in the captions. For example, if the captions talked about the White House, an image of some other Washington building would be shown.

Each topic was introduced with a simple name given on a blank screen and had eight 30-second video segments. Each segment was separated by ten seconds of blank screen on which a printed message was shown telling the subjects to mark their papers. To control for audio information, the tapes were completely silent and had no audio of any kind.

A caption script was developed for each of the three topics. These scripts were divided into eight parts, one for each of the eight video segments of the topic. Each part of the caption script had a specific number of words in it which reflected the caption speed. For example, a segment captioned at 110 WPM would have exactly 55 words.

The caption speeds used were 96, 110, 126, 140, 156, 170, 186, and 200 WPM. The order of these speeds was randomly varied for each topic, with care being taken so that extreme speeds did not follow one another. For example, a 96 WPM segment was never followed by a 200 WPM segment. The objective was to avoid sudden extreme changes in caption speed that might artificially influence subject assessment.

The words of the script for each topic were encoded on the tapes as closed captions. A short, two-segment topic on the subject of "Art" was created as practice material to be put at the beginning of each tape. Then a total of six different experimental tapes were made. Each tape representing a different order of the three topics (123, 132, 213, 231, 312, and 321.) Each final version of the experimental tape had the two "Art" topic practice sessions followed by the three experimental topics in a particular order.

Data collection instrument

All subjects were given a spoken and signed introduction, and then handed a six-page data collection instrument. This instrument contained more introductory material and room for the subjects to record their responses to four things:

1. A background questionnaire.
2. A simple vision test.
3. A practice video.
4. Three captioned videos.

There were separate background questionnaires for adults and students. Both contained items for age, sex, hearing loss, number of people in household, and television viewing habits. In addition, the adult questionnaire asked for educational background and employment information, while the student questionnaire asked for the student's grade.

A simple vision test was given to all subjects. This was done to assure that they were physically able to see the captions on the television screen. A simple eye chart was placed on the screen and the subjects were asked to copy the letters of the eye chart onto a blank paper form. The smallest characters on the eye chart were considerably smaller than the caption characters, assuring that anyone who could copy the eye chart could see the captions clearly. The results of copying the eye chart were examined before the test videos were shown. Anyone having problems filling out the

eye chart was moved closer to the screen.

The third part of the data collection instrument gave a definition of the response categories to be used and a place for the subjects to mark their responses to the two practice video segments. The response categories used in this study and their definitions were:

Category	Definition
Too Fast	Captions should be slower. Hard to read the captions. I miss some words.
Fast	Captions should be slightly slower. Captions should be on the screen a little longer.
OK	Caption speed is comfortable to me.
Slow	Captions should be slightly faster. Captions are on the screen a little too long.
Too Slow	Captions should be much faster. I am bored while reading them.

After viewing a video segment, each subject marked a category box corresponding to his or her judgement of the caption speed.

The fourth part of the data collection instrument consisted of forms for the subjects to use in recording their responses to the experimental video segments. The layout of these forms was the same as for the two practice video segments.

Experimental procedure

All subjects were seated about 10 feet from a 27-inch television set. The experimenter gave a brief introduction to the study and handed out the data collection instrument. The subjects filled out the background questionnaire and copied the eye chart characters from the television screen to their paper form. The experimenter observed them while they copied the eye chart and anyone having problems was urged to move closer to the screen.

The categories to be used for assessing caption speed were explained and the two practice videos were shown. Any questions the subjects had concerning the caption assessment were answered.

The subjects then viewed all 24 captioned video segments without interruption except to mark their forms. There was a 10-second gap between segments for this purpose. The experimenter observed the subjects and paused the tape if the 10-second gap was not enough time for everyone to finish marking their form. Most subjects had enough time and it was seldom necessary to pause the tape.

After all 24 experimental video segments had been shown, all papers were collected from the subjects and there was a short discussion during which any questions the subjects had were answered. Finally, each subject was given $5 as an honorarium for taking part in the study.

Data was collected from 578 subjects, coded, and entered into a computer file. Because of careful experimental administration, there was very little missing data. The data file was checked for

accuracy, and then subjected to a statistical analysis, the results of which are presented in the next section.

Results

Composite Scores

Each subject's overall score for each topic was calculated by adding up the response for the eight segments of the topic and dividing by 8. The mean for each topic over all subjects was then calculated and the results are given in Table 1. There was no significant difference between the scores on the three topics. Since there was no significant difference between topics, it was decided to create and work with composite scores.

Table 1
Scores for Each Topic
(N= 573)

Topic	Mean	St. Dev.
Washington D.C.	3.02	0.93
Space Shuttle	3.13	0.93
Sailing	3.09	0.94

The scores on the three topics for each subject were added together and divided by 3 to get across-topic composite scores for each speed on each subject. Table 2 gives the mean and standard deviation of the composite score for each speed. Adding together the subject's composite scores for each speed and then dividing by 8 created an overall composite score. The mean of the overall composite score was 3.09 and the standard deviation was .39. Figure 1 shows a histogram of the overall composite scores and indicates they form a reasonable approximation of a normal distribution. In the remainder of this study, analysis will focus on the composite scores.

Comfortable Caption Speed

In the score coding used, "3" indicates the caption speed is "OK", defined as "Caption speed is comfortable to me." A higher score indicates the caption speed is faster than is comfortable, and a lower score indicates the captioning is slower than is comfortable. Table 2 indicates that a mean score of "3" would be associated with a caption speed of between 140 and 156 WPM. Using simple interpolation, the "OK" speed is estimated at 145 WPM. Figure 2 shows this graphically.

Table 2
Scores at Each Caption Speed
(N = 573)

Speed (WPM)	Mean	St. Dev.
96	2.21	0.68
110	2.61	0.54
126	2.79	0.51
140	2.89	0.47
156	3.22	0.48
170	3.49	0.55
186	3.60	0.62
200	3.95	0.66
Combined Speeds	3.09	0.39

Hearing Status

The scores were broken down by whether the subject was deaf, hard of hearing, or hearing. Table 3 gives the mean score for subjects in each hearing category at each caption speed. Figure 3 shows this in a graphic format. The differences between groups were especially noticeable at higher captioning speeds. Overall, the mean score was 3.01 for deaf subjects, 3.04 for hard of hearing subjects, and 3.18 for hearing subjects. An analysis of variance indicated a significant difference between the groups on overall scores ($F=12.572$, df 2/569, $p<.0001$). The basic conclusion is that the more hearing people had, the slower they wanted the captions to be.

Table 3
Mean Score by Hearing Status
(N = 573)

	Words Per Minute								Overall
	96	110	126	140	156	170	186	200	Score
Deaf	2.32	2.61	2.77	2.86	3.12	3.35	3.35	3.68	3.01
HOH	2.19	2.65	2.68	2.83	3.22	3.44	3.54	3.82	3.04
Hearing	2.12	2.60	2.84	2.93	3.29	3.63	3.81	4.20	3.18
All Subjects	2.21	2.61	2.79	2.89	3.22	3.49	3.60	3.95	3.09

Viewing Frequency

It was expected that the hearing subjects would want slower captions because they had less experience watching captions and were not used to reading them. An analysis was done of how often people watched captioned television. The categories for this variable were "Daily", "Weekly", "Monthly", "Yearly", and "Never". It was found that there was no significant difference between the scores for the "Weekly" and "Monthly" categories, and between the "Yearly" and "Never" categories, so these were combined. The final categories used were "Daily", Weekly/Monthly", and "Yearly/Never".

Table 4 shows the number of subjects according to their hearing status and the frequency with which they watch captioned television. The frequencies in Table 4 are very significant (chi-square=266.218, df=4, $p<.0001$). Deaf and hard of hearing people tend to watch captioned television daily and hearing people seldom watch it.

Table 4
How Often Captions are Watched

	Deaf		HOH		Hearing		All Subjects	
	N	%	N	%	N	%	N	%
Daily	169	83	74	68	30	11	273	48
Weekly / Monthly	20	10	19	17	81	31	120	21
Yearly / Never	14	7	16	15	151	58	181	32
All Subjects	203	100	109	100	262	100	574	100

As previously mentioned, comfortable caption speed has a relation to the frequency with which people watch captioned television. Table 5 gives the mean of the overall score for each caption viewing frequency category. Over all subjects, people who seldom watch captions tend to want slightly slower captions (df=2/568, F=14.838, $p<.0001$).

Table 5
Mean Overall Scores by Caption Viewing Frequency
(N = 573)

Viewing Frequency	Mean Overall Score
Daily	3.01
Weekly / Monthly	3.12
Yearly / Never	3.20
All Frequencies	3.09

The questionnaire also asked subjects how many years they had been watching closed captions. Number of years of caption viewing had no relationship to how comfortable different caption speeds were.

Age

It was originally thought that there might be a relationship between age and the caption speeds an individual thought were comfortable. Teenagers might prefer slower captions because they are still in the process of being educated. Subjects over 40 years of age might prefer slower captions because eyesight usually begins to deteriorate at about that age. However, examination of a scatter plot between overall score and age showed that there was no relationship between age and comfortable caption speed. The correlation between age and overall score was $r = .11$, clearly non-significant.

Sex

The mean overall scores for males and females were 3.04 and 3.14, respectively. This is significant ($df=571$, $t=3.001$, $p=.0028$), but the difference could be traced to hearing status. When hearing status was controlled, there was no significant difference in caption speed scores between the two sexes.

Education

The adult subjects were asked the highest level of education they had completed. The responses of those who answered ($n=402$) were coded into "High School or Less", "Trade School or College", and "Graduate School". The mean overall scores for these three categories were 3.15, 3.15, and 3.03. Subjects who had attended graduate school prefer slightly faster captions, but the results were not quite significant ($df=2/399$, $F=2.776$, $p=.0635$). Educational level does not appear to play a meaningful role in caption speed considered comfortable by adults.

A total of 120 students indicated the school grade they were in. No significant difference in overall caption speed score was found between grades.

School-Aged Deaf and Hard of Hearing Subjects

In this study we were especially interested in the caption speed scores of school-aged deaf and hard of hearing people because of the potential educational impact of captioning. The study had 160 deaf and hard of hearing subjects under the age of 20. All but 13 of these students were teenagers. The mean age was 15.2 years, with a standard deviation of 2.2 years. There were 94 male and 66 female subjects, with 106 being deaf and 54 being hard of hearing.

The means of the scores at each speed and the overall score are given in Table 6. These means are very close to those given in Table 2 for all subjects in the study and the overall comfortable speed is estimated to be around 147 WPM. This indicates that deaf and hard of hearing teenagers are most comfortable at approximately the same caption speeds as the overall viewing population.

Table 6
Scores for Deaf and
Hard of Hearing Teenagers
(N = 160)

Words Per Minute	Mean	Std. Dev.
96	2.21	0.77
110	2.60	0.63
126	2.72	0.53
140	2.89	0.57
156	3.15	0.49
170	3.38	0.61
186	3.39	0.65
200	3.73	0.74
All Speeds	3.01	0.41

Table 7 gives the frequency with which the students reported watching caption television. The results are extremely interesting, with 12 percent of the students reporting that they watched captioned television "Yearly/Never". These responses were noted during data collection and some of the subjects were questioned about them. Many of the respondents who report that they seldom watch captioned television were day students who came from poor inner-city homes with old (pre-July 1993) television sets which did not have caption decoders built in. These students had little access to captioned materials, a major educational disadvantage for them. They did watch some captioned television as part of their schoolwork, but they consider this "work." To them, "watching captioned television" means recreational viewing at home.

Table 7
Frequency of Caption Viewing by
Deaf and Hard of Hearing Teenagers

	N	%
Daily	112	71
Weekly / Monthly	26	17
Yearly / Never	19	12
All D/HOH Teens	157	100

Deaf students and hard of hearing students did not differ significantly in frequency of caption television viewing. There was also no significant relationship between viewing frequency and caption speed comfort.

Discussion

A previous study by Jensema, et. al. (1996) indicated that the overall mean speed of captioned television programs is 141 WPM, with a standard deviation of 21 WPM. A major goal of the study reported here was to determine how this compared with the caption speeds with which people were most comfortable. The data indicate that the mean caption speed that "is comfortable to me" is about 145 WPM, very close to the 141 WPM mean rate actually found in television programs. This study used 30-second video segments and watching these is obviously not directly comparable to watching a full-length television program. However, the results are suggestive and indicate that the caption speed rates used today are comfortable for most viewers.

Of particular interest in this study was the adaptability exhibited by the respondents. As caption speed increased, the respondents recognized this, but most seemed able to adjust and did not appear to consider the captions unacceptable. Table 2 shows that at 170 WPM the mean score was 3.49, about halfway between "Caption speed is comfortable to me" and "Captions should be slightly slower. Captions should be on the screen a little longer." This suggests that most viewers are able to adjust to higher captioning rates and will not object to verbatim captions when the audio rate picks up.

Another way of looking at this is to determine how many subjects checked the "Too Fast" category at different caption speeds. This category was defined as "Captions should be much slower. Hard to read the captions. I miss some words." The percentages of subjects checking "Too Fast" at various caption speeds were 200 WPM - 28%, 186 WPM - 12%, 170 WPM - 9%, 156 WPM - 4%, 140 WPM - 1%. Apparently, most subjects do not seem to have significant trouble with the captions until the caption rate is at least 170 WPM. The mean speed of captioning shown on television today (141 WPM) certainly seems acceptable. Only about 1% would consider 141 WPM "Too Fast".

It was expected that hearing people would not depend on captions and would have less practice in reading captions. Because of this, hearing people were expected to want slower captions. Table 3 showed that the more hearing people had, the slower they wanted captions to be. Table 5 showed that the less subjects viewed captions, the slower they wanted the captions to be.

The experimental tapes in this study had no audio and hearing people became effectively "deaf" for purposes of the experiment. The score differences in Tables 3 and 5 are not large, and the findings suggest that a newly deafened person needs relatively little practice to adjust to reading television captions. This conclusion was also supported by the finding that number of years of caption viewing had no relation to the scores. People apparently adjust to caption reading quickly and practice beyond this makes little difference.

A very important issue, one that was not covered in this study, is the age at which caption speed begins to matter. The study had only a few subjects under the age of 13. Certainly, most children are reading captions at a much younger age, but how young and how fast can they read? Further work is needed to determine the age at which children start to read captions and the speeds they can handle as their caption reading skills improve.

References

Jensema, C., McCann, R., and Ramsey, S. (1996). Closed-Captioned Television Presentation Speed and Vocabulary. American Annals of the Deaf. 141(4), 284-292.

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Figure 1 - Histogram of Overall Scores

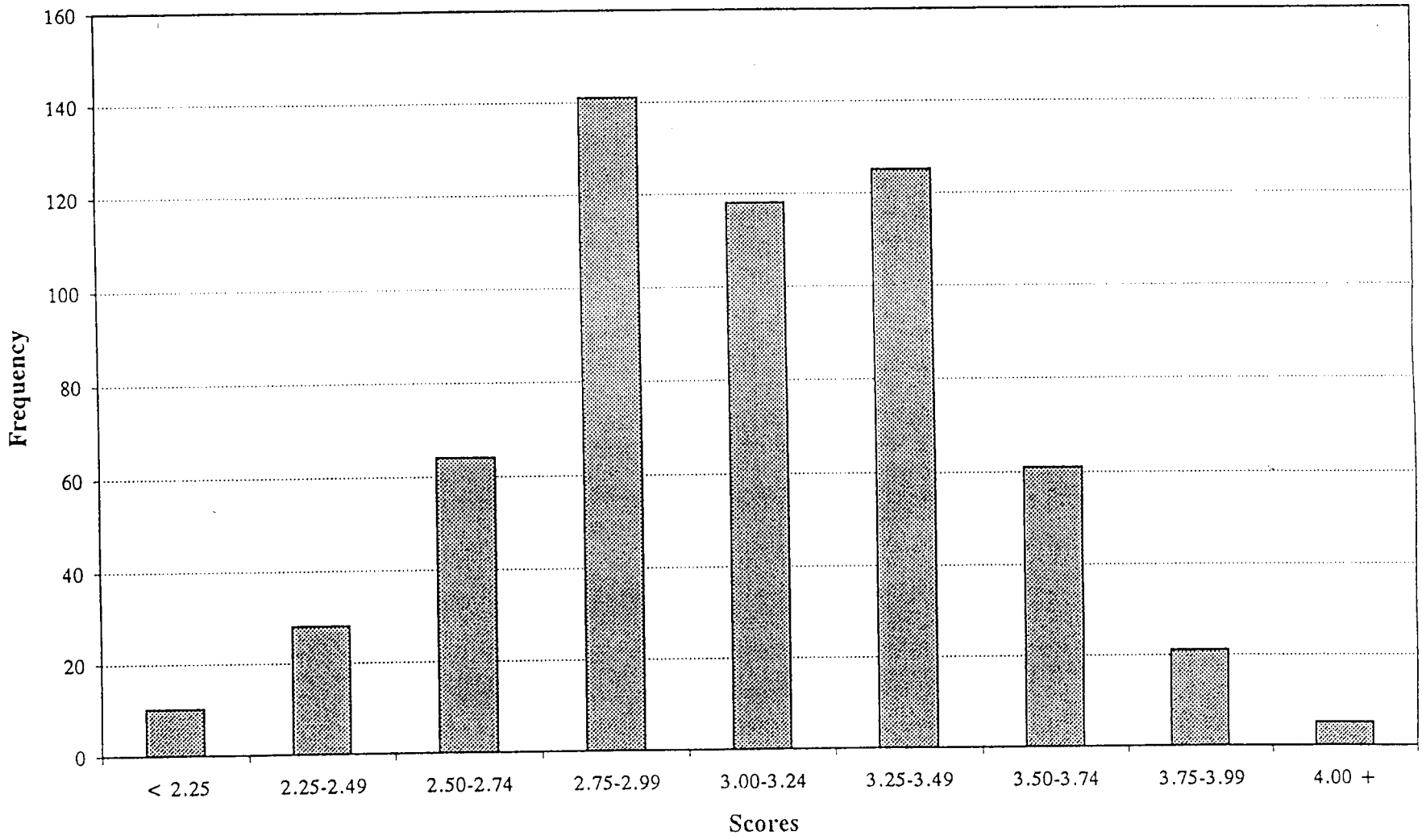


Figure 2 - Evaluation of Caption Speed

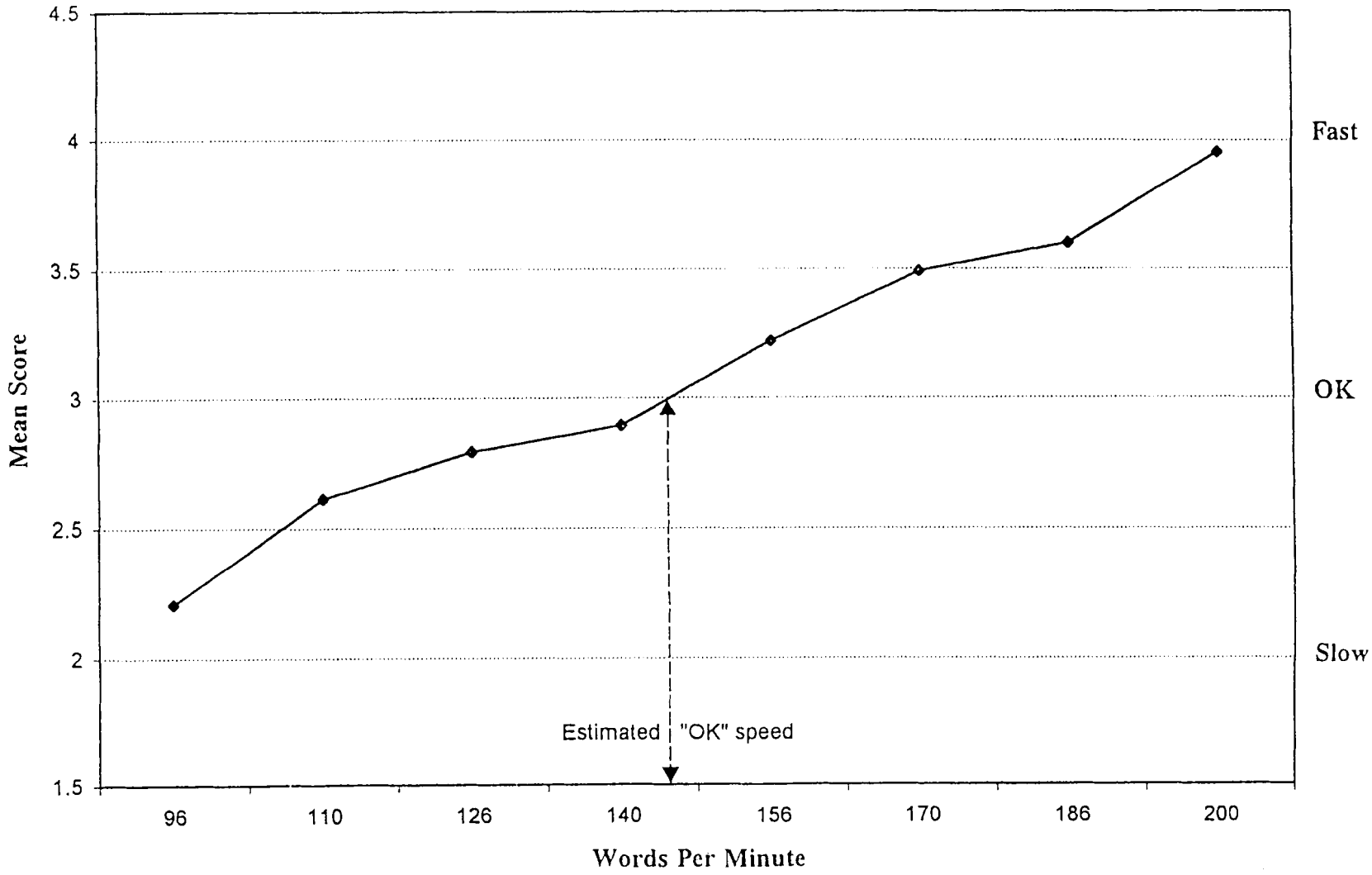
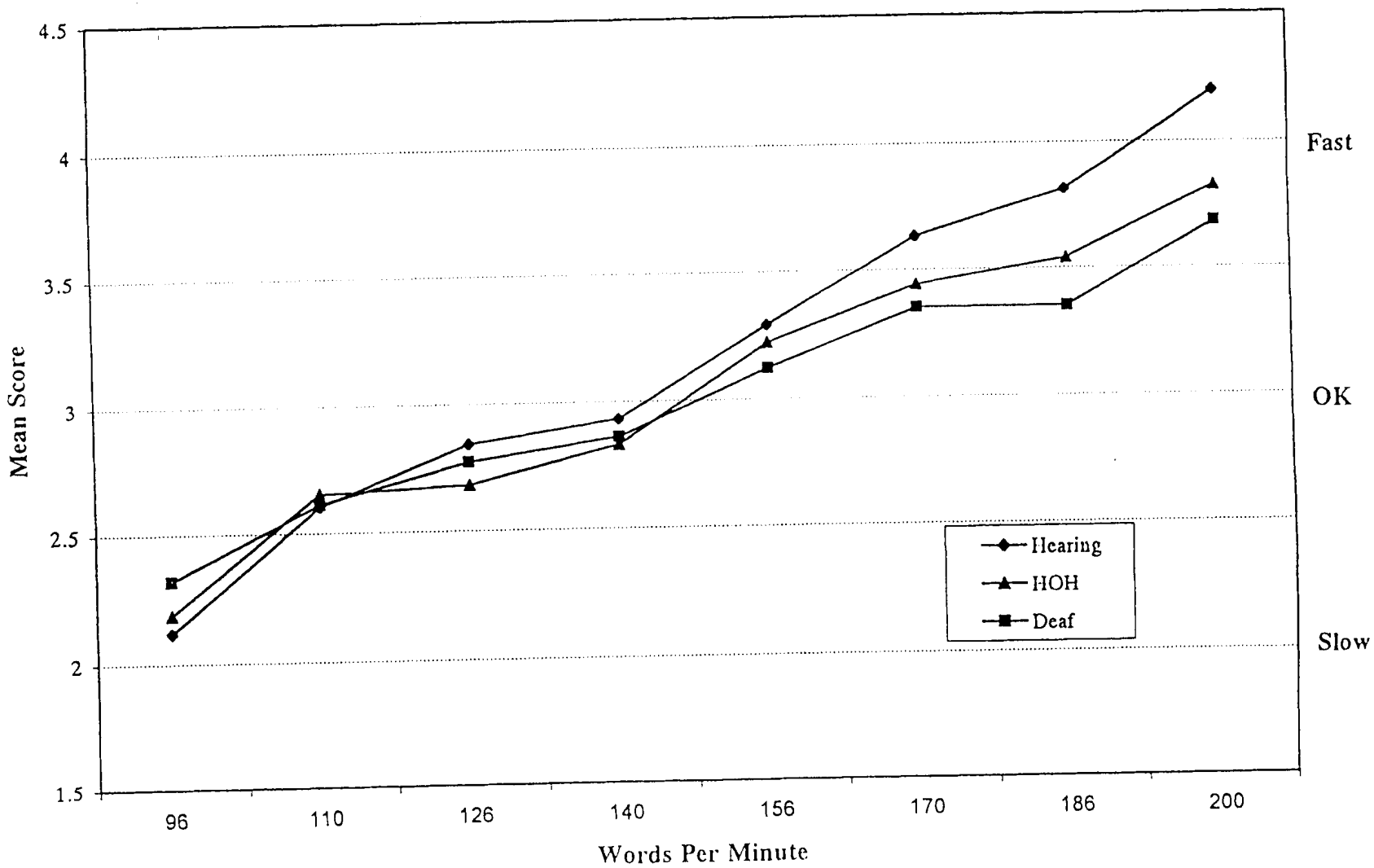


Figure 3 - Evaluation of Caption Speed by Hearing Status



Word Frequency in Captioned Television

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Introduction

Reading is often one of the main ways deaf people gain information and develop independence in learning. In recent years, television captioning has become a prime source of reading material. As Koskinen, Wilson, and Jensema (1985) noted, "Captions are reading material...They can turn television into a moving story book, a steady stream of written language presented with both video and audio reinforcement. Viewers can see words on the screen, hear them spoken, and see them put into a visual context. One of the most exciting potential applications of closed captioning is its use as an educational tool."

The use of captioned television as reading material is difficult if there are no reading skills to begin with. People need some starting point, the ability to read at least some words. In this study, a relatively short list of frequently used words is presented. The authors believe that mastery of these words can greatly assist in expanding reading skills. The report presented here is based on research by Jensema, McCann and Ramsey (1996). They obtained and analyzed caption data from 183 television programs and 22 music videos. The programs varied from thirty minutes to four hours, and the music videos were between two and five minutes in length. The research examined speed, word length, and similar characteristics of the captions. It was noted that relatively few distinct words accounted for a large proportion of the total words used in the captions.

In the present article, the observation that few words account for a large part of the total words used in captioning is carried further and the data is analyzed in more detail. The result is a caption word frequency list, the mastery of which is likely to provide an important assist to the reading skills of caption viewers.

Method

The caption scripts from all the programs in the study by Jensema, et al (1996) were combined into one large computer file. The file was edited to remove punctuation and anything else, which was not a word. The resulting file had 834.726 words.

It was decided that many words were merely variations of another word. Word endings of "s," "es," "ed," "ing," and "d" were deleted. On the other hand, certain endings created a new word which had a different meaning. It was decided to keep word endings of "ly," "t," "ive", "ion," "er," and "ie." Certain nonstandard "words", such as "uh,"

"mmmm," and "ahhh" were kept, since they are commonly used in captioning to indicate certain sounds in the audio.

The resulting edited 834.726 word list was sorted alphabetically, duplicate words were counted and then deleted, and the remaining list was sorted by frequency of occurrence. The final frequency list had 16,102 unique words, most of which were used only a few times.

Results

Table 1 presents a frequency count of the 250 words used most often in the television captions in this study. Out of 834,726 captioned words, 30,142 were the word "the," 22,600 were the word "you," and so on.

In Table 1, the word "the" accounted for 3.61% of the 834,726 captioned words. The words "the" and "you" together accounted for 6.32% of the 834,726 captioned words. Continuing in this manner, Table 1 shows that 250 unique words account for over 68% of all the words used in captioned television.

Discussion

The implications of Table 1 are striking. there are more than 500,000 words in the English language, but a person who masters the use of the 250 words in Table 1 will recognize more than two-thirds of all words shown in television captions. This is a tremendous advantage for any person with limited reading skills who attempts to read captioned television.

A beginning reader could be taught just 10 words (the, you, to, a, I, and, of, in, it, that) and would then recognize more than one out of every five words which appeared on a captioned television program. Being able to read 79 words means being able to read half of all words captioned. By using Table 1 as a guideline in teaching reading, a teacher can maximize the captioned words a student will recognize while watching television. It is suggested that teachers of deaf and hard of hearing students consider Table 1 carefully in planning their strategy for teaching reading.

The majority of the words on the list are everyday linking words, including many prepositions and pronouns. Prepositions, in particular, are traditionally problem areas for many deaf students because American Sign Language does not have prepositions.

Research shows that students learn vocabulary both definitionally and contextually (Stahl & Fairbanks, 1986). The words in Table 1 can be taught definitionally in context. Those students who develop a working knowledge of the 250 words will be able to apply them in a variety of situations and will be able to focus on other captioned television words that they many not understand.

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Stahl, S.A. & Fairbanks, M.M. (1986) The Effects of Vocabulary Instruction. A model-based meta-analysis. *Review of Educational Research*, 56, 72-110.

Word	Freq	Cum%	Word	Freq	Cum%	Word	Freq	Cum%	Word	Freq	Cum%	Word	Freq	Cum%
the	30,142	4	if	2,751	42	us	1,381	54	let	863	61	am	598	65
you	22,600	6	want	2,730	43	I'll	1,369	54	life	859	61	long	593	65
to	22,161	9	as	2,714	43	yes	1,364	55	other	852	61	ask	587	65
a	20,023	11	now	2,696	43	he's	1,359	55	night	831	61	today	587	65
I	19,991	14	she	2,686	44	thank	1,352	55	they're	829	61	name	583	65
and	16,130	16	think	2,606	44	little	1,351	55	help	805	61	run	583	65
Of	13,914	17	her	2,591	44	love	1,340	55	happen	802	61	place	581	65
in	10,941	19	go	2,584	45	why	1,278	55	what's	800	62	stop	580	66
it	10,496	20	will	2,522	45	really	1,263	56	those	784	62	which	570	66
that	10,395	21	well	2,442	45	tell	1,256	56	than	782	62	sorry	566	66
is	8,764	22	going	2,428	45	over	1,249	56	find	776	62	friend	564	66
this	7,116	23	his	2,409	46	call	1,241	56	last	760	62	better	563	66
for	6,679	24	got	2,375	46	can't	1,192	56	world	760	62	through	562	66
on	6,411	25	from	2,373	46	where	1,179	56	after	756	62	house	559	66
was	5,945	25	that's	2,343	47	said	1,169	56	she's	743	62	does	558	66
have	5,804	26	look	2,324	47	day	1,163	57	Mr.	741	62	family	555	66
me	5,740	27	him	2,316	47	never	1,158	57	even	740	62	kind	554	66
we	5,521	27	you're	2,285	47	something	1,158	57	home	735	62	may	551	66
what	5,464	28	time	2,243	48	we're	1,155	57	again	727	62	most	548	66
be	5,449	29	when	2,231	48	then	1,140	57	made	719	63	god	530	66
he	5,218	29	see	2,230	48	two	1,133	57	big	718	63	woman	524	66
with	4,895	30	how	2,214	48	because	1,115	57	doing	718	63	many	512	66
my	4,834	31	say	2,200	49	their	1,089	58	please	712	63	hi	510	67
your	4,385	31	good	2,155	49	hey	1,087	58	put	711	63	nothing	509	67
do	4,375	32	by	2,115	49	first	1,065	58	lot	709	63	next	508	67
I'm	4,258	32	had	2,041	49	need	1,049	58	should	700	63	move	503	67
are	4,224	33	yeah	1,971	50	too	1,048	58	before	694	63	another	499	67
all	4,129	33	an	1,968	50	didn't	1,040	58	around	688	63	came	498	67
not	4,117	34	would	1,899	50	he	1,034	58	wait	688	63	tonight	495	67
it's	4,111	34	did	1,804	50	new	1,023	58	still	687	63	left	493	67
know	3,962	35	take	1,794	51	talk	1,020	59	start	684	64	turn	484	67
no	3,890	35	we're	1,765	51	into	1,012	59	live	680	64	doesn't	483	67

but	3,885	35	make	1,757	51	work	1,007	59	use	675	64	I'd	482	67
don't	3,859	36	back	1,739	51	play	1,006	59	sure	674	64	neither	481	67
get	3,739	36	who	1,719	51	try	998	59	keep	671	64	must	476	67
they	3,612	37	been	1,707	52	much	998	59	sir	670	64	kill	472	67
like	3,436	37	has	1,697	52	guy	987	59	old	667	64	hand	470	67
so	3,425	38	them	1,599	52	I've	980	59	maybe	657	64	stay	468	67
just	3,300	38	or	1,553	52	uh	976	60	we'll	653	64	watch	467	67
at	3,295	38	some	1,547	52	mean	954	60	thought	652	64	you've	467	68
here	3,197	39	man	1,529	53	there's	954	60	believe	650	64	children	465	68
out	3,117	39	very	1,510	53	only	938	60	boy	646	64	hear	463	68
up	3,074	40	our	1,475	53	give	924	60	three	644	64	hope	462	68
about	3,031	40	down	1,474	53	off	920	60	every	641	65	mother	455	68
one	2,998	40	thing	1,456	53	any	917	60	caption	639	65	nice	455	68
right	2,906	41	way	1,431	53	feel	907	60	ever	639	65	remember	454	68
come	2,904	41	year	1,420	54	these	905	60	show	636	65	own	453	68
there	2,886	41	people	1,409	54	great	884	60	away	635	65	won't	451	68
oh	2,781	42	could	1,408	54	let's	884	61	always	626	65	morning	449	68
can	2,772	42	more	1,383	54	prepare	871	61	anything	607	65	everything	446	68