Japan Electronic Industry Development Association's

Common Speech Data Corpus

prepared for:

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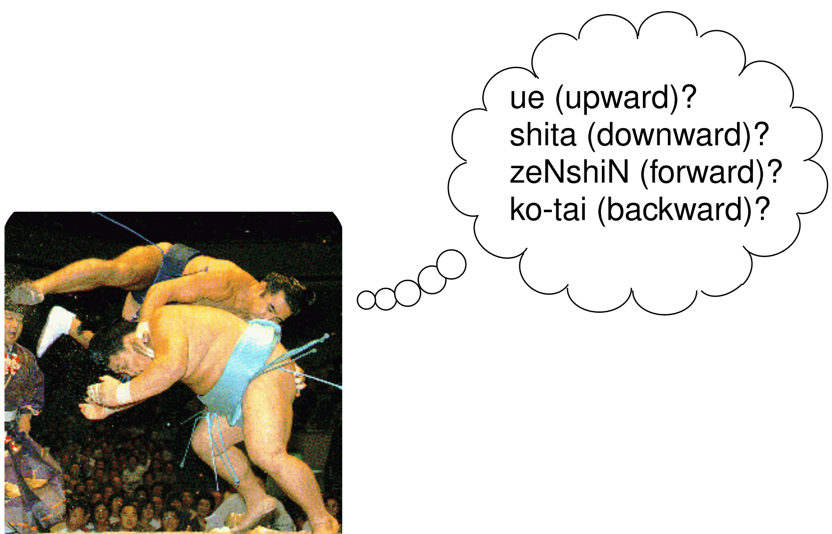

EXECUTIVE SUMMARY

The Japan Electronic Industry Development Association's Common Speech Data (JCSD) Corpus is an isolated phrase corpus consisting of 150 speakers (75 males/75 females) and almost 200,000 utterances. It represents an important milestone in Japanese speech recognition technology development. The JCSD Corpus was originally collected in 1986 in Japan in a nationwide project managed by Professor Shuichi Itahashi in coordination with the Japan Electronic Industry Association (JEIDA). Its importance to Japanese speech recognition technology development is, to some extent, comparable to Texas Instruments' famous 46-word speaker-dependent corpus. The JCSD Corpus was one of the first industry-standard and freely available corpora for the study of Japanese language speech recognition. Most of the competitive Japanese language speech recognition systems developed in Japan have been benchmarked on various subsets of this corpus. Hence, it is one of the most important standards of comparisons that exist for Japanese language systems.

As was typical of corpora developed in the mid-1980s, JCSD Corpus was collected in a quiet laboratory setting (fairly pristine recording conditions) using Sony PCM-F1 technology — a system that employed a 14 bit A/D converter that sampled data in stereo at 44.1 kHz and wrote the data to standard analog video cassette tapes in a proprietary digital format. This technology, though primitive by today's standards, provided a high quality audio recording capability —thereby making this corpus fairly uncontaminated by archaic analog impairments.

A summary of the size and content of the corpus is given below:

number of speakers	150 speakers
males	75
females	75
range of speaker age	10 yrs. to 70 yrs.
number of items per speaker	323 items
isolated digits	15
four digit sequences	35
city names	100
monosyllables	110
control words (set A)	13
control words (set B)	24
control words (set C)	26
number of repetitions per item	4 repetitions
total number of utterances	193,763 utterances (per channel)
sample frequency	16 kHz
sample type	16-bit linear
number of microphones	2 (dynamic and condenser)

Over 75 institutions in Japan have acquired this corpus and developed technology based on it. Some portions of it have become fairly famous and are quoted extensively in the literature — for example, the city name subset. Hence, the availability of this corpus will make it easier to port applications to Japanese, and to benchmark performance against state-of-the-art Japanese language technology.

TABLE OF CONTENTS

1. ABSTRACT **1**

2. HISTORICAL BACKGROUND **1**

2.1. Experimental Conditions 1
2.2 Speaker Demographics 2
2.3 Prompting Text 4
2.4 DAT Tapes 4

3. PREPARATION **5**

3.1. Digitization 5
3.2. Segmentation 6
3.3. Validation 6
3.4. Certification 8
3.5. Conversion to SPHERE 10
3.6. Verification 10
3.7. Archival to Tape and Tape Certification 10

4. SOFTWARE TOOLS **11**

4.1. Digitization 12
4.2. Segmentation 12
4.3. Validation 12
4.4. Certification 15
4.5. Conversion to SPHERE Files 16
4.6. Verification 17

5. CORPUS DESCRIPTION **17**

5.1. Overview 17
5.2. Errata 20

6. CONCLUSIONS **23**

7. ACKNOWLEDGEMENTS **24**

8. REFERENCES **24**

APPENDIX A. PROMPTING TEXT **25**

APPENDIX B. DAT INVENTORY **29**

APPENDIX C. SPEAKER SUMMARY **33**

APPENDIX D. TAPE ARCHIVE DESCRIPTION **48**

1. ABSTRACT

The Japan Electronic Industry Development Association's (JEIDA) Common Speech Data (JCSD) Corpus represents an important milestone in Japanese speech recognition technology development. The JCSD Corpus was one of the first widely available corpora to support research into Japanese language speech recognition. It is an isolated phrase corpus, consisting of three sets of control words, isolated digits, four digit sequences, city names, and monosyllables. Results on various subsets of the corpus, particularly the city names, have been extensively published. For historical reasons, this corpus constitutes a valuable addition to LDC's impressive collection of speech corpora. This document describes a computerized version of the corpus developed at the Institute for Signal and Information Processing (ISIP) at Mississippi State University for the Linguistic Data Consortium (LDC).

2. HISTORICAL BACKGROUND

The JCSD Corpus was originally collected in 1986 [1] in Japan in a nationwide project managed by Professor Shuichi Itahashi in coordination with JEIDA. Its importance to Japanese speech recognition technology development is, to some extent, comparable to Texas Instruments' famous 46-word speaker-dependent corpus [2]. The JCSD Corpus was one of the first industry-standard and freely available corpora for the study of Japanese language speech recognition. Most of the competitive Japanese language speech recognition systems developed in Japan have been benchmarked on various subsets of this corpus. Hence, it is one of the most important standards of comparisons that exist for Japanese language systems [3].

As was typical of corpora developed in the mid-1980s, JCSD Corpus was collected in a quiet laboratory setting (fairly pristine recording conditions) using Sony PCM-F1 technology — a system that employed a 14-bit A/D converter that sampled data in stereo at 44.1 kHz and wrote data to standard analog video cassette tapes in a proprietary digital format. This technology, though primitive by today's standards, provided a high quality audio recording capability — thereby making this corpus fairly uncontaminated by archaic analog impairments (such as the common phenomena of "print-through" that occurs in analog reel-to-reel tapes).

Recently, a DAT version of the corpus was made available to the general public for purchase [3]. Unfortunately, the DAT version, though it contained some segmentation information that can be used by special PC-based hardware and software, did not contain the type of segmentation useful for developing speech recognition technology. The DAT version was, in essence, simply a tape-to-tape copy of the original PCM-F1 material — the PCM-F1 tapes were converted to analog audio and re-digitized by a DAT machine. Also, the source format was recorded at a sample frequency, 44.1 kHz, much higher than what is needed by present-day research. Hence, preparation of the corpus in a format consistent with LDC's other products was essential.

2.1. Experimental Conditions

The corpus was originally recorded at 15 different sites in Japan. While attempts were made to keep the recording conditions fairly uniform across all sites, this is not what happened in practice. There is significant variation in the data from site to site, though overall the data can be classified as high signal to noise (SNR) data — comparable to a fairly quiet office environment. The corpus has been recorded on two channels. One channel contains data recorded with a standard dynamic microphone — a Sanken MU-2C microphone. The second channel contains data recorded simultaneously with a condenser microphone that presumably varied from site to site. If a single channel had to be selected for distribution, we would recommend the dynamic microphone channel. The dynamic microphone represents the best choice in that it is comparable to most of the microphone types used in research corpora and workstation speech applications (condenser microphones typically contain a battery and, hence, are not popular in workstation applications).

2.2. Speaker Demographics

There is a reasonable coverage of geographic region and age given the relatively small speaker population. Coverage by major geographic region (defined as the address at which the subject spent the most amount of time under the age of 12) is given below in Table 1:

Geographic Region	Combined (150)	Males (75)	Females (75)
Chubu	16	10	6
Chugoku	5	3	2
Hokkaido	1	1	0
Kanto	90	40	50
Kinki	16	10	6
Kyushu	9	5	4
Tohoku	10	6	4
Unknown	1	0	1

Table 1. An overview of the geographic distribution by region of the speaker population.

A more detailed analysis, showing the distribution within each geographic region, is given in Figure 1. Note that the Kanto region contains Tokyo. We expect a larger than normal concentration of speakers from that region. From Table 1, we see that 60% of the speakers in the corpus are from this region.

We also note that many of the regions are quite linguistically diverse (particularly Tokyo) and hence we don't expect a strong correlation between geographic region and dialect. One of the reasons the geographic coverage is reasonable is because the data collection sites were arranged at strategic locations around Japan. Since it is hard to assess dialect from a small sample of phrases, a dialect classification is not included in the corpus. However, informal listening indicates that the speaker population is far from homogenous, and fairly rich for such a small corpus.

The distribution of speaker age is shown below in Table 2. While the distribution at the edges is not well-sampled, the age range of 20 years to 60 years is well-represented in the corpus. A number of other interesting demographic and ambient factors are available in the corpus as well,

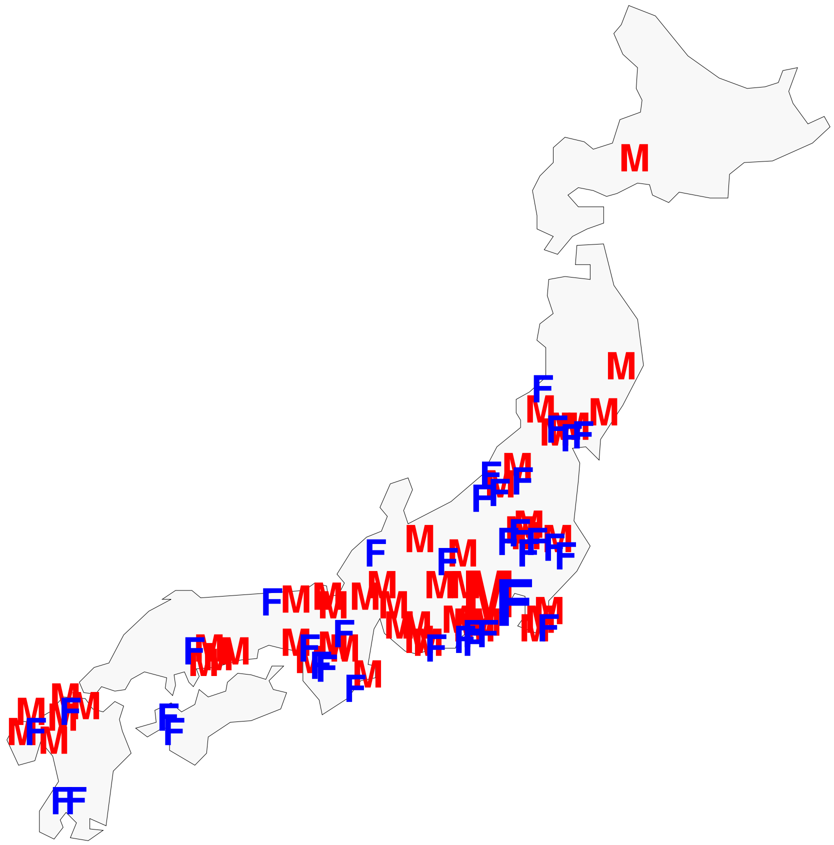

Figure 1. The geographic distribution of the speaker population is shown. The letter “M” (in red) denotes a male speaker, while the letter “F” (in blue) denotes a female speaker. These location is defined as the place in which a speaker spent the majority of time through age 12.

including height (loosely related to vocal tract length), a speaker’s present address, a brief description of the ambient recording environment, and the background noise level measured in dBA. All demographic information for the speaker population has been preserved in the corpus within each speech data file. This issue is discussed at length in Section 5.

Age	Combined (150)	Males (75)	Females (75)
10-19	1	0	1
20-29	50	25	25
30-39	40	20	20
40-49	32	15	17
50-59	22	11	11
60-69	5	4	1

Table 2. Distribution of speaker age in the JCSD Corpus.

2.3. Prompting Text

The JCSD Corpus is primarily an isolated word corpus. In addition, one segment of the corpus contains thirty-five four digit sequences that should be useful in supporting limited connected-digit recognition experimentation. A summary of the prompting material used in the corpus is shown below in Table 3.

Description	Number of items
Control Words: Banking Services Word Processors Home Electronic Equipment	 13 24 26
Digits: Isolated Digits Four Digit Sequences	 15 35
City Names: a phonetically-rich subset of common Japanese city names	100
Monosyllables: all Japanese monosyllables plus several used to pronounce foreign words	110

Table 3. An overview of the prompting material used in the JCSD Corpus.

Each speaker was presented each item in the above lists four times — enabling the corpus to support some experimentation with speaker-dependent technology. Unfortunately, for all speakers and all repetitions within a given speaker, the items were presented in EXACTLY the same order. Hence, we expect researchers to encounter some undesirable session artifacts, such as artificial prosodic queues (for example, duration profiles).

A complete listing of all prompting text is given in Appendix A.

2.4. DAT Tapes

The JCSD Corpus described in this document was derived from a DAT copy provided by Professor Itahashi of the University of Tsukuba. This version was recently released [3] and is generally available directly from JEIDA. For archival purposes, we have included an inventory of the tapes, so that the Unix-formatted tapes can be easily cross-referenced back to the original data. A detailed tape inventory is given in Appendix B.

The DAT copy of the corpus consisted of 76 tapes totaling approximately 121 hours of material. The tapes were organized by speaker and session — a single tape contained multiple speakers of the same sex from the same segment of the corpus. This is also cross-referenced in Appendix B. Each session was delimited by an audio prompt describing the contents of the session. Two-hour tapes generally contained about 3500 valid utterances, while one-hour tapes contained about

1500 utterances. The overall quality of the DAT tapes was high — only occasionally did we encounter tracking problems or dropout problems. Tracking problems could be resolved by using another DAT machine, cleaning the drive, or simply restarting the tape. Dropouts and other such anomalies are documented in Section 5.2.

3. PREPARATION

Our process for preparing the corpus consisted of eight steps: digitization, segmentation, validation, certification, conversion to SPHERE files, verification of the SPHERE files, archival to tape, and certification of the tapes. The goal of this process was to listen to every piece of data twice (a large percentage of the data was reviewed three times), and to review generated files by automated computer processing three times. We believe this careful approach has reduced the defect rate to something very close to 0%. Each of these steps is described in detail below.

3.1. Digitization

Our goal was to deliver the corpus at a sample frequency of 16 kHz. This sample frequency is a *defacto* standard today in the speech research community for high quality corpora. Such a choice provides minimal loss of information and affords a reasonable reduction in disk space requirements. It is not trivial to convert from 44.1 kHz sample frequencies in that this frequency does not easily subdivide into other commonly used frequencies. (In fact, with DAT technology, 48 kHz is a much better choice. Rather than develop custom software for this step, and use homegrown filters, we decided to use the built-in capability of our DAT-based audio systems. This allows the experimental setup to be easily replicated and implicitly documents the conversion process.

The first processing step required was to upload speech data from its original source, DAT, to our Unix disks, and to convert the sample frequency from 44.1 kHz to 16 kHz. A Townshend Computer Tools (TCT) DAT-Link Digital Audio Interface (*http://www.tct.com*) was employed for this step. This unit interfaces a DAT machine to a Sun workstation via the SCSI bus, and performs sample frequency conversion in real-time on a dedicated AT&T DSP processor. This unit has become somewhat of an industry standard in the speech research community, and is uniformly regarded as producing high quality speech. It uses the standard linear-phase FIR filter approach to signal resampling, and operates on stereo data up to sample frequencies of 48 kHz. We used the DAT-Link's standard filters, which are linear phase FIR filters that deliver SNRs in excess of our minimum requirement of 80 dB.

The DAT-Link offers superb frequency response characteristics for a sample frequency conversion from 44.1 kHz to 16 kHz. The frequency response of the downsample filter has a 3 dB point above 14 kHz, is more than 90 dB down at the half-sample frequency of 8 kHz, and has less than 0.25 dB ripple in the passband. We prefer such anti-aliasing filters for corpora involving high quality speech. We have found the DAT-Link downsample filters to be more than adequate for a wide variety of speech processing applications including speech recognition. This unit is widely used in the ARPA and DoD communities, and more importantly, by LDC as well. In addition to doing the necessary signal processing, it provides highly reliable real-time audio, and has reliable error reporting in the event there are problems in the digitization process.

3.2. Segmentation

It is unfortunate that the JCSD Corpus was not segmented in a conventional fashion. While it contains segmentation information that can be used by some custom PC-based hardware developed in Japan, we cannot access any of this segmentation information from our standard Unix tools. For example, the DAT tapes were delimited by program numbers — something the DAT machines can recognized. Individual utterances, however, were not delimited. (Also, tape dropouts and discontinuities caused program counters to be unreliable.)

Hence, each DAT had to be segmented during the digitization process. Our approach was to perform this step off-line so that problems could be easily resolved. Our process involved digitizing an entire DAT tape, postprocessing the data through a segmentation algorithm, reviewing the results, and then automatically generating files from the segmentation information. An energy-based algorithm [5] was used to perform the segmentation. In cases where the automatic algorithm failed, problems were corrected manually using some interactive tools developed for the project.

By and large, the segmentation of the data was reasonably successful once we tuned the algorithm to the specific data set. We had the most problems with the four digit sequences. These were not spoken with an acceptable amount of silence between phrases (due to the way the data was collected — this could have been prevented with computer prompting). Hence, inter-word gaps were often longer than inter-utterance gaps. A significant percentage of the utterances had to be corrected by hand. Other tapes exhibited similar problems with inter-utterance gaps. We typically had to set the signal detector to accept a gap as small as 0.3 seconds to reliably segment the data, and this often caused problems with polysyllabic phrases.

Once the endpoints were determined, we padded each utterance with approximately 0.25 secs of leading and trailing silence. This will allow technology developers a chance to get a more realistic measure of their algorithms robustness to channel impairments (a major problem in fielding speech technology). There are many examples of common mouth noises and other such artifacts in the corpus, and we have expended extra effort to mark these. It is possible, for example, to build statistically-trained models based on these markings (a popular approach in Hidden Markov Model-based technology). Since the corpus does contain some amount of nonstationary background noise, there is some value to retaining this data. Also, mouth artifacts are abundant, so algorithms developed from this data will have to deal with them in some intelligent manner (we see this as a positive aspect of the corpus).

3.3. Validation

Since the utterances were recorded in DAT in a fixed order, the task of validation, defined as the step in which we add an orthographic transcription to the data, was fairly straightforward. The data was validated using a simple tool that supports audio playback of a file, text entry, mouse-based editing of the orthographic transcription, and form-based editing of the auxiliary information identifying the utterance. The TCT DAT-Link was also used for validation — we consider the use of high-quality audio essential to performing accurate validation efficiently (especially for noting anomalous behavior). Orthographic transcriptions were performed using an

ASCII encoding of a hiragana system developed and described in [3]. Since this is an isolated phrase corpus, transcription in kanji was deemed to be an unnecessary additional burden — the kanji equivalents of the hiragana can be easily provided via a table lookup. With this streamlined approach, our validators were able to reach a peak speed of approximately 600 utterances per hour and maintain excellent accuracy and consistency.

There were two main issues involving validation. First, there was the issue of transcription conventions for marking of non-speech sounds. We based our work on other corpora [4] providing similar information, and tried to minimize the number of unique makers were used. These are shown in Table 4. Our general criteria was that if a sound was clearly audible, it should be marked. This decision was supplemented by a waveform display of the utterance. Our validators were trained to use both visual and audio cues in determining whether a non-speech sound should be marked. A significant percentage of utterances contain some amount of non-speech sounds. For example, for the isolated digits component of the corpus, 12% of the utterances contain at least one non-speech marker.

Non-speech Orthographic Items	
{breath noise}	{sigh}
{mouth noise}	{sneeze}
{throat clear}	{sniff}
{cough}	{whistle}
{paper rustle}	{non-speech noise}

Table 4. A listing of the non-speech orthographic items used in the JCSD Corpus. Note that the last item, *{non-speech}*, was only used in the rare case that none of the other existing items applied. This list is a subset of that used in other ARPA/LDC corpora [4]

Second, a convention for anomalous, or alternate, pronunciations had to be established. For the digit data, we were particularly interested in flagging uncommon pronunciations, because these have been traditionally used to optimize recognition performance. For digits, the number of variants are small and easily predicted. Hence, we decided to incorporate the set of words shown in Table 5. This system consists of standard orthography, plus the use of brackets to denote variant pronunciations in which a phone was missing or significantly reduced (for example, it is common in Japanese to drop the "i" in "hachi"). Though transcription at this level is generally expensive, transcribing data in this manner for the digit portion of the corpus did not significantly add to the cost of the project.

Thus, a typical transcription for an utterance might look something like this:

{mouth noise} ichi [shich] san [hach] {breath noise}

which indicates that the phrase "ichi shichi san hachi" was preceded and followed by the indicated non-speech noise, and contained alternate pronunciations for "shichi" and "hachi." In order that we not constrain potential users of the corpus into this system, the original prompting text, in this case "ichi shichi san hachi," was also stored in each speech file. Further, to ignore this additional

Orthographic Items Denoting Alternate Pronunciations For Digits	
[dei]	[ich]
[dok]	[doku]
[rok]	{sniff}
[shich]	[hach]

Table 5. A listing of the orthographic items corresponding to alternate pronunciations for data containing digit sequences (isolated and four digit sequences). For example, "[hach]" denotes a pronunciation of "hachi" in which the final vowel was omitted.

information, one can simply replace bracketed items with their non-bracketed equivalents, or use the prompting text as the orthographic transcription. Since the delimiters for non-speech sounds and alternate pronunciations are mutually exclusive, it is easy to mix and match this information as needed. Since SPHERE headers (described in the next section) are stored in an ASCII format, it is easy to use standard Unix tools to filter this information.

In Table 6, we present some statistics for the transcriptions of the isolated digits to provide a feel for the extent to which such nonstandard items are present in the corpus. This table provides a glimpse into the nature of the non-speech items as well. Breath noises and mouth artifacts dominate the non-speech markings. We can see that a bulk of the corpus is fairly clean, indicative of the rather controlled conditions under with which it was collected.

3.4. Certification

Once validation was completed, every file was passed through a second pass of review denoted certification. The output of the validation program is a set of files organized by speaker, session, item, etc. A second pass of review was applied to the data in which a different person (the project manager, who did not serve as a validator) listened to a file while viewing the transcription. The purpose of this step was to verify that the assignment of speaker numbers and such were correct, and to identify missing files, anomalous files that needed to be rechecked against the DATs, and resolve any other problems identified in the validation stage. The task of certification involved the following steps: software checks of data (file sizes, file integrity, etc.), human checks of data (listen to each file), and corrections of problems (most often, the original DAT recording was reviewed). This process was repeated until all outstanding issues were resolved.

There were several useful computer-automated checks that were performed using a handful of simple utilities. These utilities counted the number of files, checked each file for consistency between channels, and compared each file against each other to make sure no overlaps had occurred (a problem that arose because speakers were out of order on the original DATs, and validators sometimes transcribed the speaker and repetition numbers incorrectly). These programs (described in detail in Section 4) flag any files which deviated from the expected results. The expected results consisted of a correct number of files per speaker per repetition, identical file sizes but different sampled data for each channel, and uniqueness across all speakers and all repetitions.

Description	Frequency (17,390 items)	
"clean data": nominal pronunciation/no non-speech markers	15,364	(88.4%)
with a non-speech marker and/or an alternate pronunciation	2,026	(11.6%)
with an alternate pronunciation	1,161	(6.7%)
distribution:		
only an alternate pronunciation	1,121	(96.6%)
both an alternate pronunciation and a non-speech marker	40	(3.4%)
with a non-speech marker:	905	(5.2%)
distribution:		
only a non-speech marker	865	(95.6%)
both an alternate pronunciation and a non-speech marker	40	(4.4%)
non-speech markers	979	(5.2%)
distribution:		
{mouth noise}	543	(55.5%)
{breath noise}	344	(35.2%)
{paper rustle}	48	(4.9%)
{non-speech noise}	20	(2.0%)
{throat clear}	7	(0.7%)
{background noise}	7	(0.7%)
{cough}	6	(0.6%)
{sniff}	2	(0.2%)
{mouth_noise}	2	(0.2%)

Table 6. Distributions of nonstandard orthographic items for the isolated digit subset of the JCSD Corpus. The vast majority of the data is fairly clean, with approximately 10% showing some type of nonstandard behavior. The statistics for other segments of the corpus are comparable.

Once the computer-based checks had been performed to verify the data, and we had generated the necessary information to fix the majority of the problems, the project manager carried out such tasks as resegmentation of the data (often done manually), recording missing data, revalidation, etc. This step in the certification process often required manual listening to the validated data. This step was performed as an independent check on the data, using the *verify_data* utility. With this tool, we were able to listen to an utterance and simultaneously view its transcription. This was probably the single-most important step in the process because it provided a check on the validators' work. Common problems found in this phase were incorrectly transcribed utterances and incorrectly segmented data.

At the end of the certification stage, every utterance in the corpus had been reviewed at least twice, and the remaining problems with the corpus could generally be traced back to the source DAT data. There were three types of problems found on the original DAT tapes: a single utterance was truncated (typically the end of the utterance, occasionally the beginning of an utterance at the start of a new repetition of the data), a single utterance or group of utterances were missing on the tape, or an utterance was mispronounced on the tape. A record of each of these anomalies was maintained and is found in Section 5.2.

3.5. Conversion to SPHERE

The output of each of the previous steps was a non-SPHERE formatted file. using a simple utility we developed, the last file creation step consisted of creating SPHERE files from our raw files. This step also deposited files into the final corpus directory structure using the official filenaming scheme (described in Section 5.1). A typical SPHERE header is shown in Table 7. The range of values that each of these fields can take is fully described in Section 5.1. Note that compression was not used in storing the sampled data files. Also, anticipating that users would prefer to use only one channel of the data at a time, as has been our experience with previous corpora involving multiple microphones (for example, TIMIT), we decided to explicitly separate the data in the corpus by channel. Hence, each sampled data file contains only one channel of data.

All attempts have made to conform our construction of the SPHERE header to conventions used in other LDC corpora. Since this is an isolated phrase corpus, the header is reasonably self-contained. Since the SPHERE header simply consists of the first 1024 bytes of the file, it is also a relatively easy matter to remove the header and identify the remaining speech data (another reason we prefer to avoid the use of exotic compression schemes).

3.6. Verification

Once the files were converted into SPHERE format, two final checks were run on the data. The final SPHERE files were counted to make sure that the correct number of files were created for each speaker, channel, and repetition. Next, a utility that collects statistics on the items appearing in the orthographic transcription and prompting text fields of the SPHERE file was run. Anomalous utterances were checked against the errata to make sure everything was properly accounted for. This information is presented in detail in Section 5.2.

3.7. Archival to Tape and Tape Certification

Standard Unix tape tools were used to create the final corpus archive. A set of four 120 meter 8mm tapes totaling almost 20 Gbytes of data were delivered to LDC. ISIP also maintains two independent copies of these tapes. These tapes were created using uncompressed speech files (shorten, which is built into the SPHERE software was not used). We believe this is best for ease of portability. We did, however, use the compression capability of our Exabyte 10e tape stacker so that we could minimize the number of tapes. Hence, a typical tape command consisted of:

```
tar cvf /dev/rmt/1cn control_words_a
```

This command creates files on the tape with a root node of control_words_a, making it easy to untar and relocate the corpus. Given the size of the corpus, on most computers it will undoubtedly span multiple file systems. Hence, the tapes were mastered in a way that makes it easy to restore the data to different disks. The device “1cn” corresponds to using tape device no. 1 with the highest compression option and the no rewind option (tapes contain multiple tar files). These tapes were mastered on a Sun Sparcstation 5 running Solaris 2.4. We used GNU tar, version 1.11.2, to make tapes. The set of tapes delivered to LDC have been listed in their entirety, to make sure the contents of each tape were correct and readable. This data resides in INFO/tape_listings found at the root node of the corpus on the first tape (tape no. 1).

SPHERE Info Type Name/Value Pair	Comment
NIST_1A	SPHERE supplied
1024	SPHERE supplied
sample_min -i -9336	minimum sample value
sample_max -i 11542	maximum sample value
sample_count -i 15039	number of speech samples in the file
sample_n_bytes -i 2	speech samples are two-byte integers
sample_sig_bits -i 16	16-bit speech samples
channel_count -i 1	one channel of data
speaker_number -s5 f1027	speaker number
speaker_id -s7 IBM1301	original JEIDA speaker ID
recording_site -s3 IBM	recording site
database_id -s24 JEIDA Common Speech Data	corpus name
database_version -s3 1.0	corpus version
recording_environment -s12 Meeting room	recording environment
speaker_session_number -s4 B-03	session number
speaker_age_category -s5 30-39	age category at the time of recording
speaker_height -s5 157cm	height of the speaker
speaker_original_address -s13 Sado, Niigata	city and prefecture during childhood
speaker_present_address -s12 Komae, Tokyo	present city and prefecture
ambient_noise_level -s5 47dBA	noise level as measured in dBA
speaking_mode -s4 read	speaking mode
sample_rate -i 16000	sample frequency in Hz
orthographic_transcription -s4 ido-	ortho trans. (in this case, a control word)
prompting_text -s4 ido-	original prompting text
speaker_sex -s6 female	speaker sex
session_utterance_number -s4 b007	utterance type/number
microphone -s12 Sanken MU-2C	microphone used during recording
sample_byte_format -s2 10	samples are linearly encoded
sample_coding -s3 pcm	samples are linearly encoded
end_head	SPHERE supplied

Table 7. An example of the SPHERE header used in the JCSD Corpus.

4. SOFTWARE TOOLS

In addition to the corpus, we have included all software and documentation in the distribution. In this section, we briefly describe the major software tools we have developed for this project. Several of these, particularly the validation tool, are easily modified to support the development of new corpora. This software is located in INFO/tools at the root node of the corpus (and on the first tape in the four tape set). Underneath the tools directory, there is a directory *src* that contains source code, and *bin* which contains Solaris 2.4-compiled binaries.

4.1. Digitization

Digitization of the data on DAT tape was performed using the narecord program developed by Townshend Computer Tools (we used netaudio v2.27). This program reads stereo data in real-time from a DAT at a specified sample frequency and writes it to a file in a specified file format. The digitized data was recorded at a sample frequency of 16000 Hz, and stored in the raw data format. Tape were digitized in one or two-hour durations using the following command:

```
narecord -u isip03:0 -s 16000 -t 115200000
```

This “-u” option denotes the machine and audio device number, the “-s” option denotes the output sample frequency, and the “-t” option denotes the number of samples to record (in this case, one hour of data). The data is recorded in stereo with this command, so that both channels of the data, representing the two microphones used in the corpus, are recorded simultaneously.

4.2. Segmentation

The segmentation procedure consists of two programs: signal_detector and excise_signal. The *signal_detector* program is a flexible data-driven program that reads its parameters from a parameter file. The algorithm used is a standard energy-based adaptive-thresholding algorithm [5] used extensively in the speech research community. An example of one of the actual files used to segment the corpus is shown in Figure 2. The most important parameter in the context of this project was the *minimum_utterance_separation*, which controls the ability of the system to spot phrase boundaries versus internal pauses for polysyllabic phrases (typically inter-word pauses). The signal detector program takes a raw data file as input, and outputs start and stop times of utterances to an ASCII log file.

The second step is to run the speech data file and the log file through the *excise_signal* program. This program splits the data into a one-channel per file format, and creates the sampled data files in a generic directory structure — files are sequentially numbered and organized into subsets of 100 files per directory. At this point, the data is ready for validation.

4.3. Validation

The validation phase of this project was done using a GUI written in Tcl. This program was written to automate (as much as possible) the tasks of validation: audition, transcription, and filename creation. The GUI is mouse-driven and requires essentially no typing. This greatly decreases the time needed for validation and allows the human validator to concentrate on the task of properly transcribing the data and labeling problem utterances. A snapshot of the validation tool is shown in Figure 3(a). The validation tool was designed to make efficient use of screen real estate and computer resources, so that validators could work from small 15” black and white monitors served from a modest Sun Sparcstation (two validators can work from a Sparcstation 5 with 32M of memory and a 50 MHz processor).

The upper left of the screen contains parameter options which are used to input the initial conditions of validation, including speaker number and sex, utterance number and repetition, and output directory. Once the initial conditions are set, the validation tool automatically increments

```
# file: endpointer_00.params
#
# this file contains the parameters used to endpoint speech
# utterances recorded under near studio-quality conditions.
# it was originally developed to digitize the JEIDA CSD Corpus.
#
# this file has been “optimized” for short isolated word utterances,
# such as the isolated digits. the JEIDA data is packed quite closely,
# as little at 0.3 secs separates some utterances. so some parameters,
# such as minimum_utterance_separation, have been set very small.
#

# data format parameters
#
number_of_channels            = 2 channels
sample_size                   = 2 bytes
channel_to_be_processed       = 0 channel

# signal processing parameters
#
sample_frequency              = 16000.000 Hz
frame_duration                =     0.020 sec
window_duration               =     0.030 sec
preemphasis                   =     0.950 units

# signal level-related energy parameters
#
nominal_signal_level          = -35.00 dB
signal_adaptation_delta       =  15.00 dB
signal_adaptation_constant    =   0.50 units

# noise level-related energy parameters
#
nominal_noise_level           = -60.00 dB
noise_adaptation_delta        =  15.00 dB
noise_adaptation_constant     =   0.75 units
noise_floor                   = -70.00 dB

# utterance-related parameters
#
utterance_delta               =  6.000 dB
minimum_utterance_duration    =  0.050 sec
minimum_utterance_separation  =  0.300 sec
maximum_utterance_duration    =  99.999 sec

# debug information
#
debug_level                   = 0 level
```

Figure 2. An example of the signal_detector parameter file that provides for easy control of key parameters, including the algorithm.

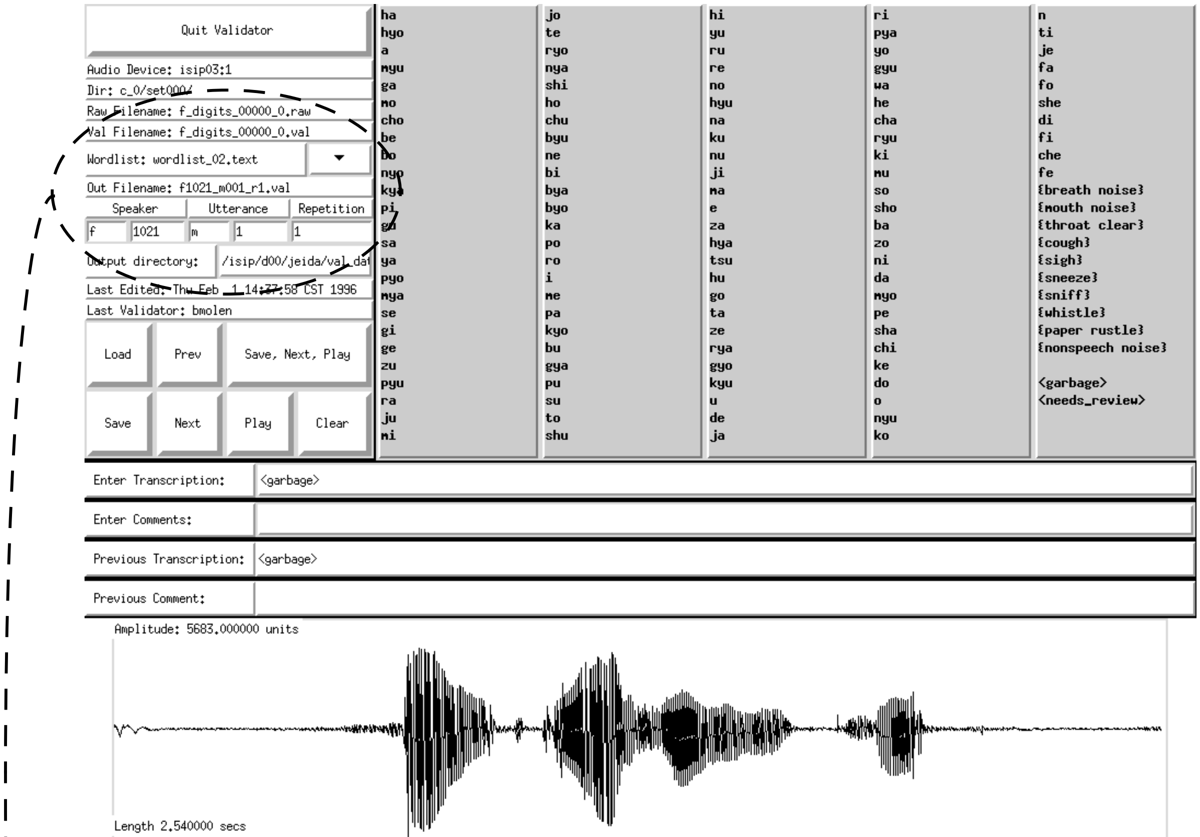

Figure 3(a). Version 2.0 of the validation tool developed for the JEIDA project is shown. Mouse functions are combined with buttons and menus to provide a high-speed validation capability.

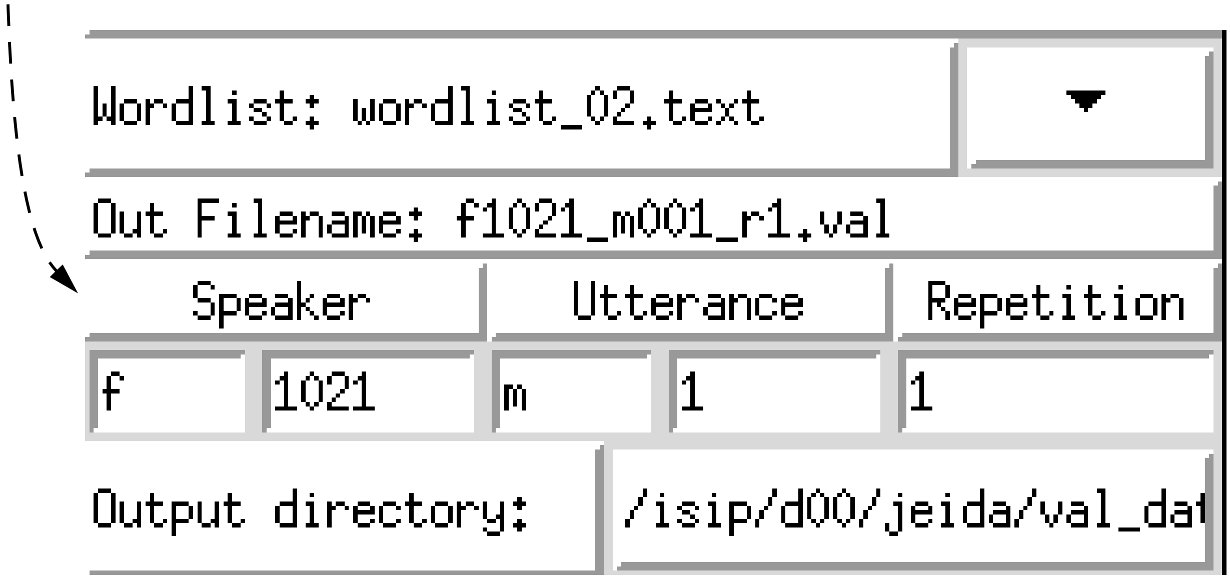

Figure 3(b). New features in version 2.0 include the ability to have the tool output final corpus files directly. Speaker number, utterance number, repetition number, and the output directory are automatically updated after each valid speech file, and only need to be set at the beginning of a tape, or after a change of speaker (the latter is a protective measure).

all utterances, repetitions, and speaker numbers in the sequence for an entire speaker's data (including multiple repetitions). This allows the validator, theoretically, to set the initial conditions and then validate an entire set (four digits, isolated digits, etc.) of the corpus without ever using the keyboard — an important consideration for maximizing throughput.

On the upper right of Figure 3(a) is the word list for a particular set of data. This word list is loaded into the program via an external file specified in the validation tool parameter file. The word list contains all of the possible "legal" utterances that would be encountered. All transcription and error labeling for a particular utterance are selected from this list via the mouse. This is a point-and-click interface, such that the validator can click on the desired transcription with the left mouse button and then click the middle mouse button to advance to the next utterance. Clicking the middle mouse button saves the output files to the proper directory, advances to the next utterance and plays it. The program was heavily tailored to the specific task of JEIDA validation. Though tcl is a good language to write such applications, the program's throughput is somewhat limited by the speed of tcl. For future projects, we plan to upgrade this program using a combination of perl and tk.

At the bottom of the screen is a waveform display corresponding to the utterance. This is accomplished using a mixture of C programs and tcl plotting. The central component is the utility *plot_signal*. This utility gives a plot of signal magnitude vs. time for the utterance duration. A comparable utility, *plot_endpoints*, is included that plots the signal and its endpoints as determined by the segmenter. Placing the *plot_signal* screen in the validator allows the validator to easily detect "illegal" data such as background noises, tape anomalies, and unusually low signal levels. The validator can then flag these instances for later review using the "needs review" transcription item.

4.4. Certification

Certification involved four distinct processes: counting files, checking raw files for consistency between channels, checking raw files for size, consistency and overwrites, and most importantly, listening to all data a second time. Several simple scripts were developed to facilitate this process.

Counting files was done using the *count_files* program. This shell script uses standard Unix commands such as *ls*, *wc*, and *awk* to determine the number and types of validation files that are produced during the validation phase. It outputs the results by speaker and repetition allowing the user to easily determine the location of the missing utterance. This program is used primarily to find missing files in the validated data or missing utterances on the DAT.

The next program used to certify validated data was the *check_channels* program. The *check_channels* program compares each file corresponding to a different channel of the same utterance to insure that the files are the same size, yet hold different data. This C++ program takes as input a list of the channel 0 files needing review. The size of the channel files are compared by counting the number of samples; files with differing sizes are flagged. The program then checks the first 256 samples of each channel to make sure they are not identical. This step serves two purposes: to find incorrectly validated utterances and to find utterances with large segments of zero data. The automatic segmentation process sometimes included adjacent zero-value data on the DAT due to the way the tapes were mastered as concatenations of other tapes.

The *check_files* utility is a C++ program used to do some rudimentary checks on the integrity of the data (files that are too long in duration, too low in amplitude, or identical to other files in the corpus are flagged for further review and correction). By tagging the files that are too long, this program finds many instances where two utterances have been segmented into the same file or where there are long runs of zero amplitude signals in the raw files. This program also finds the instances where the validator has mistakenly saved a single utterance to multiple files due to an incorrect speaker or session number setting.

Once the above utilities perform their tasks, the *verify_data* utility is used to perform a second pass at listening to the data. This shell script plays an utterance and lists the proposed transcription of that utterance. The utterances to be verified are given as input from the command line. This step in the certification process is essential as a redundancy check on the data. This program allows the user to fix instances where the validator has incorrectly labeled an utterance, where an utterance is missing or defective, and where background noises are either unlabeled or incorrectly labeled.

4.5. Conversion to SPHERE Files

This phase of the project required implementation of a *make_sphere* program. The help page for the program is shown in Figure 4. This is a simple program that stuffs the header of each file with a mixture of speaker, session, and utterance information. It takes as input three files — a session file containing information shared by all files in the session (the speaker's demographics, recording conditions, etc.), a list of the validation filenames (containing utterance-specific information such as the transcription), and a list of the raw speech data files - and a destination directory. The end result is an ASCII header such as the one shown in Table 7.

```
isip01_[2]: make_sphere -help
name: make_sphere
synopsis: make_sphere  <session_file>  <val_file_list>  <raw_file_list> <output_directory>
example: make_sphere  SESSION_INFO_FILE.text  val_list.text  raw_list.text destination

options:
 -help:                         display this help message

arguments: file names
 session_file:                  file of session information in field = value format
 val_file_list:                 file containing a list of JEIDA validation files
 raw_file_list:                 file containing a list of RAW format audio files
 destination                     a directory in which to place the sphere files

 *note: every line of val_file_list should correspond to raw_file_list
man page: none
```

Figure 4. An overview of the make_sphere program that converts raw files to SPHERE-formatted files.

4.6. Verification

Verification of the sphere data is the last “line of defense” in spotting validation and data errors. Verification involves recounting the SPHERE files and checking the transcriptions in the SPHERE files for consistency. The program used to check for transcription consistency is *check_sphere*. This shell script takes as input the directory where the SPHERE files are held and the parameter keyword to search for in the SPHERE files. It finds that keyword and counts every unique instance of its value. The program then tallies the number of times that value is found and outputs this distribution. The user should expect that each value would appear in the corpus a given number of times. Comparing the expected output and actual output gives the user the ability to find errors which may have slipped through the validation/certification process.

This collection of relatively simple programs has proven to be extremely valuable in maintaining a high quality corpus. Each step was carefully designed to provide useful information about the corpus, and serve as a redundant check. The *check_sphere* program, for example, though one of the last programs run, caught several errors in each segment of the corpus. ISIP will make every effort to maintain, support, and extend this software to support LDC’s long-term mission of providing high quality corpora cost-effectively.

5. CORPUS DESCRIPTION[1]

The Japanese Common Speech Data (JCSD) Corpus consists of a set of four 8mm tapes containing 20 Gbytes of data across 375,000 files. In this section, we summarize relevant properties of the corpus. Refer to Appendix D for information on how to read the tapes.

5.1. Overview

The corpus has been prepared on Unix tar-formatted 8mm tapes. The contents of each tape are summarized below in Table 8. The corpus has been subdivided so that it can be easily restored to reasonably small file partitions. Channel 0 and 1 have been separated in anticipation that most users will prefer to deal with only one microphone at a time.

An overview of the file and directory structure is given in Figure 5. The logical organization of the corpus begins with a subdivision by content, followed by a subdivision by channel, followed by a subdivision by sex, followed by a subdivision by speaker. This makes it easy to restore particular subsets of the corpus. The organization has been kept as symmetric as possible to facilitate regular expression/wildcard searching of the corpus. Speech data are contained in seven directories (lowercase), while documentation and readme files are presented in uppercase at the highest level of the directory hierarchy.

Our file naming convention for the corpus is described in Table 9. Other useful statistics about the size of the corpus are given in Table 10. Since this corpus is quite large, it is useful to have a detailed breakdown of the sizes of various components of the corpus. This is given below in

1. This section is meant to serve as a self-contained description of the corpus. Some of the information is redundant with other sections of this text.

Tape No.	No. Tar Files	Size (Gbytes)	Contents
1	5	0.8 1.6 1.5 0.8 0.1 Total: 4.8	Ctrl Words A Ctrl Words B Ctrl Words C Isolated Digits Documentation/Source
2	1	Total: 3.1	Four Digits
3	2	3.3 3.1 Total: 6.4	City Names: Channel 0 City Names: Channel 1
4	2	2.9 2.7 Total: 5.6	Monosyllables: Channel 0 Monosyllables: Channel 1

Table 8. A summary of the 4 tape set comprising the JCSD Corpus.

Filename: **m01i001d.sp1**	
Substring	Description
m	speaker sex (m/f)
01	speaker number: f01— f75:females m01— m77:males
i	utterance type: a: control words a b: control words b c: control words c i: isolated digits d: four digit sequences n: city_names m: monosyllables
001	utterance id (see Appendix A)
d	repetition no. 4 (out of four repetitions)
sp1	a SPHERE formatted file for channel 1

Table 9. The JCSD file naming convention.

Figure 5. An overview of the filesystem used to organize the JCSD Corpus.

number of speakers	150 speakers
males	75
females	75
range of speaker age	10 yrs. to 70 yrs.
number of items per speaker	323 items
isolated digits	15
four digit sequences	35
city names	100
monosyllables	110
control words (set A)	13
control words (set B)	24
control words (set C)	26
number of repetitions per item	4 repetitions
total number of utterances	193,763 utterances (per channel)
sample frequency	16 kHz
sample type	16-bit linear
number of microphones	2 (dynamic and condenser)

Table 10. Key dimensions of the JCSD corpus.

Table 11. From this table, it is clear that there are some missing data files. This is extensively documented in Section 5.2. It is also clear that careful structuring of the corpus is required so that the number of files per directory does not become unmanageable (a very real issue under Unix). If nothing else, the JCSD Corpus is large and comprehensive, making it one of the most extensive Japanese corpora available today.

5.2. Errata

A complete listing of the number of files for each subset of the corpus for each speaker is given in Appendix C. In this section, we document all missing utterances. There is also a directory titled *INFO/doc/errata* included in the corpus distribution. This directory contains files that we consider too anomalous to be part of the corpus proper (for example, incorrectly spoken utterances in which the contents do not match the prompting text). A small number of speaker's data fell into this category: f34, f35, f52, f69, m27, and m35. There are six utterances, one per speaker, included in this directory. We include this data mainly for archival purposes. We don't expect these files to be useful for technology development. The file organization for the errata directory mirrors the one used in the corpus.

In Table 12 below, we list all known missing files for various speakers. The majority of these were the result of data missing from our original DAT copy of the corpus. Some files contained mispronunciations of items (common examples include digits being reversed in a four digit sequence, or an incorrect word being substituted). Files corresponding to mispronunciations were excluded from the corpus even though they contained valid speech data. They were retained, however, in the directory *INFO/doc/errata*.

There were a handful of utterances that contained some anomalous behavior. These are listed in Table 13. Most often, these were the result of a recording chopping the end of a word prematurely,

Subset	Partition	Size (Gbytes)	No. Files
control words (set A)	all	0.808	15,080
	c_0 c_1	0.417 0.391	7,800 7,280
	males females	0.401 0.407	7,540 7,540
control words (set B)	all	1.624	27,840
	c_0 c_1	0.839 0.784	14,400 13,440
	males females	0.799 0.825	13,920 13,920
control words (set C)	all	1.538	30,158
	c_0 c_1	0.794 0.744	15,599 14,559
	males females	0.761 0.777	15,080 15,078
isolated digits	all	0.795	17,390
	c_0 c_1	0.411 0.384	8,995 8,395
	males females	0.400 0.395	8,700 9,230
four digit sequences	all	3.111	40,586
	c_0 c_1	1.607 1.504	20,993 19,593
	males females	1.531 1.580	20,296 20,290
city names	all	6.413	115,976
	c_0 c_1	3.313 3.100	59,987 55,989
	males females	3.159 3.254	57,992 55,984
Subset	Partition	Size (Gbytes)	No. Files
monosyllables	all	5.654	127,579
	c_0 c_1	2.918 2.736	65,989 61,590
	males females	2.805 2.849	63,797 63,782
TOTAL	all	19.943	374,609
	c_0 c_1	10.299 9.644	193,763 180,846
	males females	9.856 10.087	187,325 187,284

Table 11. Sizes of various subsets of the JCSD Corpus.

Speaker No.	Subset	Utterance/ Repetition	Explanation
f02	four digits	d025b d026b d027b	missing from DAT missing from DAT missing from DAT
f12	monosyllables	m101d	missing from DAT
f16	city names	n098b	missing from DAT
f23	isolated digits	i011a i012a i013a i014a i015a	missing from DAT missing from DAT missing from DAT missing from DAT missing from DAT
f34	control words c	c016b	mispronunciation
f35	city names	c029b	mispronunciation
f47	four digits city names monosyllables	d001a n041d n042d n043d m110a	missing from DAT missing from DAT missing from DAT missing from DAT missing from DAT
f48	city names	n001b	missing from DAT
f52	city names	n076b	mispronunciation
f53	city names	n040d	missing from DAT
f60	monosyllables	m104d m105d m106d m107d m108d m109d m110d	missing from DAT missing from DAT missing from DAT missing from DAT missing from DAT missing from DAT missing from DAT
f69	four digits	d033a	transposition of words
m01	city names	n099b	missing from DAT
m07	city names monosyllables	n100a m059d	missing from DAT missing from DAT
m10	city names	n100d	missing from DAT
m27	four digits	d016c	mispronunciation
m32	city names	n001d	missing from DAT
m35	four digits	d007c	mispronunciation
m50	monosyllables	m110b	missing from DAT
m53	city names	n021b	missing from DAT

Table 12. Documented missing files for the JCSD Corpus.

or an artifact on the tape causing some form of artificial distortion (for example, DATs tend to produce a white noise-type signal when there is a tape dropout). These files were included in the final corpus because the utterance is easily recognizable by humans. These utterances would be useful for some forms of robustness experiments, but not perhaps as useful for basic speech recognition system training. With the documentation below, they can be easily removed from the corpus by individual sites.

Speaker No.	Subset	Utterance/Repetition	Explanation
f09	control words c	c026d	end of utterance truncated
f14	four digits	d033d	beginning of utterance truncated
f27	four digits	d008b	stutter in the middle of the utterance
f29	city names	n087b	end of utterance truncated
f33	isolated digits	i013a	“shichi” pronounced as “ichi”
f45	city names	n059c	corrupted data (tape failure)
f47	monosyllables	m109a	end of utterance truncated
f48	isolated digits	i006a	end of utterance truncated
f64	four digits	d004c	end of utterance truncated
m23	control words b	b023a	end of utterance truncated
m35	four digits	d035a	end of utterance truncated
m47	control words a	a013d	end of utterance truncated
m60	control words a control words b	a013d b005a b016a b022a b003b b020b	end of utterance truncated corrupted data (tape failure) corrupted data (tape failure) corrupted data (tape failure) corrupted data (tape failure) corrupted data (tape failure)

Table 13. Miscellaneous anomalous files in the JCSD Corpus.

6. CONCLUSIONS

The JCSD Corpus is impressive if nothing else due to its size and scope. The overall quality of the data is high — only a small percentage of files (approximately 0.01% of the files) are defective. Even though speech recognition technology has moved beyond isolated phrase tasks, this corpus, due to its size and variation, still represents a useful corpus for bootstrapping Japanese language technology — particularly speaker-dependent technology.

It is interesting to note that preparation of this corpus, starting with the DAT tapes, required approximately 2080 hours of labor. This resulted in 86 hours of speech data (actually, only approximately half of that is useful speech data, the remainder is background noise), or a ratio of

0.04 hours of data per hour of labor — a reasonable ratio by today's standards for this type of corpus. Further, the nonrecurring cost of this corpus was approximately 0.3 minutes of speech per dollar of labor — again a fairly reasonable ratio in today's market. Of course, these numbers do not reflect the effort required to originally collect the data, which was easily the lion's share of the project. We believe our productivity was largely due to the highly efficient validation tools developed specifically for this project.

7. ACKNOWLEDGEMENTS

First and foremost, we wish to thank Professor Shuichi Itahashi of the University of Tsukuba for his assistance in this project. Itahashi-sensei was instrumental in facilitating the acquisition of JCSD Corpus, and supplied us with extensive documentation on the content and organization of the DAT version of the corpus. Second, we wish to thank Dr. Jack Godfrey, without whom this project would have never happened. LDC's acquisition of the corpus is largely due to his vision of LDC as an international organization offering historically significant corpora in many languages. Third, we wish to thank Dr. Mark Liberman, Dave Graff, and Rebecca Finch at LDC for their continual support and guidance during this project.

Validating over 350,000 utterances, needless to say, takes its toll on human listeners. We would like to acknowledge several people (listed alphabetically) who worked as validators on this project: Sarah Kaye Blackwell, Michael Brunt, Suehvla El-Attar, Sean Lauderdale, Brian Molen, Mary E. Weber, Leigh A. Webster, Daniel Williams. Their productivity averaged approximately 550 utterances per hour, providing enough throughput to make it possible to do extensive quality control on the corpus.

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APPENDIX A. PROMPTING TEXT

The corpus is divided into seven groups of utterances: Control Words A, Control Words B, Control Words C, Isolated Digits, Four Digit Sequences, City Names, and Monosyllables. The prompting text for each category is shown below, using a hiragana transcription system provided with the original corpus:

Control Words:

Index	Control Words A	Control Words B	Control Words C
001	syo-kai	zeNkaku	bi-
002	horyu-	so-nyu-	oN
003	hurikomi	kaigyo-	jaku
004	do-zo	haNkaku	e-
005	mo-ichido	buNmatsu	shita
006	zaNdaka	heNkaN	shi-
007	hai	ido-	dai
008	torikeshi	jipe-ji	kesu
009	owari	ke-seN	ko-tai
010	hajime	kaipe-ji	kyo-
011	i-e	katakana	shimeru
012	te-se-	seNtariNgu	suta-to
013	toritsugi	muheNkaN	hidari
014		zeNpe-ji	mae
015		taNgo to-roku	sutoppu
016		jikko-	sho-
017		kiNto-waritsuke	ushiro
018		supe-su	zeNshiN
019		tabu	ohu
020		shu-ryo-	appu
021		sakujo	chu-
022		aNda-raiN	ue
023		baikaku	dauN
024		wakuake	migi
025			tsukeru
026			akeru

Digit Sequences:

Index	Isolated Digits	Four Digit Sequences
001	zero	zero ni hachi nana
002	san	go nana san ni
003	ni	kyu roku zero ichi
004	rei	yon ichi go roku
005	nana	ichi ichi kyu kyu
006	yon	ichi san kyu hachi
007	go	roku hachi yon san
008	maru	zero nana ichi ni
009	shi	go ni roku nana
010	roku	roku roku san san
011	ku	ni yon zero kyu
012	hachi	nana kyu go yon
013	shichi	ichi hachi ni san
014	kyu	roku san nana hachi
015	ichi	hachi hachi nana nana
016		san go ichi zero
017		hachi zero roku go
018		ni kyu san yon
019		nana yon hachi kyu
020		ni ni yon yon
021		yon roku ni ichi
022		kyu ichi nana roku
023		san zero yon go
024		hachi go kyu zero
025		go go zero zero
026		roku kyu nana ni
027		go hachi roku ichi
028		san roku yon kyu
029		zero san ichi roku
030		nana zero hachi san
031		hachi ichi kyu yon
032		kyu ni zero go
033		ichi yon ni nana
034		ni go san hachi
035		yon nana go zero

City Names:

Index	City Names	Index	City Names	Index	City Names	Index	City Names
001	hachinohe	026	matto-	051	meguro	076	chiryu-
002	keseNnuma	027	o-bu	052	gushikawa	077	buNkyo-
003	yukuhashi	028	ko-be	053	numazu	078	o-muta
004	sapporo	029	gobo-	054	rikuzeNtakada	079	yu-ki
005	kitami	030	siNgu-	055	koganei	080	suzu
006	eniwa	031	kure	056	yonago	081	neyagawa
007	yokote	032	mine	057	sasebo	082	eNzaN
008	toride	033	buzeN	058	tochigi	083	hisai
009	warabi	034	beppu	059	kamo	084	muko-
010	asahi	035	nemuro	060	wako-	085	daito-
011	tsuruga	036	susono	061	bisai	086	kuroiso
012	takehu	037	gamago-ri	062	tsuru	087	ninohe
013	hekinaN	038	so-ja	063	ube	088	goteNba
014	yasugi	039	chiba	064	iyo	089	moriguchi
015	zentsu-ji	040	noda	065	nihoNmatsu	090	so-ka
016	rumoi	041	zushi	066	yame	091	seki
017	bibai	042	date	067	takeo	092	hoNjo-
018	seNdai	043	himi	068	hoNdo	093	saNjo-
019	teNdo-	044	gihu	069	mito	094	ebina
020	naNyo-	045	mutsu	070	naha	095	masuda
021	mo-ka	046	ageo	071	shiNjo-	096	ko-hu
022	kazo	047	ehime	072	kiryu-	097	bizeN
023	ni-za	048	hujiidera	073	hanyu-	098	huji
024	ho-ya	049	ibusuki	074	teNryu-	099	hagi
025	uozu	050	zama	075	huchu-	100	kiyose

Monosyllables:

Index	Mono-syllables	Index	Mono-syllables	Index	Mono-syllables	Index	Mono-syllables
001	ha	029	nya	057	na	085	mu
002	hyo	030	shi	058	ku	086	so
003	a	031	ho	059	nu	087	sho
004	myu	032	chu	060	ji	088	ba
005	ga	033	byu	061	ma	089	zo
006	mo	034	ne	062	e	090	ni
007	cho	035	bi	063	za	091	da
008	be	036	bya	064	hya	092	myo
009	bo	037	byo	065	tsu	093	pe
010	nyo	038	ka	066	hu	094	sha
011	kya	039	po	067	go	095	chi
012	pi	040	ro	068	ta	096	ke
013	gu	041	i	069	ze	097	do
014	sa	042	me	070	rya	098	o
015	ya	043	pa	071	gyo	099	nyu
016	pyo	044	kyo	072	kyu	100	ko
017	mya	045	bu	073	u	101	n
018	se	046	gya	074	de	102	ti
019	gi	047	pu	075	ja	103	je
020	ge	048	su	076	ri	104	fa
021	zu	049	to	077	pya	105	fo
022	pyu	050	shu	078	yo	106	she
023	ra	051	hi	079	gyu	107	di
024	ju	052	yu	080	wa	108	fi
025	mi	053	ru	081	he	109	che
026	jo	054	re	082	cha	110	fe
027	te	055	no	083	ryu		
028	ryo	056	hyu	084	ki		

APPENDIX B. DAT INVENTORY

The source format for the JEIDA corpus was a set of 76 Digital Audio Tapes (DAT):

Tape No.	ID No.	Material	Duration (hours)	Speakers
1	1-1	Control Words A	1	m01 — m20
2	1-2	Control Words A	1	m21 — m25, m76, m27 — m29, m77, m31 — m40
3	2-1	Control Words A	1	m41 — m44, m75, m45 — m59
4	2-2	Control Words A	1	m60 — m74
5	3-1	Control Words A	1	f01 — f20
6	3-2	Control Words A	1	f21 — f40
7	4-1	Control Words A	1	f41 — f60
8	4-2	Control Words A	1	f61 — f75
9	1-1	Control Words B	1	m01 — m15
10	1-2	Control Words B	1	m16 — m25, m76 m27 — m29, m77
11	2-1	Control Words B	1	m31 — m44, m75
12	2-2	Control Words B	1	m45 — m59
13	3	Control Words B	1	m60 — m74
14	4-1	Control Words B	1	f01 — f15
15	4-2	Control Words B	1	f16 — f30
16	5-1	Control Words B	1	f31 — f45
17	5-2	Control Words B	1	f46 — f60
18	6	Control Words B	1	f61 — f75
19	1	Control Words C	2	m01 — m25
20	2	Control Words C	2	m76, m27 — m29, m77, m31 — m44, m75, m45 — m49
21	3	Control Words C	2	m50 — m74
22	4	Control Words C	2	f01 — f25
23	5	Control Words C	2	f26 — f50
24	6	Control Words C	2	f51 — f75

Tape No.	ID No.	Material	Duration (hours)	Speakers
25	1-1	Isolated Digits	1	m01 — m20
26	1-2	Isolated Digits	1	m21 — m25, m76, m27 — m29, m77, m31 — m40,
27	2-1	Isolated Digits	1	m41 — m44, m75, m45 — m59
28	2-2	Isolated Digits	1	m60 — m74
29	3-1	Isolated Digits	1	f01 — f20
30	3-2	Isolated Digits	1	f21 — f40
31	4-1	Isolated Digits	1	f41 — f60
32	4-2	Isolated Digits	1	f61 — f0175
33	1	4-Digit Sequences	2	m01 — m17
34	2	4-Digit Sequences	2	m18 — m25, m76, m27 — m29, m77, m31 — m34
35	3	4-Digit Sequences	2	m35 — m44, m75, m45 — m50
36	4	4-Digit Sequences	2	m51 — m67
37	5	4-Digit Sequences	2	m68 — m74
38	6	4-Digit Sequences	2	f01 — f17
39	7	4-Digit Sequences	2	f18 — f34
40	8	4-Digit Sequences	2	f35 — f51
41	9	4-Digit Sequences	2	f52 — f68
42	10	4-Digit Sequences	1	f69 — f75

Tape No.	ID No.	Material	Duration (hours)	Speakers
43	1	City Names	2	m01 — m05, m09, m07, m08, m10
44	2	City Names	2	m06, m11 — m18
45	3	City Names	2	m19 — m25, m76, m27
46	4	City Names	2	m28 — m36
47	5	City Names	2	m37 — m44, m75
48	6	City Names	2	m45 — m53
49	7	City Names	2	m54 — m62
50	8	City Names	2	m63 — m71
51	9	City Names	1	m72 — m74
52	10	City Names	2	f01 — f09
53	11	City Names	2	f10 — f18
54	12	City Names	2	f19 — f27
55	13	City Names	2	f28 — f36
56	14	City Names	2	f37 — f45
57	15	City Names	2	f46 — f54
58	16	City Names	2	f55 — f63
59	17	City Names	2	f64 — f72
60	18	City Names	1	f73 — f75

Tape No.	ID No.	Material	Duration (hours)	Speakers
61	1	Monosyllables	2	m01 — m10
62	2	Monosyllables	2	m10 — m20
63	3	Monosyllables	2	m21 — m25, m76 m27 — m29, m77
64	4	Monosyllables	2	m31 — m40
65	5	Monosyllables	2	m41 — m44, m75, m45 — m49
66	6	Monosyllables	2	m50 — m59
67	7	Monosyllables	2	m60 — m69
68	8	Monosyllables	1	m70 — m74
69	9	Monosyllables	2	f01 — f10
70	10	Monosyllables	2	f11 — f20
71	11	Monosyllables	2	f21 — f30
72	12	Monosyllables	2	f31 — f40
73	13	Monosyllables	2	f41 — f50
74	14	Monosyllables	2	f51 — f60
75	15	Monosyllables	2	f61 — f70
76	16	Monosyllables	1	f71 — f75

APPENDIX C. SPEAKER SUMMARY

A listing of key demographic information for each speaker is given below.

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
f01	Female	10-19	Kanagawa, Kanto	-
	150cm	19dBA	Soundproof room	
f02	Female	20-29	Tokyo, Kanto	Minato, Tokyo
	160cm	19dBA	Soundproof room	
f03	Female	30-39	???	Suginami, Tokyo
	162cm	19dBA	Soundproof room	
f04	Female	40-49	Sodegaura, Kimizu, Chiba, Kanto	Edogawa, Tokyo
	153cm	19dBA	Soundproof room	
f05	Female	50-59	Tochigi, Tochigi, Kanto	Tochigi, Tochigi
	152cm	19dBA	Soundproof room	
f06	Female	20-29	Yokosuka, Kanagawa, Kanto	Miura, Kanagawa
	152cm	45dBA	Soundproof room	
f07	Female	20-29	Yokosuka, Kanagawa, Kanto	Yokosuka, Kanagawa
	153cm	45dBA	Soundproof room	
f08	Female	20-29	Sagamihara, Kanagawa, Kanto	Sagamihara, Kanagawa
	157cm	45dBA	Soundproof room	
f09	Female	40-49	Yokosuka, Kanagawa, Kanto	Yokosuka, Kanagawa
	151cm	45dBA	Soundproof room	
f10	Female	50-59	Tokyo, Kanto	Musashino, Tokyo
	148cm	45dBA	Soundproof room[	
f11	Female	20-29	Yuki, Ibaraki, Kanto	-
	153cm	-	Simple soundproof room	
f12	Female	20-29	Yokohama, Kanagawa, Kanto	-
	155cm	< 30dBA	Simple soundproof room	
f13	Female	30-39	Niigata, Niigata, Chubu	-
	158cm	< 30dBA	Simple soundproof room	
f14	Female	40-49	Ota, Tokyo, Kanto	-
	153cm	< 30dBA	Simple soundproof room	
f15	Female	50-59	Dairen, Kanton, Mansyu, Kanto	-
	156cm	< 30dBA	Simple soundproof room	
f16	Female	20-29	Yokohama, Kanagawa, Kanto	Suginami, Tokyo
	156cm	< 30dBA	Soundproof room	
f17	Female	20-29	Nerima, Tokyo, Kanto	Suginami, Tokyo
	161cm	< 30dBA	Soundproof room	
f18	Female	30-39	Nakano, Tokyo, Kanto	Ichikawa, Chiba
	162cm	< 30dBA	Soundproof room	
f19	Female	40-49	Shima, Mie, Kinki	Kamakura, Kanagawa
	158cm	< 30dBA	Soundproof room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
f20	Female	50-59	Mito, Ibaraki, Kanto	Meguro, Tokyo
	160cm	< 30dBA	Soundproof room	
f21	Female	20-29	Okaya, Nagano, Chubu	Hachioji, Tokyo
	156cm	46dBA	Soundproof room	
f22	Female	30-39	Oume, Tokyo, Kanto	Oume, Tokyo
	153cm	46dBA	Soundproof room	
f23	Female	30-39	Nishitama, Tokyo, Kanto	Nishitama, Tokyo
	163cm	46dBA	Soundproof room	
f24	Female	40-49	Tokyo, Kanto	Kokubunji, Tokyo
	149cm	46dBA	Soundproof room	
f25	Female	50-59	Tokyo, Kanto	Kokubunji, Tokyo
	153cm	46dBA	Soundproof room	
f26	Female	20-29	Fuji, Shizuoka, Chubu	Setagaya, Tokyo
	157cm	-	Meeting room	
f27	Female	30-39	Sado, Niigata, Chubu	Komae, Tokyo
	157cm	47dBA	Meeting room	
f28	Female	30-39	Tokyo, Kanto	Hachioji, Tokyo
	150cm	-	Meeting room	
f29	Female	40-49	Tokyo, Kanto	Musashino, Tokyo
	158cm	-	Meeting room	
f30	Female	40-49	Kokubunji, Tokyo, Kanto	Toshima, Tokyo
	150cm	-	-	
f31	Female	20-29	Komae, Tokyo, Kanto	Yokohama, Kanagawa
	158cm	29dBA	Simple soundproof room	
f32	Female	20-29	Kawasaki, Kanagawa, Kanto	Kawasaki, Kanagawa
	163cm	29dBA	Simple soundproof room	
f33	Female	30-39	Higashiuwa, Ehime, Shikoku	Machida, Tokyo
	149cm	29dBA	Simple soundproof room	
f34	Female	40-49	Tokyo, Kanto	Yokohama, Kanagawa
	150cm	29dBA	Simple soundproof room	
f35	Female	50-59	Tokyo, Kanto	Yokohama, Kanagawa
	150cm	29dBA	Simple soundproof room	
f36	Female	20-29	Nishinomiya, Hyogo, Kinki	Yokohama, Kanagawa
	163cm	34dBA	Simple soundproof room	
f37	Female	20-29	Naka, Kanagawa, Kanto	Naka, Kanagawa
	153cm	34dBA	Simple soundproof room	
f38	Female	30-39	Odawara, Kanagawa, Kanto	Odawara, Kanagawa
	155cm	34dBA	Simple soundproof room	
f39	Female	40-49	Minamikorai, Nagasaki, Kyushu	Kamakura, Kanagawa
	158cm	34dBA	Simple soundproof room	
f40	Female	50-59	Kamakura, Kanagawa, Kanto	Kamakura, Kanagawa
	158cm	34dBA	Simple soundproof room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
f41	Female	20-29	Yokohama, Kanagawa, Kanto	Minato, Tokyo
	159cm	30dBA	Soundproof room	
f42	Female	20-29	Tanashi, Tokyo, Kanto	Yokohama, Kanagawa
	150cm	30dBA	Soundproof room	
f43	Female	30-39	Kawasaki, Kanagawa, Kanto	Kawasaki, Kanagawa
	156cm	30dBA	Soundproof room	
f44	Female	30-39	Ota, Tokyo, Kanto	Yokohama, Kanagawa
	149cm	30dBA	Soundproof room	
f45	Female	40-49	Chuo, Tokyo, Kanto	Yokohama, Kanagawa
	150cm	30dBA	Soundproof room	
f46	Female	20-29	Hachioji, Tokyo, Kanto	Setagaya, Tokyo
	155cm	30dBA	Soundless room	
f47	Female	30-39	Kamakura, Kanagawa, Kanto	Setagaya, Tokyo
	154cm	30dBA	Soundless room	
f48	Female	30-39	Takada, Niigata, Chubu	Sagamihara, Kanagawa
	151cm	30dBA	Soundless room	
f49	Female	40-49	Bunkyo, Tokyo, Kanto	Bunkyo, Tokyo
	158cm	30dBA	Soundless room	
f50	Female	40-49	Tokyo, Kanto	Suginami, Tokyo
	145cm	30dBA	Soundless room	
f51	Female	20-29	Setagaya, Tokyo, Kanto	Setagaya, Tokyo
	160cm	37dBA	Soundproof room	
f52	Female	30-39	Chuo, Tokyo, Kanto	Hachioji, Tokyo
	153cm	37dBA	Soundproof room	
f53	Female	30-39	Hachioji, Tokyo, Kanto	Hachioji, Tokyo
	161cm	37dBA	Soundproof room	
f54	Female	40-49	Tokyo, Kanto	Hino, Tokyo
	153cm	-	Soundproof room	
f55	Female	50-59	Saeki, Hiroshima, Chugoku	Hachioji, Tokyo
	158cm	37dBA	Soundproof room	
f56	Female	20-29	Toyonaka, Osaka, Kinki	Nara, Nara
	162cm	30dBA	Soundproof room	
f57	Female	20-29	Kitauwa, Ehime, Shikoku	Tenri, Nara
	165cm	30dBA	Soundproof room	
f58	Female	20-29	Aira, Kagoshima, Kyushu	Nara, Nara
	155cm	29dBA	Soundproof room	
f59	Female	40-49	Higashiosaka, Osaka, Kinki	Nara, Nara
	158cm	32dBA	Soundproof room	
f60	Female	50-59	Tenri, Nara, Kinki	Tenri, Nara
	152cm	32dBA	Soundproof room	
f61	Female	20-29	Yokohama, Kanagawa, Kanto	Yokohama, Kanagawa
	168cm	40dBA	Simple soundproof room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
f62	Female	20-29	Fukushima, Tohoku	Kawasaki, Kanagawa
	154cm	40dBA	Simple soundproof room	
f63	Female	30-39	Yokohama, Kanagawa, Kanto	Inagi, Tokyo
	158cm	40dBA	Simple soundproof room	
f64	Female	40-49	Niigata, Kanto	Kawasaki, Kanagawa
	151cm	40dBA	Simple soundproof room	
f65	Female	50-59	Fukuoka, Fukuoka, Kyushu	Kawasaki, Kanagawa
	160cm	40dBA	Simple soundproof room	
f66	Female	20-29	Nanyo, Yamagata, Tohoku	Sakura, Niihari, Ibaraki
	159cm	< 25dBA	Simple soundless room	
f67	Female	30-39	Iwaki, Fukushima, Tohoku	Sakura, Niihari, Ibaraki
	157cm	< 25dBA	Simple soundless room	
f68	Female	30-39	Osaka, Kinki	Sakura, Niihari, Ibaraki
	155cm	< 25dBA	Simple soundless room	
f69	Female	40-49	Tokyo, Kanto	Sakura, Niihari, Ibaraki
	162cm	< 25dBA	Simple soundless room	
f70	Female	60-69	Ibusuki, Kagoshima, Kyushu	Sakura, Niihari, Ibaraki
	157cm	< 25dBA	Simple soundless room	
f71	Female	20-29	Utsunomiya, Tochigi, Kanto	Shimotsuga, Tochigi
	156cm	25dBA	Soundproof room	
f72	Female	30-39	Nihonmatsu, Fukushima, Tohoku	Utsunomiya, Tochigi
	157cm	25dBA	Soundproof room	
f73	Female	30-39	Touhaku, Tottori, Chugoku	Utsunomiya, Tochigi
	159cm	25dBA	Soundproof room	
f74	Female	40-49	Tochigi, Kanto	Utsunomiya, Tochigi
	156cm	25dBA	Soundproof room	
f75	Female	50-59	Utsunomya, Tochigi, Kanto	Utsunomya, Tochigi
	156cm	25dBA	Soundproof room	
m01	Male	20-29	Yokohama, Kanagawa, Kanto	Sagamihara, Kanagawa
	181cm	19dBA	Soundproof room	
m02	Male	20-29	Tokyo, Kanto	Yokohama, Kanagawa
	171cm	19dBA	Soundproof room	
m03	Male	30-39	Shinagawa, Tokyo, Kanto	Machida, Tokyo
	169cm	19dBA	Soundproof room	
m04	Male	40-49	Fuchu, Hiroshima, Chugoku	Funabashi, Chiba
	164cm	19dBA	Soundproof room	
m05	Male	50-59	Tokyo, Kanto	Shinjuku, Tokyo
	167cm	19dBA	Soundproof room	
m06	Male	50-59	Tokyo, Kanto	Kokubunji, Tokyo
	161cm	45dBA	Soundproof room	
m07	Male	30-39	Himeji, Hyogo, Kinki	Koganei, Tokyo
	173cm	45dBA	Soundproof room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
m08	Male	30-39	Kobe, Hyogo, Kinki	Yokosuka, Kanagawa
	168cm	45dBA	Soundproof room	
m09	Male	20-29	Fukuoka, Fukuoka, Kyushu	Yokosuka, Kanagawa
	174cm	45dBA	Soundproof room	
m10	Male	40-49	Kobe, Hyogo, Kinki	Yokosuka, Kanagawa
	169cm	45dBA	Soundproof room	
m11	Male	20-29	Hanejima, Gifu, Chubu	Tsukuba, Ibaraki
	174cm	< 30dBA	Simple soundproof room	
m12	Male	30-39	Toyama, Chubu	Niihari, Ibaraki
	176cm	< 30dBA	Simple soundproof room	
m13	Male	30-39	Morioka, Iwate, Tohoku	Toride, Ibaraki
	170cm	< 30dBA	Simple soundproof room	
m14	Male	40-49	Takayama, Gifu, Chubu	Ushiku, Ibaraki
	162cm	< 30dBA	Simple soundproof room	
m15	Male	50-59	Ota, Tokyo, Kanto	Sakura, Niihari,Ibaraki
	167cm	< 30dBA	Simple soundproof room	
m16	Male	20-29	Nakano, Tokyo, Kanto	-
	170cm	< 30dBA	Soundproof room	
m17	Male	20-29	Minato, Tokyo, Kanto	-
	172cm	< 30dBA	Soundproof room	
m18	Male	30-39	Saaebo, Nagasaki, Kyushu	-
	170cm	< 30dBA	Soundproof room	
m19	Male	40-49	Hamakita, Shizuoka, Chubu	-
	167cm	< 30dBA	Soundproof room	
m20	Male	60-69	Ueno, Mie, Kinki	-
	155cm	< 30dBA	Soundproof room	
m21	Male	20-29	Toyoshima, Tokyo, Kanto	Kawasaki, Kanagawa
	176cm	46dBA	Soundproof room	
m22	Male	20-29	Yokohama, Kanagawa, Kanto	Kokubunji, Tokyo
	170cm	46dBA	Soundproof room	
m23	Male	30-39	Sugakawa, Fukushima, Tohoku	Tsukui, Kanagawa
	172cm	46dBA	Soundproof room	
m24	Male	40-49	Suginami, Tokyo, Kanto	Musashino, Tokyo
	174cm	46dBA	Soundproof room	
m25	Male	50-59	Sumida, Tokyo, Kanto	Tsukui, Kanagawa
	163cm	46dBA	Soundproof room	
m27	Male	20-29	Chigasaki, Kanagawa, Kanto	Shibuya, Tokyo
	180cm	-	Meeting room	
m28	Male	30-39	Meguro, Tokyo, Kanto	Yokohama, Kanagawa
	170cm	-	Meeting room	
m29	Male	40-49	Mitaka, Tokyo, Kanto	Yokohama, Kanagawa
	175cm	-	Meeting room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
m31	Male	20-29	Tokyo, Kanto	Machida, Tokyo
	168cm	29dBA	Simple soundproof room	
m32	Male	30-39	Numatsu, Shizuoka, Chubu	Sagamihara, Kanagawa
	166cm	29dBA	Simple soundproof room	
m33	Male	30-39	Minato, Tokyo, Kanto	Minato, Tokyo
	165cm	29dBA	Simple soundproof room	
m34	Male	40-49	Shirakawa, Fukushima, Tohoku	Yokohama, Kanagawa
	167cm	29dBA	Simple soundproof room	
m35	Male	50-59	Omiya, Saitama, Kanto	Yokohama, Kanagawa
	166cm	29dBA	Simple soundproof room	
m36	Male	20-29	Ota, Tokyo, Kanto	Yokohama, Kanagawa
	168cm	34dBA	Simple soundproof room	
m37	Male	20-29	Yokohama, Kanagawa, Kanto	Fujisawa, Kanagawa
	175cm	34dBA	Simple soundproof room	
m38	Male	30-39	Iida, Nagano, Chubu	Hiratsuka, Kanagawa
	171cm	34dBA	Simple soundproof room	
m39	Male	40-49	Kyoto, Kyoto, Kinki	Kamakura, Kanagawa
	166cm	34dBA	Simple soundproof room	
m40	Male	60-69	Tokyo, Kanto	Kamakura, Kanagawa
	163cm	34dBA	Simple soundproof room	
m41	Male	20-29	Karatsu, Saga, Kyushu	Kawasaki, Kanagawa
	172cm	30dBA	Soundproof room	
m42	Male	30-39	Musashino, Tokyo, Kanto	Musashino, Tokyo
	170cm	30dBA	Soundproof room	
m43	Male	30-39	Shinjuku, Tokyo, Kanto	Kawasaki, Kanagawa
	170cm	30dBA	Soundproof room	
m44	Male	40-49	Ota, Tokyo, Kanto	Machida, Tokyo
	163cm	30dBA	Soundproof room	
m45	Male	20-29	Funabashi, Chiba, Kanto	Setagaya, Tokyo
	170	30dBA	Soundless room	
m46	Male	20-29	Fuchu, Tokyo, Kanto	Komae, Tokyo
	165cm	30dBA	Soundless room	
m47	Male	30-39	Urawa, Saitama, Kanto	Suginami, Tokyo
	165cm	30dBA	Soundless room	
m48	Male	40-49	Nakauonuma, Niigata, Chubu	Minato, Tokyo
	168cm	30dBA	Soundless room	
m49	Male	50-59	Tokyo, Kanto	Shibuya, Tokyo
	173cm	30dBA	Soundless room	
m50	Male	20-29	Hitachiota, Ibaraki, Kanto	Kodaira, Tokyo
	166cm	37dBA	Soundproof room	
m51	Male	30-39	Kitakyushu, Fukuoka, Kyushu	Sagamihara, Kanagawa
	168cm	37dBA	Soundproof room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
m52	Male	20-29	Mitaka, Tokyo, Kanto	Mitaka, Tokyo
	172cm	37dBA	Soundproof room	
m53	Male	50-59	Sakura, Chiba, Kanto	Nakano, Tokyo
	164cm	37dBA	Soundproof room	
m54	Male	40-49	Tokyo, Kanto	Hachioji, Tokyo
	165cm	37dBA	Soundproof room	
m55	Male	20-29	Kure, Hiroshima, Chugoku	Tenri, Nara
	173cm	27dBA	Soundproof room	
m56	Male	30-39	Nara, Nara, Kinki	Nara, Nara
	176cm	30dBA	Soundproof room	
m57	Male	30-39	Nagoya, Aichi, Chubu	Nara, Nara
	164cm	30dBA	Soundproof room	
m58	Male	40-49	Osaka, Osaka, Kinki	Nara, Nara
	174cm	32dBA	Soundproof room	
m59	Male	50-59	Sakata, shiga, Kinki	Nara, Nara
	166cm	32dBA	Soundproof room	
m60	Male	20-29	Fukuoka, Fukuoka, Kyushu	Ota, Tokyo
	170cm	40dBA	Simple soundproof room	
m61	Male	30-39	Sapporo, Hokkaido, Hokkaido	Yokohama, Kanagawa
	166cm	40dBA	Simple soundproof room	
m62	Male	30-39	Kobe, Hyogo, Kinki	Yokohama, Kanagawa
	170cm	40dBA	Simple soundproof room	
m63	Male	40-49	Yokohama, Kanagawa, Kanto	Yokohama, Kanagawa
	168cm	40dBA	Simple soundproof room	
m64	Male	60-69	Tokyo, Kanto	Shinagawa, Tokyo
	163cm	40dBA	Simple soundproof room	
m65	Male	20-29	Naka, Kanagawa, Kanto	Sakura, Niihari, Ibaraki
	160cm	< 25dBA	Simple soundless room	
m66	Male	20-29	Joetsu, Niigata, Chubu	Sakura, Niihari, Ibaraki
	173cm	< 25dBA	Simple soundless room	
m67	Male	20-29	Fukushima, Fukushima, Tohoku	Sakura, Niihari, Ibaraki
	169cm	< 25dBA	Simple soundless room	
m68	Male	40-49	Furukawa, Miyagi, Tohoku	Sakura, Niihari, Ibaraki
	161cm	< 25dBA	Simple soundless room	
m69	Male	60-69	Hiroshima, Hiroshima, Chugoku	Sakura, Niihari, Ibaraki
	168cm	< 25dBA	Simple soundless room	
m70	Male	20-29	Utsunomiya, Tochigi, Kanto	-
	172cm	25dBA	Soundproof room	
m71	Male	20-29	Awa, Chiba, Kanto	-
	165cm	25dBA	Soundproof room	
m72	Male	30-39	Utsunomiya, Tochigi, Kanto	-
	175cm	25dBA	Soundproof room	

Speaker No.	Information			
	Sex	Age	Address Under Age 12	Present Address
	Height	Noise	Recording Environment	
m73	Male	40-49	Nishitagawa, Yamagata, Tohoku	Utsunomiya, Tochigi
	171cm	25dBA	Soundproof room	
m74	Male	50-59	Utsunomya, Tochigi, Kanto	-
	165cm	25dBA	Soundproof room	
m75	Male	50-59	Shinagawa, Tokyo, Kanto	Shinagawa, Tokyo
	165cm	30dBA	Soundproof room	
m76	Male	20-29	Kashihara, Nara, Kinki	Yokohama, Kanagawa
	177cm	-	Meeting room	
m77	Male	50-59	Nagoya, Aichi, Chubu	Kawasaki, Kanagawa
	164cm	-	Meeting room	

A listing of the file count for each speaker in the corpus follows. Each entry contains two values: the number of files for channel 0 and channel 1. Discrepancies occur because some speakers were missing data for channel 1. Note that speakers f06 through f10, and m06 through m10 were missing channel 1.

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
f01	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f02	c0	52	96	104	60	137	400	440
	c1	52	96	104	60	137	400	440
f03	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f04	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f05	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f06	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
f07	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
f08	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
f09	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
f10	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
f11	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
f12	c0	52	96	104	60	140	400	439
	c1	52	96	104	60	140	400	439
f13	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f14	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f15	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f16	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
f17	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f18	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f19	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f20	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f21	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f22	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f23	c0	52	96	104	55	140	400	440
	c1	52	96	104	55	140	400	440
f24	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f25	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f26	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f27	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f28	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f29	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f30	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f31	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f32	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
f33	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f34	c0	52	96	103	60	140	400	440
	c1	52	96	103	60	140	400	440
f35	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
f36	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f37	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f38	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f39	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f40	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f41	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f42	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f43	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f44	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f45	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f46	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f47	c0	52	96	104	60	139	397	439
	c1	52	96	104	60	139	397	439
f48	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
f49	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f50	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f51	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f52	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
f53	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
f54	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f55	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f56	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f57	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f58	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f59	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f60	c0	52	96	104	60	140	400	433
	c1	52	96	104	60	140	400	433
f61	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f62	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f63	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f64	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f65	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f66	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f67	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f68	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f69	c0	52	96	104	60	139	400	440
	c1	52	96	104	60	139	400	440
f70	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f71	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f72	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f73	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
f74	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
f75	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m01	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
m02	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m03	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m04	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m05	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m06	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
m07	c0	52	96	104	60	140	399	439
	c1	0	0	0	0	0	0	0
m08	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
m09	c0	52	96	104	60	140	400	440
	c1	0	0	0	0	0	0	0
m10	c0	52	96	104	60	140	399	440
	c1	0	0	0	0	0	0	0
m11	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m12	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m13	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m14	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m15	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m16	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m17	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m18	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m19	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m20	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
m21	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m22	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m23	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m24	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m25	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m27	c0	52	96	104	60	139	400	440
	c1	52	96	104	60	139	400	440
m28	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m29	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m31	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m32	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
m33	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m34	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m35	c0	52	96	104	60	139	400	440
	c1	52	96	104	60	139	400	440
m36	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m37	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m38	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m39	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m40	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m41	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m42	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m43	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
m44	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m45	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m46	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m47	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m48	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m49	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m50	c0	52	96	104	60	140	400	439
	c1	52	96	104	60	140	400	439
m51	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m52	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m53	c0	52	96	104	60	140	399	440
	c1	52	96	104	60	140	399	440
m54	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m55	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m56	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m57	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m58	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m59	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m60	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m61	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m62	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m63	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m64	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

Speaker No.	Chan	Ctrl Words A (a)	Ctrl Words B (b)	Ctrl Words C (c)	Isolated Digits (i)	Four Digits (d)	City Names (n)	Mono-syllables (m)
m65	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m66	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m67	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m68	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m69	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m70	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m71	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m72	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m73	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m74	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m75	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m76	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440
m77	c0	52	96	104	60	140	400	440
	c1	52	96	104	60	140	400	440

APPENDIX D. TAPE ARCHIVE DESCRIPTION

The corpus has been archived on a set of four tapes using the following tools:

- Sun Sparcstation 5
- Solaris 2.4
- Exabyte 8505XL 8mm tape drive
- GNU Tar 1.11.2

The tapes provided were 120m 8mm tapes. The tapes were created using the highest compression mode available. The command used to master these tapes was:

```
tar cvhf /dev/rmt/1cn -C corpus control_words
```

This is a fairly standard command with the notable exception that “1cn” instructs Solaris to use the highest compression mode for tape device no. 1, and to not rewind the drive when finished (thereby allowing multiple tar files to be written to a single tape). Each tape contains multiple tar files (except for tape no. 2). The contents to the tapes are described in Table 8.

To restore these tapes, the command for the above environment is:

```
tar xvf /dev/rmt/1cn
```

If a tape contains more than one file, this command must be run multiple times, once for each tar file. The contents of a tape can be listed using the option “t” (for table of contents) instead of “x” (for extract). Tar is a fairly common command across many platforms, particularly Unix platforms.

The tapes were written with multiple tar files to allow the data to be restored to different physical disks. We recommend building the corpus from a common mount point, and using links to reach the physical disks containing the data.