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Changes in Speech with Modifications in Stimulation from a Cochlear Implant

by

Lekisha S. Jackson

Submitted to the Department of Electrical Engineering and Computer Science

in Partial Fulfillment of the Requirements for the Degrees of

Bachelor of Science in Electrical Science and Engineering

and Master of Engineering in Electrical Engineering and Computer Science

at the Massachusetts Institute of Technology

May 26, 1998

[June 1998]

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May 26, 1998

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ABSTRACT

The phonemic and postural parameters of two postlingually deafened adults with cochlear implants were investigated. The adults read four utterances (a shed, a shad, a sad, and a said) while changes in the speech processor state (on-to-off and vice versa) occurred. Digitization, signal processing, and data extraction were performed on the recorded utterances with programs written in the MITSYN language. Variables measured included vowel acoustics (sound-pressure level, duration, and formant frequencies) and sibilant parameters (median and skewness). The postural parameters (SPL and duration) changed instantaneously for both subjects. The phonemic parameters with the exception of the first and second formant frequencies of /ae/ did not change rapidly. These changes observed in the phonemic parameters can attributed to interdependency changes - formant frequencies are dependent on the changes in the speaking rate of the subjects.

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Acknowledgments

I would like to thank my advisor, Joseph S. Perkell, for making this thesis possible. I am deeply grateful for his constant encouragement, guidance, and personal attention. I would also like to thank Majid Zandipour for his technical assistance and Jennell Vick for her help with digitization and data extraction and analysis. Thanks to Melanie Matthies for her help with MITSYN and Harlan Lane for his guidance on statistics. Finally, thanks to my family for their devotion and support during my years at MIT.

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Chapter 1

Introduction

1.1 Purpose

Most people are aware that they tend to increase the volume of their speech when they walk into a noisy room or, more commonly, when they are listening to music through headphones. However, very few people are aware of the amount of research that has been dedicated to understanding this phenomenon, which is referred to as the Lombard effect. The Lombard effect describes the increase in sound level that occurs when a speaker is placed in a noisy environment.

Early attempts to investigate the Lombard effect used individuals with normal hearing who were subjected to masking noises (high intensity sound). In one of his studies, Lombard, for whom this effect is named, presented monaural and binaural noise to a set of normal-hearing subjects (Lane and Tranel, 1971). He found that binaural noise caused a significant increase in the sound level of the subject's speech. In 1951, Black presented noise at 110 decibels (dB) to 144 male college students to measure hearing loss and increase in voice level during the reading of phrases (Lane and Tranel, 1971). His findings suggested that "a 10-dB increase in threshold caused a 5.7-dB increase in voice level" (Lane and Tranel, 1971). The results from additional studies by Takakura and Yannoulis yielded an increase of 9 dB in voice level with 70 dB noise and an increase of 20 dB with 90 dB noise, respectively (Lane and Tranel, 1971). By increasing the intensity of auditory feedback through headphones for adult speakers, Siegel and Pick (1974) found a direct correlation between the level of noise and the increase in sound level of the speaker's voice. These results and others from similar research suggest that an increase in intensity of speech arises when the level of noise increases. These results also led to new theories for researchers to explore.

One of the theories that recent research has been exploring is that of auditory feedback as a servomechanism. In the investigation of this theory, researchers strive to determine whether or not "auditory feedback monitors transmission conditions, leading the speaker to respond adaptively with changes in speech parameters such as average sound level and segment duration by adjusting speech 'postures'" (Lane *et al.*, 1995). More specifically, these investigators seek to find which speech parameters besides intensity

of speech, such as vowel formants, fundamental frequency (F0), and speaking rate change with modification to auditory feedback and to what extent these parameters change. This thesis describes an attempt to determine the rate of change in speech parameters in response to a modification of auditory feedback.

1.2 Background

Several short-term modification studies (altering auditory feedback a number of times within one experimental session) have been conducted to test the servomechanism theory. The results from these studies have been mixed or inconclusive--some support the servomechanism theory, while others do not. Some of these studies (Svirsky *et al.*, 1992; Lane *et al.*, 1995) have also hypothesized and tested the relative rate of change for two time constants - postural and phonemic. More specifically, postural parameters (i.e., speaking rate, sound-pressure level (SPL)) are expected to change quickly because the speaker has the ability to monitor conditions for the transmission of spoken messages and make the necessary adjustments to ensure a certain level of intelligibility (Lane *et al.*, 1995). However, phonemic parameters (i.e., vowel formants and fricative spectra) are expected to change slowly or not at all because they are produced by underlying synergisms that are over-learned with the use of auditory feedback during language acquisition.

In 1991, Svirsky and Tobey conducted two studies to examine phonemic parameters. Their studies concentrated mainly on vowel formant frequencies. The results indicate significant shifts in formant frequencies during short-term modifications which do not support the above hypothesis - phonemic parameters should change slowly or not at all. In the first experiment with a male subject (Svirsky and Tobey, 1991), the frequencies of the first formants increased and the frequencies of the second formants decreased when the processor was turned ON. Alternatively, in the second experiment with a female and a different male subject, the second formant frequencies were significantly lower when the processor was OFF or when only one channel was excited. The shift in first formant frequencies differed for the two subjects. For the male subject, his first formant frequencies increased when the processor was turned ON; while the female's first formant frequencies increased with the processor OFF or partially stimulated (only one channel on). These significant shifts in formant frequencies may be attributed to the speaker's

reaction to hearing a given phonemic speech parameter for the first time in many years and attempting to bring anomalous parameter values into line with phonemic intentions by making an articulatory adjustments (Lane *et al.*, 1995). It should be noted that the procedures for the two experiments differed. In the first experiment, the subject (female) read utterances while the processor was OFF, immediately after the processor was turned ON, and after the processor was on for 20 minutes. In the second experiment, two subjects (one male and one female) read the utterances during the following sequence of conditions: ON, one channel on, OFF, one channel on, ON, and one channel on.

In 1992, Svirsky, Lane, Perkell, and Wozniak investigated postural (SPL, F0, rate) parameters and phonemic (vowel formants) settings using three subjects with cochlear implants (one male, MA, and two females, FA and FB). Svirsky et al. note "some parameters (different combinations of SPL, F0, H1-H2 and formants for different subjects) showed very rapid changes when turning the speech processor on or off. Parameter changes were faster and more pronounced when the speech processor was turned on than when it was turned off" (Svirsky *et al.*, 1992). The results seemingly do not support the relative rate of change hypothesis (as stated above) which suggests that phonemic parameters (formants in this case) should change slowly or not at all. However, the simple form of the hypothesis does not account for the inter-dependency of parameters. For example, an increase or decrease in speaking rate could cause a change in formants by not allowing the articulators or jaw to obtain the right position. Thus, the results may not be inconsistent with the hypothesis. However, the precise time constants of change in the parameters cannot be determined due to the design of Svirsky *et al.*'s experiment.

Svirsky *et al.* employed two transitions (change between processor state - ON-to-OFF or vice versa) during their experiment. These transitions occurred at approximately 20-minute intervals. Using such a small number of transitions and large time frame, it is impossible to say exactly when or how rapidly the change in the speech parameter occurred because the data are too variable. In other words, the changed could have happened after a few seconds or a few minutes. There are not sufficient data to perform a meaningful statistical data analysis. Decreasing the length of time between transitions and increasing the number of transitions should provide adequate data to perform statistical analysis.

1.3 Summary and Organization of Thesis

Despite previous studies, no results provide precise time rates of change in speech parameters although relative rates of change have been found. Postural parameters are expected to change quickly, while phonemic parameters are expected to change slowly or not all. The main purpose of this thesis is to explore this last claim by determining the time constants of change in these parameters. This study is similar in nature to that of Svirsky *et al.* (1992); however, the approach is to be more refined. Specifically, this study will utilize more transitions in the state of the processor, and the length of time between transition will be shorter.

The two experiments conducted in this thesis are described in Chapter 2. This chapter discusses the subjects' hearing loss and the methodology of the experiment -- including speech material, recording procedures, and signal processing. The chapter continues with the presentation and analysis of the data, and it concludes with a brief summary of the results.

Chapter 3 discusses the changes in postural and phonemic parameters and provides explanations for the changes in phonemic parameters. Finally, Chapter 4 presents the conclusions of the thesis. A summary of new ideas and some direction for further investigations are also presented in Chapter 4.

Chapter 2

Experiments

2.1 Overview

The two experiments described herein were attempts at refining the method presented in Svirsky *et al.* The major distinction between these experiments and Svirsky *et al.* was an increase in the number of transitions between the states (ON/OFF) of the processor. Postural (i.e. SPL and duration) and phonemic (i.e. vowel formants, F1 and F2, and sibilant spectra) parameters were examined during these experiments. Also, the question of whether or not the subjects hear any auditory warning during the switching of the processor state was investigated.

2.2 Subjects

2.2.1 Hearing Loss

Subject MA is a 63 year old male, and subject MB is a 69 year old male. Both subjects have profound bilateral sensorineural hearing loss. MA lost his hearing at the age of 59 after having meningitis. MB lost his hearing in his late 30's. The subjects, both, have worn hearing aids during their lives.

2.2.2 Prosthesis - Cochlear Implant

The cochlear implant consists of an implanted electrode array, a connector, and an external sound processor. The sound-processor has an ear level microphone, a wideband automatic gain control, and a six-channel overlapping bandpass filter system. The outputs of the filter system are delivered to the electrodes. Gain controls include user adjustments for input sensitivity and volume.

2.3 Speech Elicitation

The speech material contained the utterances, "a /sVd/" and "a /shVd/." The corresponding vowels were /ae/ and /E/ yielding the utterances, "a sad", "a said", "a shad", and "a shed", respectively. These utterances were grouped differently in the two experiments. In the first experiment with subject MA, these four utterances arranged in random order, created a block. A minimum of four blocks (16 utterances) or a maximum of six blocks (28 utterances) comprised a repetition. At the end of each repetition, the state (ON or OFF) of the processor was switched [Note: subject MA was not informed about the switch]. The list of utterances contained a total of 60 repetitions. Figure 2.1 illustrates a portion of the utterance material (see Appendix A for the entire list of the utterances). This figure presents the utterances, the blocks, the repetition, and when the processor state was changed.

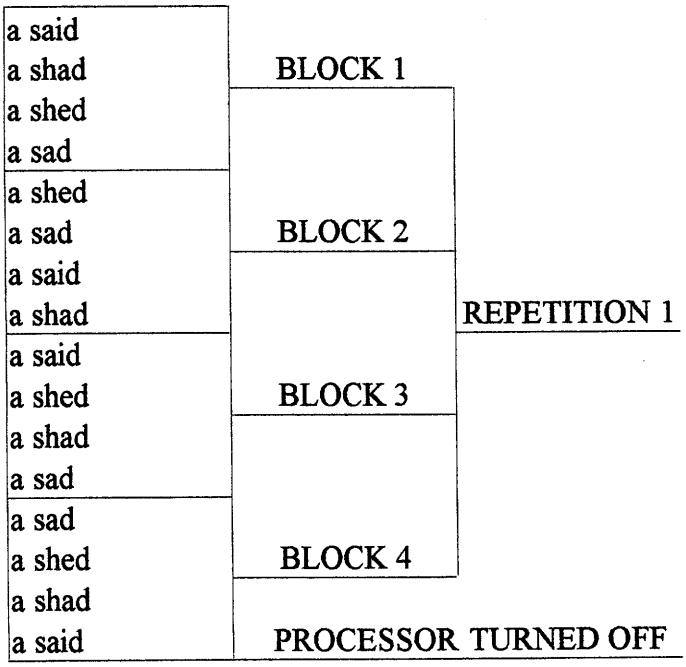

Figure 2.1. An example of a repetition. This particular repetition contained 4 blocks. The state of the processor was changed at the end of the 4th block.

In the second experiment with subject MB, the repetitions were categorized as the following: 1-repetition, 2-repetition, and 3-repetition. Figures 2.2 a, b, and c illustrate these three types of repetitions. A 1-repetition contained exactly 3 blocks. In a

1-repetition, a foil[a] occurred on the 8th utterance, and the processor changed states on the 12th utterance. A 2-repetition consisted of exactly 4 blocks. Foils occurred on the 8th and 12th utterances, and the processor was switched on the 16th utterance. A 3-repetition was composed of 5 blocks. Foils took place on the 8th, 12th, and 16th utterances, and the processor changed states on the 20th utterance. Similarly to the previous experiment, the processor was switched at the end of each repetition. The list of utterances contained these three types of repetitions in random order (see Appendix B for the complete list of utterances).

	Utterance	Proc State
1	a shad	ON
2	a said	ON
3	a shed	ON
4	a sad	ON
5	a shed	ON
6	a shad	ON
7	a said	ON
8	a sad	FOIL
9	a shad	ON
10	a sad	ON
11	a said	ON
12	a shed	FOIL
13	a shad	ON
14	a said	ON
15	a sad	ON
16	a shed	FOIL
17	a shad	ON
18	a sad	ON
19	a said	ON
20	a shed	SWITCH

Figure 2.2a. 3-repetition.

	Utterance	Proc State
1	a shed	OFF
2	a sad	OFF
3	a shad	OFF
4	a said	OFF
5	a said	OFF
6	a shad	OFF
7	a sad	OFF
8	a shed	FOIL
9	a shed	OFF
10	a said	OFF
11	a shad	OFF
12	a sad	FOIL
13	a shed	OFF
14	a sad	OFF
15	a said	OFF
16	a shad	SWITCH

Figure 2.2b. 2-repetition.

Figures 2.2 a and b show two of the three types of repetitions - 3-repetition and 2-repetition respectively. These figures indicate the utterance type and number and the state of the processor. Also, the blocks are outlined.

a) A foil was basically two quick switches - a switch to the other state, then a switch back to the original state. For example, assume the processor was ON. When a foil occurred, the processor was switched OFF then immediately back ON.

	Utterance	Proc State
1	a shad	ON
2	a sad	ON
3	a shed	ON
4	a said	ON
5	a sad	ON
6	a shed	ON
7	a shad	ON
8	a said	FOIL
9	a shad	ON
10	a shed	ON
11	a sad	ON
12	a said	SWITCH

Figure 2.2c shows the 1-repetition. This figure indicates the utterance type and number and the state of the processor. Also, the blocks are outlined.

2.4 Recording Procedures

Subject MA was seated in a chair in a sound-proof room. Prior to conducting the experiment, a simple investigation was performed to determine whether MA received any auditory warning (e.g., humming sensation) during a switching of the processor's state (ON to OFF or vice versa). MA's processor was replaced with the lab's processor. Two programs were stored in the lab's processor. The subject's normal program was stored in position 1, and a program with all the channels "off" was stored in position 2. The processor was intermittently switched between states (ON and OFF). At specified times, subject MA was asked (through the use of a sign) whether or not the processor was ON. MA recognized that a change was occurring; however, he did not instantaneously know the state of the processor. Apparently, the sound of the microphone rubbing against the chair provided some assistance in determining the state of the processor after a few seconds had elapsed.

For the experiment with MA, two pieces of wood were placed underneath the rocking chair to keep it stationary. A pillow was also placed behind MA's head to keep his head from moving during the experiment. An electret microphone was placed 20 cm from MA's lips. The calibration of sound-pressure level (SPL) was then performed. A

sound generator was placed in front of MA's lips while the sound-pressure was read off the SPL meter and recorded on an analog recorder.

A computer program (see Appendix C) was written in BASIC to display the utterances on a computer screen located a few feet directly in front of MA. The program also indicated the times the processor should be switched through the use of two different beeps which were heard by the experimenter who was outside of the sound-proof room. A high tone was a signal to turn the processor ON, while a low tone meant to turn the processor OFF. MA read the utterances as they appeared on the screen. An experimenter manually switched the processor's knob between position 1 (ON) and position 2 (OFF) according to the beeps produced by the computer program. MA's voice was recorded on an analog recorder (channel 1). Likewise, the experimenter's voice denoting the state of the processor was recorded on the analog recorder (channel 2).

The second experiment with subject MB followed the same procedure with a few minor exceptions, which will be noted here. First, the simple investigation regarding the auditory warning was not conducted. Instead, an exploration succeeded the experiment to ascertain whether subject MB could determine the state of the processor following switch in processor state or a foil. The processor was intermittently changed between states (ON, OFF, and FOIL). Like the previous experiment, MB was asked (again using a sign) whether or not the processor was ON at given times. Eventually, MB was able to determine the state of the processor after a switch or a foil. However, a foil delayed his ability to determine the processor's state a few seconds longer than a switch. The second difference between the two procedures was the meaning of the tones. The tones indicated a foil or a switch rather than a switch ON or a switch OFF. Finally, the changes in the processor's state were achieved through the use of software instead of manually setting the processor's switch.

2.5 Signal Processing

Digitization, signal processing, and data extraction were performed on the recorded utterances using programs written in the MITSYN language. The recorded signal was low-pass filtered at 7.5 kHz and digitized at 20 kHz. The digitized signal was then demultiplexed into a time-aligned signal-stream file (Svirsky *et al.*, 1992). Using this signal-stream file, the times for the beginning and end of the sibilant (/s/ and /sh/) and the

beginning and end of the vowel (/ae/ and /E/) were marked interactively. These times were utilized by an algorithm (written in the MITSYN language) to decide where to perform the spectral analyses.

The output variables from the algorithm were placed into three categories: record-keeping variables, vowel variables, and sibilant variables. The record-keeping variables were Label$ - the name of the utterance, status$ - the state of the processor, condnum - the repetition number, and rep - the block number. The vowel variables were vbg - the time at the beginning of the vowel, vend - the time at the end of the vowel, and vdur - the length of time from the beginning to end of the vowel. The sibilant variables were sibbeg - the beginning time of the sibilant, sibend - the ending time of the sibilant, sibdur - the length of time which elapses from the beginning to end of the sibilant, mean - the average value of the frequency distribution, skew - the lack of symmetry in the sibilant spectra, and kurt - the peakedness of the sibilant spectra.

As indicated above, the phonemic parameters (med and skew) of the sibilant spectra and the vowel duration were direct outputs of the algorithm. However, other vowel acoustics, such as SPL and formants, were not outputs. Using the extracted data, the SPL values were calculated in Systat. To calculate SPL, the rms of the recorded, digitized sound-pressure signal was expressed as a ratio of the rms of the calibration tone and converted to dB. This value was then added to the metered SPL of the calibration tone (Svirsky *et al.*, 1992). The equations used to calculate SPL were the following:

$$spl = 20 * \log (rms/.0926) / \log(10) + 82.1 \quad \text{(experiment 1)}$$

and

$$spl = 20 * \log (rms/.123446) / \log(10) + 79 \quad \text{(experiment 2).}$$

2.6 Data Analysis

Figures 2.3 through 2.6 display data using the same format. In each figure, individual data values for all of the repetitions that span a transition (on-off or off-on) are shown versus time (seconds). The vertical line at t = 0 indicates the time of the transition. In addition, a solid line connects the mean values in the successive 3-second time bins. Given that some

changes across a transition are unclear (see Figures 2.5 and 2.6), paired-sample t-tests were performed on the 3-second time bin averages to determine the reliability of the changes.

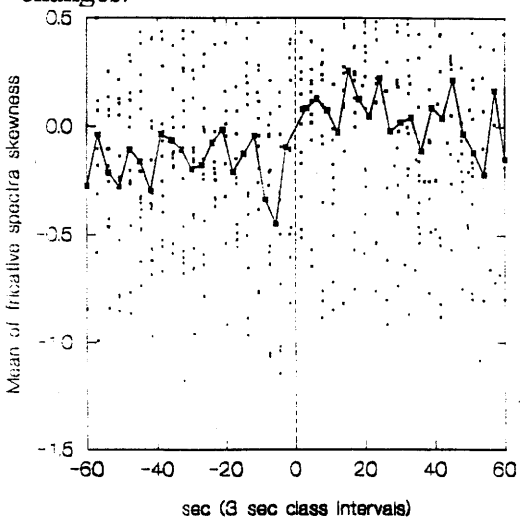

Figure 2.3 shows the skewness of /sh/ increased when the processor was turned ON.

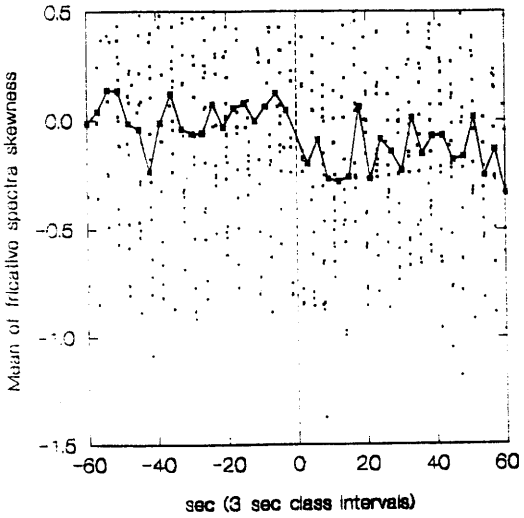

Figure 2.4 shows the skewness of /sh/ decreased when the processor was turned OFF.

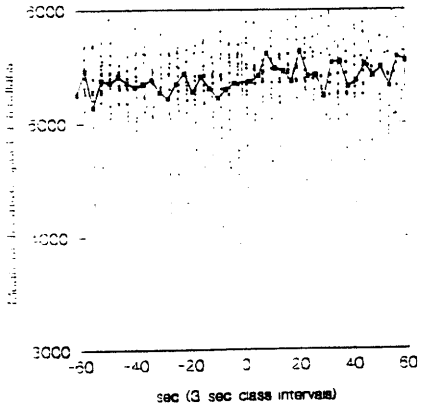

Figure 2.5 shows the mean of /s/. The change is not clear, but the mean appears to increase when the processor is turned ON.

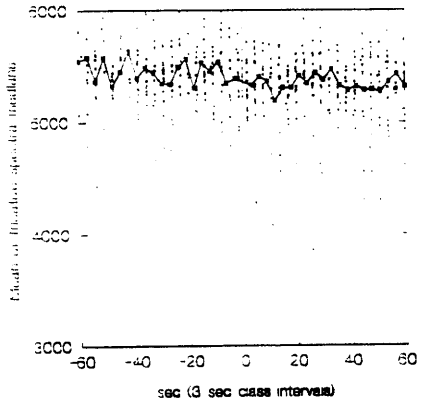

Figure 2.6 shows the mean of /s/. The change is not clear, but the mean appears to decrease when the processor is turned OFF.

Statistical analysis was performed on the following variables: the median and skewness of the sibilant spectra, vowel duration, sound-pressure level, and formant frequencies (F1 and F2). The utterances were assigned times relative to their respective on-off transition. For example, the last utterance proceeding an on-off transition was given a time of -3 seconds.

Similarly, the second-to-last utterance was assigned a time of -6 seconds and so forth. The first utterance succeeding an on-off transition was given a time of +3 seconds, the next utterance had a time of +6 seconds, etc. Table 2.1 illustrates this timing scheme. After the times had been assigned, the average of the specified variable for each 3-second interval was calculated. Using these average values, a paired-sample t-test was performed. The paired-sample t-test subtracted each negative 3-second interval (i.e. -3, -6, -9, etc.) average from its corresponding positive 3-second interval (i.e. +3, +6, +9, etc.) average to obtain each "class difference." The average difference for each variable was then computed by adding the individual class differences and dividing the resulting sum by the number of 3-second class pairs. In order to determine whether the changes at transitions were reliable, a one-sample t-test was performed on the average differences. A one-sample t-test was also performed on the average difference between the positive and negative 3-second time bins to determine the significance of the change at the boundary. The results of the t-test (one-sample) indicated the probability of obtaining these mean differences by chance. If the probability was less than 0.05 ($p < 0.05$), the change was considered reliable. The above procedure was also conducted for off-on transitions

Processor State	Utterances	Time (seconds)
ON	a shad	-24
ON	a said	-21
ON	a sad	-18
ON	a shed	-15
ON	a said	-12
ON	a sad	-9
ON	a shad	-6
ON	a shed	-3
OFF	a sad	3
OFF	a said	6
OFF	a shed	9
OFF	a shad	12
OFF	a shad	15
OFF	a said	18
OFF	a sad	21
OFF	a shed	24

Table 2.1: This table illustrates how the times were assigned to each utterance. The utterances prior to the transition have negative times, and the utterances following the transition have positive times.

2.7 Results

The results of the t-tests for the phonemic, sibilant parameters are displayed in Tables 2.2 and 2.3. The results for the spectral median over the 60-second time interval was not consistent across the two subjects. Subject MA showed significant changes in response to turning the processor on or off. The median of /s/ for MA decreased significantly by 129 Hz when the processor was turned OFF. A similar magnitude of increase (136 Hz) was observed when the processor was turned ON. MA's changes in the median of /sh/ shifted in the opposite direction relative to the median of /s/. The median of /sh/ increased significantly by 188 Hz when the processor was turned OFF and decreased significantly by 315 Hz when the processor was turned ON. These changes suggest that MA's /s/-/sh/ distinction was not as pronounced with the processor OFF since the frequencies of /s/ and /sh/ moved closer together. Subject MB's changes in the median showed a similar trend. However, all of MB's changes were not significant except for the increase (64 Hz) in the median of /s/ when the processor was turned ON.

MA's decrease (367 Hz) in the median of /sh/ which resulted from turning the processor ON was the only significant change in the median across the boundary. It should be mentioned that the median changes for MA and MB shifted in the opposite direction. For example, MA's median of /s/ decreased regardless of whether the processor was turned ON or OFF, while MB's median of /s/ increased regardless of whether the processor was turned ON or OFF. Also, the median of /sh/ increased for MA when the processor was turned OFF. MB's median of /sh/ decreased when the processor was turned OFF.

Most of the changes in skewness over the 60-second time interval also failed to be significant. Only the changes in MA's skewness of /sh/ were significant. MA's skewness of /sh/ decreased by 0.14 when the processor was turned OFF indicating a slightly more /s/-like production. The effect of turning the processor ON raised the skewness of /sh/ by 0.22. A similar trend was seen in the results of skewness across the boundary. Again, all of the changes except MA's changes in /sh/ were determined not to be significant. MA's skewness of /sh/ decreased (0.19) when the processor was turned OFF and increased (0.30) when the processor was turned ON.

Subject MA		60-second time interval /s/		/sh/		The Boundary /s/		/sh/	
		on-off	off-on	on-off	off-on	on-off	off-on	on-off	off-on
Median	pre	5465	5319	4400	4615	5394	5374	4225	4655
	post	5336	5455	4588	4300	5313	5349	4432	4288
	delta	-129	136	188	-315	-81	-25	207	-367
	t	-3.9*	6.4*	2.8*	-5.0*	-1.0 ns	-0.3 ns	1.8 ns	-3.5*
Skew	pre	-0.67	-0.58	-0.02	-0.17	-0.64	-0.65	0.07	-0.21
	post	-0.6	-0.66	-0.16	0.05	-0.5	-0.57	-0.13	0.1
	delta	0.07	-0.08	-0.14	0.22	0.14	0.08	-0.19	0.3
	t	1.8 ns	-2.0 ns	-3.2*	5.9*	1.8 ns	0.8 ns	-2.5*	4.4*

Table 2.2 shows the results of the t-tests for sibilant parameters (median and skewness) - for Subject MA. The mean values before and after the transition are noted for both directions, on-off and off-on. The mean changes across the transition are also given. Finally, the t-values resulting from the t-tests are shown. An asterisk (*) indicates a significant change, and "ns" indicates not significant.

Subject MB		60-second time interval /s/		/sh/		The Boundary /s/		/sh/	
		on-off	off-on	on-off	off-on	on-off	off-on	on-off	off-on
Median	pre	4580	4464	3932	3931	4531	4416	3962	4069
	post	4488	4528	3935	3954	4534	4559	3813	3950
	delta	-91	64	4	22	2	143	-149	-119
	t	-1.9 ns	2.2*	0.1 ns	0.7 ns	0.0 ns	1.9 ns	-1.5 ns	-1.0 ns
Skew	pre	0.16	0.23	0.31	0.3	0.23	0.23	0.3	0.25
	post	0.21	0.21	0.31	0.31	0.2	0.1	0.35	0.32
	delta	0.05	-0.02	0	0.01	-0.03	-0.13	0.05	0.08
	t	1.2 ns	-0.6 ns	-0.3 ns	0.5 ns	-0.5 ns	-2.0 ns	1.0 ns	1.2 ns

Table 2.3 shows the results of the t-tests for sibilant parameters (median and skewness) - for Subject MB. The mean values before and after the transition are noted for both directions, on-off and off-on. The mean changes across the transition are also given. Finally, the t-values resulting from the t-tests are shown. An asterisk (*) indicates a significant change, and "ns" indicates not significant.

Continuing with phonemic parameters, Tables 2.4 and 2.5 show the statistical results for the vowel formants. The changes in the first formant (F1) over a 60-second time interval were not uniform across the two subjects. For subject MA, F1 changed in the same direction for both vowels. F1 rose slightly when processor was turned OFF. The increases were 12 Hz for /E/ and 32 Hz for /ae/. F1 decreased by 17 Hz for /E/ and 29 Hz for /ae/ when the processor was turned ON. On the average, F1 exhibited higher values with the processor OFF. The direction of the changes in F1 for subject MB was not the same. Like MA, F1 for /E/ increased (10 Hz) when the processor was turned OFF. F1 dropped by 11 Hz when the processor was turned ON. Unlike /E/, F1 of /ae/ rose by 11 Hz when the processor was turned ON and decreased by 12 Hz when the processor was turned OFF. No trend in the average magnitude of the frequency of F1 is evident for MB.

Similar results occurred at the boundaries. However, a few of the changes in F1 were found unreliable at the boundaries. More specifically, F1 of /E/ and /ae/ for MA decreased (28 Hz for /E/ and 67 Hz for /ae/) significantly when the processor was turned ON. F1 increased (43 Hz) significantly when the processor was turned OFF for /ae/. MA's F1 of /ae/ was lowered 17 Hz when the processor was turned OFF and raised 16 Hz when the processor was turned ON.

None of the changes in MA's F2 values across a 60-second time interval and boundary were found reliable. On the contrary, all of MB's changes in F2 were significant except the increase of 48 Hz (over the boundary) that resulted from the processor being turned OFF. MB's F2 for /E/ and /ae/ increased significantly (with the exception noted above) when the processor was turned OFF over both the 60-second interval and the boundary. All of MB's F2 values decreased significantly when the processor was turned ON. The frequencies of F2 for MB were higher on average with the processor OFF.

Finally, the results of the postural parameters (vowel duration and SPL) are displayed in tables 2.6 and 2.7. The changes in duration were uniform across subjects and vowels. The duration was longer with the processor OFF than with the processor ON - implying that both subjects spoke more slowly with the processor OFF. It should also be noted that subject MB's duration on average were longer than subject MA's. SPL had a similar uniformity to duration. The sound-level became louder with the processor OFF for both vowels and subjects. MA tended to speak louder than MB on average.

Subject MA		60-second time interval /E/		/ae/		The Boundary /E/		/ae/	
		on-off	off-on	on-off	off-on	on-off	off-on	on-off	off-on
F1	pre	642	657	704	740	646	660	712	747
	post	654	640	736	711	652	631	756	680
	delta	12	-17	32	-29	6	-28	43	-67
	t	2.7*	-3.4*	5.7*	-5.2*	0.5 ns	-2.7*	3.4*	-3.8*
F2	pre	1804	1794	1724	1715	1801	1794	1722	1727
	post	1789	1791	1717	1712	1832	1785	1751	1714
	delta	-15	-3	-7	-3	31	-8	30	-14
	t	-1.6 ns	-0.3 ns	-1.0 ns	-0.4 ns	1.6 ns	-0.4 ns	1.2 ns	-0.5 ns

Table 2.4 shows the results of the t-tests for phonemic, vowel parameters (F1 and F2) - for Subject MA. The mean values before and after the transition are noted for both directions, on-off and off-on. The mean changes across the transition are also given. Finally, the t-values resulting from the t-tests are shown. An asterisk (*) indicates a significant change, and "ns" indicates not significant.

Subject MB		60-second time interval /E/		/ae/		The Boundary /E/		/ae/	
		on-off	off-on	on-off	off-on	on-off	off-on	on-off	off-on
F1	pre	503	515	542	529	515	518	542	533
	post	513	504	530	540	504	507	524	549
	delta	10	-11	-12	11	-11	-11	-17	16
	t	2.8*	-3.6*	-3.6*	5.1*	-2.0 ns	-2.0 ns	-3.3*	2.8*
F2	pre	1363	1450	1412	1525	1384	1446	1415	1526
	post	1452	1369	1509	1405	1433	1342	1511	1392
	delta	89	-80	97	-120	48	-105	95	-134
	t	5.5*	-5.3*	8.4*	-9*	1.9 ns	-2.7*	3.8*	-3.3*

Table 2.5 shows the results of the t-tests for phonemic, vowel parameters (F1 and F2) - for Subject MB. The mean values before and after the transition are noted for both directions, on-off and off-on. The mean changes across the transition are also given. Finally, the t-values resulting from the t-tests are shown. An asterisk (*) indicates a significant change, and "ns" indicates not significant.

Subject MA		60-second time interval /E/		/ae/		The Boundary /E/		/ae/	
		on-off	off-on	on-off	off-on	on-off	off-on	on-off	off-on
DUR	pre	165	191	267	302	168	192	269	304
	post	192	167	301	270	188	167	302	270
	delta	27	-24	34	-33	20	-24	33	-34
	t	13.8*	-11.3*	11.8*	-10.5*	4.3*	-3.5*	4*	-4.5*
SPL	pre	89.3	90.1	88.1	89.7	89.5	90.3	88.5	89.7
	post	90.1	89.1	89.7	88.3	90.4	88.5	90	86.8
	delta	0.8	-1	1.6	-1.4	0.9	-1.7	1.5	-2.9
	t	6.4*	-5.7*	7.3*	-6.3*	2.5*	-4.3*	3.3*	-7.5*

Table 2.6 shows the results of the t-tests for postural parameters (duration and SPL) - for Subject MA. The mean values before and after the transition are noted for both directions, on-off and off-on. The mean changes across the transition are also given. Finally, the t-values resulting from the t-tests are shown. An asterisk (*) indicates a significant change, and "ns" indicates not significant.

Subject MB		60-second time interval /E/		/ae/		The Boundary /E/		/ae/	
		on-off	off-on	on-off	off-on	on-off	off-on	on-off	off-on
DUR	pre	259	327	413	473	291	327	432	468
	post	322	263	464	407	311	237	463	370
	delta	63	-64	51	-65	20	-90	31	-98
	t	7.7*	-10.6*	7.0*	-6.9*	1.5 ns	-8.8*	2.3*	-8.7*
SPL	pre	75.8	79.8	74	78.9	73.6	80.6	71.8	80.2
	post	79.4	75	78.7	73.6	79.2	77.3	76.7	75.9
	delta	3.6	-4.8	4.6	-5.4	5.6	-3.2	4.9	-4.3
	t	6.8*	-9.0*	10.7*	-11.4*	7.6*	-4.6*	6.6*	-4.4*

Table 2.7 shows the results of the t-tests for postural parameters (duration and SPL) - for Subject MB. The mean values before and after the transition are noted for both directions, on-off and off-on. The mean changes across the transition are also given. Finally, the t-values resulting from the t-tests are shown. An asterisk (*) indicates a significant change, and "ns" indicates not significant.

In summary, the vowel parameters in which a statistically significant change occurred shifted in the same direction for both vowels, /E/ and /ae/, with the exception of one case. The exception was the changes in F1 for MB. F1 shifted in opposite directions; F1 for

/E/ increased when the processor was turned OFF and F1 for /ae/ decreased when the processor was turned OFF. More noticeably, vowel parameters (excluding the noted exception) increased significantly when the processor was turned OFF and decreased when the processor was turned ON. Sibilant parameters, however, did not change as uniformly. The skewness of /s/ and /sh/ shifted in the opposite direction. Similarly, the median of /s/ and /sh/ did not change in the same direction. In the sibilant parameters, the changes were more pronounced (greater mean difference) when the processor was turned ON.

Chapter 3

Discussion

As hypothesized in Chapter 1, the postural parameters (duration and SPL) changed rapidly. However, majority of the phonemic parameters (F1, F2, and median) also changed rapidly. This chapter will provide possible explanations for the changes in phonemic parameters.

The Lombard effect, referred to in Chapter 1, describes the change in a postural parameter, specifically sound-pressure level. The Lombard effect consists of an increase in sound-level that arises when a speaker is placed in a noisy environment. The results of the above experiments support this theory. For both subjects, sound-pressure level increased when the processor was turned OFF (which has the same effects as a noisy environment). The sound- pressure resumed its normal level when the processor was turned ON. The other postural parameter, duration of the vowels, which is not a direct result of the Lombard effect, moved in the same direction as sound-pressure level.

To understand what caused the phonemic parameters, particularly the first formant (F1) to change, the features of the vowels must be examined. The vowels utilized in the experiment, /E/ and /ae/, are low, front vowels. F1 is the formant which determines the height (low or high) of a vowel. For a low vowel, F1 has a relatively high frequency. To produce such a frequency, the vocal tract must be opened - the tongue and jaw must be lowered. These vowels are not produced in isolation; therefore, the sibilants, /s/ and /sh/, must also be considered. Both sibilants are generated with the mouth in a closed position and the tongue forward and raised (/s/ is a dental, and /sh/ is a palatoalveolar). Thus, a considerable amount of change in the articulators' (tongue and jaw) positions must occur to produce a vowel, which suggest that speaking rate can affect the articulators' ability to reach their desired position. For example, if the speaking rate increases (vowel duration decreases), the tongue and jaw could possibly not have enough time to lower, leading to a decrease in F1. Recall duration and F1 change in the same direction. Thus, the results with the exception of MB's F1 of /ae/ support such a correlation between duration and F1. One last observation, which also supports this correlation, is the magnitude of the average decrease of F1 of /ae/ for MA when duration decreases. F1 for /ae/ decreases more than /E/; /ae/ has a higher F1 than for /E/. To obtain a higher F1, the jaw must drop farther;

however, the shorter duration prevents the jaw from fully lowering. As a result, the decrease in /ae/ is greater than /E/ because /E/ has a higher jaw position than /ae/.

So, why is the change in the second formant (F2) insignificant for MA and significant for MB? F2 is the formant which is controlled by the lateral position (front or back) of a vowel. In this case, both vowels, /E/ and /ae/, are front vowels. To produce a front vowel, the tongue must be forward. As mentioned above, the tongue is in a forward position for both sibilants, /s/ and /sh/. Therefore, little lateral adjustment is needed - resulting in a relatively constant second formant. The results for subject MA support such a theory; however, MB's F2 changed significantly. There are two plausible explanations as to why MB's F2 values changed reliably. First, MB could generate the vowel /ae/ with his articulators in slightly different manner than described above. Also, the significant shift in F2 for MB could be attributed to his reaction to hearing a given phonemic speech parameter for the first time in many years and attempting to bring anomalous parameter values into line with phonemic intentions by making an articulatory adjustments (Lane *et al.*, 1995).

Finally, the spectral median of subject MA's sibilants changed significantly. The frequency of the median of /s/ lowered and /sh/ rose when the processor was turned OFF. Thus, the frequencies of /s/ and /sh/ moved closer together. This observation suggests that MA had a more difficult time producing a distinction between the sibilants /s/ and /sh/ when the processor was OFF. This also suggests that MA relied on auditory feedback to produce such a contrast since the articulation is very precise and complex. To produce a good contrast, MA must position his tongue precisely and direct the air stream towards the lower incisors for /s/ (the /sh/ air stream is not as directed) (Matthies *et al.*, 1994). Also, the constriction formed to produce /s/ and /sh/ is smaller and more anterior for /s/ than /sh/. These articulatory differences produce the spectral contrast that distinguish among these two speech sounds. MB did not exhibit a diminished /s-sh/ contrast with the processor OFF.

Chapter 4

Conclusion

This chapter presents conclusions and suggestions for further research.

The primary objective of this thesis was to investigate the following hypothesis - postural parameters change rapidly, while phonemic parameters change slowly or not at all. This was to be done by determining the time rates of change for these parameters. Two experiments employing cochlear implant users were conducted. The subjects read many repetitions of four utterances ("a shad", "a shed", "a sad", and "a said") in quasi-random order while their speech was being recorded. Their implant processors were switched ON and OFF a number of times during the recording. Digitization, signal processing, and data extraction were performed on the recorded utterances using programs written in the MITSYN language. Postural (vowel duration and sound-pressure level) and phonemic (vowel formants and sibilant spectra - median and skewness) parameters were measured. All of subject MA's parameters changed significantly with processor state when averaged over the 60-second time intervals preceding and following the processor transition, except the frequencies of the second formant and the skewness of /s/. However, only vowel duration, sound-pressure level, and the frequencies of the first formant changed rapidly across the boundary (from immediately before to immediately after the transition). Similarly, most of subject MB's parameters (except the median and skewness of the sibilants) changed reliably over a 60-second time interval. Only vowel duration, sound-pressure level, and the formant frequencies of /ae/ changed significantly across the boundary for MB.

To determine how quickly each speech parameter changed, the significance of the changes at the boundary was compared to the significance of the change over the 60-second time interval. If a parameter changed instantaneously, both of the changes (at the boundary and over the 60-second interval) must be significant. For subject MA, vowel duration of /E/ and /ae/, sound-pressure levels of /E/ and /ae/, and the first formant frequency of /ae/ changed instantly. It should also be noted that the second formant frequencies of /E/ and /ae/ and the skewness of /s/ did not change significantly over the time interval or at the boundary. For subject MB, the vowel duration of /E/ and /ae/, the

sound-pressure levels of /E/ and /ae/, and the first and second formant frequencies of /ae/ changed instantaneously. The median and skewness of the sibilants did not change significantly over either the time interval or at the boundary. In conclusion, the results of this thesis support the hypothesis regarding the rate of change in speech parameters. The postural parameters (SPL and duration) changed instantly for both subjects. Also, the phonemic parameters with the exception of the first and second formant frequencies of /ae/ did not change rapidly. The changes in the phonemic parameters was attributed to interdependency changes - formant frequencies may be dependent on the changes in the speaking rate of the subjects.

In future studies, any changes which occur during a foil should be examined more carefully to determine whether anticipation is an issue. This could be achieved by examining the utterances immediately before and after the foil in a similar manner to the method use to study the boundary in this thesis.

Appendix A

Speech List for Subject MA

jb3.dat
Minimun number of tokens collect = 150
Delay between tokens = 2

ON	a SAID
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OFF	a SHAD	ON	a SHED	OFF	a SHAD
OFF	a SAID	ON	a SAD	OFF	a SAID
OFF	a SAID	ON	a SHED	OFF	a SHED
OFF	a SHAD	ON	a SHAD	OFF	a SAD
ON	a SAID	ON	a SAID	OFF	a SAD
ON	a SHAD	ON	a SAID	ON	a SAID
ON	a SHED	ON	a SHAD	ON	a SAD
ON	a SAD	ON	a SAD	ON	a SHED
ON	a SHED	ON	a SHED	ON	a SHAD
ON	a SHAD	ON	a SHED	ON	a SAD
ON	a SAID	ON	a SAD	ON	a SHED
ON	a SAD	ON	a SAID	ON	a SHAD
ON	a SAD	ON	a SHAD	ON	a SAID
ON	a SHED	OFF	a SAD	ON	a SAD
ON	a SAID	OFF	a SHAD	ON	a SAID
ON	a SHAD	OFF	a SAID	ON	a SHED
ON	a SHAD	OFF	a SHED	ON	a SHAD
ON	a SHED	OFF	a SHED	ON	a SHAD
ON	a SAD	OFF	a SHAD	ON	a SHED
ON	a SAID	OFF	a SAD	ON	a SAID
ON	a SAID	OFF	a SAID	ON	a SAD
ON	a SHAD	OFF	a SHED	ON	a SHAD
ON	a SHED	OFF	a SAID	ON	a SAD
ON	a SAD	OFF	a SAD	ON	a SHED
ON	a SHAD	OFF	a SHAD	ON	a SAID
ON	a SAD	OFF	a SHED	OFF	a SAID
ON	a SAID	OFF	a SAD	OFF	a SHAD
ON	a SHED	OFF	a SHAD	OFF	a SAD
ON	a SHAD	OFF	a SAID	OFF	a SHED
ON	a SAD	ON	a SHED	OFF	a SHAD
ON	a SAID	ON	a SHAD	OFF	a SAD
OFF	a SAD	ON	a SAID	OFF	a SHED
OFF	a SHED	ON	a SAD	OFF	a SAID
OFF	a SHAD	ON	a SHED	OFF	a SAID
OFF	a SAID	ON	a SHAD	OFF	a SHED
OFF	a SHAD	ON	a SAD	OFF	a SAD
OFF	a SAD	ON	a SAID	OFF	a SHAD

OFF	a SAID	ON	a SHAD	OFF	a SHAD
OFF	a SHED	ON	a SAID	OFF	a SAD
OFF	a SHAD	ON	a SAD	OFF	a SAID
OFF	a SAD	ON	a SHED	OFF	a SHED
ON	a SAD	ON	a SHED	OFF	a SAD
ON	a SHED	ON	a SHAD	OFF	a SHAD
ON	a SAID	ON	a SAID	OFF	a SAID
ON	a SHAD	OFF	a SHAD	OFF	a SHED
ON	a SAD	OFF	a SHED	OFF	a SAID
ON	a SAID	OFF	a SAD	OFF	a SHED
ON	a SHED	OFF	a SAID	OFF	a SHAD
ON	a SHAD	OFF	a SHAD	OFF	a SAD
ON	a SAD	OFF	a SHED	OFF	a SHED
ON	a SAID	OFF	a SAID	OFF	a SAD
ON	a SHAD	OFF	a SAD	OFF	a SHAD
ON	a SHED	OFF	a SHED	OFF	a SAID
ON	a SHED	OFF	a SAID	OFF	a SHAD
ON	a SAID	OFF	a SAD	OFF	a SAD
ON	a SHAD	OFF	a SHAD	OFF	a SAID
ON	a SAD	OFF	a SAD	OFF	a SHED
ON	a SHAD	OFF	a SHAD	ON	a SHAD
ON	a SHED	OFF	a SAID	ON	a SAD
OFF	a SAD	OFF	a SHED	ON	a SHED
OFF	a SAID	OFF	a SHED	ON	a SAID
OFF	a SHAD	OFF	a SAID	ON	a SAID
OFF	a SHED	OFF	a SHAD	ON	a SAD
OFF	a SAID	OFF	a SAD	ON	a SHED
OFF	a SAD	OFF	a SAD	ON	a SHAD
OFF	a SHED	OFF	a SAID	ON	a SHAD
OFF	a SHAD	ON	a SAID	ON	a SAD
OFF	a SAD	ON	a SAD	ON	a SHED
OFF	a SHAD	ON	a SHED	ON	a SAID
OFF	a SAID	ON	a SHAD	ON	a SHAD
OFF	a SHED	ON	a SHAD	ON	a SAD
OFF	a SHAD	ON	a SAD	ON	a SAID
OFF	a SAD	ON	a SHED	ON	a SHED
OFF	a SHED	ON	a SAID	ON	a SAID
OFF	a SAID	ON	a SAD	ON	a SAD
OFF	a SHAD	ON	a SAID	ON	a SHAD
OFF	a SHED	ON	a SHED	OFF	a SAD
OFF	a SAD	ON	a SHAD	OFF	a SAID
ON	a SAID	ON	a SAID	OFF	a SHAD
ON	a SHAD	ON	a SAD	OFF	a SHED
ON	a SAD	ON	a SHAD	OFF	a SAID
ON	a SHED	ON	a SHED	OFF	a SHAD
ON	a SHAD	ON	a SAD	OFF	a SHED
ON	a SAID	ON	a SHED	OFF	a SAD
ON	a SHED	ON	a SHAD	OFF	a SHAD
ON	a SAD	ON	a SAID	OFF	a SAD
ON	a SHAD	ON	a SHAD	OFF	a SAID
ON	a SAID	ON	a SAD	OFF	a SHED
ON	a SHED	ON	a SAID	OFF	a SHAD
ON	a SAD	ON	a SHED	OFF	a SAID
ON	a SHED	ON	a SHED	OFF	a SHED
ON	a SAID	ON	a SAID	OFF	a SAD
ON	a SHAD	ON	a SHAD	OFF	a SAD
ON	a SAD	ON	a SAD	OFF	a SAID

OFF	a SHED	ON	a SAD	OFF	a SAD
OFF	a SHAD	ON	a SHAD	OFF	a SAD
ON	a SAID	ON	a SAID	OFF	a SHAD
ON	a SHAD	ON	a SHED	OFF	a SAID
ON	a SAD	OFF	a SAID	ON	a SHAD
ON	a SHED	OFF	a SAD	ON	a SHED
ON	a SHAD	OFF	a SHED	ON	a SAD
ON	a SHED	OFF	a SHAD	ON	a SAD
ON	a SAID	OFF	a SHED	ON	a SAID
ON	a SAD	OFF	a SAID	ON	a SHED
ON	a SAD	OFF	a SHAD	ON	a SHAD
ON	a SAID	OFF	a SAD	ON	a SHED
ON	a SHAD	OFF	a SHAD	ON	a SAD
ON	a SHED	OFF	a SAID	ON	a SHAD
ON	a SAD	OFF	a SHED	ON	a SHED
ON	a SHED	OFF	a SAD	ON	a SAID
ON	a SHAD	OFF	a SAID	ON	a SAID
ON	a SAID	OFF	a SAD	ON	a SHED
ON	a SHED	OFF	a SHED	ON	a SAD
ON	a SHAD	OFF	a SHAD	ON	a SHAD
OFF	a SHED	OFF	a SAD	ON	a SAD
OFF	a SAID	ON	a SHAD	ON	a SHAD
OFF	a SAD	ON	a SHED	ON	a SAID
OFF	a SHAD	ON	a SAD	ON	a SHED
OFF	a SAID	ON	a SAID	ON	a SHED
OFF	a SHED	ON	a SAD	ON	a SHAD
OFF	a SHAD	ON	a SHAD	ON	a SAID
OFF	a SAD	ON	a SAID	OFF	a SAD
OFF	a SHAD	ON	a SHED	OFF	a SHAD
OFF	a SAID	ON	a SAID	OFF	a SAID
OFF	a SHED	ON	a SAD	OFF	a SHED
OFF	a SAD	ON	a SHED	OFF	a SAD
OFF	a SAID	ON	a SHAD	OFF	a SHED
OFF	a SAD	ON	a SHAD	OFF	a SHAD
OFF	a SHAD	ON	a SAID	OFF	a SAID
OFF	a SHED	ON	a SAD	OFF	a SAID
OFF	a SHED	ON	a SHED	OFF	a SHED
OFF	a SHAD	ON	a SHED	OFF	a SHAD
OFF	a SAID	OFF	a SAID	OFF	a SAD
OFF	a SAD	OFF	a SHAD	OFF	a SHAD
OFF	a SAD	OFF	a SHED	OFF	a SAD
OFF	a SHED	OFF	a SAD	OFF	a SHED
ON	a SAID	OFF	a SAID	OFF	a SAID
ON	a SAD	OFF	a SHED	OFF	a SHAD
ON	a SHAD	OFF	a SAD	OFF	a SAID
ON	a SHED	OFF	a SHAD	OFF	a SHED
ON	a SHAD	OFF	a SAID	OFF	a SAD
ON	a SAD	OFF	a SAD	OFF	a SHED
ON	a SHED	OFF	a SHAD	OFF	a SHAD
ON	a SAID	OFF	a SHED	ON	a SAD
ON	a SAD	OFF	a SHED	ON	a SHAD
ON	a SHED	OFF	a SHAD	ON	a SHED
ON	a SHAD	OFF	a SAD	ON	a SAID
ON	a SAID	OFF	a SAID	ON	a SAID
ON	a SHED	OFF	a SAID	ON	a SAD
ON	a SHAD	OFF	a SHED	ON	a SHED
ON	a SAID	OFF	a SHAD	ON	a SHAD

ON	a SHED	ON	a SHED	OFF	a SHAD
ON	a SAID	OFF	a SAID	OFF	a SAID
ON	a SHAD	OFF	a SAD	OFF	a SAD
ON	a SAD	OFF	a SHED	OFF	a SHED
ON	a SAID	OFF	a SHAD	OFF	a SAD
ON	a SHAD	OFF	a SAID	OFF	a SAID
ON	a SHED	OFF	a SAD	OFF	a SHED
ON	a SAD	OFF	a SHED	OFF	a SHAD
ON	a SHED	OFF	a SHAD	OFF	a SAD
ON	a SHAD	OFF	a SHAD	ON	a SHAD
ON	a SAD	OFF	a SAID	ON	a SAID
ON	a SAID	OFF	a SHED	ON	a SAD
ON	a SHED	OFF	a SAD	ON	a SHED
ON	a SHAD	OFF	a SAID	ON	a SHED
ON	a SAID	OFF	a SHAD	ON	a SHAD
ON	a SAD	OFF	a SHED	ON	a SAID
OFF	a SHAD	OFF	a SAD	ON	a SAD
OFF	a SAD	OFF	a SHED	ON	a SHED
OFF	a SHED	OFF	a SAD	ON	a SAID
OFF	a SAID	OFF	a SHAD	ON	a SAD
OFF	a SHED	OFF	a SAID	ON	a SHAD
OFF	a SAID	OFF	a SHED	ON	a SAD
OFF	a SHAD	ON	a SAID	ON	a SAID
OFF	a SAD	ON	a SAD	ON	a SHAD
OFF	a SHED	ON	a SHAD	ON	a SHED
OFF	a SAID	ON	a SHED	ON	a SHED
OFF	a SHAD	ON	a SAD	ON	a SHAD
OFF	a SAD	ON	a SAID	ON	a SAID
OFF	a SAID	ON	a SHAD	ON	a SAD
OFF	a SAD	ON	a SHED	ON	a SHED
OFF	a SHAD	ON	a SHED	ON	a SHAD
OFF	a SHED	ON	a SHAD	ON	a SAID
OFF	a SHAD	ON	a SAID	OFF	a SHED
OFF	a SAID	ON	a SAD	OFF	a SAID
OFF	a SAD	ON	a SHAD	OFF	a SHAD
ON	a SHED	ON	a SHED	OFF	a SAD
ON	a SAID	ON	a SAD	OFF	a SHED
ON	a SAD	ON	a SAID	OFF	a SAID
ON	a SHAD	ON	a SHED	OFF	a SAD
ON	a SAD	ON	a SHAD	OFF	a SHAD
ON	a SAID	ON	a SAD	OFF	a SHED
ON	a SHAD	ON	a SAID	OFF	a SAID
ON	a SHED	ON	a SHAD	OFF	a SAD
ON	a SAID	ON	a SHED	OFF	a SAD
ON	a SHED	ON	a SAID	OFF	a SHAD
ON	a SAD	OFF	a SHED	OFF	a SHED
ON	a SHAD	OFF	a SAD	OFF	a SAID
ON	a SAD	OFF	a SAID	OFF	a SAD
ON	a SHED	OFF	a SHAD	ON	a SHED
ON	a SAID	OFF	a SAID	ON	a SAID
ON	a SHAD	OFF	a SAD	ON	a SAD
ON	a SHAD	OFF	a SHAD	ON	a SHAD
ON	a SHED	OFF	a SHED	ON	a SHAD
ON	a SAD	OFF	a SAID	ON	a SAD
ON	a SAID	OFF	a SAD	ON	a SAID
ON	a SAD	OFF	a SHED	ON	a SHED
ON	a SAID	OFF	a SHAD	ON	a SHED

```
ON              a SHED
ON              a SAD
ON              a SAID
ON              a SHAD
ON              a SHED
ON              a SAD
ON              a SHAD
ON              a SAID
ON              a SAD
ON              a SHAD
ON              a SHED
ON              a SAID
ON              a SHAD
ON              a SAD
ON              a SAID
OFF             a SAD
OFF             a SAID
OFF             a SHED
OFF             a SHAD
OFF             a SHED
OFF             a SAID
OFF             a SAD
OFF             a SHAD
OFF             a SAID
OFF             a SHED
OFF             a SHAD
OFF             a SAD
OFF             a SAID
OFF             a SAD
OFF             a SHAD
OFF             a SHED
ON              a SHAD
ON              a SAD
ON              a SHED
ON              a SAID
ON              a SHAD
ON              a SAD
ON              a SHED
Total Count =  255
Condition      SAID
SHED           SAD
SHAD
OFF             28
29             30
29
ON              35
35             33
36
```

Appendix B

Speech List for Subject MB

cknf1.dat
Number of runs = 100
Delay between tokens = 2.5

Total Count = 4800

Session	Utterance			
1	3	a	SHAD,	ON
2	3	a	SAID,	ON
3	3	a	SHED,	ON
4	3	a	SAD,	ON
5	3	a	SHED,	ON
6	3	a	SHAD,	ON
7	3	a	SAID,	ON
8	3	a	SAD,	Foil
9	3	a	SHAD,	ON
10	3	a	SAD,	ON
11	3	a	SAID,	ON
12	3	a	SHED,	Foil
13	3	a	SHAD,	ON
14	3	a	SAID,	ON
15	3	a	SAD,	ON
16	3	a	SHED,	Foil
17	3	a	SHAD,	ON
18	3	a	SAD,	ON
19	3	a	SAID,	ON
20	3	a	SHED,	Switch
21	2	a	SHED,	OFF
22	2	a	SAD,	OFF
23	2	a	SHAD,	OFF
24	2	a	SAID,	OFF
25	2	a	SAID,	OFF
26	2	a	SHAD,	OFF
27	2	a	SAD,	OFF
28	2	a	SHED,	Foil
29	2	a	SHED,	OFF
30	2	a	SAID,	OFF
31	2	a	SHAD,	OFF
32	2	a	SAD,	Foil
33	2	a	SHED,	OFF
34	2	a	SAD,	OFF
35	2	a	SAID,	OFF
36	2	a	SHAD,	Switch
37	1	a	SHAD,	ON
38	1	a	SAD,	ON
39	1	a	SHED,	ON
40	1	a	SAID,	ON
41	1	a	SAD,	ON
42	1	a	SHED,	ON
43	1	a	SHAD,	ON
44	1	a	SAID,	Foil
45	1	a	SHAD,	ON
46	1	a	SHED,	ON
47	1	a	SAD,	ON
48	1	a	SAID,	Switch
49	2	a	SAID,	OFF
50	2	a	SAD,	OFF
51	2	a	SHAD,	OFF
52	2	a	SHED,	OFF
53	2	a	SAID,	OFF
54	2	a	SAD,	OFF
55	2	a	SHED,	OFF
56	2	a	SHAD,	Foil
57	2	a	SAID,	OFF
58	2	a	SAD,	OFF
59	2	a	SHAD,	OFF
60	2	a	SHED,	Foil
61	2	a	SHAD,	OFF
62	2	a	SHED,	OFF
63	2	a	SAID,	OFF
64	2	a	SAD,	Switch
65	1	a	SAD,	ON
66	1	a	SAID,	ON
67	1	a	SHED,	ON
68	1	a	SHAD,	ON
69	1	a	SAID,	ON
70	1	a	SHAD,	ON
71	1	a	SHED,	ON
72	1	a	SAD,	Foil
73	1	a	SAD,	ON
74	1	a	SAID,	ON
75	1	a	SHED,	ON
76	1	a	SHAD,	Switch
77	3	a	SHAD,	OFF
78	3	a	SAD,	OFF
79	3	a	SAID,	OFF
80	3	a	SHED,	OFF
81	3	a	SAD,	OFF
82	3	a	SHED,	OFF
83	3	a	SHAD,	OFF
84	3	a	SAID,	Foil
85	3	a	SAID,	OFF
86	3	a	SAD,	OFF
87	3	a	SHAD,	OFF
88	3	a	SHED,	Foil
89	3	a	SHED,	OFF
90	3	a	SHAD,	OFF
91	3	a	SAD,	OFF
92	3	a	SAID,	Foil
93	3	a	SHAD,	OFF
94	3	a	SAD,	OFF
95	3	a	SAID,	OFF
96	3	a	SHED,	Switch
97	2	a	SHED,	ON
98	2	a	SHAD,	ON
99	2	a	SAID,	ON
100	2	a	SAD,	ON
101	2	a	SAID,	ON
102	2	a	SAD,	ON
103	2	a	SHED,	ON
104	2	a	SHAD,	Foil
105	2	a	SHED,	ON
106	2	a	SHAD,	ON
107	2	a	SAD,	ON
108	2	a	SAID,	Foil
109	2	a	SAID,	ON
110	2	a	SHED,	ON
111	2	a	SHAD,	ON
112	2	a	SAD,	Switch
113	3	a	SAD,	OFF
114	3	a	SHAD,	OFF
115	3	a	SHED,	OFF
116	3	a	SAID,	OFF
117	3	a	SHAD,	OFF
118	3	a	SAD,	OFF
119	3	a	SHED,	OFF
120	3	a	SAID,	Foil
121	3	a	SAID,	OFF
122	3	a	SAD,	OFF
123	3	a	SHED,	OFF
124	3	a	SHAD,	Foil
125	3	a	SHAD,	OFF
126	3	a	SHED,	OFF
127	3	a	SAD,	OFF
128	3	a	SAID,	Foil
129	3	a	SHED,	OFF
130	3	a	SAD,	OFF
131	3	a	SHAD,	OFF
132	3	a	SAID,	Switch
133	1	a	SAID,	ON
134	1	a	SAD,	ON
135	1	a	SHED,	ON
136	1	a	SHAD,	ON
137	1	a	SHED,	ON
138	1	a	SAD,	ON
139	1	a	SHAD,	ON
140	1	a	SAID,	Foil
141	1	a	SAID,	ON
142	1	a	SHED,	ON
143	1	a	SHAD,	ON
144	1	a	SAD,	Switch
145	3	a	SAD,	OFF
146	3	a	SAID,	OFF
147	3	a	SHED,	OFF
148	3	a	SHAD,	OFF
149	3	a	SHED,	OFF
150	3	a	SAID,	OFF
151	3	a	SHAD,	OFF
152	3	a	SAD,	Foil
153	3	a	SAD,	OFF
154	3	a	SHAD,	OFF
155	3	a	SHED,	OFF
156	3	a	SAID,	Foil
157	3	a	SHAD,	OFF
158	3	a	SAID,	OFF
159	3	a	SAD,	OFF
160	3	a	SHED,	Foil
161	3	a	SHED,	OFF
162	3	a	SHAD,	OFF
163	3	a	SAD,	OFF
164	3	a	SAID,	Switch
165	1	a	SAID,	ON

166 1 , a SAD, ON
167 1 , a SHAD, ON
168 1 , a SHED, ON
169 1 , a SAID, ON
170 1 , a SHED, ON
171 1 , a SAD, ON
172 1 , a SHAD, Foil
173 1 , a SAD, ON
174 1 , a SAID, ON
175 1 , a SHED, ON
176 1 , a SHAD, Switch
177 2 , a SHAD, OFF
178 2 , a SAID, OFF
179 2 , a SAD, OFF
180 2 , a SHED, OFF
181 2 , a SAID, OFF
182 2 , a SAD, OFF
183 2 , a SHED, OFF
184 2 , a SHAD, Foil
185 2 , a SAD, OFF
186 2 , a SAID, OFF
187 2 , a SHAD, OFF
188 2 , a SHED, Foil
189 2 , a SAD, OFF
190 2 , a SHAD, OFF
191 2 , a SAID, OFF
192 2 , a SHED, Switch
193 3 , a SHED, ON
194 3 , a SAID, ON
195 3 , a SAD, ON
196 3 , a SHAD, ON
197 3 , a SAID, ON
198 3 , a SHED, ON
199 3 , a SHAD, ON
200 3 , a SAD, Foil
201 3 , a SHED, ON
202 3 , a SAID, ON
203 3 , a SAD, ON
204 3 , a SHAD, Foil
205 3 , a SHED, ON
206 3 , a SAID, ON
207 3 , a SHAD, ON
208 3 , a SAD, Foil
209 3 , a SHED, ON
210 3 , a SHAD, ON
211 3 , a SAD, ON
212 3 , a SAID, Switch
213 2 , a SAID, OFF
214 2 , a SHED, OFF
215 2 , a SHAD, OFF
216 2 , a SAD, OFF
217 2 , a SHAD, OFF
218 2 , a SAID, OFF
219 2 , a SAD, OFF
220 2 , a SHED, Foil
221 2 , a SHAD, OFF
222 2 , a SAD, OFF
223 2 , a SHED, OFF
224 2 , a SAID, Foil
225 2 , a SHED, OFF
226 2 , a SAID, OFF
227 2 , a SAD, OFF
228 2 , a SHAD, Switch
229 1 , a SHAD, ON
230 1 , a SAD, ON
231 1 , a SAID, ON
232 1 , a SHED, ON
233 1 , a SHAD, ON
234 1 , a SAID, ON
235 1 , a SHED, ON
236 1 , a SAD, Foil
237 1 , a SHAD, ON
238 1 , a SAID, ON
239 1 , a SAD, ON
240 1 , a SHED, Switch
241 2 , a SHED, OFF
242 2 , a SHAD, OFF
243 2 , a SAD, OFF
244 2 , a SAID, OFF
245 2 , a SHAD, OFF
246 2 , a SAID, OFF
247 2 , a SHED, OFF
248 2 , a SAD, Foil
249 2 , a SAID, OFF
250 2 , a SHAD, OFF
251 2 , a SAD, OFF
252 2 , a SHED, Foil
253 2 , a SHED, OFF
254 2 , a SHAD, OFF
255 2 , a SAID, OFF
256 2 , a SAD, Switch
257 3 , a SAD, ON
258 3 , a SHED, ON
259 3 , a SAID, ON
260 3 , a SHAD, ON
261 3 , a SHED, ON
262 3 , a SAD, ON
263 3 , a SAID, ON
264 3 , a SHAD, Foil
265 3 , a SHAD, ON
266 3 , a SAD, ON
267 3 , a SAID, ON
268 3 , a SHED, Foil
269 3 , a SHAD, ON
270 3 , a SAID, ON
271 3 , a SAD, ON
272 3 , a SHED, Foil
273 3 , a SAD, ON
274 3 , a SHED, ON
275 3 , a SAID, ON
276 3 , a SHAD, Switch
277 1 , a SHAD, OFF
278 1 , a SAD, OFF
279 1 , a SAID, OFF
280 1 , a SHED, OFF
281 1 , a SAD, OFF
282 1 , a SAID, OFF
283 1 , a SHED, OFF
284 1 , a SHAD, Foil
285 1 , a SHED, OFF
286 1 , a SAD, OFF
287 1 , a SHAD, OFF
288 1 , a SAID, Switch
289 2 , a SAID, ON
290 2 , a SHED, ON
291 2 , a SAD, ON
292 2 , a SHAD, ON
293 2 , a SHAD, ON
294 2 , a SHED, ON
295 2 , a SAD, ON
296 2 , a SAID, Foil
297 2 , a SHED, ON
298 2 , a SHAD, ON
299 2 , a SAD, ON
300 2 , a SAID, Foil
301 2 , a SHAD, ON
302 2 , a SHED, ON
303 2 , a SAID, ON
304 2 , a SAD, Switch
305 1 , a SAD, OFF
306 1 , a SHED, OFF
307 1 , a SHAD, OFF
308 1 , a SAID, OFF
309 1 , a SHED, OFF
310 1 , a SAD, OFF
311 1 , a SAID, OFF
312 1 , a SHAD, Foil
313 1 , a SHAD, OFF
314 1 , a SAID, OFF
315 1 , a SAD, OFF
316 1 , a SHED, Switch
317 3 , a SHED, ON
318 3 , a SAID, ON
319 3 , a SHAD, ON
320 3 , a SAD, ON
321 3 , a SHED, ON
322 3 , a SAID, ON
323 3 , a SAD, ON
324 3 , a SHAD, Foil
325 3 , a SAID, ON
326 3 , a SHAD, ON
327 3 , a SHED, ON
328 3 , a SAD, Foil
329 3 , a SHED, ON
330 3 , a SAD, ON
331 3 , a SHAD, ON
332 3 , a SAID, Foil
333 3 , a SHAD, ON
334 3 , a SAID, ON
335 3 , a SAD, ON
336 3 , a SHED, Switch

337 2 , a SHED, OFF
338 2 , a SHAD, OFF
339 2 , a SAD, OFF
340 2 , a SAID, OFF
341 2 , a SAID, OFF
342 2 , a SHAD, OFF
343 2 , a SHED, OFF
344 2 , a SAD, Foil
345 2 , a SHED, OFF
346 2 , a SHAD, OFF
347 2 , a SAD, OFF
348 2 , a SAID, Foil
349 2 , a SHED, OFF
350 2 , a SAID, OFF
351 2 , a SAD, OFF
352 2 , a SHAD, Switch
353 1 , a SHAD, ON
354 1 , a SAID, ON
355 1 , a SHED, ON
356 1 , a SAD, ON
357 1 , a SAID, ON
358 1 , a SHED, ON
359 1 , a SHAD, ON
360 1 , a SAD, Foil
361 1 , a SAD, ON
362 1 , a SHAD, ON
363 1 , a SHED, ON
364 1 , a SAID, Switch
365 3 , a SAID, OFF
366 3 , a SHED, OFF
367 3 , a SHAD, OFF
368 3 , a SAD, OFF
369 3 , a SAID, OFF
370 3 , a SHED, OFF
371 3 , a SHAD, OFF
372 3 , a SAD, Foil
373 3 , a SAID, OFF
374 3 , a SHAD, OFF
375 3 , a SHED, OFF
376 3 , a SAD, Foil
377 3 , a SAID, OFF
378 3 , a SHAD, OFF
379 3 , a SHED, OFF
380 3 , a SAD, Foil
381 3 , a SHED, OFF
382 3 , a SAID, OFF
383 3 , a SHAD, OFF
384 3 , a SAD, Switch
385 1 , a SAD, ON
386 1 , a SHED, ON
387 1 , a SAID, ON
388 1 , a SHAD, ON
389 1 , a SAD, ON
390 1 , a SHED, ON
391 1 , a SAID, ON
392 1 , a SHAD, Foil
393 1 , a SHED, ON
394 1 , a SAD, ON
395 1 , a SHAD, ON
396 1 , a SAID, Switch
397 3 , a SAID, OFF
398 3 , a SHAD, OFF
399 3 , a SHED, OFF
400 3 , a SAD, OFF
401 3 , a SHED, OFF
402 3 , a SHAD, OFF
403 3 , a SAD, OFF
404 3 , a SAID, Foil
405 3 , a SAD, OFF
406 3 , a SHED, OFF
407 3 , a SAID, OFF
408 3 , a SHAD, Foil
409 3 , a SAD, OFF
410 3 , a SHED, OFF
411 3 , a SAID, OFF
412 3 , a SHAD, Foil
413 3 , a SAID, OFF
414 3 , a SHED, OFF
415 3 , a SAD, OFF
416 3 , a SHAD, Switch
417 2 , a SHAD, ON
418 2 , a SAD, ON
419 2 , a SHED, ON
420 2 , a SAID, ON
421 2 , a SHAD, ON
422 2 , a SAD, ON
423 2 , a SAID, ON
424 2 , a SHED, Foil
425 2 , a SAID, ON
426 2 , a SHED, ON
427 2 , a SHAD, ON
428 2 , a SAD, Foil
429 2 , a SHAD, ON
430 2 , a SAID, ON
431 2 , a SHED, ON
432 2 , a SAD, Switch
433 2 , a SAD, OFF
434 2 , a SAID, OFF
435 2 , a SHED, OFF
436 2 , a SHAD, OFF
437 2 , a SHAD, OFF
438 2 , a SAD, OFF
439 2 , a SHED, OFF
440 2 , a SAID, Foil
441 2 , a SAID, OFF
442 2 , a SHED, OFF
443 2 , a SAD, OFF
444 2 , a SHAD, Foil
445 2 , a SHAD, OFF
446 2 , a SAID, OFF
447 2 , a SAD, OFF
448 2 , a SHED, Switch
449 3 , a SHED, ON
450 3 , a SHAD, ON
451 3 , a SAID, ON
452 3 , a SAD, ON
453 3 , a SHAD, ON
454 3 , a SAD, ON
455 3 , a SAID, ON
456 3 , a SHED, Foil
457 3 , a SAID, ON
458 3 , a SHAD, ON
459 3 , a SAD, ON
460 3 , a SHED, Foil
461 3 , a SHAD, ON
462 3 , a SHED, ON
463 3 , a SAID, ON
464 3 , a SAD, Foil
465 3 , a SHAD, ON
466 3 , a SHED, ON
467 3 , a SAID, ON
468 3 , a SAD, Switch
469 1 , a SAD, OFF
470 1 , a SAID, OFF
471 1 , a SHED, OFF
472 1 , a SHAD, OFF
473 1 , a SHAD, OFF
474 1 , a SAD, OFF
475 1 , a SAID, OFF
476 1 , a SHED, Foil
477 1 , a SAD, OFF
478 1 , a SAID, OFF
479 1 , a SHAD, OFF
480 1 , a SHED, Switch
481 1 , a SHED, ON
482 1 , a SAD, ON
483 1 , a SAID, ON
484 1 , a SHAD, ON
485 1 , a SHED, ON
486 1 , a SAID, ON
487 1 , a SAD, ON
488 1 , a SHAD, Foil
489 1 , a SAID, ON
490 1 , a SHED, ON
491 1 , a SAD, ON
492 1 , a SHAD, Switch
493 3 , a SHAD, OFF
494 3 , a SAID, OFF
495 3 , a SAD, OFF
496 3 , a SHED, OFF
497 3 , a SAID, OFF
498 3 , a SHAD, OFF
499 3 , a SAD, OFF
500 3 , a SHED, Foil
501 3 , a SAID, OFF
502 3 , a SHAD, OFF
503 3 , a SHED, OFF
504 3 , a SAD, Foil
505 3 , a SAID, OFF
506 3 , a SAD, OFF
507 3 , a SHAD, OFF

508 3 , a SHED, Foil
509 3 , a SAD, OFF
510 3 , a SHED, OFF
511 3 , a SHAD, OFF
512 3 , a SAID, Switch
513 2 , a SAID, ON
514 2 , a SHED, ON
515 2 , a SAD, ON
516 2 , a SHAD, ON
517 2 , a SAID, ON
518 2 , a SHAD, ON
519 2 , a SAD, ON
520 2 , a SHED, Foil
521 2 , a SHAD, ON
522 2 , a SHED, ON
523 2 , a SAID, ON
524 2 , a SAD, Foil
525 2 , a SHAD, ON
526 2 , a SHED, ON
527 2 , a SAID, ON
528 2 , a SAD, Switch
529 2 , a SAD, OFF
530 2 , a SHED, OFF
531 2 , a SAID, OFF
532 2 , a SHAD, OFF
533 2 , a SHAD, OFF
534 2 , a SAD, OFF
535 2 , a SAID, OFF
536 2 , a SHED, Foil
537 2 , a SAID, OFF
538 2 , a SHAD, OFF
539 2 , a SAD, OFF
540 2 , a SHED, Foil
541 2 , a SAID, OFF
542 2 , a SAD, OFF
543 2 , a SHED, OFF
544 2 , a SHAD, Switch
545 1 , a SHAD, ON
546 1 , a SAD, ON
547 1 , a SAID, ON
548 1 , a SHED, ON
549 1 , a SAID, ON
550 1 , a SHED, ON
551 1 , a SHAD, ON
552 1 , a SAD, Foil
553 1 , a SAID, ON
554 1 , a SAD, ON
555 1 , a SHAD, ON
556 1 , a SHED, Switch
557 3 , a SHED, OFF
558 3 , a SAID, OFF
559 3 , a SHAD, OFF
560 3 , a SAD, OFF
561 3 , a SAID, OFF
562 3 , a SHAD, OFF
563 3 , a SAD, OFF
564 3 , a SHED, Foil
565 3 , a SHAD, OFF
566 3 , a SAID, OFF
567 3 , a SHED, OFF
568 3 , a SAD, Foil
569 3 , a SAID, OFF
570 3 , a SAD, OFF
571 3 , a SHAD, OFF
572 3 , a SHED, Foil
573 3 , a SHAD, OFF
574 3 , a SHED, OFF
575 3 , a SAD, OFF
576 3 , a SAID, Switch
577 2 , a SAID, ON
578 2 , a SHED, ON
579 2 , a SAD, ON
580 2 , a SHAD, ON
581 2 , a SAD, ON
582 2 , a SHAD, ON
583 2 , a SHED, ON
584 2 , a SAID, Foil
585 2 , a SAD, ON
586 2 , a SHED, ON
587 2 , a SAID, ON
588 2 , a SHAD, Foil
589 2 , a SHAD, ON
590 2 , a SAD, ON
591 2 , a SHED, ON
592 2 , a SAID, Switch
593 3 , a SAID, OFF
594 3 , a SAD, OFF
595 3 , a SHAD, OFF
596 3 , a SHED, OFF
597 3 , a SAD, OFF
598 3 , a SAID, OFF
599 3 , a SHAD, OFF
600 3 , a SHED, Foil
601 3 , a SHED, OFF
602 3 , a SHAD, OFF
603 3 , a SAD, OFF
604 3 , a SAID, Foil
605 3 , a SHAD, OFF
606 3 , a SAD, OFF
607 3 , a SHED, OFF
608 3 , a SAID, Foil
609 3 , a SAD, OFF
610 3 , a SHED, OFF
611 3 , a SAID, OFF
612 3 , a SHAD, Switch
613 1 , a SHAD, ON
614 1 , a SHED, ON
615 1 , a SAID, ON
616 1 , a SAD, ON
617 1 , a SHED, ON
618 1 , a SAD, ON
619 1 , a SHAD, ON
620 1 , a SAID, Foil
621 1 , a SAD, ON
622 1 , a SHAD, ON
623 1 , a SAID, ON
624 1 , a SHED, Switch
625 3 , a SHED, OFF
626 3 , a SAID, OFF
627 3 , a SAD, OFF
628 3 , a SHAD, OFF
629 3 , a SAD, OFF
630 3 , a SHED, OFF
631 3 , a SAID, OFF
632 3 , a SHAD, Foil
633 3 , a SAID, OFF
634 3 , a SHAD, OFF
635 3 , a SAD, OFF
636 3 , a SHED, Foil
637 3 , a SAD, OFF
638 3 , a SAID, OFF
639 3 , a SHAD, OFF
640 3 , a SHED, Foil
641 3 , a SHED, OFF
642 3 , a SAID, OFF
643 3 , a SHAD, OFF
644 3 , a SAD, Switch
645 2 , a SAD, ON
646 2 , a SAID, ON
647 2 , a SHAD, ON
648 2 , a SHED, ON
649 2 , a SHED, ON
650 2 , a SAID, ON
651 2 , a SAD, ON
652 2 , a SHAD, Foil
653 2 , a SAID, ON
654 2 , a SHED, ON
655 2 , a SHAD, ON
656 2 , a SAD, Foil
657 2 , a SAD, ON
658 2 , a SAID, ON
659 2 , a SHAD, ON
660 2 , a SHED, Switch
661 1 , a SHED, OFF
662 1 , a SHAD, OFF
663 1 , a SAID, OFF
664 1 , a SAD, OFF
665 1 , a SAD, OFF
666 1 , a SHED, OFF
667 1 , a SHAD, OFF
668 1 , a SAID, Foil
669 1 , a SHAD, OFF
670 1 , a SHED, OFF
671 1 , a SAID, OFF
672 1 , a SAD, Switch
673 1 , a SAD, ON
674 1 , a SHAD, ON
675 1 , a SHED, ON
676 1 , a SAID, ON
677 1 , a SAD, ON
678 1 , a SAID, ON

679 1 , a SHAD, ON
680 1 , a SHED, Foil
681 1 , a SHAD, ON
682 1 , a SHED, ON
683 1 , a SAD, ON
684 1 , a SAID, Switch
685 2 , a SAID, OFF
686 2 , a SHED, OFF
687 2 , a SAD, OFF
688 2 , a SHAD, OFF
689 2 , a SAID, OFF
690 2 , a SHAD, OFF
691 2 , a SAD, OFF
692 2 , a SHED, Foil
693 2 , a SHAD, OFF
694 2 , a SHED, OFF
695 2 , a SAD, OFF
696 2 , a SAID, Foil
697 2 , a SAID, OFF
698 2 , a SHED, OFF
699 2 , a SAD, OFF
700 2 , a SHAD, Switch
701 3 , a SHAD, ON
702 3 , a SAID, ON
703 3 , a SAD, ON
704 3 , a SHED, ON
705 3 , a SAID, ON
706 3 , a SHED, ON
707 3 , a SHAD, ON
708 3 , a SAD, Foil
709 3 , a SAD, ON
710 3 , a SHED, ON
711 3 , a SHAD, ON
712 3 , a SAID, Foil
713 3 , a SHAD, ON
714 3 , a SAID, ON
715 3 , a SAD, ON
716 3 , a SHED, Foil
717 3 , a SHAD, ON
718 3 , a SAD, ON
719 3 , a SAID, ON
720 3 , a SHED, Switch
721 3 , a SHED, OFF
722 3 , a SHAD, OFF
723 3 , a SAID, OFF
724 3 , a SAD, OFF
725 3 , a SHED, OFF
726 3 , a SAD, OFF
727 3 , a SAID, OFF
728 3 , a SHAD, Foil
729 3 , a SAD, OFF
730 3 , a SHAD, OFF
731 3 , a SAID, OFF
732 3 , a SHED, Foil
733 3 , a SHAD, OFF
734 3 , a SHED, OFF
735 3 , a SAID, OFF
736 3 , a SAD, Foil
737 3 , a SAID, OFF
738 3 , a SAD, OFF
739 3 , a SHED, OFF
740 3 , a SHAD, Switch
741 2 , a SHAD, ON
742 2 , a SAD, ON
743 2 , a SAID, ON
744 2 , a SHED, ON
745 2 , a SAD, ON
746 2 , a SHAD, ON
747 2 , a SHED, ON
748 2 , a SAID, Foil
749 2 , a SHED, ON
750 2 , a SAID, ON
751 2 , a SAD, ON
752 2 , a SHAD, Foil
753 2 , a SHAD, ON
754 2 , a SHED, ON
755 2 , a SAID, ON
756 2 , a SAD, Switch
757 1 , a SAD, OFF
758 1 , a SHED, OFF
759 1 , a SAID, OFF
760 1 , a SHAD, OFF
761 1 , a SHED, OFF
762 1 , a SAD, OFF
763 1 , a SAID, OFF
764 1 , a SHAD, Foil
765 1 , a SAD, OFF
766 1 , a SHED, OFF
767 1 , a SHAD, OFF
768 1 , a SAID, Switch
769 1 , a SAID, ON
770 1 , a SAD, ON
771 1 , a SHED, ON
772 1 , a SHAD, ON
773 1 , a SAD, ON
774 1 , a SAID, ON
775 1 , a SHAD, ON
776 1 , a SHED, Foil
777 1 , a SHAD, ON
778 1 , a SAD, ON
779 1 , a SAID, ON
780 1 , a SHED, Switch
781 3 , a SHED, OFF
782 3 , a SAD, OFF
783 3 , a SHAD, OFF
784 3 , a SAID, OFF
785 3 , a SAD, OFF
786 3 , a SHAD, OFF
787 3 , a SHED, OFF
788 3 , a SAID, Foil
789 3 , a SAD, OFF
790 3 , a SHAD, OFF
791 3 , a SAID, OFF
792 3 , a SHED, Foil
793 3 , a SAID, OFF
794 3 , a SAD, OFF
795 3 , a SHAD, OFF
796 3 , a SHED, Foil
797 3 , a SHAD, OFF
798 3 , a SHED, OFF
799 3 , a SAID, OFF
800 3 , a SAD, Switch
801 2 , a SAD, ON
802 2 , a SAID, ON
803 2 , a SHAD, ON
804 2 , a SHED, ON
805 2 , a SHED, ON
806 2 , a SAD, ON
807 2 , a SAID, ON
808 2 , a SHAD, Foil
809 2 , a SHED, ON
810 2 , a SAID, ON
811 2 , a SHAD, ON
812 2 , a SAD, Foil
813 2 , a SHED, ON
814 2 , a SAD, ON
815 2 , a SAID, ON
816 2 , a SHAD, Switch
817 1 , a SHAD, OFF
818 1 , a SHED, OFF
819 1 , a SAD, OFF
820 1 , a SAID, OFF
821 1 , a SAD, OFF
822 1 , a SHAD, OFF
823 1 , a SAID, OFF
824 1 , a SHED, Foil
825 1 , a SHAD, OFF
826 1 , a SAD, OFF
827 1 , a SHED, OFF
828 1 , a SAID, Switch
829 2 , a SAID, ON
830 2 , a SAD, ON
831 2 , a SHED, ON
832 2 , a SHAD, ON
833 2 , a SHED, ON
834 2 , a SHAD, ON
835 2 , a SAID, ON
836 2 , a SAD, Foil
837 2 , a SHED, ON
838 2 , a SHAD, ON
839 2 , a SAD, ON
840 2 , a SAID, Foil
841 2 , a SAD, ON
842 2 , a SHED, ON
843 2 , a SHAD, ON
844 2 , a SAID, Switch
845 3 , a SAID, OFF
846 3 , a SHED, OFF
847 3 , a SHAD, OFF
848 3 , a SAD, OFF
849 3 , a SAID, OFF

850	3 , a SHED,	OFF	907	3 , a SAID,	ON	964	3 , a SAD,	ON
851	3 , a SAD,	OFF	908	3 , a SHED,	Foil	965	3 , a SHED,	ON
852	3 , a SHAD,	Foil	909	3 , a SAID,	ON	966	3 , a SAD,	ON
853	3 , a SAID,	OFF	910	3 , a SHED,	ON	967	3 , a SAID,	ON
854	3 , a SHED,	OFF	911	3 , a SHAD,	ON	968	3 , a SHAD,	Foil
855	3 , a SHAD,	OFF	912	3 , a SAD,	Switch	969	3 , a SAD,	ON
856	3 , a SAD,	Foil	913	3 , a SAD,	OFF	970	3 , a SHAD,	ON
857	3 , a SAID,	OFF	914	3 , a SHED,	OFF	971	3 , a SAID,	ON
858	3 , a SHED,	OFF	915	3 , a SHAD,	OFF	972	3 , a SHED,	Foil
859	3 , a SHAD,	OFF	916	3 , a SAID,	OFF	973	3 , a SAD,	ON
860	3 , a SAD,	Foil	917	3 , a SAD,	OFF	974	3 , a SHED,	ON
861	3 , a SHED,	OFF	918	3 , a SAID,	OFF	975	3 , a SAID,	ON
862	3 , a SHAD,	OFF	919	3 , a SHAD,	OFF	976	3 , a SHAD,	Foil
863	3 , a SAID,	OFF	920	3 , a SHED,	Foil	977	3 , a SAD,	ON
864	3 , a SAD,	Switch	921	3 , a SHAD,	OFF	978	3 , a SHED,	ON
865	2 , a SAD,	ON	922	3 , a SHED,	OFF	979	3 , a SAID,	ON
866	2 , a SHED,	ON	923	3 , a SAD,	OFF	980	3 , a SHAD,	Switch
867	2 , a SHAD,	ON	924	3 , a SAID,	Foil	981	2 , a SHAD,	OFF
868	2 , a SAID,	ON	925	3 , a SAD,	OFF	982	2 , a SAD,	OFF
869	2 , a SAID,	ON	926	3 , a SHED,	OFF	983	2 , a SHED,	OFF
870	2 , a SHAD,	ON	927	3 , a SHAD,	OFF	984	2 , a SAID,	OFF
871	2 , a SAD,	ON	928	3 , a SAID,	Foil	985	2 , a SAD,	OFF
872	2 , a SHED,	Foil	929	3 , a SAD,	OFF	986	2 , a SHAD,	OFF
873	2 , a SAID,	ON	930	3 , a SHED,	OFF	987	2 , a SAID,	OFF
874	2 , a SHED,	ON	931	3 , a SHAD,	OFF	988	2 , a SHED,	Foil
875	2 , a SHAD,	ON	932	3 , a SAID,	Switch	989	2 , a SAD,	OFF
876	2 , a SAD,	Foil	933	2 , a SAID,	ON	990	2 , a SHAD,	OFF
877	2 , a SHAD,	ON	934	2 , a SHAD,	ON	991	2 , a SAID,	OFF
878	2 , a SAD,	ON	935	2 , a SAD,	ON	992	2 , a SHED,	Foil
879	2 , a SAID,	ON	936	2 , a SHED,	ON	993	2 , a SAD,	OFF
880	2 , a SHED,	Switch	937	2 , a SAD,	ON	994	2 , a SHAD,	OFF
881	1 , a SHED,	OFF	938	2 , a SHED,	ON	995	2 , a SAID,	OFF
882	1 , a SAD,	OFF	939	2 , a SAID,	ON	996	2 , a SHED,	Switch
883	1 , a SHAD,	OFF	940	2 , a SHAD,	Foil	997	1 , a SHED,	ON
884	1 , a SAID,	OFF	941	2 , a SAID,	ON	998	1 , a SAD,	ON
885	1 , a SAD,	OFF	942	2 , a SHAD,	ON	999	1 , a SHAD,	ON
886	1 , a SHED,	OFF	943	2 , a SHED,	ON	1000	1 , a SAID,	ON
887	1 , a SHAD,	OFF	944	2 , a SAD,	Foil	1001	1 , a SAID,	ON
888	1 , a SAID,	Foil	945	2 , a SAID,	ON	1002	1 , a SHAD,	ON
889	1 , a SHED,	OFF	946	2 , a SHED,	ON	1003	1 , a SAD,	ON
890	1 , a SAID,	OFF	947	2 , a SAD,	ON	1004	1 , a SHED,	Foil
891	1 , a SAD,	OFF	948	2 , a SHAD,	Switch	1005	1 , a SHAD,	ON
892	1 , a SHAD,	Switch	949	1 , a SHAD,	OFF	1006	1 , a SHED,	ON
893	3 , a SHAD,	ON	950	1 , a SAID,	OFF	1007	1 , a SAD,	ON
894	3 , a SAID,	ON	951	1 , a SHED,	OFF	1008	1 , a SAID,	Switch
895	3 , a SAD,	ON	952	1 , a SAD,	OFF	1009	1 , a SAID,	OFF
896	3 , a SHED,	ON	953	1 , a SHED,	OFF	1010	1 , a SAD,	OFF
897	3 , a SAID,	ON	954	1 , a SHAD,	OFF	1011	1 , a SHED,	OFF
898	3 , a SHED,	ON	955	1 , a SAID,	OFF	1012	1 , a SHAD,	OFF
899	3 , a SHAD,	ON	956	1 , a SAD,	Foil	1013	1 , a SHAD,	OFF
900	3 , a SAD,	Foil	957	1 , a SAID,	OFF	1014	1 , a SAID,	OFF
901	3 , a SHAD,	ON	958	1 , a SHAD,	OFF	1015	1 , a SAD,	OFF
902	3 , a SAID,	ON	959	1 , a SAD,	OFF	1016	1 , a SHED,	Foil
903	3 , a SHED,	ON	960	1 , a SHED,	Switch	1017	1 , a SHAD,	OFF
904	3 , a SAD,	Foil	961	3 , a SHED,	ON	1018	1 , a SHED,	OFF
905	3 , a SHAD,	ON	962	3 , a SHAD,	ON	1019	1 , a SAID,	OFF
906	3 , a SAD,	ON	963	3 , a SAID,	ON	1020	1 , a SAD,	Switch

1021 2 , a SAD, ON
1022 2 , a SHED, ON
1023 2 , a SAID, ON
1024 2 , a SHAD, ON
1025 2 , a SAID, ON
1026 2 , a SHAD, ON
1027 2 , a SHED, ON
1028 2 , a SAD, Foil
1029 2 , a SAD, ON
1030 2 , a SHED, ON
1031 2 , a SAID, ON
1032 2 , a SHAD, Foil
1033 2 , a SAD, ON
1034 2 , a SAID, ON
1035 2 , a SHED, ON
1036 2 , a SHAD, Switch
1037 3 , a SHAD, OFF
1038 3 , a SHED, OFF
1039 3 , a SAD, OFF
1040 3 , a SAID, OFF
1041 3 , a SHAD, OFF
1042 3 , a SAD, OFF
1043 3 , a SHED, OFF
1044 3 , a SAID, Foil
1045 3 , a SAD, OFF
1046 3 , a SHAD, OFF
1047 3 , a SHED, OFF
1048 3 , a SAID, Foil
1049 3 , a SAID, OFF
1050 3 , a SHED, OFF
1051 3 , a SHAD, OFF
1052 3 , a SAD, Foil
1053 3 , a SAID, OFF
1054 3 , a SAD, OFF
1055 3 , a SHAD, OFF
1056 3 , a SHED, Switch
1057 3 , a SHED, ON
1058 3 , a SAID, ON
1059 3 , a SAD, ON
1060 3 , a SHAD, ON
1061 3 , a SAID, ON
1062 3 , a SHED, ON
1063 3 , a SHAD, ON
1064 3 , a SAD, Foil
1065 3 , a SHAD, ON
1066 3 , a SHED, ON
1067 3 , a SAD, ON
1068 3 , a SAID, Foil
1069 3 , a SHED, ON
1070 3 , a SHAD, ON
1071 3 , a SAID, ON
1072 3 , a SAD, Foil
1073 3 , a SHED, ON
1074 3 , a SHAD, ON
1075 3 , a SAD, ON
1076 3 , a SAID, Switch
1077 2 , a SAID, OFF
1078 2 , a SHAD, OFF
1079 2 , a SHED, OFF
1080 2 , a SAD, OFF
1081 2 , a SHED, OFF
1082 2 , a SAID, OFF
1083 2 , a SHAD, OFF
1084 2 , a SAD, Foil
1085 2 , a SAD, OFF
1086 2 , a SHED, OFF
1087 2 , a SHAD, OFF
1088 2 , a SAID, Foil
1089 2 , a SHAD, OFF
1090 2 , a SHED, OFF
1091 2 , a SAID, OFF
1092 2 , a SAD, Switch
1093 1 , a SAD, ON
1094 1 , a SHAD, ON
1095 1 , a SHED, ON
1096 1 , a SAID, ON
1097 1 , a SAID, ON
1098 1 , a SHAD, ON
1099 1 , a SAD, ON
1100 1 , a SHED, Foil
1101 1 , a SAD, ON
1102 1 , a SAID, ON
1103 1 , a SHED, ON
1104 1 , a SHAD, Switch
1105 3 , a SHAD, OFF
1106 3 , a SHED, OFF
1107 3 , a SAD, OFF
1108 3 , a SAID, OFF
1109 3 , a SHAD, OFF
1110 3 , a SAD, OFF
1111 3 , a SHED, OFF
1112 3 , a SAID, Foil
1113 3 , a SAD, OFF
1114 3 , a SAID, OFF
1115 3 , a SHAD, OFF
1116 3 , a SHED, Foil
1117 3 , a SAD, OFF
1118 3 , a SHED, OFF
1119 3 , a SAID, OFF
1120 3 , a SHAD, Foil
1121 3 , a SHAD, OFF
1122 3 , a SHED, OFF
1123 3 , a SAID, OFF
1124 3 , a SAD, Switch
1125 1 , a SAD, ON
1126 1 , a SHAD, ON
1127 1 , a SAID, ON
1128 1 , a SHED, ON
1129 1 , a SAD, ON
1130 1 , a SAID, ON
1131 1 , a SHAD, ON
1132 1 , a SHED, Foil
1133 1 , a SAID, ON
1134 1 , a SAD, ON
1135 1 , a SHAD, ON
1136 1 , a SHED, Switch
1137 2 , a SHED, OFF
1138 2 , a SAID, OFF
1139 2 , a SAD, OFF
1140 2 , a SHAD, OFF
1141 2 , a SAID, OFF
1142 2 , a SHED, OFF
1143 2 , a SAD, OFF
1144 2 , a SHAD, Foil
1145 2 , a SAD, OFF
1146 2 , a SHED, OFF
1147 2 , a SAID, OFF
1148 2 , a SHAD, Foil
1149 2 , a SHED, OFF
1150 2 , a SHAD, OFF
1151 2 , a SAD, OFF
1152 2 , a SAID, Switch
1153 3 , a SAID, ON
1154 3 , a SHAD, ON
1155 3 , a SHED, ON
1156 3 , a SAD, ON
1157 3 , a SHAD, ON
1158 3 , a SHED, ON
1159 3 , a SAD, ON
1160 3 , a SAID, Foil
1161 3 , a SAD, ON
1162 3 , a SHED, ON
1163 3 , a SHAD, ON
1164 3 , a SAID, Foil
1165 3 , a SHED, ON
1166 3 , a SAD, ON
1167 3 , a SHAD, ON
1168 3 , a SAID, Foil
1169 3 , a SAID, ON
1170 3 , a SHAD, ON
1171 3 , a SHED, ON
1172 3 , a SAD, Switch
1173 1 , a SAD, OFF
1174 1 , a SHAD, OFF
1175 1 , a SAID, OFF
1176 1 , a SHED, OFF
1177 1 , a SHAD, OFF
1178 1 , a SAD, OFF
1179 1 , a SAID, OFF
1180 1 , a SHED, Foil
1181 1 , a SHAD, OFF
1182 1 , a SAID, OFF
1183 1 , a SAD, OFF
1184 1 , a SHED, Switch
1185 2 , a SHED, ON
1186 2 , a SAD, ON
1187 2 , a SAID, ON
1188 2 , a SHAD, ON
1189 2 , a SHAD, ON
1190 2 , a SAD, ON
1191 2 , a SAID, ON

1192 2 , a SHED, Foil
1193 2 , a SAID, ON
1194 2 , a SHED, ON
1195 2 , a SHAD, ON
1196 2 , a SAD, Foil
1197 2 , a SHED, ON
1198 2 , a SHAD, ON
1199 2 , a SAD, ON
1200 2 , a SAID, Switch
1201 1 , a SAID, OFF
1202 1 , a SAD, OFF
1203 1 , a SHAD, OFF
1204 1 , a SHED, OFF
1205 1 , a SAID, OFF
1206 1 , a SAD, OFF
1207 1 , a SHAD, OFF
1208 1 , a SHED, Foil
1209 1 , a SHED, OFF
1210 1 , a SAD, OFF
1211 1 , a SAID, OFF
1212 1 , a SHAD, Switch
1213 3 , a SHAD, ON
1214 3 , a SHED, ON
1215 3 , a SAD, ON
1216 3 , a SAID, ON
1217 3 , a SAD, ON
1218 3 , a SAID, ON
1219 3 , a SHAD, ON
1220 3 , a SHED, Foil
1221 3 , a SHED, ON
1222 3 , a SHAD, ON
1223 3 , a SAID, ON
1224 3 , a SAD, Foil
1225 3 , a SAID, ON
1226 3 , a SAD, ON
1227 3 , a SHED, ON
1228 3 , a SHAD, Foil
1229 3 , a SHED, ON
1230 3 , a SAID, ON
1231 3 , a SHAD, ON
1232 3 , a SAD, Switch
1233 2 , a SAD, OFF
1234 2 , a SHAD, OFF
1235 2 , a SHED, OFF
1236 2 , a SAID, OFF
1237 2 , a SAID, OFF
1238 2 , a SHED, OFF
1239 2 , a SAD, OFF
1240 2 , a SHAD, Foil
1241 2 , a SAID, OFF
1242 2 , a SHAD, OFF
1243 2 , a SAD, OFF
1244 2 , a SHED, Foil
1245 2 , a SAD, OFF
1246 2 , a SAID, OFF
1247 2 , a SHAD, OFF
1248 2 , a SHED, Switch
1249 3 , a SHED, ON
1250 3 , a SAID, ON
1251 3 , a SHAD, ON
1252 3 , a SAD, ON
1253 3 , a SAD, ON
1254 3 , a SAID, ON
1255 3 , a SHAD, ON
1256 3 , a SHED, Foil
1257 3 , a SAID, ON
1258 3 , a SAD, ON
1259 3 , a SHAD, ON
1260 3 , a SHED, Foil
1261 3 , a SAD, ON
1262 3 , a SHAD, ON
1263 3 , a SAID, ON
1264 3 , a SHED, Foil
1265 3 , a SHED, ON
1266 3 , a SAD, ON
1267 3 , a SAID, ON
1268 3 , a SHAD, Switch
1269 2 , a SHAD, OFF
1270 2 , a SHED, OFF
1271 2 , a SAID, OFF
1272 2 , a SAD, OFF
1273 2 , a SHAD, OFF
1274 2 , a SAID, OFF
1275 2 , a SAD, OFF
1276 2 , a SHED, Foil
1277 2 , a SAD, OFF
1278 2 , a SHAD, OFF
1279 2 , a SHED, OFF
1280 2 , a SAID, Foil
1281 2 , a SHAD, OFF
1282 2 , a SAD, OFF
1283 2 , a SHED, OFF
1284 2 , a SAID, Switch
1285 1 , a SAID, ON
1286 1 , a SHED, ON
1287 1 , a SHAD, ON
1288 1 , a SAD, ON
1289 1 , a SHED, ON
1290 1 , a SAID, ON
1291 1 , a SHAD, ON
1292 1 , a SAD, Foil
1293 1 , a SHED, ON
1294 1 , a SAD, ON
1295 1 , a SHAD, ON
1296 1 , a SAID, Switch
1297 3 , a SAID, OFF
1298 3 , a SHAD, OFF
1299 3 , a SAD, OFF
1300 3 , a SHED, OFF
1301 3 , a SAID, OFF
1302 3 , a SHAD, OFF
1303 3 , a SHED, OFF
1304 3 , a SAD, Foil
1305 3 , a SHAD, OFF
1306 3 , a SAD, OFF
1307 3 , a SAID, OFF
1308 3 , a SHED, Foil
1309 3 , a SHAD, OFF
1310 3 , a SAD, OFF
1311 3 , a SHED, OFF
1312 3 , a SAID, Foil
1313 3 , a SAID, OFF
1314 3 , a SHAD, OFF
1315 3 , a SAD, OFF
1316 3 , a SHED, Switch
1317 2 , a SHED, ON
1318 2 , a SAD, ON
1319 2 , a SHAD, ON
1320 2 , a SAID, ON
1321 2 , a SHAD, ON
1322 2 , a SAD, ON
1323 2 , a SHED, ON
1324 2 , a SAID, Foil
1325 2 , a SAD, ON
1326 2 , a SAID, ON
1327 2 , a SHAD, ON
1328 2 , a SHED, Foil
1329 2 , a SAID, ON
1330 2 , a SHAD, ON
1331 2 , a SHED, ON
1332 2 , a SAD, Switch
1333 1 , a SAD, OFF
1334 1 , a SHED, OFF
1335 1 , a SAID, OFF
1336 1 , a SHAD, OFF
1337 1 , a SHED, OFF
1338 1 , a SAID, OFF
1339 1 , a SHAD, OFF
1340 1 , a SAD, Foil
1341 1 , a SAD, OFF
1342 1 , a SAID, OFF
1343 1 , a SHED, OFF
1344 1 , a SHAD, Switch
1345 3 , a SHAD, ON
1346 3 , a SAD, ON
1347 3 , a SHED, ON
1348 3 , a SAID, ON
1349 3 , a SAID, ON
1350 3 , a SHED, ON
1351 3 , a SAD, ON
1352 3 , a SHAD, Foil
1353 3 , a SHED, ON
1354 3 , a SHAD, ON
1355 3 , a SAID, ON
1356 3 , a SAD, Foil
1357 3 , a SHED, ON
1358 3 , a SAID, ON
1359 3 , a SAD, ON
1360 3 , a SHAD, Foil
1361 3 , a SHAD, ON
1362 3 , a SHED, ON

1363 3 , a SAID, ON
1364 3 , a SAD, Switch
1365 2 , a SAD, OFF
1366 2 , a SAID, OFF
1367 2 , a SHED, OFF
1368 2 , a SHAD, OFF
1369 2 , a SHAD, OFF
1370 2 , a SHED, OFF
1371 2 , a SAD, OFF
1372 2 , a SAID, Foil
1373 2 , a SAID, OFF
1374 2 , a SAD, OFF
1375 2 , a SHED, OFF
1376 2 , a SHAD, Foil
1377 2 , a SHED, OFF
1378 2 , a SHAD, OFF
1379 2 , a SAD, OFF
1380 2 , a SAID, Switch
1381 1 , a SAID, ON
1382 1 , a SAD, ON
1383 1 , a SHAD, ON
1384 1 , a SHED, ON
1385 1 , a SHAD, ON
1386 1 , a SAD, ON
1387 1 , a SHED, ON
1388 1 , a SAID, Foil
1389 1 , a SHAD, ON
1390 1 , a SAD, ON
1391 1 , a SAID, ON
1392 1 , a SHED, Switch
1393 2 , a SHED, OFF
1394 2 , a SAD, OFF
1395 2 , a SHAD, OFF
1396 2 , a SAID, OFF
1397 2 , a SHED, OFF
1398 2 , a SAID, OFF
1399 2 , a SAD, OFF
1400 2 , a SHAD, Foil
1401 2 , a SHED, OFF
1402 2 , a SAID, OFF
1403 2 , a SHAD, OFF
1404 2 , a SAD, Foil
1405 2 , a SHED, OFF
1406 2 , a SAD, OFF
1407 2 , a SAID, OFF
1408 2 , a SHAD, Switch
1409 1 , a SHAD, ON
1410 1 , a SAID, ON
1411 1 , a SHED, ON
1412 1 , a SAD, ON
1413 1 , a SHED, ON
1414 1 , a SHAD, ON
1415 1 , a SAD, ON
1416 1 , a SAID, Foil
1417 1 , a SHAD, ON
1418 1 , a SAID, ON
1419 1 , a SAD, ON
1420 1 , a SHED, Switch
1421 3 , a SHED, OFF
1422 3 , a SAD, OFF
1423 3 , a SHAD, OFF
1424 3 , a SAID, OFF
1425 3 , a SAID, OFF
1426 3 , a SAD, OFF
1427 3 , a SHED, OFF
1428 3 , a SHAD, Foil
1429 3 , a SAD, OFF
1430 3 , a SAID, OFF
1431 3 , a SHED, OFF
1432 3 , a SHAD, Foil
1433 3 , a SAID, OFF
1434 3 , a SAD, OFF
1435 3 , a SHED, OFF
1436 3 , a SHAD, Foil
1437 3 , a SHAD, OFF
1438 3 , a SAID, OFF
1439 3 , a SHED, OFF
1440 3 , a SAD, Switch
1441 3 , a SAD, ON
1442 3 , a SHED, ON
1443 3 , a SAID, ON
1444 3 , a SHAD, ON
1445 3 , a SHAD, ON
1446 3 , a SHED, ON
1447 3 , a SAD, ON
1448 3 , a SAID, Foil
1449 3 , a SAID, ON
1450 3 , a SHAD, ON
1451 3 , a SAD, ON
1452 3 , a SHED, Foil
1453 3 , a SAID, ON
1454 3 , a SHAD, ON
1455 3 , a SAD, ON
1456 3 , a SHED, Foil
1457 3 , a SAID, ON
1458 3 , a SHED, ON
1459 3 , a SAD, ON
1460 3 , a SHAD, Switch
1461 2 , a SHAD, OFF
1462 2 , a SAID, OFF
1463 2 , a SHED, OFF
1464 2 , a SAD, OFF
1465 2 , a SAD, OFF
1466 2 , a SHAD, OFF
1467 2 , a SHED, OFF
1468 2 , a SAID, Foil
1469 2 , a SHED, OFF
1470 2 , a SAID, OFF
1471 2 , a SHAD, OFF
1472 2 , a SAD, Foil
1473 2 , a SHED, OFF
1474 2 , a SHAD, OFF
1475 2 , a SAD, OFF
1476 2 , a SAID, Switch
1477 1 , a SAID, ON
1478 1 , a SAD, ON
1479 1 , a SHAD, ON
1480 1 , a SHED, ON
1481 1 , a SHAD, ON
1482 1 , a SAD, ON
1483 1 , a SHED, ON
1484 1 , a SAID, Foil
1485 1 , a SAD, ON
1486 1 , a SHED, ON
1487 1 , a SAID, ON
1488 1 , a SHAD, Switch
1489 3 , a SHAD, OFF
1490 3 , a SAD, OFF
1491 3 , a SAID, OFF
1492 3 , a SHED, OFF
1493 3 , a SAID, OFF
1494 3 , a SHAD, OFF
1495 3 , a SAD, OFF
1496 3 , a SHED, Foil
1497 3 , a SAD, OFF
1498 3 , a SAID, OFF
1499 3 , a SHAD, OFF
1500 3 , a SHED, Foil
1501 3 , a SAID, OFF
1502 3 , a SAD, OFF
1503 3 , a SHED, OFF
1504 3 , a SHAD, Foil
1505 3 , a SHAD, OFF
1506 3 , a SAD, OFF
1507 3 , a SAID, OFF
1508 3 , a SHED, Switch
1509 2 , a SHED, ON
1510 2 , a SAID, ON
1511 2 , a SHAD, ON
1512 2 , a SAD, ON
1513 2 , a SHAD, ON
1514 2 , a SAD, ON
1515 2 , a SHED, ON
1516 2 , a SAID, Foil
1517 2 , a SHED, ON
1518 2 , a SAID, ON
1519 2 , a SHAD, ON
1520 2 , a SAD, Foil
1521 2 , a SHAD, ON
1522 2 , a SHED, ON
1523 2 , a SAD, ON
1524 2 , a SAID, Switch
1525 1 , a SAID, OFF
1526 1 , a SHED, OFF
1527 1 , a SHAD, OFF
1528 1 , a SAD, OFF
1529 1 , a SHAD, OFF
1530 1 , a SAD, OFF
1531 1 , a SAID, OFF
1532 1 , a SHED, Foil
1533 1 , a SHAD, OFF

1534 1 , a SHED, OFF
1535 1 , a SAID, OFF
1536 1 , a SAD, Switch
1537 2 , a SAD, ON
1538 2 , a SHAD, ON
1539 2 , a SAID, ON
1540 2 , a SHED, ON
1541 2 , a SAD, ON
1542 2 , a SHED, ON
1543 2 , a SAID, ON
1544 2 , a SHAD, Foil
1545 2 , a SHED, ON
1546 2 , a SHAD, ON
1547 2 , a SAD, ON
1548 2 , a SAID, Foil
1549 2 , a SAID, ON
1550 2 , a SHED, ON
1551 2 , a SHAD, ON
1552 2 , a SAD, Switch
1553 3 , a SAD, OFF
1554 3 , a SHAD, OFF
1555 3 , a SAID, OFF
1556 3 , a SHED, OFF
1557 3 , a SAID, OFF
1558 3 , a SHED, OFF
1559 3 , a SHAD, OFF
1560 3 , a SAD, Foil
1561 3 , a SHED, OFF
1562 3 , a SHAD, OFF
1563 3 , a SAD, OFF
1564 3 , a SAID, Foil
1565 3 , a SHAD, OFF
1566 3 , a SAD, OFF
1567 3 , a SHED, OFF
1568 3 , a SAID, Foil
1569 3 , a SHAD, OFF
1570 3 , a SAD, OFF
1571 3 , a SHED, OFF
1572 3 , a SAID, Switch
1573 1 , a SAID, ON
1574 1 , a SAD, ON
1575 1 , a SHED, ON
1576 1 , a SHAD, ON
1577 1 , a SHAD, ON
1578 1 , a SAID, ON
1579 1 , a SHED, ON
1580 1 , a SAD, Foil
1581 1 , a SAD, ON
1582 1 , a SHED, ON
1583 1 , a SAID, ON
1584 1 , a SHAD, Switch
1585 2 , a SHAD, OFF
1586 2 , a SAID, OFF
1587 2 , a SAD, OFF
1588 2 , a SHED, OFF
1589 2 , a SAID, OFF
1590 2 , a SHED, OFF
1591 2 , a SHAD, OFF
1592 2 , a SAD, Foil
1593 2 , a SHED, OFF
1594 2 , a SHAD, OFF
1595 2 , a SAD, OFF
1596 2 , a SAID, Foil
1597 2 , a SHAD, OFF
1598 2 , a SAD, OFF
1599 2 , a SAID, OFF
1600 2 , a SHED, Switch
1601 3 , a SHED, ON
1602 3 , a SAD, ON
1603 3 , a SHAD, ON
1604 3 , a SAID, ON
1605 3 , a SHED, ON
1606 3 , a SAID, ON
1607 3 , a SAD, ON
1608 3 , a SHAD, Foil
1609 3 , a SHED, ON
1610 3 , a SAD, ON
1611 3 , a SHAD, ON
1612 3 , a SAID, Foil
1613 3 , a SAD, ON
1614 3 , a SAID, ON
1615 3 , a SHED, ON
1616 3 , a SHAD, Foil
1617 3 , a SAD, ON
1618 3 , a SHAD, ON
1619 3 , a SAID, ON
1620 3 , a SHED, Switch
1621 1 , a SHED, OFF
1622 1 , a SAID, OFF
1623 1 , a SHAD, OFF
1624 1 , a SAD, OFF
1625 1 , a SAD, OFF
1626 1 , a SHAD, OFF
1627 1 , a SHED, OFF
1628 1 , a SAID, Foil
1629 1 , a SAD, OFF
1630 1 , a SAID, OFF
1631 1 , a SHED, OFF
1632 1 , a SHAD, Switch
1633 1 , a SHAD, ON
1634 1 , a SHED, ON
1635 1 , a SAD, ON
1636 1 , a SAID, ON
1637 1 , a SAD, ON
1638 1 , a SHAD, ON
1639 1 , a SHED, ON
1640 1 , a SAID, Foil
1641 1 , a SAD, ON
1642 1 , a SHAD, ON
1643 1 , a SHED, ON
1644 1 , a SAID, Switch
1645 2 , a SAID, OFF
1646 2 , a SHAD, OFF
1647 2 , a SAD, OFF
1648 2 , a SHED, OFF
1649 2 , a SHED, OFF
1650 2 , a SAD, OFF
1651 2 , a SAID, OFF
1652 2 , a SHAD, Foil
1653 2 , a SHAD, OFF
1654 2 , a SAID, OFF
1655 2 , a SHED, OFF
1656 2 , a SAD, Foil
1657 2 , a SAID, OFF
1658 2 , a SHED, OFF
1659 2 , a SHAD, OFF
1660 2 , a SAD, Switch
1661 3 , a SAD, ON
1662 3 , a SHED, ON
1663 3 , a SHAD, ON
1664 3 , a SAID, ON
1665 3 , a SHED, ON
1666 3 , a SAD, ON
1667 3 , a SAID, ON
1668 3 , a SHAD, Foil
1669 3 , a SHED, ON
1670 3 , a SAD, ON
1671 3 , a SAID, ON
1672 3 , a SHAD, Foil
1673 3 , a SHAD, ON
1674 3 , a SAD, ON
1675 3 , a SHED, ON
1676 3 , a SAID, Foil
1677 3 , a SAID, ON
1678 3 , a SHED, ON
1679 3 , a SAD, ON
1680 3 , a SHAD, Switch
1681 1 , a SHAD, OFF
1682 1 , a SHED, OFF
1683 1 , a SAID, OFF
1684 1 , a SAD, OFF
1685 1 , a SHED, OFF
1686 1 , a SHAD, OFF
1687 1 , a SAD, OFF
1688 1 , a SAID, Foil
1689 1 , a SHED, OFF
1690 1 , a SAD, OFF
1691 1 , a SHAD, OFF
1692 1 , a SAID, Switch
1693 2 , a SAID, ON
1694 2 , a SHAD, ON
1695 2 , a SAD, ON
1696 2 , a SHED, ON
1697 2 , a SHED, ON
1698 2 , a SAD, ON
1699 2 , a SAID, ON
1700 2 , a SHAD, Foil
1701 2 , a SAD, ON
1702 2 , a SHAD, ON
1703 2 , a SAID, ON
1704 2 , a SHED, Foil

Appendix C

Basic Program - Subject MA

```
CLS
CLEAR
RANDOMIZE TIMER

INPUT "Enter the number of runs ->"; ns
INPUT "Enter the delay between utterances ->"; delay
showtime = .25
shtime2 = .5
DIM utt(4 * 12 * ns)
DIM sesstype(4 * 12 * ns)
DIM session(3 * ns)
DIM lasttoken(3 * ns)

text$(1) = "a SAD"
text$(2) = "a SHAD"
text$(3) = "a SAID"
text$(4) = "a SHED"

INPUT "Enter the name of datafile, or press ENTER to create one: "; datafile$
IF datafile$ <> "" THEN GOTO 20

REM Find the session sequence:
REM sessiontype(1)=8+4, sessiontype(2)=8+8, sessiontype(3)=8+12 tokens

seq = 3
FOR i% = 1 TO 3 * ns STEP 3
        REDIM SHARED rseq(seq): GOSUB 2000
        session(i%) = rseq(1)
        session(i% + 1) = rseq(2)
        session(i% + 2) = rseq(3)
NEXT i%

seq = 4
FOR i% = 1 TO 3 * ns STEP 4
        REDIM SHARED rseq(seq): GOSUB 2000
        lasttoken(i%) = rseq(1)
        lasttoken(i% + 1) = rseq(2)
        lasttoken(i% + 2) = rseq(3)
        lasttoken(i% + 3) = rseq(4)
NEXT i%
prevtoken = lasttoken(3 * ns)
cutt% = 1
FOR i% = 1 TO 3 * ns
5       REDIM SHARED rseq(seq): GOSUB 2000
        IF rseq(1) <> prevtoken THEN GOTO 5
        sesstype(cutt%) = session(i%): utt(cutt%) = rseq(1): cutt% = cutt% + 1
        sesstype(cutt%) = session(i%): utt(cutt%) = rseq(2): cutt% = cutt% + 1
        sesstype(cutt%) = session(i%): sesstype(cutt%) = session(i%):
        utt(cutt%) = rseq(3): cutt% = cutt% + 1
        sesstype(cutt%) = session(i%): utt(cutt%) = rseq(4): cutt% = cutt% + 1

        FOR k% = 1 TO session(i%)
           REM
           REDIM SHARED rseq(seq): GOSUB 2000
           sesstype(cutt%) = session(i%): utt(cutt%) = rseq(1): cutt% = cutt% + 1
           sesstype(cutt%) = session(i%): utt(cutt%) = rseq(2): cutt% = cutt% + 1
           sesstype(cutt%) = session(i%): utt(cutt%) = rseq(3): cutt% = cutt% + 1
```

```
         sesstype(cutt%) = session(i%): utt(cutt%) = rseq(4): cutt% = cutt% + 1
      NEXT k%
10    REDIM SHARED rseq(seq): GOSUB 2000
      IF rseq(4) <> lasttoken(i%) THEN GOTO 10
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(1): cutt% = cutt% + 1
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(2): cutt% = cutt% + 1
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(3): cutt% = cutt% + 1
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(4): cutt% = cutt% + 1
      prevtoken = rseq(4)
NEXT i%

PRINT cutt%

INPUT "Enter the name of datafile: "; datafile$
OPEN datafile$ FOR OUTPUT AS #1
PRINT #1, datafile$
PRINT #1, "Number of runs = "; ns
PRINT #1, "Delay between tokens = "; delay

PRINT #1,

PRINT #1, "Total Count = "; cutt% - 1
PRINT #1, "Session", "Utterance"
condition$ = "ON"
j% = 0

FOR i% = 1 TO cutt% - 1
   IF sesstype(i%) = 1 THEN maxtoken = 12
   IF sesstype(i%) = 2 THEN maxtoken = 16
   IF sesstype(i%) = 3 THEN maxtoken = 20
   j% = j% + 1
   PRINT #1, i%, sesstype(i%); ", "; text$(utt(i%)); ", ",
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) AND j% >= 8 THEN IF j% < maxtoken THEN
      PRINT #1, "Foil",
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) THEN IF j% = maxtoken THEN PRINT #1,
      "Switch",
   IF (i% MOD 4 <> 0 AND i% < (cutt% - 1)) OR j% < 8 THEN IF sesstype(i% + 1) =
      sesstype(i%) THEN PRINT #1, condition$,
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) THEN IF j% = maxtoken THEN IF condition$
      = "ON" THEN condition$ = "OFF" ELSE condition$ = "ON"

   IF i% = cutt% - 1 THEN PRINT #1, "Switch",
   PRINT #1, " "
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) THEN IF j% = maxtoken THEN j% = 0
NEXT i%

CLOSE

20 REM

OPEN datafile$ FOR INPUT AS #1

FOR i% = 1 TO 6
    LINE INPUT #1, a$
NEXT i%
i% = 0
DO
```

```
        i% = i% + 1
        INPUT #1, cutt%, sesstype(i%), token$, condition$
        IF token$ = "a SAD" THEN utt(i%) = 1
        IF token$ = "a SHAD" THEN utt(i%) = 2
        IF token$ = "a SAID" THEN utt(i%) = 3
        IF token$ = "a SHED" THEN utt(i%) = 4
LOOP UNTIL (EOF(1))

CLOSE

CLS

PRINT "Press 'r' to start!"

WHILE INKEY$ <> "r"
WEND

i% = 0
j% = 0
m% = 1
SCREEN 13

30 REM
holdtime = delay: GOSUB 1500
k$ = INKEY$

WHILE k$ <> "s" AND k$ <> "e"
        IF sesstype(i%) = 1 THEN maxtoken = 12
        IF sesstype(i%) = 2 THEN maxtoken = 16
        IF sesstype(i%) = 3 THEN maxtoken = 20
        k$ = INKEY$
        i% = i% + 1
        j% = j% + 1
        GOSUB 3000
        LOCATE 1, 1: COLOR 7:
        IF j% <> maxtoken - 1 THEN PRINT i% ELSE PRINT "*"; i%
        LOCATE row, col
        COLOR 10 + utt(i%)
        PRINT text$(utt(i%))
        REM IF (i% MOD 4 = 0) AND (m% MOD 2 = 0) THEN IF j% = maxtoken THEN
SOUND 3000, 10
        holdtime = showtime: GOSUB 1500
        REM CLS
        IF i% MOD 4 = 0 AND j% >= 8 THEN IF j% < maxtoken THEN SOUND 750, 10
        IF i% MOD 4 = 0 THEN IF j% = maxtoken THEN SOUND 1500, 10
        REM IF (i% MOD 4 = 0) AND (m% MOD 2 = 1) THEN IF j% = maxtoken THEN
SOUND 3000, 10
        IF i% MOD 4 = 0 THEN IF j% = maxtoken THEN j% = 0
        IF j% = 0 THEN m% = m% + 1
        holdtime = shtime2: GOSUB 1500
        CLS
        holdtime = delay: GOSUB 1500

WEND

IF k$ = "s" THEN GOSUB 1300: REM Stop temporarily
IF k$ = "r" THEN GOTO 30: REM Resume the program
```

```
IF k$ = "e" THEN END: REM End the program

END


1300 REM
SCREEN 12
LOCATE 1, 1
PRINT "press 'r' to resume!"
1310 REM
k$ = INKEY$
IF k$ <> "r" AND k$ <> "e" THEN GOTO 1310
SCREEN 13
RETURN

1500 REM
lasttime = TIMER
WHILE TIMER - lasttime < holdtime
WEND
RETURN


2000 REM
insert$ = "y"
2020 rseq(1) = INT(seq * RND + 1)
IF rseq(1) < 1 OR rseq(1) > seq THEN GOTO 2020
j = 2
WHILE rseq(seq) = 0
2040    p = INT(seq * RND + 1)
        IF p < 1 OR p > seq THEN GOTO 2040
        FOR i = 1 TO j - 1
                IF rseq(i) = p THEN insert$ = "n"
        NEXT
        IF insert$ = "n" THEN GOTO 2060
        rseq(j) = p
        j = j + 1
2060    insert$ = "y"
WEND
RETURN

3000 REM Random Screen Location
row = 1: col = 1
WHILE (row < 10 OR row > 20) OR (col < 15 OR col > 25)
        row = INT(25 * RND + 1)
        col = INT(40 * RND + 1)
WEND
RETURN
```

Appendix D

Basic Program - Subject MB

```
CLS
CLEAR
RANDOMIZE TIMER

INPUT "Enter the number of runs ->"; ns
INPUT "Enter the delay between utterances ->"; delay
showtime = .25
shtime2 = .5
DIM utt(4 * 12 * ns)
DIM sesstype(4 * 12 * ns)
DIM session(3 * ns)
DIM lasttoken(3 * ns)

text$(1) = "a SAD"
text$(2) = "a SHAD"
text$(3) = "a SAID"
text$(4) = "a SHED"

INPUT "Enter the name of datafile, or press ENTER to create one: "; datafile$
IF datafile$ <> "" THEN GOTO 20

REM Find the session sequence:
REM sessiontype(1)=8+4, sessiontype(2)=8+8, sessiontype(3)=8+12 tokens

seq = 3
FOR i% = 1 TO 3 * ns STEP 3
        REDIM SHARED rseq(seq): GOSUB 2000
        session(i%) = rseq(1)
        session(i% + 1) = rseq(2)
        session(i% + 2) = rseq(3)
NEXT i%

seq = 4
FOR i% = 1 TO 3 * ns STEP 4
        REDIM SHARED rseq(seq): GOSUB 2000
        lasttoken(i%) = rseq(1)
        lasttoken(i% + 1) = rseq(2)
        lasttoken(i% + 2) = rseq(3)
        lasttoken(i% + 3) = rseq(4)
NEXT i%
prevtoken = lasttoken(3 * ns)
cutt% = 1
FOR i% = 1 TO 3 * ns
5       REDIM SHARED rseq(seq): GOSUB 2000
        IF rseq(1) <> prevtoken THEN GOTO 5
        sesstype(cutt%) = session(i%): utt(cutt%) = rseq(1): cutt% = cutt% + 1
        sesstype(cutt%) = session(i%): utt(cutt%) = rseq(2): cutt% = cutt% + 1
        sesstype(cutt%) = session(i%): sesstype(cutt%) = session(i%):
        utt(cutt%) = rseq(3): cutt% = cutt% + 1
        sesstype(cutt%) = session(i%): utt(cutt%) = rseq(4): cutt% = cutt% + 1

        FOR k% = 1 TO session(i%)
           REM
           REDIM SHARED rseq(seq): GOSUB 2000
           sesstype(cutt%) = session(i%): utt(cutt%) = rseq(1): cutt% = cutt% + 1
           sesstype(cutt%) = session(i%): utt(cutt%) = rseq(2): cutt% = cutt% + 1
           sesstype(cutt%) = session(i%): utt(cutt%) = rseq(3): cutt% = cutt% + 1
```

```
         sesstype(cutt%) = session(i%): utt(cutt%) = rseq(4): cutt% = cutt% + 1
      NEXT k%
10    REDIM SHARED rseq(seq): GOSUB 2000
      IF rseq(4) <> lasttoken(i%) THEN GOTO 10
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(1): cutt% = cutt% + 1
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(2): cutt% = cutt% + 1
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(3): cutt% = cutt% + 1
      sesstype(cutt%) = session(i%): utt(cutt%) = rseq(4): cutt% = cutt% + 1
      prevtoken = rseq(4)
NEXT i%

PRINT cutt%

INPUT "Enter the name of datafile: "; datafile$
OPEN datafile$ FOR OUTPUT AS #1
PRINT #1, datafile$
PRINT #1, "Number of runs = "; ns
PRINT #1, "Delay between tokens = "; delay

PRINT #1,

PRINT #1, "Total Count = "; cutt% - 1
PRINT #1, "Session", "Utterance"
condition$ = "ON"
j% = 0

FOR i% = 1 TO cutt% - 1
   IF sesstype(i%) = 1 THEN maxtoken = 12
   IF sesstype(i%) = 2 THEN maxtoken = 16
   IF sesstype(i%) = 3 THEN maxtoken = 20
   j% = j% + 1
   PRINT #1, i%, sesstype(i%); ", "; text$(utt(i%)); ", ",
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) AND j% >= 8 THEN IF j% < maxtoken THEN
      PRINT #1, "Foil",
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) THEN IF j% = maxtoken THEN PRINT #1,
      "Switch",
   IF (i% MOD 4 <> 0 AND i% < (cutt% - 1)) OR j% < 8 THEN IF sesstype(i% + 1) =
      sesstype(i%) THEN PRINT #1, condition$,
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) THEN IF j% = maxtoken THEN IF condition$
      = "ON" THEN condition$ = "OFF" ELSE condition$ = "ON"

   IF i% = cutt% - 1 THEN PRINT #1, "Switch",
   PRINT #1, " "
   IF i% MOD 4 = 0 AND i% < (cutt% - 1) THEN IF j% = maxtoken THEN j% = 0
NEXT i%

CLOSE

20 REM

OPEN datafile$ FOR INPUT AS #1

FOR i% = 1 TO 6
    LINE INPUT #1, a$
NEXT i%
i% = 0
DO
```

```
        i% = i% + 1
        INPUT #1, cutt%, sesstype(i%), token$, condition$
        IF token$ = "a SAD" THEN utt(i%) = 1
        IF token$ = "a SHAD" THEN utt(i%) = 2
        IF token$ = "a SAID" THEN utt(i%) = 3
        IF token$ = "a SHED" THEN utt(i%) = 4
LOOP UNTIL (EOF(1))

CLOSE

CLS

PRINT "Press 'r' to start!"

WHILE INKEY$ <> "r"
WEND

i% = 0
j% = 0
m% = 1
SCREEN 13

30 REM
holdtime = delay: GOSUB 1500
k$ = INKEY$

WHILE k$ <> "s" AND k$ <> "e"
        IF sesstype(i%) = 1 THEN maxtoken = 12
        IF sesstype(i%) = 2 THEN maxtoken = 16
        IF sesstype(i%) = 3 THEN maxtoken = 20
        k$ = INKEY$
        i% = i% + 1
        j% = j% + 1
        GOSUB 3000
        LOCATE 1, 1: COLOR 7:
        IF j% <> maxtoken - 1 THEN PRINT i% ELSE PRINT "*"; i%
        LOCATE row, col
        COLOR 10 + utt(i%)
        PRINT text$(utt(i%))
        REM IF (i% MOD 4 = 0) AND (m% MOD 2 = 0) THEN IF j% = maxtoken THEN
SOUND 3000, 10
        holdtime = showtime: GOSUB 1500
        REM CLS
        IF i% MOD 4 = 0 AND j% >= 8 THEN IF j% < maxtoken THEN SOUND 750, 10
        IF i% MOD 4 = 0 THEN IF j% = maxtoken THEN SOUND 1500, 10
        REM IF (i% MOD 4 = 0) AND (m% MOD 2 = 1) THEN IF j% = maxtoken THEN
SOUND 3000, 10
        IF i% MOD 4 = 0 THEN IF j% = maxtoken THEN j% = 0
        IF j% = 0 THEN m% = m% + 1
        holdtime = shtime2: GOSUB 1500
        CLS
        holdtime = delay: GOSUB 1500

WEND

IF k$ = "s" THEN GOSUB 1300: REM Stop temporarily
IF k$ = "r" THEN GOTO 30: REM Resume the program
```

```
IF k$ = "e" THEN END: REM End the program

END


1300 REM
SCREEN 12
LOCATE 1, 1
PRINT "press 'r' to resume!"
1310 REM
k$ = INKEY$
IF k$ <> "r" AND k$ <> "e" THEN GOTO 1310
SCREEN 13
RETURN

1500 REM
lasttime = TIMER
WHILE TIMER - lasttime < holdtime
WEND
RETURN


2000 REM
insert$ = "y"
2020 rseq(1) = INT(seq * RND + 1)
IF rseq(1) < 1 OR rseq(1) > seq THEN GOTO 2020
j = 2
WHILE rseq(seq) = 0
2040    p = INT(seq * RND + 1)
        IF p < 1 OR p > seq THEN GOTO 2040
        FOR i = 1 TO j - 1
                IF rseq(i) = p THEN insert$ = "n"
        NEXT
        IF insert$ = "n" THEN GOTO 2060
        rseq(j) = p
        j = j + 1
2060    insert$ = "y"
WEND
RETURN

3000 REM Random Screen Location
row = 1: col = 1
WHILE (row < 10 OR row > 20) OR (col < 15 OR col > 25)
        row = INT(25 * RND + 1)
        col = INT(40 * RND + 1)
WEND
RETURN
```

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