SYNTHESIS AS FEEDBACK IN FIELD LINGUISTICS

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ABSTRACT

Interim field reports on the phonologies of previously undescribed languages can be tested for consistency using synthesis-by-rule techniques. Such a report on Mura-Pirahã of Brazil provided information for the feature rule component of Hertz's Cornell Speech Research System. Values for the parameter rules came from spectrograms made from a tape recorded in the field containing the examples in the report. Both sets of rules were revised to improve the match between the synthesized speech and the recordings. Out of this revision came recommendations about changes to the phonological description that the investigator can follow up on his next opportunity to do field work. In the current absence of such opportunity, several linguists attempted to transcribe the forms phonetically. One had special orientation to Mura-Pirahã phonology and the others had only general phonetic background. Variability was high, probably due to the complete lack of word recognition capability.

Mura-Pirahã is a language isolate, possibly Macro-Chibchan,[1] that is spoken by about 100 people south of the Amazon in Brazil. Little has appeared on its phonology.[2] It is of interest to linguists because of a propensity it has for pitch updrift rather than downdrift, and also because of the external flap variant of its non-labial voiced stop following a back vowel -- a flap in which the tongue, after brushing past the alveolar ridge, continues forward until the tip is outside the lower lip, as in

ibògì [ɩ́b̃òɭ̣ì] 'milk'

Because of its lack of linguistic reputation, it is also a good language on which to test an idea about one more thing that speech synthesis is useful for. Linguists have for years examined the way sounds interrelate in phonological systems, but they have rarely had recourse to instrumental aids for studying these interrelationships in the field. They might resolve complexities or test alternate analyses by combining two things: first, a means of tracing the logical consequences of phonological rules, and second, a means of mapping from the phonology to the sounds themselves. This guarantees that no relevant factors are overlooked; to the extent that the output is intelligible, they may be doing something right. A simulator that handles both these aspects, such as Hertz's Cornell Speech Research System,[3] thus introduces an experimental loop into linguistic field research.

The consonantal system of Mura-Pirahã distinguishes only voiceless and voiced stops and continuants. The voiceless stops are /p t k ʔ/. The voiced are /b g/, but /g/ has both alveolar and velar variants. The continuants are /s, h/. There are three vowels /i a o/, and three levels of tone. Syllables are CV or V. Words range from two to seven or more syllables, with complex morphological structure.

Eighteen feature value assignment rules specify redundancies and some of the more distinctive contextual variants of sounds. For example,

(1) [ar.2 cons] → [pal] / _ [voc ar.2]

expresses the palatalization of alveolars before a front vowel: /t/ to [t^y] and /s/ to [s^y]. Both the alveolar point of articulation and the front vowel position are assigned to the second value in a multi-valued feature scale, [ar.2].

(2) [stop voic] → [-stop nas] / [fin] _

expresses the conversion of an initial voiced stop to a nasal at the beginning of a word (expressed by means of the boundary feature [fin]), and

(3) [ar.3 nas] → [ar.2]

gives the correct alveolar allophone of the nonlabial voiced stop. Other feature rules give /h/ the features of the vowel that follows it and specify the occurrence of the external flap allophone of /g/.

Since the Speech Research System does not yet have variable frequency rule capability, allophones that fluctuate like the presence or absence of the flap, trilling or not trilling of the bilabial stop when it comes between /i/ and /o/, the height of non-low vowels, and the nasalization of noninitial voiced stops are fixed rather than made to vary. The idea for now is to synthesize one plausible pronunciation rather than the range of plausible pronunciations.

Ninety-seven parameter rules supply values derived from spectrograms. They relate certain features assigned to each segment to acoustic values. Some of these rules are also context sensitive, using feature information from neighboring segments. An F1 assignment rule for non-low vowels, for example, assigns a default value of 600 Hz; but in a cluster following /i/ it makes it be 400 Hz instead:

(4) [voc -low] F1 → ($,400) / [voc ar.3] _

Another set of context sensitive rules squeeze the non-transitional part of vowels in certain vowel clusters:

(5) [voc]   DU → (.2) 75% (.8) / _ [voc ar.2]

(6) [voc ar.2] DU → (.2) 60% (.8) / [voc] _

The field report from which these rules were derived covered the essentials of the sound system without extensive need for modification. It mentioned the lengthening of voiceless segments that takes place between vowels, for example, though it did not distinguish the greater length of stops from the moderate length of spirants. In stating the nasalization of word initial voiced stops it proved necessary to change the manner value at the same time to [-stop] in order to eliminate the strong burst associated with stops. Even though any three of the place-of-articulation features are sufficient to distinguish the three vowels, I added a feature [low] to the central vowel /a/ to permit the general F1 rules for /i/ and /u/ already mentioned to be written; but [-low] could have been specified equally well as [voc -ar.3] . The lengthening of vowels in final position was not in the report either, nor was the tendency for them to trail off into aspiration. Finally, some of the tones in the transcriptions of examples had to be changed. All in all, the original field report appears to have covered the ground fairly well.

After a number of Mura-Pirahã forms were synthesized from these rules, several linguists transcribed them. Three graduate students and one faculty member had no orientation to the sound system they were dealing with except to be told that it was an attempt to synthesize forms from a natural language. Another graduate student had been given a phonological sketch of the language to read before he did the transcribing. Each auditor listened to the same recording using the same equipment under approximately the same conditions, individually rather than at the same time as some other auditor

Figure 1 is the confusion matrix for consonants. Segments listed at the left are manifestations of Mura-Pirahã phonemes; segments listed across the top are phonetic segments that appeared in the transcriptions. Figures 1 and 2 each contain a residuals column marked with an asterisk. This column gives the number of miscellaneous segments that are found only once in the transcription but that did not fit in the figure.

																y																		
					w				m					ʔ		1									k		g	g	g					
		ʔ			ɡ̶	u		m	ʔ	ʔ				ʔ	c	•	i	~		ʔ			ʔ		k	ʔ		w	u	g				
	p	p	b	w	w	ʔ	m	b	m	m	t	d	c	c	w	r	y	l	l	l	s	y	y	k	+	y	g	ʔ	l	w	ɡ̶	h	ʔ	#	*
p:	3	3	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	•	•	1	•	•	•	•	•	•	•	•	•	2	•	5
b	•	•	2	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	•	1	•	•	•	•	•	•	•	5
b	•	•	•	•	1	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	•	•	•	•	0
m	•	•	3	•		•	1	3	2	•	•	•	•	•	•	•	•	•	3	•		1	•	•	•	•	1	•	•	•	•	•	•	•	1
t	•	•	1	•	•	•	•	•	•	•	1	•	1	•	•	•	•	•	•	•	•	1	•	•	•	•	•	•	•	•	•	•	1	•	0
t:	•	•	•	•	•	•	•	•	•	•	•	•	4	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	0
ty	•	•	•	•	•	•	•	•	•	•	•	•	4	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	•	0
t:y	•	•	•	•	•	•	•	•	•	•	•	•	6	7	•	•	•	•	•	•	•	•	•	•	•	2	•	•	•	•	•	•	•	•	0
n		•	•	•	•	•	1	•	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	3	•	•	•	•	•	•	•	0
l	•		•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	•	•	•	•	•	•	•	•	•	•	•	•	1	•	1	•	0
sy	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	3	•	•	•	•	•	•	•	•	•	•	2	2	2	1
k	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	2	•	•	3	•	1	•	•	•	•	•	•	•	•	2	6	0
k:	•	2	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	2	•	•	2	•	•	•	2	•	•	•	•	•	1	•	1
g	•	•	•	•	•	•	•	•	•	•	1	6	•	•	•	•	•	2	2	•	•	•	6	•	•	•	19	•	•	•	2	•	1	1	5
h	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	2	•	1	•	•	•	•	4	9	2	2
ʔ	1	•	•	•	•	•	•	•	•	•	•	•	•	2	•	•	•	•	•	•	•	•	•	•	•	•	1	•	•	•	•	•	3	2	1

Figure 1. Mura-Pirahã confusion matrix for consonants.
* = residuals.

Fiqure 2 is the confusion matrix for vowels and word boundaries. Allophonic segments and boundary symbols are listed down the left. Phonetic symbols from the transcription are listed across the top, including # for silence.

	y	i			e			a			o	w	ʔ	#	*
i	3	•	•	•	•	•	•	•	•	•	•	•	•	•	0
e	7	7	11	5	51	40	4	•	•	•	•	•	•	•	0
a	•	•	•	•	•	•	•	54	5	17	33	•		•	2
o	•	•	•	•	•	•	•	4	•	11	19	5	•	•	2
#-	•	•	•		•	•	•	•	•	•	•	•	5	10	0
-#	•	•	•	•	•	•	•	•	•	•	•	•	13	50	3

Figure 2. Mura-Pirahã confusion matrix for vowels and boundary symbols.
* = residuals.

The dispersal of responses in Figures 1 and 2 -- generally plausible responses close to the target, but far from consistent nevertheless -- calls attention to the fact that none of the linguists who transcribed the forms had ever heard the language before, let alone spoken it. Hence there was no possibility for any word recognition processes to operate, as there often is in research where the sounds introduced are at least expected to be sounds of a language one knows.

Here only one of the respondents had any notion of possible word shapes or of available segments. This suggests how much potential for recognition even a little orientation to a language provides when we observe that, inasmuch as he was expecting less syllabic and segmental complexity, his transcriptions came close to a phonological transcription in terms of syllable shape, even though his segment identifications showed about the same variability as those of the others.

The role of prior knowledge of the language can possibly be tested in situations like this one. My hypothesis is that someone who speaks the language will show considerably less variability of response, simply because he knows the possible words. Even though the rules used to synthesize the speech for this experiment could still be refined in such a way as to reduce the variability for non-speakers, I would expect that such refinement would not give a commensurate reduction in variability for speakers, because the clues they use are not purely phonetic.

FOOTNOTES

1. Voegelin and Voegelin (1977) list Mura-Pirahã as a language isolate following Greenberg, but no real comparative studies have been made.

2. Sheldon (1974) summarizes the contrastive system but gives no further details. The rules in this paper are taken from a manuscript by Heinrichs and Heinrichs. Sheldon, on a trip to the area, recorded the examples given in that manuscript for me.

3. The Cornell Speech Research System (SRS) takes strings of symbols defined in terms of binary and multi-valued features chosen by the linguist, passes them through feature modification rules and parameter value assignment rules in common linguistic format, and produces a file of acoustic parameters that are clocked into an OVE-IIId synthesizer or a Computalker to produce synthetic speech. The system, which is highly interactive and responds ideally for this kind of research, was implemented by Hertz (1979).

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BAT	=	(SYM)	# h o \ a \ h o / i \ #
BATHES	=	(SYM)	# i = s a \ h a / i \ #
BIG	=	(SYM)	# h i \ o \ g i \ a \ i / ʔ i \ #
BRING	=	(SYM)	# k a \ o \ ʔ o \ i \ #
CHARGE	=	(SYM)	# t i = g a = i = t i \ #
CLOUD	=	(SYM)	# b i \ g a / p o \ i \ #
COTTON	=	(SYM)	# p i = i \ s i \ #
DEER	=	(SYM)	# b a \ i \ t o / i = #
DOG	=	(SYM)	# g i \ o \ p a / i / #
DUGOUT	=	(SYM)	# k a \ g a \ h o \ i / #
EYE	=	(SYM)	# t i = i \ k o / s a = a = g a / #
HAWK	=	(SYM)	# t o \ i \ s i \ #
I	=	(SYM)	# ʔ i = p i \ #
KEROSE	=	(SYM)	# s i \ h o \ a / #
LAKE	=	(SYM)	# a \ a \ b o \ i \ #
LIME	=	(SYM)	# g a \ g a = i = a = #
MAN	=	(SYM)	# h i \ g i \ h i / #
MILK	=	(SYM)	# i / b o \ g i \ #
MONKEY	=	(SYM)	# k a = i / b a \ i \ #
PLATE	=	(SYM)	# p a \ g a \ t o \ i \ #
POTATO	=	(SYM)	# b a \ a / g a \ h a / 1 / #
SOUP	=	(SYM)	# s i \ i \ s i / #
STUDY	=	(SYM)	# k a \ p i = g a = k a / g a \ k a = a / t i \ #
SUCK	=	(SYM)	# t o = b a = i = #
SWELL	=	(SYM)	# t o \ o \ g i \ ʔ i \ #
TAPIR	=	(SYM)	# k a \ b a \ t i \ i = #
TEA	=	(SYM)	# ʔ i \ p i \ #
TEA2	=	(SYM)	# ʔ i = p i \ #
TOUCAN	=	(SYM)	# a \ b a \ g i \ #
TRAIL	=	(SYM)	# a \ g i / #

FEATURE SYMBOLS:

#	=	(SEGMENT)	fin
/	=	(PRECEDE)	t.1
=	=	(PRECEDE)	t.2
ʔ	=	(SEGMENT)	ar.5 stop
\	=	(PRECEDE)	t.3
a	=	(SEGMENT)	ar.3 voc
b	=	(SEGMENT)	ar.1 stop voic
g	=	(SEGMENT)	ar.3 stop voic
h	=	(SEGMENT)	lg.1
i	=	(SEGMENT)	ar.2 voc
k	=	(SEGMENT)	ar.3 stop
o	=	(SEGMENT)	ar.4 voc
p	=	(SEGMENT)	ar.1 stop
s	=	(SEGMENT)	ar.2 cons
t	=	(SEGMENT)	ar.2 stop
F	=	(PARAM)	F1 F2 F3
A	=	(PARAM)	AV AH AC
B	=	(PARAM)	B1 B2 B3

TOF:

RULE 1: [stop] → [cons]

RULE 2: [voc] → [lg.1 voic]

RULE 3: [cons] → [lg.1]

RULE 4: [-voic] → [lg.2]

RULE 5: [-voic stop] → [lg.3] / [voc] _ [voc]

RULE 6: [ar.1 stop voic] → [lg.3] / _ [ar.4 voc]

RULE 7: [ar.1 stop voic] → [lg.3] / [ar.2 voc] _ [ar.4 voc]

RULE 8: [ar.2 cons] → [pal] / _ [ar.2 voc]

RULE 9: [cons voic] → [-stop nas] / [fin] _ [voc]

RULE 10: [ar.3 nas] → [ar.2]

RULE 11: [-cons -voc] → [ar.2] / _ [ar.2]

RULE 12: [-cons -voc] → [ar.3] / _ [ar.3]

RULE 13: [-cons -voc] → [ar.4] / _ [ar.4]

RULE 14: [-cons ar.3] → [low]

RULE 15: [lg.1 voc] → [lg.2] / _ [voc]

RULE 16: [lg.1 voc] → [lg-2] / [voc] _

RULE 17: [ar.3 stop voic] → [ar.2 flap] / [ar.4 voc] _ [voc]

RULE 18: [voc] → [lg.3] / _ [fin]

TOF:

RULE 1: [lg.1] DU → 70

RULE 2: [lg.2] DU → 110

RULE 3: [lg.3] DU → 180

RULE 4: [lg.3 stop] DU → 260

RULE 5: [ar.4 voc] DU → 50 / [ar.2 voc] _ [ar.1 stop]

RULE 6: [voc] DU → (.20) 75% (.80) / _ [ar.2 voc]

RULE 7: [ar.2 voc] DU → (.20) 60% (.80) / [voc] _

RULE 8: [flap] DU → 30

TOF:

RULE 9: [stop voic] A → (.80,$)

RULE 10: [-stop cons] A → (.10,$)_(.90,$)

RULE 11: [nas] A → (.0,$)_(.99,$)

RULE 12: [-cons -voc] AH → ($,2)_($,2)

RULE 13: [fin] AH → (.0,0)_(.99,0)

RULE 14: [-stop cons pal] AH → ($,2)_($,2)

RULE 15: [voc] AH → (.0,0)_(.99,0)

RULE 16: [voc] AH → (.0,0) fin (.99,0) / _ [fin]

RULE 17: [stop] AH → (.0,0) off (.90,5)

RULE 18: [fin] AC → (.0,0)_(.99,0)

RULE 19: [voc] AC → (.0,0)_(.99,0)

RULE 20: [stop] AC → (.0,0) off (.99,20)

RULE 21: [pal stop] AC → (.0,0) vasp (.99,0)

RULE 22: [-nas -stop ar.2 cons] AC → ($,10)

RULE 23: [-stop cons pal] AC → ($,2)_($,2)

RULE 24: [voc] AN → (.20,0)_(.80,0) / [-nas] _

RULE 25: . [voc] AN → (.60,0)_(.80,0) / [nas] __

RULE 26: [nas] AN → (.0,10)_(.99,10)

RULE 27: [voc] AV → (.10,30)_(.90,28)

RULE 28: [voc] AV → (.30,$)_(.70,0) / _ [fin]

RULE 29: [ar.1 stop voic] AV—> ($,5)

RULE 30: [ar.1 stop voic] AV → (.30,2) tril (.90,6) / [ar.2 voc] _ [ar.4 voc]

RULE 31: [ar.3 stop voic] AV → (.70,0)_(.99,0)

RULE 32: [nas] AV → ($,10)

RULE 33: [flap] AV → (.80,5) affr

RULE 34: [-voic] AV → (.0,0)_(.99,0)

RULE 35: [voc] F → (.20,$)_(.80,$)

RULE 36: [stop voic] F → (.20,$)_(.80,$)

TOF:

RULE 37: [-stop cons] F → (.10,$)_(.90,$)

RULE 38: [nas] F → (.0,$)_(.99,$)

RULE 39: [flap] F → (.80,$)

RULE 40: [-low voc] F1 → ($,600)

RULE 41: [-low voc] F1 → ($,400) / [ar.3 voc] _

RULE 42: [low voc] F1 → ($,750)

RULE 43: [-voic stop] F1 → (.20,$)_(.85,$)

RULE 44: [ar.1 stop] F1 → ($,300)_($,300)

RULE 45: [ar.1 nas] F1 → ($,300)

RULE 46: [ar.2 stop] F1 → ($,450)_($,450)

RULE 47: [ar.2 nas] F1 → ($,500)_($,500)

RULE 48: [flap] F1 → ($,400)

RULE 49: [ar.3 stop] F1 → ($,350)

RULE 50: [-voic ar.4 stop] F1 → ($,500)_($,500)

RULE 51: [ar.4 stop voic] F1 → ($,600)_($,600)

RULE 52: [ar.5] F1 → ($,500) / _ [-low]

RULE 53: [-stop cons pal] F1 → ($,500)_($,500)

RULE 54: [nas] N1 → (.0,400)_(.99,400)

RULE 55: [ar.2 nas] N1 → ($,1200)_($,1200)

RULE 56: [low voc] F2 → ($,1200)

RULE 57: [low voc] F2 → ($,1500) / _ [-low voc]

RULE 58: [-voic stop] F2 → (.30,$)_(.70.,$)

RULE 59: [ar.1 stop] F2 → ($,700)_($,700)

RULE 60: [ar.1 nas] F2 → ($,900)

RULE 61: [ar.2] F2 → ($,2400)

RULE 62: [ar.2 stop] F2 → (.50,3109)_(.95,3109)

RULE 63: [ar.2 nas] F2 → ($,1800)

RULE 64: [flap] F2 → ($,1400)

TOF:

RULE 65: [ar.3 stop] F2 → ($,2200)

RULE 66: [ar.4] F2 → ($,1000)

RULE 67: [ar.4] F2 → ($,800) / _ [voc]

RULE 68: [-voic ar.4 stop] F2 → ($,800)_($,800)

RULE 69: [ar.4 stop voic] F2 → ($,1500)_($,1500)

RULE 70: [ar.5] F2 → ($,2400) / _ [ar.2]

RULE 71: [-stop cons pal] F2 → ($,2300)_($,2300)

RULE 72: [-voic stop] F3 → (.20,$)_(.80,$)

RULE 73: [nas] F3 → ($,2100)

RULE 74: [ar.1 stop] F3 → ($,1800)_($,1800)

RULE 75: [ar.1 stop voic] F3 → (.60,2200)

RULE 76: [ar.2] F3 → ($,3000)

RULE 77: [ar.2 stop] F3 → ($,4935)

RULE 78: [ar.2 nas] F3 → ($,2400)_($,2400)

RULE 79: [flap] F3 → ($,1500)

RULE 80: [ar.3] F3 → ($,2200)

RULE 81: [ar.4] F3 → ($,2500)

RULE 82: [ar.4] F3 → ($,1500) / _ [voc]

RULE 83: [-voic ar.4 stop] F3 → (.20,2600)_(.90,1800)

RULE 84: [ar.4 stop voic] F3 → ($,2100)_($,2100)

RULE 85: [-stop cons pal] F3 → ($,3100)_($,3100)

RULE 86: [t.1] F0 → ($,150)

RULE 87: [t.2] F0 → ($,145)

RULE 88: [t.3] F0 → ($,130)

RULE 89: [ar.1 stop voic] AK → ($,20)

RULE 90: [ar.2 cons] AK → ($,20)_($,20)

RULE 91: [-stop cons pal] AK → ($,0)_($,0)

RULE 92: [ar.1 stop] K1 → ($,1000)

TOF:

RULE 93: [ar.2 cons] K1 → ($,2000)_($,2000)

RULE 94: [-stop cons pal] K1 → ($,4000)_($,4000)

RULE 95: [ar.1 stop voic] K2 → ($,3000)_($,3000)

RULE 96: [ar.2 cons] K2 → ($,5000)_($,5000)

RULE 97: [-stop cons pal] K2 → ($,6500)_($,6500)

SEGMENT 1 (110 MS): #

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	6
2	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	4
3	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	6
4	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	4
5	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	6
6	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	4
7	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	6
8	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	4
9	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	6
10	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	4
11	0	0	10	0	20	2016	4935	504	2397	3020	72	93	200	1199	150	6
12	0	0	10	0	20	2016	4935	504	2329	2934	72	93	200	1199	150	4
13	0	0	10	0	20	2016	4935	504	2329	2934	72	93	200	1199	150	6
14	0	0	10	0	20	2016	4935	504	2263	2851	72	93	200	1199	150	4
15	0	0	10	0	20	2016	4935	504	2198	2770	72	93	200	1199	150	6
16	0	0	10	0	20	2016	4935	504	2136	2770	72	93	200	1199	150	4
17	0	0	10	0	20	2016	4935	504	2076	2691	72	93	200	1199	150	6
18	0	0	10	0	20	2016	4935	504	2016	2614	72	93	200	1199	150	4
19	0	0	10	0	20	2016	4935	504	2016	2614	72	93	200	1199	150	6
20	0	0	10	0	20	2016	4935	504	1958	2540	72	93	200	1199	150	4
21	0	0	10	0	20	2016	4935	504	1903	2468	72	93	200	1199	150	6
22	0	0	10	0	20	2016	4935	504	1849	2468	72	93	200	1199	150	4

SEGMENT 2 (70 MS): g

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	6
2	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	6
3	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	4
4	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	5
5	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	6
6	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	6
7	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	150	5
8	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	146	6

SEGMENT 2 (70 MS): g

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
9	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	146	6
10	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	146	5
11	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	141	6
12	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	141	6
13	10	0	10	0	20	2016	4935	504	1796	2397	72	93	200	1199	137	3

SEGMENT 3 (70 MS): a

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	16	0	9	0	20	2016	4935	534	1695	2397	72	93	200	1199	137	6
2	29	0	8	0	20	2016	4935	673	1385	2263	72	93	200	1199	137	6
3	29	0	6	0	20	2016	4935	755	1199	2198	72	93	200	1199	133	4
4	29	0	5	0	20	2016	4935	755	1199	2198	72	93	200	1199	133	5
5	29	0	4	0	20	2016	4935	755	1199	2198	72	93	200	1199	133	6
6	29	0	3	0	20	2016	4935	755	1199	2198	72	93	200	1199	130	6
7	28	0	1	0	20	2016	4935	755	1199	2198	72	93	200	1199	130	5
8	28	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	130	6
9	28	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	130	6
10	28	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	130	5
11	28	0	0	0	20	2016	4935	713	1270	2198	72	93	200	1199	130	6
12	28	0	0	0	20	2016	4935	617	1510	2198	72	93	200	1199	130	6
13	24	0	0	0	20	2016	4935	534	1745	2198	72	93	200	1199	130	3

SEGMENT 4 (70 MS): g

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	23	0	0	0	20	2016	4935	504	1796	2198	72	93	200	1199	130	6
2	20	0	0	1	20	2016	4935	412	2016	2198	72	93	200	1199	130	6
3	17	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	130	4
4	15	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	130	5
5	12	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	130	6
6	9	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	130	6
7	6	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	130	5
8	4	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	130	6
9	1	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	133	6
10	0	0	0	0	20	2016	4935	346	2198	2198	72	93	200	1199	133	5
11	0	0	0	0	20	2016	4935	378	2136	2198	72	93	200	1199	133	6
12	0	5	0	0	20	2016	4935	449	2016	2198	72	93	200	1199	133	6
13	0	1	0	20	20	2016	4935	519	1903	2198	72	93	200	1199	137	3

SEGMENT 5 (92 MS): a

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	7	0	0	0	20	2016	4935	550	1849	2198	72	93	200	1199	137	6
2	30	0	0	0	20	2016	4935	635	1695	2198	72	93	200	1199	137	4
3	29	0	0	0	20	2016	4935	673	1647	2198	72	93	200	1199	137	6
4	29	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	141	4

SEGMENT 5 (92 MS): a

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
5	29	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	141	5
6	29	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	141	5
7	29	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	141	5
8	29	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	141	5
9	29	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	146	5
10	28	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	146	5
11	28	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	146	5
12	28	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	146	5
13	28	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	146	5
14	28	0	0	0	20	2016	4935	755	1510	2198	72	93	200	1199	146	5
15	28	0	0	0	20	2016	4935	734	1554	2263	72	93	200	1199	146	5
16	28	0	0	0	20	2016	4935	692	1647	2329	72	93	200	1199	146	3
17	28	0	0	0	20	2016	4935	654	1745	2397	72	93	200	1199	146	4
18	28	0	0	0	20	2016	4935	635	1796	2468	72	93	200	1199	146	6
19	29	0	0	0	20	2016	4935	566	1958	2614	72	93	200	1199	146	4

SEGMENT 6 (81 MS): i

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	29	0	0	0	20	2016	4935	550	2016	2691	72	93	200	1199	146	6
2	30	0	0	0	20	2016	4935	490	2198	2770	72	93	200	1199	146	4
3	29	0	0	0	20	2016	4935	462	2263	2851	72	93	200	1199	146	6
4	29	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	4
5	29	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	5
6	29	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	6
7	29	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	6
8	29	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	6
9	28	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	6
10	28	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	6
11	28	0	0	0	20	2016	4935	400	2397	3020	72	93	200	1199	146	6
12	28	0	0	0	20	2016	4935	412	2329	2934	72	93	200	1199	146	4
13	28	0	0	0	20	2016	4935	436	2263	2934	72	93	200	1199	146	3
14	28	0	0	0	20	2016	4935	462	2198	2851	72	93	200	1199	146	3
15	28	0	0	0	20	2016	4935	490	2076	2770	72	93	200	1199	146	4
16	28	0	0	0	20	2016	4935	519	2016	2770	72	93	200	1199	146	6

SEGMENT 7 (180 MS): a

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	28	0	0	0	20	2016	4935	550	1849	2614	72	93	200	1199	146	5
2	28	0	0	0	20	2016	4935	599	1745	2540	72	93	200	1199	146	5
3	28	0	0	0	20	2016	4935	635	1600	2468	72	93	200	1199	146	6
4	28	0	0	0	20	2016	4935	673	1467	2397	72	93	200	1199	146	5
5	29	0	0	0	20	2016	4935	713	1345	2263	72	93	200	1199	146	6
6	29	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
7	29	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6

SEGMENT 7 (180 MS): a

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
8	29	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
9	29	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
10	30	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
11	27	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
12	25	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
13	23	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
14	20	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
15	18	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
16	16	2	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
17	13	2	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
18	11	2	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
19	9	2	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
20	6	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
21	4	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
22	2	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
23	0	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
24	0	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
25	0	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
26	0	1	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
27	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
28	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
29	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
30	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
31	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
32	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	5
33	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6

SEGMENT 8 (110 MS): #

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
1	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
2	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
3	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
4	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
5	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
6	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
7	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
8	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
9	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
10	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
11	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
12	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
13	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
14	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
15	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6

SEGMENT 8 (110 MS): #

ST	AV	AH	AN	AC	AK	K1	K2	F1	F2	F3	B1	B2	B3	N1	F0	DU
16	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
17	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
18	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
19	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
20	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4
21	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	6
22	0	0	0	0	20	2016	4935	755	1199	2198	72	93	200	1199	146	4