Consonant confusion matrices to accompany

by Eric W. Healy, Sarah E. Yoho, Yuxuan Wang, Frederic Apoux, and DeLiang Wang

NH Listeners -- Speech-shaped noise

SNR -12 dB

Unprocessed

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	7	6	5	1	3	2	3	1	2	2	1	3	2	0	2	0
t	1	28	2	2	0	0	1	0	1	0	3	1	0	0	1	0
k	5	3	6	1	2	4	2	3	1	0	5	2	1	2	2	1
b	4	1	2	7	5	1	2	0	0	5	1	2	2	6	0	2
d	2	4	2	1	13	3	4	1	0	1	4	2	0	1	1	1
g	1	1	9	0	2	15	1	1	0	1	1	0	1	5	1	1
f	1	4	1	2	4	5	5	0	0	1	1	0	1	10	2	3
s	0	1	2	1	0	0	0	25	0	0	10	1	0	0	0	0
ʃ	0	2	3	0	1	2	0	1	24	0	1	5	0	1	0	0
v	2	1	4	3	0	2	6	2	1	6	2	3	3	2	1	2
z	0	1	2	1	1	0	2	3	1	3	22	2	1	0	1	0
dʒ	0	2	0	1	1	8	4	0	1	3	2	17	0	0	1	0
m	2	3	4	1	3	6	3	2	1	4	5	0	1	3	1	1
n	0	2	3	2	3	6	2	0	0	1	0	0	7	13	0	1
θ	3	7	1	2	4	5	3	1	0	5	0	0	2	4	2	1
ð	1	6	3	4	4	2	6	0	2	1	1	4	1	2	1	2

Algorithm

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	2	2	8	2	2	14	1	1	1	1	0	0	0	1	4	1
t	1	17	0	0	1	0	0	3	3	0	6	9	0	0	0	0
k	0	4	18	0	0	3	7	1	3	2	1	0	0	0	1	0
b	0	0	1	14	8	8	5	0	0	2	0	0	0	0	1	1
d	0	7	1	0	18	3	3	0	0	0	0	2	0	0	5	1
g	0	0	5	1	3	29	0	0	0	0	1	0	0	0	0	1
f	0	2	1	8	0	1	8	6	1	1	9	1	0	0	2	0
s	0	0	0	0	0	0	0	26	9	0	5	0	0	0	0	0
ʃ	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
v	0	1	0	0	22	2	1	0	0	3	1	0	2	3	3	2
z	0	0	0	0	0	0	0	0	0	0	39	1	0	0	0	0
dʒ	0	0	0	0	2	5	0	0	0	0	7	22	0	0	0	4
m	0	0	0	8	1	6	0	0	0	1	0	0	6	18	0	0
n	0	0	0	2	1	2	0	0	0	0	0	0	8	27	0	0
θ	2	9	1	4	1	3	2	5	0	3	3	3	1	0	1	2
ð	2	0	0	10	7	6	6	0	0	1	3	0	0	0	3	2

IBM

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	21	1	1	6	2	1	3	0	0	0	0	0	0	0	2	3
t	0	37	1	0	0	0	0	0	0	0	0	2	0	0	0	0
k	0	0	36	0	0	1	0	0	1	0	0	1	0	0	1	0
b	0	0	0	33	3	2	0	0	0	0	0	0	0	0	0	2
d	0	0	0	0	30	3	0	0	0	0	2	4	0	0	0	1
g	0	0	0	0	1	38	0	0	0	0	0	0	0	0	1	0
f	1	0	0	1	0	0	22	7	1	2	2	0	0	0	3	1
s	0	0	0	0	0	0	0	31	8	0	0	0	0	0	1	0
ʃ	0	0	0	0	0	0	0	0	38	0	0	2	0	0	0	0
v	0	0	0	11	4	1	0	1	0	13	1	0	0	0	2	7
z	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0
dʒ	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	1
m	0	0	0	1	0	0	0	0	0	0	0	0	17	21	1	0
n	0	0	0	0	0	0	0	0	0	0	0	0	1	39	0	0
θ	0	8	0	4	0	0	6	13	1	1	1	1	0	0	5	1
ð	0	0	0	3	12	11	2	0	0	3	0	0	1	1	1	6

SNR -8 dB

Unprocessed

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	13	1	10	0	2	0	3	2	0	1	1	2	0	2	1	2
t	0	39	0	0	1	0	0	0	0	0	0	0	0	0	0	0
k	1	4	23	2	0	6	2	0	0	0	0	1	0	0	1	0
b	4	4	6	2	4	10	0	1	0	5	1	1	1	1	0	0
d	0	10	2	1	18	2	1	0	0	0	1	1	1	2	0	1
g	0	0	4	1	3	25	0	1	0	3	0	0	0	2	1	0
f	6	3	6	4	1	4	3	0	1	6	2	0	0	1	2	1
s	0	0	0	0	0	0	0	26	2	1	9	2	0	0	0	0
ʃ	0	0	1	0	0	1	0	0	30	2	0	4	2	0	0	0
v	0	2	4	5	3	2	3	0	0	10	6	1	1	1	0	2
z	0	0	1	0	0	0	1	0	0	1	34	3	0	0	0	0
dʒ	0	0	2	0	2	5	1	0	1	1	0	25	0	2	1	0
m	1	3	0	1	2	4	1	1	0	2	1	1	5	15	1	2
n	1	0	0	0	0	4	1	1	0	0	1	2	0	29	1	0
θ	4	1	7	2	1	5	11	0	0	2	4	1	0	0	1	1
ð	1	2	3	2	4	4	4	0	1	4	6	0	3	3	1	2

Algorithm

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	4	5	12	7	3	0	2	1	0	1	0	1	1	0	1	2
t	2	33	1	0	1	0	0	0	0	0	0	0	2	0	0	1
k	0	3	28	2	1	3	1	0	0	0	0	0	0	0	0	2
b	0	0	0	25	6	2	3	0	0	0	0	0	0	1	1	2
d	0	4	0	1	22	2	0	0	0	0	0	6	0	1	3	1
g	0	0	0	5	6	26	0	0	0	0	0	1	0	0	2	0
f	3	2	1	2	1	4	5	16	0	0	1	0	0	0	3	2
s	0	1	0	0	0	0	0	31	8	0	0	0	0	0	0	0
ʃ	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
v	0	0	0	20	3	8	2	0	0	3	1	0	1	0	0	2
z	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0
dʒ	0	0	0	0	2	1	0	0	0	0	0	36	0	0	0	1
m	0	0	0	8	0	0	0	0	0	0	0	0	15	17	0	0
n	0	0	0	0	0	2	0	0	0	0	0	0	2	36	0	0
θ	0	9	0	1	7	0	8	7	0	1	2	0	0	0	3	2
ð	1	0	0	7	7	12	1	0	0	3	0	0	1	3	1	4

IBM

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	19	5	0	4	5	0	2	0	0	3	0	0	0	0	0	2
t	0	39	0	0	0	0	0	0	0	0	0	1	0	0	0	0
k	0	0	38	0	0	2	0	0	0	0	0	0	0	0	0	0
b	0	0	0	29	1	1	1	0	0	2	1	0	0	0	1	4
d	0	0	0	0	37	0	0	0	0	0	0	3	0	0	0	0
g	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0
f	3	6	0	0	0	1	18	3	2	1	0	0	0	0	3	3
s	0	0	0	0	0	0	0	32	7	0	1	0	0	0	0	0
ʃ	0	0	0	0	0	0	0	0	38	0	0	2	0	0	0	0
v	0	1	0	16	4	4	0	0	0	10	0	0	0	0	2	3
z	0	0	0	0	0	0	0	1	0	0	39	0	0	0	0	0
dʒ	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0
m	0	0	0	6	0	0	0	0	0	0	1	0	10	23	0	0
n	0	0	0	0	0	1	0	0	0	0	0	0	0	39	0	0
θ	3	2	0	3	1	0	6	14	0	1	1	1	0	0	4	4
ð	0	0	0	4	14	9	0	0	0	6	1	0	0	0	0	6

SNR -8 dB

Unprocessed

	p	t	k	b	d	g	f	s	∫	v	z	d3	m	n	θ	ð
p	5	9	9	0	4	2	1	1	2	1	0	2	1	0	2	1
t	3	18	6	1	0	1	4	1	0	0	1	1	0	1	2	1
k	3	3	13	1	1	2	2	7	3	0	2	1	0	1	0	1
b	4	4	7	2	0	3	4	2	3	2	2	2	0	3	1	1
d	0	6	2	1	14	5	0	3	3	1	2	1	0	1	0	1
g	1	3	3	2	4	15	1	4	1	2	1	2	0	1	0	0
f	2	4	6	5	3	2	11	0	1	2	2	1	0	0	1	0
s	2	0	1	0	0	0	3	28	0	1	2	0	2	0	1	0
∫	0	4	0	2	0	0	2	2	23	2	2	0	1	1	1	0
v	2	5	7	5	0	4	7	0	2	4	1	0	1	1	1	0
z	1	1	1	2	3	1	0	6	2	1	19	0	1	0	1	1
d3	0	0	2	2	2	1	1	7	9	0	2	10	0	4	0	0
m	5	5	4	6	2	0	3	0	4	3	1	0	6	0	1	0
n	0	9	1	0	4	2	0	0	3	0	0	2	1	16	0	2
θ	5	4	8	0	3	1	8	3	1	1	2	1	1	1	1	0
ð	0	1	8	1	3	8	2	2	1	3	6	0	1	3	0	1

Algorithm

	p	t	k	b	d	g	f	s	∫	v	z	d3	m	n	θ	ð
p	4	1	7	6	6	0	6	0	0	5	0	0	0	0	2	3
t	0	28	0	0	9	2	0	0	0	0	0	1	0	0	0	0
k	3	2	15	2	3	4	2	1	0	1	0	2	0	4	0	1
b	0	1	0	14	9	2	1	1	0	6	1	1	0	0	0	4
d	0	2	2	0	12	17	0	0	0	0	0	5	0	1	0	1
g	0	0	2	0	2	27	0	0	0	0	0	0	0	8	0	1
f	0	1	0	8	0	0	15	5	0	1	5	1	1	0	2	1
s	0	1	0	0	0	0	1	31	5	0	1	0	0	0	1	0
∫	0	0	0	0	0	0	0	0	38	1	0	1	0	0	0	0
v	0	0	1	18	1	0	4	0	0	11	0	0	0	1	1	3
z	0	0	0	0	0	1	0	4	1	0	29	5	0	0	0	0
d3	0	0	0	1	1	2	1	0	1	0	0	28	0	2	3	1
m	0	0	0	6	1	0	0	0	0	0	0	0	21	12	0	0
n	0	0	0	0	2	0	0	0	0	0	1	0	0	37	0	0
θ	4	4	0	7	0	0	10	8	0	3	4	0	0	0	0	0
ð	1	3	0	7	5	3	2	0	0	1	9	2	2	3	1	1

IBM

	p	t	k	b	d	g	f	s	∫	v	z	d3	m	n	θ	ð
p	20	0	0	8	2	0	5	0	0	1	0	0	0	0	1	3
t	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
k	0	0	37	0	0	3	0	0	0	0	0	0	0	0	0	0
b	0	0	1	35	2	0	0	0	0	1	0	0	0	0	0	1
d	0	0	0	0	34	2	0	0	0	0	0	4	0	0	0	0
g	0	0	0	0	3	35	0	0	0	0	0	0	0	0	0	2
f	0	0	1	0	0	0	28	4	0	0	4	0	0	0	3	0
s	0	0	0	0	0	0	0	35	5	0	0	0	0	0	0	0
∫	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
v	0	0	0	15	0	0	0	0	0	24	0	0	0	0	0	1
z	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0
d3	0	0	0	0	0	1	0	0	1	0	0	37	0	0	0	1
m	0	0	0	2	1	0	0	0	0	0	0	0	34	2	0	1
n	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0
θ	0	1	3	1	0	1	10	11	0	1	0	0	0	0	8	4
ð	0	0	0	9	18	2	0	0	0	4	0	0	0	0	2	5

SNR -5 dB

Unprocessed

	p	t	k	b	d	g	f	s	∫	v	z	d3	m	n	θ	ð
p	9	8	5	2	0	0	3	0	1	4	1	0	3	2	1	1
t	0	28	4	1	0	0	4	2	0	1	0	0	0	0	0	0
k	3	3	23	0	1	0	2	1	1	1	1	1	0	1	1	1
b	5	1	2	7	3	3	4	2	1	2	0	0	3	3	2	2
d	0	0	1	1	32	1	1	0	0	0	2	1	0	0	1	0
g	0	0	3	1	2	23	0	0	1	0	3	1	2	1	2	1
f	5	6	4	1	1	0	16	2	0	0	0	0	2	0	2	1
s	1	0	0	0	1	0	2	33	1	1	1	0	0	0	0	0
∫	0	0	1	0	1	1	1	0	33	1	0	2	0	0	0	0
v	2	1	4	5	2	3	6	0	1	11	1	0	0	2	2	0
z	0	1	0	0	1	2	1	0	1	1	31	1	0	0	0	1
d3	0	0	0	0	4	2	0	0	4	0	3	24	0	1	1	1
m	1	0	4	0	1	0	0	1	0	0	0	0	24	8	0	1
n	0	1	2	0	0	0	0	0	1	0	0	0	1	35	0	0
θ	4	4	2	1	2	2	16	1	1	2	0	0	1	1	1	2
ð	3	0	2	3	4	7	4	2	0	6	1	1	2	0	2	3

Algorithm

	p	t	k	b	d	g	f	s	∫	v	z	d3	m	n	θ	ð
p	11	0	0	9	7	2	4	1	0	0	0	2	0	0	1	3
t	0	38	0	0	0	0	0	0	1	0	0	1	0	0	0	0
k	1	6	20	0	3	0	4	1	0	1	2	0	0	0	2	0
b	0	0	0	24	2	2	6	0	0	2	0	0	0	0	2	2
d	0	5	0	0	29	5	0	0	0	0	0	0	0	0	0	1
g	0	0	0	0	7	33	0	0	0	0	0	0	0	0	0	0
f	3	0	0	0	0	1	21	2	0	3	1	0	0	0	5	4
s	0	0	0	0	0	0	0	32	7	0	0	0	0	0	1	0
∫	0	0	0	0	0	0	1	0	38	0	0	1	0	0	0	0
v	1	0	0	12	2	1	3	0	0	16	1	1	0	0	2	1
z	0	0	0	0	0	0	0	0	0	0	38	2	0	0	0	0
d3	0	0	0	0	0	4	0	0	1	2	0	32	0	0	0	1
m	0	0	0	0	0	0	0	0	0	0	0	0	27	13	0	0
n	0	0	0	0	0	0	0	0	0	0	0	0	1	39	0	0
θ	3	1	0	4	0	2	13	1	0	2	2	1	0	0	10	1
ð	0	0	0	13	7	11	0	0	0	3	1	0	0	0	1	4

IBM

	p	t	k	b	d	g	f	s	∫	v	z	d3	m	n	θ	ð
p	21	1	0	5	3	0	8	0	0	0	0	0	0	0	0	2
t	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
k	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
b	0	0	1	32	1	0	0	0	0	4	0	0	0	0	1	1
d	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0
g	0	0	0	0	2	37	0	0	0	0	0	0	0	0	0	1
f	3	0	0	0	0	0	27	2	0	0	0	0	0	0	5	3
s	0	0	0	0	0	0	0	36	4	0	0	0	0	0	0	0
∫	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
v	0	0	0	1	0	2	1	0	0	31	0	0	0	0	0	5
z	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0
d3	0	0	0	0	0	0	0	0	1	0	0	39	0	0	0	0
m	0	0	0	0	0	0	0	0	0	0	0	0	34	6	0	0
n	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0
θ	1	2	0	1	0	1	5	11	0	1	2	0	0	0	12	4
ð	0	0	0	7	5	4	0	0	0	7	0	0	0	0	6	11

HI Listeners -- Speech-shaped noise

SNR -8 dB

Unprocessed

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	7	5	3	4	2	8	2	3	0	1	2	1	1	0	1	0
t	4	25	0	3	4	1	0	1	0	1	1	0	0	0	0	0
k	7	4	10	1	2	2	2	4	3	2	0	1	0	1	0	1
b	6	1	0	4	6	5	2	2	0	4	2	1	2	3	2	0
d	4	7	0	1	13	2	4	3	2	0	0	1	0	0	2	1
g	4	3	2	2	2	11	3	1	1	3	2	1	2	2	1	0
f	10	5	2	1	3	4	5	1	0	4	1	0	2	0	2	0
s	4	1	0	1	0	1	0	23	2	0	5	3	0	0	0	0
ʃ	4	0	0	1	1	0	1	6	21	0	2	1	1	1	1	0
v	4	4	2	1	4	2	4	5	1	3	2	1	2	2	2	1
z	5	2	0	2	0	3	1	4	0	3	14	3	1	0	1	1
dʒ	6	3	1	7	1	4	1	1	2	1	2	10	1	0	0	0
m	6	4	0	3	3	4	5	1	1	0	2	0	3	5	2	1
n	4	1	2	2	6	6	2	4	0	3	1	0	1	6	1	1
θ	7	6	2	2	6	2	5	3	0	2	0	1	1	1	1	1
ð	5	3	1	1	6	3	1	5	0	2	1	3	4	3	2	0

Algorithm

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	3	8	10	13	0	0	1	0	0	2	0	0	0	1	1	1
t	0	32	1	0	1	1	0	1	0	0	0	1	0	0	3	0
k	1	6	17	3	1	3	0	0	1	1	1	0	0	1	4	1
b	2	0	0	19	0	1	8	0	0	4	0	0	3	0	1	2
d	1	6	0	7	19	5	0	0	0	0	0	1	1	0	0	0
g	1	0	2	5	0	26	0	0	0	1	0	1	1	0	3	0
f	3	0	0	2	1	2	8	6	0	7	0	0	1	0	7	3
s	1	0	0	0	0	1	0	25	7	0	3	2	0	0	0	1
ʃ	0	0	0	0	0	0	0	1	36	0	0	2	0	0	0	1
v	0	0	0	14	5	3	3	0	0	7	0	1	0	1	1	5
z	0	0	0	1	0	1	0	3	2	0	27	5	0	0	0	1
dʒ	0	1	0	0	0	5	0	1	0	0	1	29	0	0	0	3
m	0	0	1	6	0	0	0	0	0	1	0	0	18	13	1	0
n	0	1	0	0	0	2	1	0	0	0	0	0	1	34	1	0
θ	0	8	0	7	1	0	7	3	0	4	2	0	0	0	8	0
ð	0	0	0	9	7	3	0	1	0	7	0	0	0	7	4	2

IBM

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	13	4	3	5	2	0	6	0	0	2	0	0	2	1	2	0
t	0	35	0	0	0	1	0	0	0	0	0	1	0	0	2	1
k	1	1	30	1	1	2	2	0	0	0	0	0	0	0	2	0
b	1	0	0	31	0	1	0	0	0	3	0	0	2	0	0	2
d	0	2	0	0	31	4	1	0	0	0	1	0	0	0	0	1
g	1	0	2	0	2	32	1	0	0	0	0	0	0	1	1	0
f	0	1	0	5	0	0	16	1	3	3	0	0	3	1	6	1
s	0	0	0	0	0	1	0	28	4	0	3	3	0	0	0	1
ʃ	0	0	0	0	0	0	0	0	38	0	0	1	0	0	0	1
v	1	0	0	8	4	1	0	0	0	15	0	0	1	1	6	3
z	0	0	0	0	0	0	0	0	0	0	37	1	0	0	0	2
dʒ	0	0	0	0	0	0	0	2	0	0	1	35	0	0	2	0
m	0	0	0	6	0	0	0	0	0	0	0	0	19	15	0	0
n	0	0	0	0	1	0	0	0	0	0	0	0	7	31	1	0
θ	3	2	0	3	0	1	10	5	0	2	0	1	0	0	11	2
ð	0	0	0	7	13	1	0	0	0	4	2	0	1	2	5	5

SNR -5 dB

Unprocessed

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	5	8	6	3	3	3	3	1	0	0	1	3	2	1	1	0
t	1	28	0	1	0	1	1	0	1	5	0	0	0	1	0	1
k	0	2	13	1	0	3	2	1	2	2	3	3	3	2	2	1
b	2	0	4	4	2	6	3	1	1	7	0	0	2	2	5	1
d	0	6	0	3	21	0	1	0	1	1	1	2	0	2	1	1
g	0	2	3	1	4	19	1	0	0	2	0	0	1	4	2	1
f	1	2	7	2	3	1	7	2	0	8	0	0	3	3	1	0
s	0	0	0	0	0	0	2	22	3	0	8	5	0	0	0	0
ʃ	0	0	0	0	0	1	1	1	27	1	0	7	1	1	0	0
v	0	1	1	6	4	2	3	0	1	10	2	2	1	1	5	1
z	0	2	1	2	0	0	2	4	1	2	22	3	0	0	1	0
dʒ	0	0	0	1	1	4	2	0	6	4	3	14	0	1	2	2
m	2	1	3	2	0	2	3	1	2	4	1	0	3	13	2	1
n	0	2	2	3	2	2	3	0	1	2	1	0	4	17	0	1
θ	4	6	2	0	1	3	8	0	1	4	3	2	1	0	5	0
ð	1	2	0	6	7	2	3	1	0	5	2	0	1	3	4	3

Algorithm

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	13	0	6	6	3	1	4	0	0	3	0	0	0	1	2	2
t	1	34	0	0	0	1	1	0	0	0	0	0	0	0	2	1
k	1	1	24	2	0	2	5	0	0	1	0	1	0	0	3	0
b	0	0	0	20	1	2	2	0	0	9	1	2	2	0	0	1
d	0	3	0	6	22	6	0	0	0	0	0	1	0	1	0	1
g	0	0	1	0	1	36	0	0	0	0	0	0	0	2	0	0
f	1	0	0	15	0	1	9	1	2	2	0	3	0	0	5	1
s	0	0	1	0	0	0	1	22	9	0	5	0	0	0	2	0
ʃ	0	0	0	0	0	0	0	1	32	0	6	0	0	0	0	1
v	0	0	0	11	6	3	0	0	0	11	0	2	1	0	2	4
z	0	0	0	0	0	1	0	0	0	0	30	7	0	0	0	2
dʒ	0	0	0	0	0	2	0	1	2	0	1	33	0	0	0	1
m	0	0	0	3	0	0	0	0	0	0	0	0	23	12	1	1
n	0	0	0	0	1	0	0	0	0	0	0	0	3	36	0	0
θ	0	10	1	4	0	2	10	3	0	0	3	0	0	1	6	0
ð	1	0	0	13	3	4	1	1	0	3	0	1	0	8	4	1

IBM

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	15	4	0	8	0	2	4	0	0	3	0	1	1	0	1	1
t	0	36	1	0	0	1	0	0	0	0	0	1	0	0	0	1
k	1	2	31	0	0	3	0	0	0	0	0	1	0	1	1	0
b	1	0	0	29	0	0	1	1	0	3	0	0	0	0	2	3
d	0	0	0	0	37	3	0	0	0	0	0	0	0	0	0	0
g	0	0	1	0	0	37	0	0	0	1	0	0	0	1	0	0
f	0	1	0	6	0	1	19	3	1	3	0	1	0	0	4	1
s	0	0	0	1	0	0	0	20	9	0	9	1	0	0	0	0
ʃ	0	0	0	0	0	0	0	0	36	0	1	3	0	0	0	0
v	0	0	0	5	1	1	2	0	0	21	0	0	0	0	6	4
z	0	0	0	0	0	0	2	0	0	0	32	5	0	0	0	1
dʒ	0	0	0	0	0	0	0	1	1	0	2	35	0	0	0	1
m	0	0	0	1	0	0	0	0	0	0	0	0	26	12	1	0
n	0	0	0	0	0	0	0	0	0	0	0	0	4	36	0	0
θ	0	3	0	5	1	1	14	6	0	3	2	0	0	0	5	0
ð	0	1	0	4	8	8	0	0	0	11	0	1	0	3	2	2

HI Listeners -- Babble

SNR -5 dB

Unprocessed

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	6	8	1	5	3	2	3	5	1	2	2	0	0	2	0	0
t	7	19	5	2	2	1	0	0	0	0	0	1	1	0	1	1
k	5	4	13	6	1	1	1	2	2	0	2	2	0	0	0	1
b	4	3	1	7	6	3	4	4	3	1	0	0	1	2	1	0
d	3	4	0	1	19	5	0	1	1	0	2	0	1	0	1	2
g	5	3	1	3	3	12	2	4	1	0	1	1	2	0	1	1
f	5	3	3	1	1	3	10	4	0	3	1	3	3	0	0	0
s	4	2	1	1	2	1	3	15	0	3	3	4	0	0	1	0
ʃ	2	0	0	0	1	1	3	0	24	2	0	4	0	0	1	2
v	6	5	1	2	4	1	6	1	3	7	2	0	0	0	2	0
z	4	4	1	0	3	3	5	2	3	2	7	0	1	2	2	1
dʒ	3	1	2	0	5	0	1	0	5	2	1	12	2	3	3	0
m	6	7	2	3	0	1	4	2	2	2	1	2	4	2	2	0
n	5	8	3	2	3	3	1	4	1	3	2	0	4	0	1	0
θ	6	12	2	1	3	0	1	1	5	3	2	0	0	0	3	1
ð	2	5	1	1	3	2	1	2	5	7	5	1	1	1	1	2

Algorithm

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	7	4	5	10	0	1	1	1	0	4	0	1	1	0	5	0
t	0	37	0	0	0	0	0	1	0	0	1	0	0	0	1	0
k	2	4	17	1	5	0	7	0	0	1	1	0	0	0	2	0
b	1	0	0	26	1	0	4	0	0	5	1	1	1	0	0	0
d	0	1	0	0	27	10	0	0	0	0	1	0	0	1	0	0
g	1	0	1	2	6	29	0	0	0	0	0	0	0	1	0	0
f	3	0	0	1	0	0	23	0	1	3	1	0	1	0	6	1
s	0	0	0	0	0	0	0	29	4	0	2	3	0	0	0	2
ʃ	0	0	0	0	0	0	0	0	37	0	0	3	0	0	0	0
v	1	0	2	10	2	1	2	0	0	14	0	1	2	1	2	2
z	0	0	0	0	0	0	1	4	0	0	31	1	0	0	1	2
dʒ	0	0	0	0	0	2	0	0	0	1	1	31	0	0	0	5
m	0	0	0	0	1	0	1	0	0	0	0	0	19	19	0	0
n	0	0	1	0	0	1	0	0	0	0	0	0	3	34	0	1
θ	1	0	0	0	2	0	14	1	0	3	0	2	1	0	12	4
ð	0	1	0	8	4	3	3	0	0	11	2	0	0	0	3	5

IBM

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	17	2	1	8	0	1	9	0	0	2	0	0	0	0	0	0
t	0	38	0	0	0	0	0	0	0	0	0	0	0	0	1	1
k	0	3	37	0	0	0	0	0	0	0	0	0	0	0	0	0
b	0	0	0	31	0	1	1	0	0	6	0	0	0	0	0	1
d	0	0	0	0	36	1	0	0	0	0	0	0	0	0	2	1
g	0	0	0	1	3	31	0	0	0	1	0	0	0	1	1	2
f	1	0	0	1	0	0	25	2	0	2	0	0	1	0	7	1
s	0	0	0	0	0	0	0	28	4	0	4	2	0	0	2	0
ʃ	0	0	0	0	0	0	0	0	38	0	0	2	0	0	0	0
v	0	0	1	4	2	1	3	0	0	20	1	0	0	0	5	3
z	0	0	0	0	0	0	1	2	0	1	32	2	0	0	0	2
dʒ	0	0	0	0	0	1	0	0	0	0	1	35	0	0	1	2
m	0	0	0	0	0	0	0	0	0	0	0	0	30	8	2	0
n	0	0	0	0	0	0	0	0	0	0	0	0	2	38	0	0
θ	0	0	0	0	0	0	19	6	0	2	1	0	1	0	8	3
ð	0	1	0	4	4	3	3	0	0	11	1	0	1	1	6	5

SNR -3 dB

Unprocessed

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	5	5	4	5	1	4	5	2	2	4	1	0	2	0	0	0
t	1	22	1	5	1	0	0	2	0	0	1	2	3	0	2	0
k	1	7	13	2	3	0	1	2	1	2	3	1	3	0	1	0
b	2	8	3	5	2	4	5	1	0	2	2	0	1	1	1	3
d	1	8	0	3	13	3	0	0	2	3	0	3	3	1	0	0
g	0	5	1	0	6	3	2	4	0	5	4	5	3	2	0	0
f	3	3	3	2	0	1	9	6	2	7	1	0	1	0	1	1
s	0	0	1	0	1	0	0	25	2	2	4	1	2	1	1	0
ʃ	1	1	1	1	0	0	3	2	26	0	0	3	1	0	0	1
v	4	2	0	5	1	2	6	1	0	8	0	1	6	0	2	2
z	1	1	2	3	0	3	3	2	2	4	12	2	2	0	1	2
dʒ	3	3	2	3	2	1	1	0	3	3	1	11	1	0	4	2
m	0	4	4	2	2	4	2	1	1	5	0	0	9	2	3	1
n	0	1	0	2	3	2	4	2	2	4	4	2	6	1	3	
θ	0	4	3	1	2	2	6	5	2	2	1	2	3	2	3	2
ð	0	4	2	4	3	1	2	3	4	3	5	0	5	2	1	1

Algorithm

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	11	0	10	7	2	1	4	0	0	3	0	0	0	0	1	1
t	0	32	1	0	0	0	1	0	1	0	0	0	0	0	5	0
k	0	9	21	3	0	0	4	0	0	1	0	0	1	0	0	1
b	1	0	0	12	6	2	4	0	0	5	1	0	0	0	5	4
d	0	2	0	0	26	7	0	0	0	1	0	1	0	0	2	1
g	0	0	1	2	8	20	2	0	0	2	0	2	1	0	1	1
f	0	0	1	3	0	0	21	2	1	6	0	0	0	0	4	2
s	0	0	0	0	0	0	1	29	5	0	3	0	0	0	0	2
ʃ	0	0	0	0	0	0	0	1	35	0	4	0	0	0	0	0
v	0	2	0	5	0	1	10	0	0	7	1	5	5	0	0	4
z	0	0	0	0	0	0	2	3	2	0	25	4	0	0	0	4
dʒ	0	0	1	1	0	2	0	1	1	0	3	22	1	4	1	3
m	0	0	0	6	0	0	0	0	0	0	0	0	20	11	2	1
n	0	0	0	1	1	0	0	0	0	1	0	0	9	25	2	1
θ	3	0	0	8	1	0	10	1	0	3	2	0	0	0	10	2
ð	1	0	0	9	4	4	1	1	0	7	0	2	1	1	4	5

IBM

	p	t	k	b	d	g	f	s	ʃ	v	z	dʒ	m	n	θ	ð
p	19	0	2	7	0	1	6	1	0	2	0	0	0	0	2	0
t	0	38	0	0	0	0	0	0	0	0	0	0	0	0	2	0
k	0	1	37	0	0	2	0	0	0	0	0	0	0	0	0	0
b	0	0	0	29	0	0	0	0	0	5	0	0	0	0	2	4
d	0	0	0	0	38	0	0	0	0	0	0	0	0	1	0	1
g	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	1
f	0	0	1	2	0	0	29	0	1	4	0	0	0	0	3	0
s	0	0	0	0	0	0	0	32	3	0	1	1	0	0	0	3
ʃ	0	0	0	0	0	0	0	0	40	0	0	3	0	0	0	0
v	1	0	0	7	0	0	0	0	0	20	1	0	0	0	7	4
z	0	0	0	0	0	0	0	0	0	0	34	4	0	0	1	1
dʒ	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	3
m	0	0	0	1	1	1	0	0	0	0	0	0	28	7	1	1
n	0	0	0	0	0	0	0	0	0	0	0	0	3	34	3	0
θ	0	4	0	5	2	1	13	3	0	1	1	1	0	0	8	1
ð	0	0	1	7	5	5	1	0	0	6	0	0	0	2	7	6