

**ACOUSTIC REFERENCE DATA
FOR /s/ IN ADOLESCENTS**

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This report provides the data values used to generate Figures 1–3 in Flipsen, Shriberg, Weismer, Karlsson, and McSweeny (1999). These data were obtained from speech productions of a group of 26 typically speaking adolescents (12 females, 14 males; ages 9;7–15;2). Rationale for the study, analysis, methods, and implications of findings are presented in Flipsen et al. (1999). Additional detail on the acoustic analysis procedures is provided in Flipsen, Tjaden, Weismer, and Karlsson (1996).

Tables 1–6 contain the reference data values. Each pair of tables (1 and 2, 3 and 4, 5 and 6) contain data obtained at the onset, midpoint, and offset of the frication for /s/ respectively. The first table in each pair includes linear data and the second includes Bark-transformed data. Data in each table are presented by sex for each target word for each of the four spectral moments. Statistically significant sex differences are indicated by subscripts. The data are pooled across age because regression analyses indicated no significant age trends (cf. Flipsen et al., 1999).

REFERENCES

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- Flipsen, P., Jr, Tjaden, K., Weismer, G., & Karlsson, H. (1996). *Acoustic analysis protocol* (Tech. Rep. No. 4). Phonology Project, Waisman Center on Mental Retardation and Human Development, University of Wisconsin-Madison.

Table 1
Linear reference data for /s/ at frication onset produced by 26 typically speaking adolescents

Target word	Moment 1 Linear Frequency Mean (KHz)		Moment 2 Linear Frequency Std. Dev. (KHz)		Moment 3 Linear Frequency Skew		Moment 4 Linear Frequency Kurtosis	
	Females	Males	Females	Males	Females	Males	Females	Males
assign	4.95 (1.22)	5.07 (0.86)	1.81 (0.33) _a	1.49 (0.33) _a	0.05 (0.81)	0.10 (0.49)	1.44 (1.58)	1.40 (1.26)
sin	4.93 (1.14)	4.83 (0.72)	1.86 (0.30) _b	1.54 (0.24) _b	0.19 (0.78)	0.09 (0.38)	1.00 (1.73)	1.02 (1.14)
kiss	5.82 (1.02)	5.33 (0.60)	1.80 (0.35) _c	1.42 (0.28) _c	-0.35 (0.61)	0.03 (0.57)	1.28 (1.51)	1.61 (1.29)
spin	5.35 (1.28)	4.73 (0.72)	1.83 (.037) _d	1.46 (0.26) _d	-0.04 (0.80)	0.41 (0.54)	0.98 (1.79)	1.68 (1.56)
kicks	3.57 (1.05)	4.05 (0.82)	2.00 (0.52)	1.68 (0.43)	1.43 (1.23)	0.79 (0.69)	5.29 (9.28)	2.51 (3.08)
skin	5.26 (1.35)	4.77 (0.72)	1.71 (0.32)	1.48 (0.24)	-0.05 (0.90)	0.27 (0.56)	1.82 (1.85)	1.45 (1.16)
soon	5.13 (1.16)	4.68 (0.61)	1.78 (0.34) _e	1.38 (0.27) _e	0.08 (0.71)	0.35 (0.47)	0.80 (1.53) _j	2.19 (1.73) _j
cosine	4.97 (1.16)	4.35 (0.67)	1.59 (0.30) _f	1.35 (0.33) _f	0.16 (0.66) _i	0.99 (0.65) _i	2.30 (2.43)	3.64 (2.15)
kits	6.82 (0.96)	6.18 (0.89)	1.80 (0.44) _g	1.40 (0.29) _g	-0.60 (0.54)	-0.30 (0.73)	1.35 (1.55)	2.59 (2.95)
spoon	5.28 (1.25)	4.69 (0.81)	1.76 (0.34) _h	1.39 (0.30) _h	0.01 (0.76)	0.39 (0.46)	1.08 (1.57)	2.18 (1.68)

Note. Cell entries are means (and standard deviations) averaged across speakers. Cells sharing the same subscript differ significantly (Wilcoxon-Mann-Whitney; $p < .05$).

Table 2
Bark reference data for /s/ at frication onset produced by 26 typically speaking adolescents

Target word	Moment 1		Moment 2		Moment 3		Moment 4	
	Bark Frequency Mean (KHz)		Bark Frequency Std. Dev. (KHz)		Bark Frequency Skew		Bark Frequency Kurtosis	
	Females	Males	Females	Males	Females	Males	Females	Males
assign	15.45 (1.97)	16.63 (2.00)	4.20 (0.56)	3.45 (1.13)	-1.58 (0.86)	-2.32 (1.04)	4.22 (4.72)	10.57 (9.48)
sin	15.59 (1.58)	16.31 (1.46)	4.17 (0.72) _b	3.39 (0.82) _b	-1.51 (0.59)	-1.93 (0.77)	3.55 (3.22) _d	7.71 (6.03) _d
kiss	16.84 (1.83)	17.40 (1.14)	4.11 (0.74) _c	3.14 (1.13) _c	-1.99 (0.86)	-2.58 (0.81)	5.97 (5.18)	13.22 (10.58)
spin	16.59 (1.78)	16.46 (1.55)	3.66 (0.46)	3.26 (1.04)	-1.78 (0.85)	-2.12 (0.82)	5.88 (4.87)	8.70 (5.79)
kicks	13.49 (1.04) _a	15.03(1.17) _a	3.38 (0.77)	3.02 (0.55)	-0.50 (0.57)	-0.86 (0.64)	2.69 (2.40)	3.45 (2.98)
skin	16.52 (2.06)	16.43 (1.48)	3.68 (0.50)	3.35 (1.00)	-1.94 (0.81)	-2.16 (0.86)	6.28 (5.06)	9.45 (8.92)
soon	16.33 (1.63)	16.43 (1.39)	3.66 (0.51)	3.30 (1.00)	-1.78 (0.90)	-2.31 (0.92)	6.92 (8.16)	9.98 (8.31)
cosine	16.07 (2.16)	15.95 (2.33)	3.59 (0.83)	2.87 (2.33)	-1.98 (1.23)	-2.28 (1.38)	7.92 (11.32)	16.91 (15.42)
kits	18.20 (1.99)	18.53 (1.27)	3.49 (1.31)	2.63 (0.95)	-2.75 (1.51)	-2.95 (1.15)	17.53 (19.19)	21.15 (15.56)
spoon	16.56 (1.73)	16.42 (1.53)	3.72 (0.54)	3.25 (1.00)	-1.85 (0.82)	-2.29 (0.80)	6.38 (7.80)	10.49 (8.84)

Note. Cell entries are means (and standard deviations) averaged across speakers. Cells sharing the same subscript differ significantly (Wilcoxon-Mann-Whitney; $p < .05$).

Table 3***Linear reference data for /s/ at friction midpoint produced by 26 typically speaking adolescents***

Target word	Moment 1		Moment 2		Moment 3		Moment 4	
	Linear Frequency Mean (KHz)		Linear Frequency Std. Dev. (KHz)		Linear Frequency Skew		Linear Frequency Kurtosis	
	Females	Males	Females	Males	Females	Males	Females	Males
assign	7.40 (0.86) _a	6.29 (0.65) _a	1.43 (0.43)	1.27 (0.27)	-1.03 (0.86) _i	0.14 (0.71) _i	4.83 (6.58)	1.69 (1.91)
sin	7.39 (0.85) _b	6.35 (0.67) _b	1.44 (0.32)	1.22 (0.25)	-1.05 (0.76) _m	-0.08 (0.57) _m	4.17 (4.33)	2.20 (2.47)
kiss	7.33 (0.97) _c	6.20 (0.67) _c	1.39 (0.40)	1.19 (0.26)	-0.94 (0.72) _n	0.04 (0.72) _n	3.75 (3.47)	2.57 (3.00)
spin	7.14 (1.03) _d	5.84 (0.70) _d	1.39 (0.21)	1.31 (0.29)	-0.73 (0.73) _o	0.48 (0.74) _o	2.49 (1.45)	2.36 (4.69)
kicks	7.12 (0.84) _e	5.99 (0.60) _e	1.45 (0.31)	1.29 (0.24)	-0.88 (0.57) _p	0.08 (0.48) _p	3.23 (2.21) _v	1.37 (1.46) _v
skin	7.09 (0.85) _f	6.07 (0.64) _f	1.52 (0.34)	1.26 (0.27)	-0.82 (0.61) _q	0.12 (0.57) _q	2.20 (1.80)	1.86 (2.03)
soon	7.03 (0.90) _g	5.89 (0.84) _g	1.27 (0.26)	1.26 (0.31)	-0.48 (0.90) _r	0.50 (0.97) _r	3.32 (2.38)	2.86 (3.77)
cosine	6.95 (0.96) _h	5.57 (0.57) _h	1.30 (0.24)	1.30 (0.30)	-0.35 (0.99) _s	0.80 (0.75) _s	3.06 (1.68)	2.41 (3.87)
kits	6.91 (0.87) _i	6.18 (0.73) _i	1.47 (0.33) _k	1.22 (0.22) _k	-0.57 (0.61) _t	0.11 (0.67) _t	1.89 (1.00)	1.88 (1.72)
spoon	6.85 (1.09) _j	5.73 (0.85) _j	1.41 (0.24)	1.24 (0.24)	-0.60 (0.77) _u	0.43 (0.68) _u	2.54 (1.46)	2.13 (2.16)

Note. Cell entries are means (and standard deviations) averaged across speakers. Cells sharing the same subscript differ significantly (Wilcoxon-Mann-Whitney; $p < .05$).

Table 4
Bark reference data for /s/ at frication midpoint produced by 26 typically speaking adolescents

Target word	Moment 1		Moment 2		Moment 3		Moment 4	
	Bark Frequency Mean (KHz)		Bark Frequency Std. Dev. (KHz)		Bark Frequency Skew		Bark Frequency Kurtosis	
	Females	Males	Females	Males	Females	Males	Females	Males
assign	19.80 (1.32)	19.27 (0.63)	2.26 (0.91) _e	1.62 (0.52) _e	-3.77 (2.06)	-2.72 (1.35)	30.51 (31.33)	22.94 (18.12)
sin	19.82 (1.12)	19.28 (0.70)	2.26 (0.76)	1.75 (0.61)	-3.57 (1.61)	-2.82 (1.34)	27.65 (24.81)	22.21 (19.36)
kiss	19.75 (1.50)	19.24 (0.55)	2.26 (1.01)	1.62 (0.43)	-3.80 (1.73)	-2.83 (1.48)	29.73 (24.41)	20.62 (11.11)
spin	19.71 (1.16) _a	18.76 (0.73) _a	2.12 (0.58)	1.77 (0.46)	-3.39 (0.98) _j	-2.36 (1.65) _j	22.09 (12.76)	20.31 (24.93)
kicks	19.58 (0.97) _b	18.87 (0.66) _b	2.34 (0.60) _f	1.78 (0.49) _f	-3.32 (1.26) _k	-2.27 (1.04) _k	23.01 (17.25)	15.21 (8.93)
skin	19.46 (1.16)	19.02 (0.62)	2.41 (0.64) _g	1.74 (0.43) _g	-3.04 (1.30)	-2.36 (1.18)	19.20 (15.40)	16.34 (11.33)
soon	19.82 (1.00) _c	18.86 (0.72) _c	1.85 (0.58)	1.61 (0.48)	-3.76 (1.13) _l	-2.26 (1.72) _l	29.78 (14.87) _n	21.66 (29.46) _n
cosine	19.67 (0.95) _d	18.56 (0.60) _d	1.98 (0.73)	1.59 (0.36)	-3.70 (1.03) _m	-1.90 (1.47) _m	29.37 (18.09)	18.63 (14.03)
kits	19.35 (1.26)	19.17 (0.75)	2.29 (0.85) _h	1.66 (0.44) _h	-3.01 (1.26)	-2.86 (1.53)	19.92 (15.58)	24.65 (19.77)
spoon	19.39 (1.22)	18.64 (0.91)	2.24 (0.50) _i	1.76 (0.52) _i	-3.18 (1.17)	-2.16 (1.71)	20.48 (15.23)	19.28 (11.03)

Note. Cell entries are means (and standard deviations) averaged across speakers. Cells sharing the same subscript differ significantly (Wilcoxon-Mann-Whitney; $p < .05$).

Table 5
Linear reference data for /s/ at frication offset produced by 26 typically speaking adolescents

Target word	Moment 1 Linear Frequency Mean (KHz)		Moment 2 Linear Frequency Std. Dev. (KHz)		Moment 3 Linear Frequency Skew		Moment 4 Linear Frequency Kurtosis	
	Females	Males	Females	Males	Females	Males	Females	Males
assign	4.93 (1.12)	4.76 (0.85)	1.90 (0.25) _d	1.57 (0.37) _d	0.26 (0.84)	0.38 (0.62)	1.16 (1.42)	1.75 (1.88)
sin	5.31 (1.00)	4.90 (0.71)	1.93 (0.37) _e	1.56 (0.40) _e	0.14 (0.77)	0.32 (0.62)	0.68 (1.55) _m	2.00 (2.20) _m
kiss	5.12 (1.17)	4.77 (0.71)	1.78 (0.33) _f	1.49 (0.40) _f	0.19 (0.85)	0.39 (0.63)	1.73 (2.38)	2.85 (3.09)
spin	6.52 (1.03) _a	4.64 (0.62) _a	1.15 (0.16)	1.27 (0.39)	-0.36 (0.98) _j	1.33 (0.63) _j	3.78 (2.35)	5.14 (4.57)
kicks	4.88 (1.21)	4.59 (0.47)	1.92 (0.31) _g	1.58 (0.35) _g	0.36 (0.99)	0.47 (0.36)	1.35 (2.06)	1.73 (1.75)
skin	6.35 (1.06) _b	5.35 (0.70) _b	1.48 (0.29)	1.47 (0.29)	-0.44 (0.75)	0.02 (0.61)	2.44 (1.37) _n	1.22 (1.87) _n
soon	4.35 (0.84)	3.95 (0.50)	1.52 (0.29)	1.30 (0.28)	0.79 (0.69) _k	1.44 (0.62) _k	2.80 (2.56) _o	6.42 (3.67) _o
cosine	4.36 (0.89)	4.29 (0.78)	1.89 (0.34) _h	1.55 (0.34) _h	0.55 (0.70)	0.70 (0.56)	1.48 (1.74)	2.49 (1.61)
kits	4.75 (1.02)	4.72 (0.66)	1.83 (0.27) _i	1.50 (0.44) _i	0.51 (1.18)	0.47 (0.70)	2.55 (5.82)	2.39 (2.39)
spoon	5.86 (1.29) _c	4.33 (0.64) _c	1.16 (0.14)	1.27 (0.36)	0.11 (0.88) _l	1.33 (0.54) _l	4.40 (2.48)	5.46 (4.33)

Note. Cell entries are means (and standard deviations) averaged across speakers. Cells sharing the same subscript differ significantly (Wilcoxon-Mann-Whitney; $p < .05$).

Table 6
Bark reference data for /s/ at frication offset produced by 26 typically speaking adolescents

Target word	Moment 1		Moment 2		Moment 3		Moment 4	
	Bark Frequency Mean (KHz)		Bark Frequency Std. Dev. (KHz)		Bark Frequency Skew		Bark Frequency Kurtosis	
	Females	Males	Females	Males	Females	Males	Females	Males
assign	15.43 (2.01)	16.09 (1.69)	4.06 (0.69)	3.39 (1.08)	-1.25 (0.59)	-1.70 (0.94)	2.45 (2.52)	6.95 (7.97)
sin	16.42 (1.95)	16.49 (1.35)	3.52 (0.83)	3.19 (1.15)	-1.63 (1.07)	-1.92 (0.80)	6.19 (7.83)	8.50 (7.01)
kiss	16.32 (2.04)	16.42 (1.26)	3.46 (0.81)	3.14 (0.96)	-1.67 (0.89)	-2.02 (0.91)	6.96 (9.30)	9.94 (9.68)
spin	19.41 (1.18) _a	17.19 (0.82) _a	1.86 (0.62)	2.03 (0.60)	-4.00 (1.48) _c	-2.05 (1.32) _c	31.78 (24.38)	16.09 (8.29)
kicks	15.74 (1.92)	16.09 (1.11)	3.58 (0.67)	3.09 (0.89)	-1.27 (0.73)	-1.58 (0.74)	3.81 (3.32)	6.37 (5.99)
skin	18.69 (1.37)	17.68 (1.00)	2.40 (0.53)	2.34 (0.59)	-2.37 (1.01) _d	-1.26 (0.80) _d	12.24 (7.77) _f	5.19 (4.62) _f
soon	15.89 (1.45)	15.76 (0.98)	2.91 (0.66)	2.66 (0.76)	-1.50 (0.90)	-2.00 (0.83)	6.81 (4.33)	11.98 (9.85)
cosine	14.60 (1.82)	15.12 (2.00)	4.01 (0.75)	3.51 (1.01)	-0.96 (0.60)	-1.54 (0.86)	1.90 (2.61) _g	6.82 (7.74) _g
kits	15.75 (1.86)	16.35 (1.27)	3.48 (0.75)	2.96 (1.07)	-1.35 (0.58)	-1.87 (0.94)	5.14 (4.91)	9.50 (7.92)
spoon	18.48 (1.75) _b	16.64 (1.00) _b	2.16 (0.75)	2.24 (0.59)	-3.38 (0.98) _e	-2.14 (1.15) _e	24.17 (15.88)	14.90 (9.42)

Note. Cell entries are means (and standard deviations) averaged across speakers. Cells sharing the same subscript differ significantly (Wilcoxon-Mann-Whitney; $p < .05$).