Emergence of Consonants in Young Children with Hearing Loss

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Children & Families

Objectives

- Describe consonant emergence in young children with hearing loss.
- Identify how severity of hearing loss impacts consonant emergence.
- Educate families and school professionals on the importance of continued monitoring for speech development in young children with hearing loss.

Typical Phoneme Development

TABLE 1. Ages of acquisition of specific sounds determined in several different ways provided by Prather, Hedrick, and Kern (1975) and by Templin (1957).

Sound	Prather, Hedrick, and Kern Two-position norms (I, F)			Templin	
	All data sets	*Complete data sets only*	*Sets With data From at Least 14 Ss*	*Two-position norms (I, F)*	*Three-position norms (I, M, F)*
m	≤2;0	>4;0	2;4	≤3;0	≤3;0
n	≤2;0	3;8	2;4	≤3;0	≤3;0
h[a]	<2;0	>4;0	2;8	≤3;0	≤3;0
p	≤2;0	>4;0	2;4	≤3;0	≤3;0
ŋ	<2;0	4;0	2;4	≤3;0	≤3;0
f	2;4	4;0	2;4	≤3;0	≤3;0
j[a]	<2;0	>4;0	3;0	3;6	3;6
k	2;4	4;0	2;4	4;0	4;0
d	3;0	3;8	3;0	4;0	4;0
w[a]	2;8	4;0	2;8	≤3;0	≤3;0
b	2;8	4;0	2;8	4;0	4;0
t	2;8	3;8	2;8	≤3;0	6;0
g	2;4[b]	4;0	2;4[b]	4;0	4;0
s	3;8	3;8	3;8	4;0	4;6
r	3;4[b]	>4;0	3;4[b]	4;0	4;0
l	3;4[b]	4;0	3;4[b]	6;0	6;0
ʃ	3;8	3;8	3;8	4;0	4;6
tʃ	3;8	3;8	3;8	4;6	4;6
ð	>4;0	>4;0	>4;0	7;0	7;0
ʒ[a]	4;0	>4;0	4;0	7;0	7;0
dʒ	3;4[b]	>4;0	3;4[b]	7;0	7;0
θ	>4;0	>4;0	>4;0	6;0	6;0
v	>4;0	>4;0	>4;0	6;0	6;0
z	>4;0	>4;0	>4;0	7;0	7;0
hw[a]	>4;0	>4;0	>4;0	>8;0	>8;0

Note. The age of acquisition in each case is the earliest age at which at least 75% of children produced the designated sound correctly in each indicated word position.
[a]Sound does not occur in all word positions in English.
[b]A reversal occurs in older age groups.

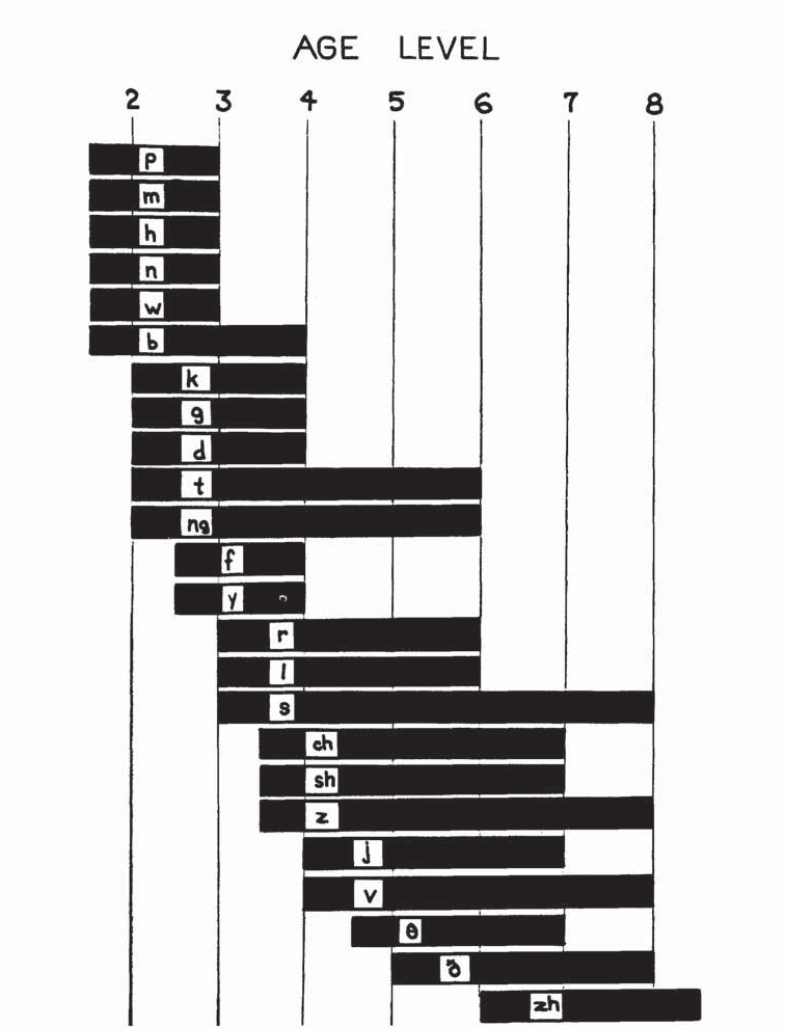


Figure 1. Average age estimates and upper age limits of customary consonant production. The solid bar corresponding to each sound starts at the median age of customary articulation; it stops at an age level at which 90% of all children are customarily producing the sound. (From Templin, 1957; Wellman et al., 1931.)

Sander, E. (1972). When are speech sounds are learned? *Journal of Speech and Hearing Disorders, 37,* 55-63.

Consonants

unvoiced	p	t	ʧ	k	f	θ	s	ʃ
voiced	b	d	ʤ	g	v	ð	z	ʒ
	m	n	ŋ	h	l	r	w	j

HOW IS PHONEME DEVELOPMENT IMPACTED BY DEGREE OF HEARING LOSS?

Participants

- 269 children with hearing loss
- Data from 885 test sessions (226 children contributed longitudinal data)
- Between 15 and 84 months of age
- Hearing loss ranged from mild to profound
- Hearing aid & CI Users
- Speech or speech & sign

Demographic Characteristics

Table 1.
Demographic characteristics within each age range (number of participants at each test session)

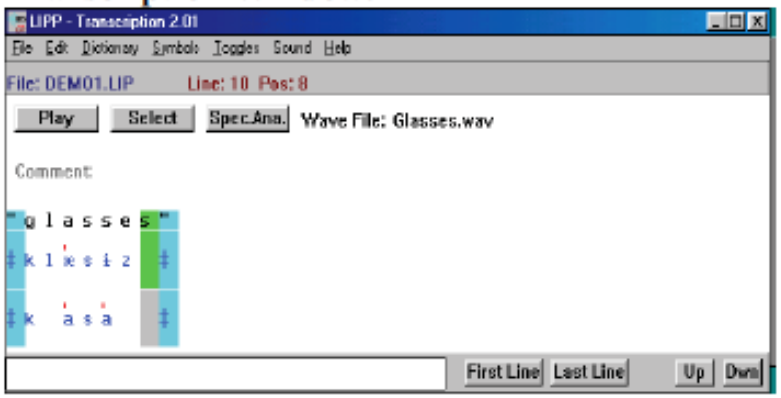
	Age group +/- 2 months							
Characteristic	15 (*n*=26)	21 (*n*=81)	27 (*n*=139)	33 (*n*=169)	48 (*n*=147)	60 (*n*=138)	72 (*n*=112)	84 (*n*=72)
Gender								
Boy	10	38	69	81	75	68	59	40
Girl	16	43	70	88	72	69	52	32
Degree of loss								
Mild	12	34	48	45	34	28	20	11
Moderate	7*	33	51	64	48	42	37	24
Severe	4*	7*	17	22	21	21	11	6
Profound	1*	3*	5*	6*	8*	7*	3*	4*
Cochlear implant	2*	4*	18	32	36	40	41	28
Ethnicity								
Minority	5	16	32	40	34	32	31	24
Not a minority	21	65	107	129	114	105	80	48
Age of identification								
By 6 months	24	69	100	102	74	70	59	35
After 6 months	2	11	38	65	71	66	51	36
Mother's education								
Below high school	0	4	7	10	9	7	10	7
High school	1	18	40	60	46	48	40	22
At least some college	3	6	15	18	22	18	18	12
College degree	12	33	50	51	52	49	33	23
Advanced degree	10	20	27	29	16	13	9	7

* Small sample sizes are due to a low number of children producing spoken language during the 25-minute interaction

Procedure

25-minute <u>spontaneous</u> language sample, children needed to produce at least 10 words for inclusion in analysis

Transcription Window:



Transcribed in Logical International Phonetics Program (LIPP) (Oller & Delgado, 1990) – First 100 utterances were transcribed

Interpreting Charts

Six charts arranged by manner of production

The beginning of each solid bar represents the age at which at least 50% of the children produced a given phoneme and ends when at least 80% of the children produced the sound.

Stop Phonemes

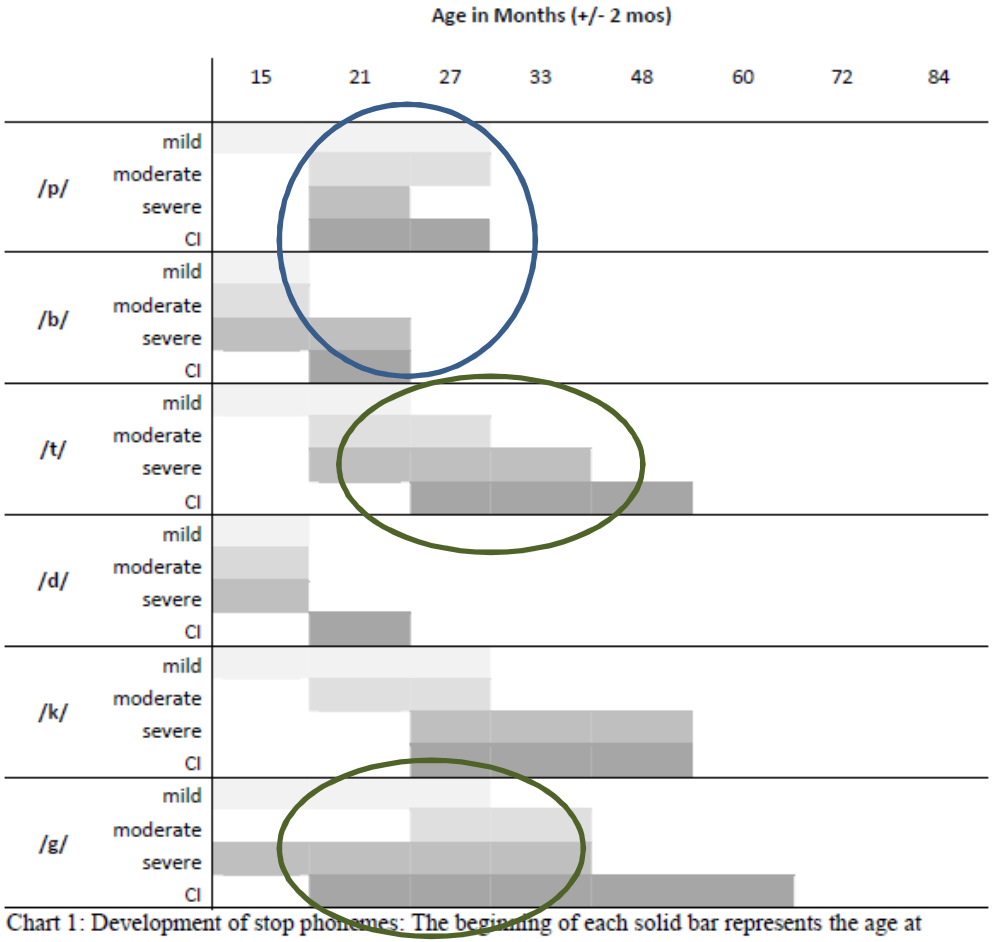


Chart 1: Development of stop phonemes: The beginning of each solid bar represents the age at which at least 50% of the children produced the sound and ends when at least 80% of the children produced the sound.

Nasal Phonemes

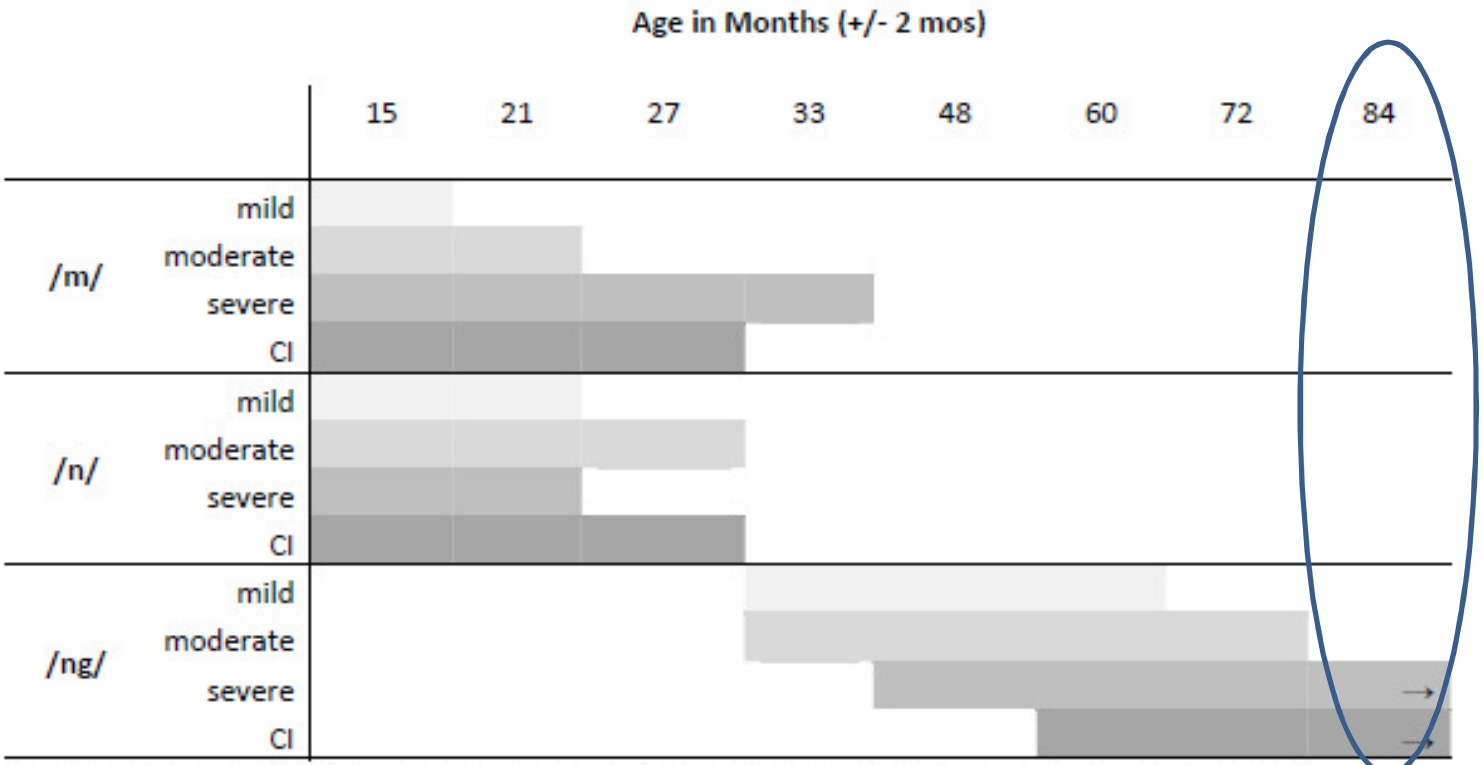


Chart 2: Development of nasal phonemes: The beginning of each solid bar represents the age at which at least 50% of the children produced the sound and ends when at least 80% of the children produced the sound. The arrow (→) indicates that 80% of the children were not yet producing the phoneme by 84 months of age.

Liquid Phonemes

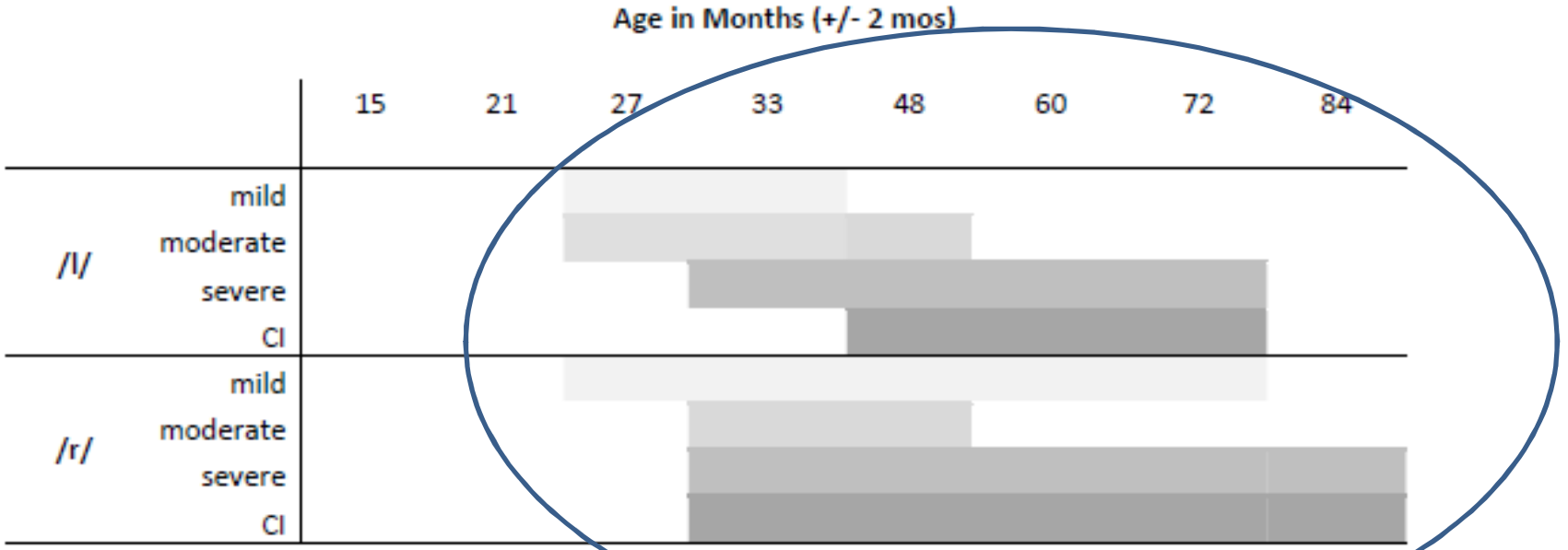


Chart 3: Development of liquid phonemes: The beginning of each solid bar represents the age at which at least 50% of the children produced the sound and ends when at least 80% of the children produced the sound.

Affricate Phonemes

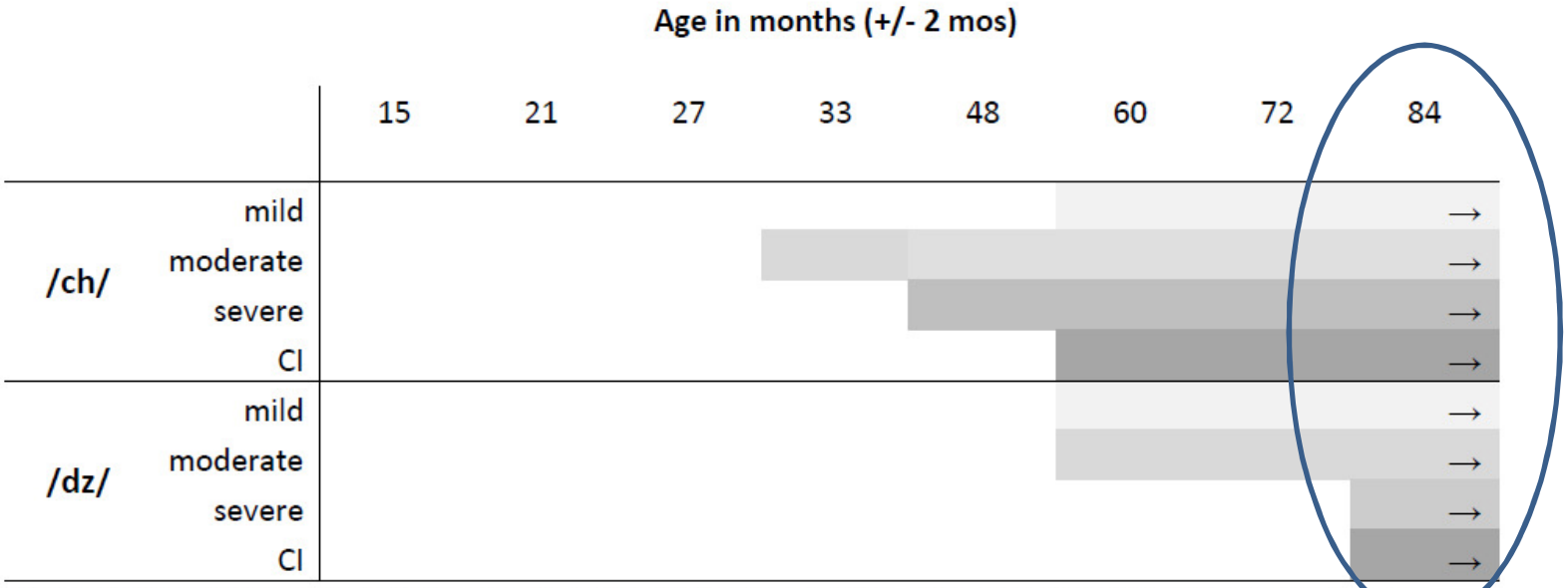


Chart 4: Development of affricate phonemes: The beginning of each solid bar represents the age at which at least 50% of the children produced the sound and ends when at least 80% of the children produced the sound. The arrow (→) indicates that 80% of the children were not yet producing the phoneme by 84 months of age. Children with profound hearing loss who wore hearing aids are excluded due to small sample size.

Fricative Phonemes

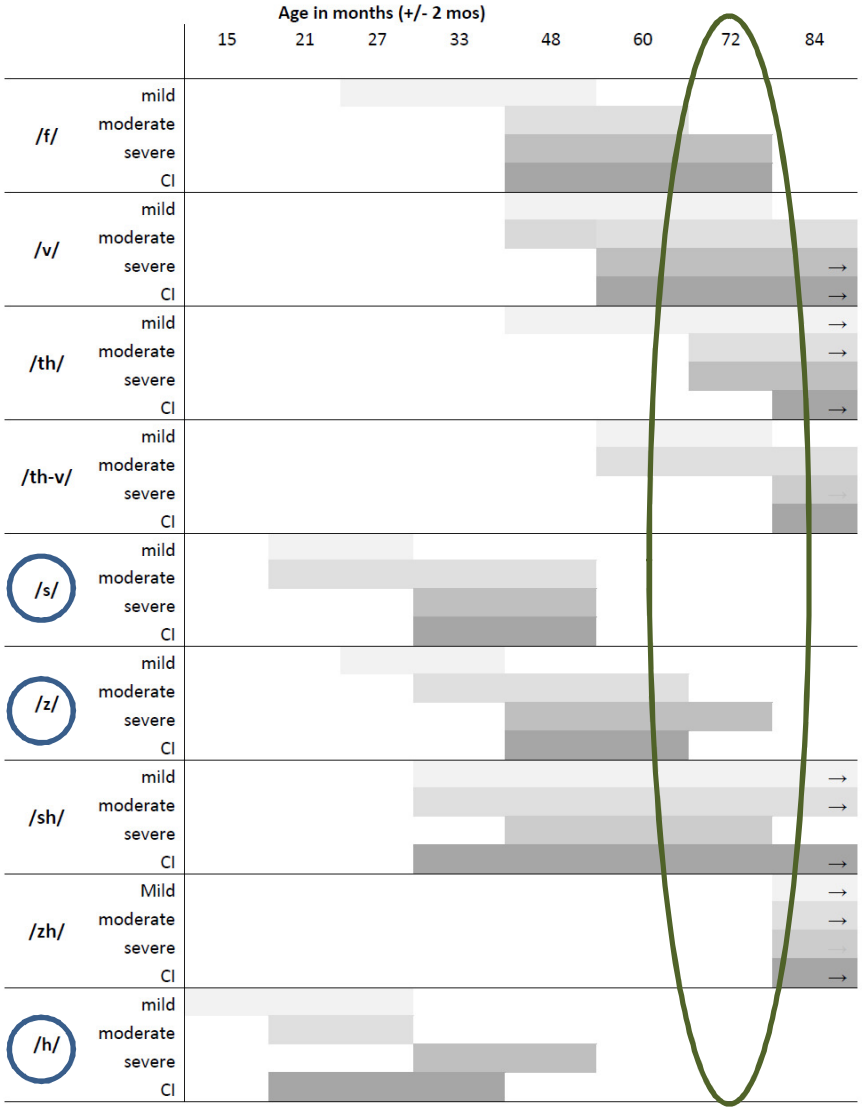


Chart 6: Development of fricative phonemes: The beginning of each solid bar represents when at least 50% of the children produced the sound and ends when at least 80% of the children produced the sound. The arrow (→) indicates that 80% of the children were not yet producing the phoneme by 84 months of age. Children with profound hearing loss are excluded due to small sample size.

Glide Phonemes

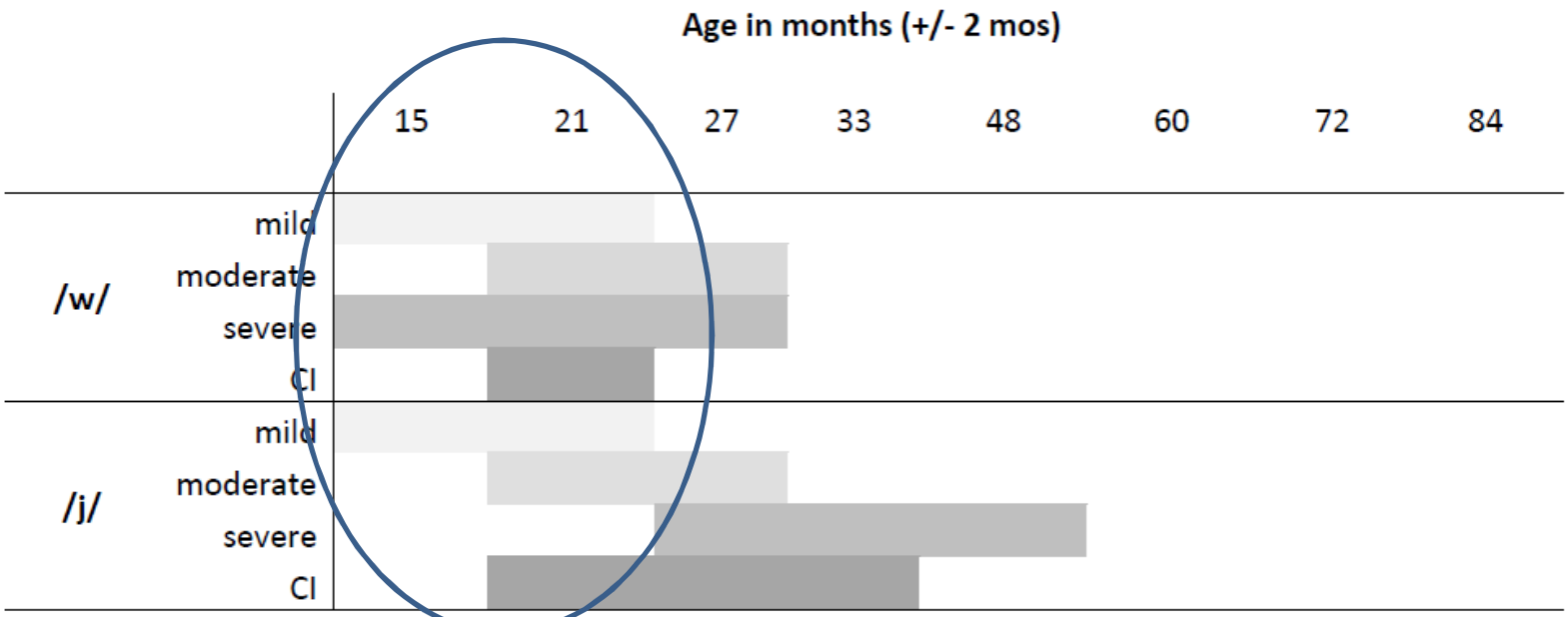


Chart 5: Development of glide phonemes: The beginning of each solid bar represents when at least 50% of the children produced the sound and ends when at least 80% of the children produced the sound. Children with profound hearing loss who wore hearing aids are excluded due to small sample size.

General Results

- By 7 years of age, all of the consonants were produced by at least 50% of the participants.
- Across all degrees of hearing loss, stops, glides, and two of the three nasal consonants /m,n/ appeared first.
- Although /h,s,z/ were produced relatively early, the remaining fricative consonants and the affricates appeared to be the most difficult to produce for all of the hearing loss categories with /ch,dz,v,t, d,z,s/ generally not yet produced by 80% of children at 6 years of age.
- In evaluating consonant production by voicing, voiced stop consonants appeared before voiceless stop consonants, however voiceless fricatives appeared prior to voiced fricatives.
- In general, as severity of hearing loss increased, phonemes either emerged later or the point at which the majority of children produced the sounds was later.
- In general, it took the same amount of time or longer for 80% of the children with implants to produce most sounds when compared to the children with mild through severe losses who wore hearing aids.

Reminders:
Considerations in Interpretation

- the use of a spontaneous sample
- designated testing ages
- hearing loss categories that had limited sample sizes in some age groups

Implications for Clinical Practice

- Early Intervention
  - Evaluate Goals (Remember, always use typical development to set goals!)
  - Identify Possibility Secondary disabilities
  - Education (families, professionals)
  - Progression of hearing loss
  - Adjust therapy techniques
- Audiology
  - Acoustic analysis
  - Appropriate amplification

QUESTIONS?
THANKS FOR JOINING US!

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References

Blamey, P.J., Barry, J.G., & Jacq, P. (2001). Phonetic inventory development in young cochlear implant users 6years postoperation. *Journal of Speech Language and Hearing Research, 44,* 73-79.

Boothroyd, A. (1978). Speech perception and sensorineural hearing loss. In M. Ross & T.G. Giolas (Eds.), *Auditory management of hearing-impaired children* (pp. 117-144). Baltimore: University Park Press.

Dawson, P.W., Blamey, S.J., Dettman, S.J., Rowland, L.C., Barker, E.J., Tobey, E.A., et al.(1995). A clinical report on speech production of cochlear implant users. *Ear and Hearing, 16,* 551-561.

Elfenbein, J.L., Hardin-Jones, M.A., & Davis, J.M. (1994). Oral communication skills of children who are hard of hearing. *Journal of Speech and Hearing Research, 37,* 216-226.

Ertmer, D. J. (2010). Relationships between speech intelligibility and word articulation scores in children with hearing loss. *Journal of Speech and Hearing Research,* 53, 1075-1086.

Geers, A., & Moog, J. (1994). Spoken language results: Vocabulary, syntax, and communication. *Volta Review, 96*(5), 131-148.

Geers, A., Moog, J., & Schick, B. (1984). Acquisition of spoken and signed English by profoundly deaf children. *Journal of Speech and Hearing Disorders, 49,* 378-388.

Goldman, R., & Fristoe, M. (2000). *Goldman-Fristoe Test of Articulation.* Circle Pines, MN: American Guidance Service.

Gordon, T.G. (1987). Communication skills of mainstreamed hearing-impaired children. In H. Levitt, N. McGarr, & D. Geffner (Eds.), Development of language and communication skills in hearing-impaired children. *Monographs of the American Speech-Language-Hearing Association, 26,* 108-122.

skills in hearing-impaired children. *Monographs of the American Speech-Language-Hearing Association, 26,* 108-122.

Grunwell, P. (1981). The development of phonology. *First Language, iii*, 161-191.

Hudgins, C.V., & Numbers, F.C. (1942). An investigation of the intelligibility of speech of the deaf. *Genetic Psychology Monographs, 25*, 289-392.

Kirk, K., & Hill-Brown, C. (1985). Speech and language results in children with a cochlear implant. *Ear and Hearing, 6,* 36S-47S.

Levitt, H., McGarr, N., & Geffner, D. (1987). Development of language and communication skills in hearing-impaired children. Introduction. *Monographs of the American Speech-Language-Hearing Association, 26,* 1-8.

Markides, A. (1970). The speech of deaf and partially-hearing children with special reference to factors affecting intelligibility. *British Journal of Disorders of Communication, 5,* 126-140.

Mavilya, M. (1972). Spontaneous vocalization and babbling in hearing impaired children. In G. Fant (Ed.), *International symposium on speech communication ability and profound deafness* (pp. 163-171). Washington, DC: Alexander Graham Bell Association for the Deaf.

Moeller, M.P., Hoover, B., Putman, C., Arbataitis, K., Bohnenkamp, G., Peterson, B., et al. (2007). Vocalizations of infants with hearing loss compared with infants with normal hearing: Part I- Phonetic development. *Ear and Hearing, 28*, 605-627.

Moeller, M. P., McCleary, E., Putman, C., Tyler-Krings, A., Hoover, B., Stelmachowicz, P. (2010). Longitudinal development of phonology and morphology in children with late identified mild-moderate sensorineural hearing loss. *Ear and Hearing,* 31, 625-635.

Monsen, R.B. (1978). Toward measuring how well hearing -impaired children speak. *Journal of Speech and Hearing Research, 21,* 197-219.

National Institutes of Health Consensus Statement. (1995). Cochlear implants in adults and children. *13*(2), 1-30.

Poole, I. (1934). Genetic development of articulation of consonant sounds in speech. *Elementary English Review, 11,* 159-161.

Prather, E., Hendrick, D., & Kern, C. (1975). Articulation development in children aged two to four years. *Journal of Speech and Hearing Disorders, 40,* 179-191.

Robbins, A.M., Renshaw, J.J., & Berry, S.W. (1991). Evaluating meaningful auditory integration in profoundly hearing -impaired children. *American Journal of Otology, 12* (Suppl), 144-150.

Sander, E. (1972). When are speech sounds are learned? *Journal of Speech and Hearing Disorders, 37,* 55-63.

Smit, A.B., Hand, L., Freiling, J.J., Bernthal, J.E., & Bird, A. (1990). The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders, 55,* 779-798.

Spencer, L.J., Tye -Murray, N., & Tomblin, J.B. (1998). The production of English inflectional morphology, speech production and listening performance in children with cochlear implants. *Ear and Hearing, 19*, 310-318.

Stoel-Gammo n, C. (1988). Prelinguistic vocalizations of hearing -impaired and normally hearing subjects: A comparison of consontantal inventories. *Journal of Speech and Hearing Disorders, 53,* 302-315.

Stoel-Gammon, C., & Otomo, K. (1986). Babbling development of hea ring-impaired and normally hearing subjects. *Journal of Speech and Hearing Disorders, 51,* 33-41.

Svirsky, M.A., Robbins, A.M., Kirk, K.I., Pisoni, D.B., & Miyamoto, R.T. (2000). Language development in profoundly deaf children with cochlear implants. *Psychological Science, 11*, 153-158.

Templin, M. (1957). *Certain language skills in children.* Minneapolis, MN: University of Minnesota Press.

Tobey, E.A., & Hasenstab, M.S. (1991). Effects of a Nucleus multichannel cochlear implant upon speech productio n in children. *Ear and Hearing, 12* (4 Suppl), 48S-54S.

Tye-Murray, N., Spencer, L., & Woodworth, G. (1995). Acquisition of speech by children who have prolonged cochlear implant experience. *Journal of Speech and Hearing Research, 38,* 327-337.

Watson, M.M., & Scukanec, G.P. (1997). Profiling the phonological abilities of 2 -year-olds: A longitudinal investigation. *Child Language Teaching and Therapy, 13,* 327-337.

Wellman, B., Case, I., Mengert, I., & Bradbury, D. (1931). Speech sounds of young children. *University of Iowa Studies in Child Welfare, 5,* 1-82.

Yoshinaga -Itano, C., Stredler -Brown, A., & Jancosek, B. (1992). From phone to phoneme: What we can understand from babble. *Volta Review, 94,* 283-314.