Spontaneous Vocalizations in Two Nonverbal Children with Autism

Maureen Maney Boner, M.S., C.C.C.-SLP Loyola College in Maryland, Baltimore, MD
Barry Gordon, MD, PhD, Cognitive Neurology, Depts. of Neurology and Cognitive Science, Johns Hopkins Medical Institutions, Baltimore, MD

Abstract

Up to 50% of individuals with autism never learn to speak[1]. Most can learn the basic skills necessary for alternative forms of communication such as sign language, picture symbols, or voice output communication devices. At least one of the barriers to the development of speech may be a deficit in oromotor skills or oromotor planning[2]. However, virtually no studies have analyzed the vocal abilities of older, nonverbal autistic children in detail. This study, therefore, asked the following questions about older individuals with autism who were considered completely nonverbal:

- Are these children vocalizing sounds that can be characterized as speech-like?
- Are they trying to use the sounds that they can produce to communicate in some manner?
- Is there a pattern to the sounds they can and cannot produce?

A retrospective study was undertaken to determine whether such individuals might have at least some of the oromotor abilities required for speech production. We examined the spontaneous vocalizations of two older nonverbal individuals with autism. Vocalizations were analyzed by: communicative intent; distinctive feature; muscles of the tongue, jaw, and face used in typical production of the sounds.

Results. Formal analysis revealed production of a fairly broad repertoire of sounds, similar to those of typically developing pre-linguistic children. Communicative intent was observed, with some evidence of gross word approximations to which the listener did not respond. Distinctive feature analysis was significant for manner and place of articulation, correlating with an atypical pattern of muscle use.

Methods

Subjects

Subject 1: AI, a 10-year old male
Subject 2: SR, an 8-year old male

Both were low-functioning, nonverbal, and had a diagnosis of autism. Both communicated almost exclusively using Picture Communication Symbols, as well as emotional expressions (guttural sounds, cries, squeals, and screams). Neither learned any sign or gestural system effectively. Both were enrolled in school and in-home training programs.

Procedures

Twenty five (25) hours of structured work and spontaneous play situations were videotaped using Hi8 video cameras with built-in microphones. Tapes were viewed and transcribed by a certified speech pathologist. Original tapes were then digitized and divided into 10-minute segments on DVD. Ten randomly selected segments were recoded by two speech pathologists (one was the original transcriber) using the Noldus* *Observer* (version 5.0) coding and analysis system, then compared for agreement. Codes included: Consonant, Vowel, Isolated CV, Isolated VC, CV string, VC string, and Other. Specific phonemes were transcribed using the International Phonetic Alphabet.

Phonemes from each subject's repertoire were subjected to Distinctive Feature Analysis[3]. Further comparison by muscles typically used in production[4] were made. Situations of presumed communicative intent[5] were classified.

Results

Both subjects produced the consonants /m,n,j,d,h,k,b,w,g,l/ and the vowels /ʌ,æ,i,u,ɛ,ɪ,a,ʊ,e,aɪ/. The CV syllable unit was used most frequently.

Communicative Intent

- Both subjects used a combination of gestural (including facial expression), vocal (phonemic and non-phonemic), alternative (PCS[6]), and prosodic (i.e., intonation and melody) elements to convey their intentions.
- Many of the communicative attempts were not perceived as such or responded to by the listener.
- Two specific vocalizations were considered word approximations by the raters.
 AI produced /nʌ nʌ nʌ/ three times in combination with gesture or a PCS to indicate "No!" and /di/ while pointing to a specific item upon request of an adult, indicating "This [one]." SR produced /ʌn ʌhn ʌ nʌ nʌ/. interspersed with cries in long strings to indicate "No!"
- Both utilized more sophisticated methods when communicating strong desire or when protesting.
- 51 instances of intent were recorded for AI:
 25% fatigue/desire to end activity; 20% frustration/anger; 20% requests, half were for specific food/drink; others were more difficult to categorize. These included: readiness, gaining attention, requesting help.
- 28 instances of intent were recorded for SR:
 43% to protest/No!; 21% frustration with task or individual; 18% need for help.
- Neither used the following intentions:
 Comment on Action, Showing Off, Clarification, Requesting Information, Requesting Permission, Requesting Social Routines, Greeting.

Distinctive Feature Analysis

Manner of Production

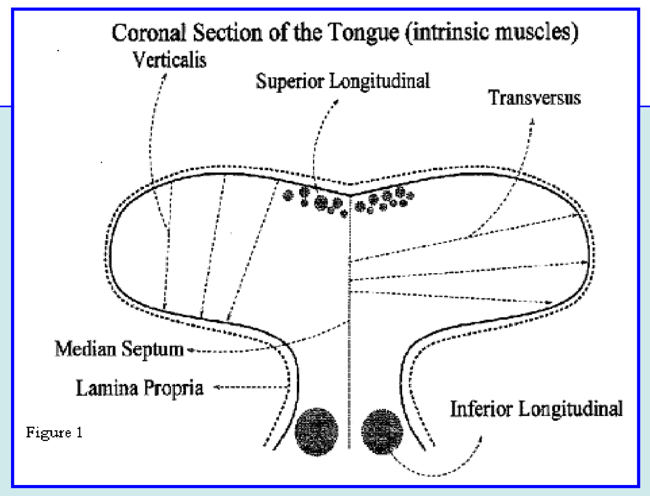
- Both subjects produced all *sonorants* (except /r/)
 Significance: Consistent with typically developing infants[7]
- Both used many *obstruents*
 Significance: Consistent with typically developing infants[7]
- Neither produced *groove fricatives:*
 SR did not produce any fricatives; AI produced two slit fricatives (/f,v/)
- SR omitted *sibilants*

Place of Articulation

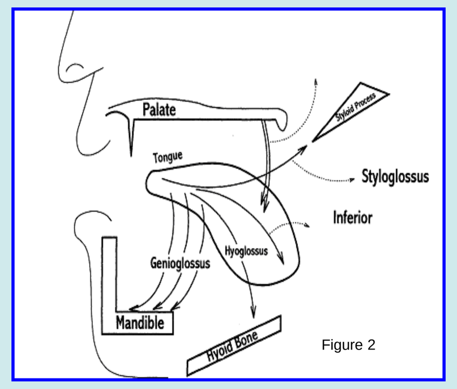
- Both subjects produced *bilabials* and *velars*
 Significance: Consistent with typically developing infants[7]
- Nearly all productions required maximum or minimum opening of the oral cavity
 Significance: consistent with decreased graded jaw movement
- Diphthong production was minimal and included only front-to-front or back-to-back vs. front-to-back or back-to-front transitions
 Significance: These movements are mechanically easier

Analysis by Muscle Use

- Both subjects demonstrated movements of the jaw and face necessary for production of most phonemes.
- Both produced phonemes requiring use of the primary jaw depressors:
 anterior belly of the digastric, mylohyoid, geniohyoid, and lateral pterygoid muscles.
- Neither produced phonemes requiring use of the primary jaw elevators:
 temporalis, masseter, and medial pterygoid.
- AI had difficulty with sounds requiring simultaneous contraction of the vertical intrinsic muscles and genioglossus extrinsic muscles of the tongue.
 Significance: More than one half of continuants, a group he did not produce, require co-contraction of these muscles.
- SR did not produce any sounds requiring active use of the following muscles:
 buccinator, vertical instrinsic, inferior longitudinal, genioglossus, or hyoglossus muscles.



Extrinsic Musculature of the Tongue



from Barlow, S. , Andreatta, R., & Kahane, J. (1999). Muscle systems of the vocal tract. In S.M. Barlow (Ed), Handbook of Clinical Speech Physiology (Figure 1, p. 86; Figure 2, p. 88). San Diego, Singular Publishing Group.

Tentative Impressions

- Even apparently nonverbal, older individuals with autism may have enough oromotor capabilities to use as the substrate for effective speech production.
- There is a pattern of oromotor impairment, suggesting that there may be a specific pattern of brainstem neuroanatomic involvement.
- These individuals are already trying to communicate (sometimes orally). However, because their vocalizations may be very brief and atypical, these attempts at communication may not be appreciated as such.
- Oral communication attempts, without reinforcement, may be extinguished and contribute to the apparent "inability" to speak.

Future Directions

- Compare current vocalizations of the same 2 subjects to previous vocalizations to determine how stable the repertoire has been over time.
- Increase the scope of the study to include more subjects to determine if similar patterns exist in other children within this subpopulation,
- Complete spectrographic analysis to determine if perceptual data are supported by acoustic data.

Acknowledgements: Many thanks to the participating subjects and their families; to Andrea Hayes, M.S., C.C.C.-SLP who helped develop the Noldus coding and rated segments for reliability comparison; to Richard Skolasky, M.A. who provided statistical analysis; and to Erin Andersson, M.A., C.C.C.-SLP who contributed the spectrograms.
Support: This investigation was supported in part by an anonymous donor, The Therapeutic Cognitive Neuroscience Fund, and by The Benjamin A. Miller Family Endowment for Aging, Alzheimer's Disease, and Autism.

* Noldus Information Technology, Leesburg, Virginia; www.noldus.com

ASHA Convention – Philadelphia, PA
November 18, 2004
Maureen M. Boner, M.S., C.C.C.-SLP
Loyola College in Maryland
410-617-1530
Mboner@Loyola.edu

References

1. Rutter, M. (1968). Language disorder and infantile autism. In M. Rutter and E. Schopler (eds.), *Autism: a reappraisal of concepts and treatment*. New York: Plenum.

Howlin, P. (1981). The effectiveness of operant language training with autistic children. *J of Aut and Dev Dis*, 11(1), 89-105.

Bryson, S. (1996). Brief report: epidemiology of autism. *J Autism Dev Disord*, 26 (2), 165-167.

Lord, C. & Paul, R. (1997). Language and communication in autism. In D. Cohen & M. Volkmar, M. (Eds), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 195-225) New York: J. Wiley.

2. Adams, L. (1998). Oral-motor and motor-speech characteristics of children with autism. *Focus on Autism & Other Developmental Disabilities*, 13, 108-112.

Amato, J. & Slavin, D. (1998). A preliminary investigation of oromotor function in young verbal and nonverbal children with autism. *Transdisciplinary J*, 8 (2), 175-84.

Nishimura, B, Watamaki, T, Sato, M, & Wakabayashi, S. (1987). *The criteria for early use of nonvocal communication systems with nonspeaking autistic children*. J of Aut and Dev Dis, 17 (2), 243-253.

Page, J. and Boucher, J. (1998). Motor impairments in children with autistic disorder. *Child Language Teaching and Therapy*, 14(3), 233-259.

3. Singh, S. & Singh, K.S. (1979). *Phonetics principles and practices*. Baltimore: University Park Press.

4. Morris, S.E. (1985). Developmental implications for the management of feeding problems in neurologically impaired infants. *Semin Speech Lang*, 6, 293-315.

Palmer, J.M. (1993) *Anatomy for Speech and Hearing* (4th Ed.). Baltimore: Williams & Wilkins.

Sieg, K.W., Adams, S.P., Scott, A.D., & Conway, D. (1985). Illustrated Essentials of Musculoskeletal Anatomy (2nd Ed.)

Zemlin, W.R. (1968). *Speech and Hearing Science: Anatomy and Physiology*. Englewood Cliffs, NJ: Prentice-Hall.

Zemlin, W.R. (1998). *Speech and Hearing Science: Anatomy and Physiology* (4th ed). Boston: Allyn & Bacon.

Bahr, D.C. & Hillis, A.E. (2001). *Oral motor assessment and treatment: Ages and stages*. Boston: Allyn and Bacon.

5. Wetherby, A.M., Prizant, B.M., & Hutchinson, T. (1998). Communicative, social-affective, and symbolic profiles of young children with autism and pervasive developmental disorder. *AJSLP*, 7, 79-91.

6. Mayer-Johnson, Inc. copyright 1981-2003
http://www.mayer-johnson.com/

7. Davis, B.L., & MacNeilage, P.F. (1995). The Articulatory Basis of Babbling. *J Speech Hear Res*, 38, 1199-1211.

Muscles involved in typical production of consonants and vowels																			
		Muscles of the Jaw and Face										**Intrinsic Tongue**				**Extrinsic Tongue**			
Phoneme	**Produced by**	**Digastric-anterior**	**Mylohyoid**	**Geniohyoid**	**Lateral Pterygoid**	**Temporalis**	**Masseter**	**Medial Pterygoid**	**Buccinator**	**Orbicularis Oris**	**Mentalis**	**Vertical**	**Transverse**	**Inferior Longitudinal**	**Superior Longitudinal**	**Styloglossus**	**Genioglossus**	**Hyoglossus**	**Glossopalatine**
m	AI, SR									ST*									
n	AI, SR	S	S	S	S											Y			
j	AI, SR	S	S	S	S					S	S		Y						Y
d	AI, SR														Y	Y			
h	AI, SR	S	S	S	S														
k	AI, SR															Y			Y
b	AI, SR	S	S	S	S					ST*									
l	AI, SR	S	S	S	S								Y		Y	Y			Y
w	AI, SR	S	S	S	S					ST*	ST*								
g	AI, SR															Y			Y
t	AI, SR														Y	Y			
f	AI	S	S	S	S				Y	S	S								
v	AI	S	S	S	S				Y	S	S								
ʃ	AI	S	S	S	S					S	S	Y		Y			Y	Y	
ʤ	AI														Y	Y			
ʧ	AI														Y	Y			
ʒ	N/A	S	S	S	S					S	S	Y		Y			Y	Y	
ŋ	N/A	S	S	S	S											Y			Y
p	N/A	S	S	S	S					ST*									
Θ	N/A	S	S	S	S							Y					Y		
ð	N/A	S	S	S	S							Y					Y		
s	N/A					Y	Y	Y					Y				Y		
r	N/A	S	S	S	S					S	S		Y	Y			Y	Y	Y
vowels																			
i	AI, SR	S	S	S	S									Y		Y	Y	Y	Y
I	AI, SR	S	S	S	S									Y		Y	Y	Y	Y
u	AI, SR	S	S	S	S					ST*	ST*			Y			Y	Y	
e	AI, SR	M	M	M	M									Y		Y	Y	Y	Y
ε	AI, SR	M	M	M	M						M*					Y			Y
a	AI, SR	M	M	M	M												Y	Y	
æ	AI, SR	ST	ST	ST	ST												Y	Y	
ʊ	AI, SR	S	S	S	S					M*				Y			Y		
Λ	AI, SR	S	S	S	S									Y			Y	Y	
o	AI	S	S	S	S					M*	M*						Y	Y	
ɔ	AI	S	S	S	S					M*	M*			Y			Y	Y	

KEY

S = slight muscle contraction; **M =** Moderate contraction; **ST =** Strong/significant contraction; **Y =** Yes, contraction noted;

*** =** Indicates the strength of contraction which is normally present in the production of the phonemes is significantly reduced in productions by subject(s) in the current study

Table adapted from Morris (1985), Palmer (1993), Sieg et al. (1985), Zemlin (1968 & 1998), as summarized in Bahr & Hillis (2001).