Mass General Brigham

Chewing in Minimally Verbal and Verbal Children with Autism Spectrum Disorder

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Agenda

- Introduction
- Literature Review
- Methods
- Results
- Discussion
- Questions

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Introduction

Chewing in Typically Developing Children

- Insufficiencies: prolonged chewing time (Gisel, 1988, 1991; Schwaab et al., 1986; Wilson et al., 2012), increased number of chewing cycles per bite (Gisel, 1988, 1991; Schwaab et al., 1986; Wilson et al., 2012), increased lateral jaw displacement (Wilson & Green, 2009), decreased vertical jaw displacement (Steeve, 2010)
- Chewing sequence decreases consistently with age (mature chewing 18 months, established by 24-30 months)

Relationship Between Chewing and Language

- Development of mandibular movements used for chewing could be the basis for establishing complex speech movements (Moore, 2004)
- Skills in complex oral motor movements have been related to language development (Alcock, 2006; Gernsbacher et al., 2008; LeBarton & Iverson, 2013)
- Self-feeding may aid in developing oral motor and motor skills required for language production (Webber et al, 2021)

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Introduction

Chewing and Autism Spectrum Disorder

- 5x more likely than neurotypical peers to have feeding challenges: restricted and repetitive behaviors (Ahearn et al., 2001; Raiten & Massaro, 1986; Schreck et al., 2004; Williams et al., 2005; Williams et al., 2000), food selectivity influenced by sensory sensitivities (Ashley et al., 2020; Ayres, 1979; Cermak et al., 2010, Dunn, 1999; Twachtman-Reilley et al., 2008; Williams, 2000)
- Not all components of motor and language are bidirectional, may be influenced by age and motor task

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Introduction

Relationship of Oral Motor Skills and Language

- ASD can exhibit persistent motor difficulties (e.g., gross, fine motor) (Alcock, 2006; Bhat et al., 2011; LeBarton & Iverson, 2013)
- In infants and toddlers, oral motor skills (e.g., producing animal sounds or raspberries) and manual motor skills (e.g., pointing distally, clapping) were predictive of later speech fluency in ASD (Gernsbacher et al., 2008)
- Motor deficits indicate and influence development of speech and language in ASD (Chenausky et al., 2019; Prizant, 1996; Szypulski, 2003; Velleman et al., 2010)

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Introduction

Relationship of Motor and Language Skills

Development of motor skills	
Fine motor skills 12-18 months and 24 months (LeBarton & Iverson, 2013; Libertus & Violi, 2016)	Predictive of expressive language skills at 36 months (LeBarton & Iverson, 2013; Libertus & Violi, 2016)
Oral motor control 21 months (Alcock & Krawczyk, 2010; Libertus & Violi, 2016)	Correlates positively with language skills
Oral motor skills are associated with language production past the earliest stages of language development (Alcock, 2006; Alcock & Conner, 2021; Belmonte et al., 2013)	

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Introduction

Duration of Chewing Sequence- the interval beginning when the dried oat cereal entered the child's mouth and ending with the first swallow. required to have at least three chewing cycles before the swallow and be free from distractions such as talking, laughing, or obstructions of view (i.e., hand in the face, face out of camera frame)

Number of Cycles per Chewing Sequence- began at the point of maximal jaw displacement, continued through the point of minimal jaw displacement, and ended at the subsequent point of maximal jaw displacement.

Number of Extraneous Movements per Chewing Sequence- tongue thrusting, sweeping, and lip flapping. Tongue thrusting occurred when the tongue protruded outside the mouth during the swallow (Hanson & Utah, 2018). Tongue sweeping was when the tongue moved either left or right within the oral cavity past the vertical midline (Adams et al., 2020). This included jaw skewing/displacement when the mouth was open and the tongue pushing the cheek when the mouth was closed before the swallow. Lip flapping was defined as instances when the lips made contact with each other one or more times, similar to lip-smacking.

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Hypotheses

1. We hypothesize that MV children will have, on average longer chewing sequence durations, more chewing cycles per sequence, and more extraneous movements per sequence than V children
2. We hypothesize that the three chewing variables will correlate with language and motor scores (e.g., longer chewing sequence duration = lower language and motor scores).
3. We hypothesize that the three chewing variables will not correlate with autism severity or age.

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Methods

	Age (Months)	Autism Severity Score (SCQ)	Number of Different Words	VABS-3 Expressive Language	VABS-3 Receptive Language	VABS-3 Motor Composite
M (SD)	73.2 (14.2)	16.4 (11)	48.7 (53.6)	4.6 (4.6)	7.6 (4.33)	73.9 (10.4)
Range [min-max]	[49-95]	[.00-65]	[.00-174]	[1-15]	[1-17]	52-100]

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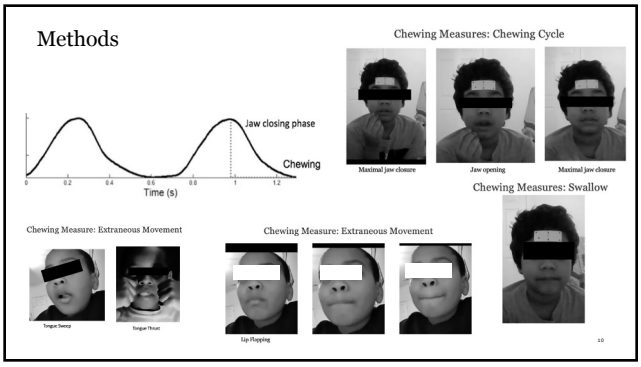
Methods



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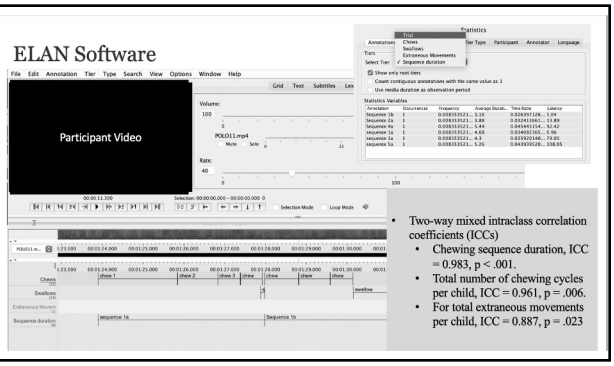
ELAN Software



- Two-way mixed intraclass correlation coefficients (ICCs)
  - Chewing sequence duration, ICC = 0.983, p < .001.
  - Total number of chewing cycles per child, ICC = 0.961, p = .006.
  - For total extraneous movements per child, ICC = 0.887, p = .023

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Results & Discussion

Results: No significant differences between groups on any measure.

	Average Sequence Duration (seconds)	Cycles per Sequence	Extraneous Movements per Sequence
MV (n=15)	.03 (.02)	4.7 (1.07)	.59 (.44)
V (n=19)	.05 (.03)	5.1 (1.49)	.87 (.86)
P-value	.121	.392	.260

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Results & Discussion

Results: Significant positive correlations between average cycles per sequence, and measures of language and motor skills. Vineland Motor Composite score significantly positively correlated with the average number of chewing cycles per sequence. The higher the motor composite score, the greater the number of chewing cycles per sequence. There was no correlation between any of the chewing variables and age.

	Average Sequence Duration	Average Cycles per Sequence	Extraneous Movements per Sequence
VABS-3 EL	.436*	.329	.086
VABS-3 RL	.181	.118	.012
NDW	.384*	.311	.102
VABS-3 Motor	.308	.508**	-.084

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Results & Discussion

Results: No correlation between Autism severity and the chewing variables.

	Average Sequence Duration	Average Cycles per Sequence	Extraneous Movements per Sequence	Age (months)
SCQ	-.001	-.063	-.091	-.037

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Limitations and Future Work

Limitations

1. One food consistency (i.e., dried oat cereal)
2. No information on sensory functions
3. Constraints of using remotely collected video-recorded data

Future Work

- Does chewing development at younger ages differ in ASD than in TD children?
- Additional considerations: extraneous movements, sensory feedback, and developmental contexts.
- Comparing extraneous movements in children with ASD to NT
- Do extraneous movements demonstrate delayed chewing maturity compared to TD counterparts?

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References

Adams S. N. (2022). Feeding and swallowing issues in autism spectrum disorders. *Neuropsychiatric disease and treatment, 18,* 2311–2321. https://doi.org/10.2147/NDT.S332523

Ahearn, W. H., Castine, T., Nault, K., & Green, G. (2001). An assessment of food acceptance in children with autism or pervasive developmental disorder-not otherwise specified. *Journal of Autism and developmental disorders, 31*(5), 505–511. https://doi.org/10.1023/a:1012221026124

Alcock, K. (2006) The development of oral motor control and language. *Down Syndrome Research and Practice, 11*(1), 1–8. doi:10.3104/reports.310

Alcock, K., & Connor, S. (2021). Oral motor and gesture abilities independently associated with preschool language skill: Longitudinal and concurrent relationships at 21 months and 3–4 years. *Journal of Speech, Language, and Hearing Research, 64*(6), 1944–1963. https://doi.org/10.1044/2021_JSLHR-19-00377

Amato & Slavin (1998). A preliminary investigation of oromotor function in young verbal and nonverbal children with Autism. *The Transdisciplinary Journal, 8(2),* 175-184.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (edition 5.). Arlington, VA: American Psychiatric Association.

Ashley, K., Steinfeld, M. B., Young, G. S., & Ozonoff, S. (2020). Onset, trajectory, and pattern of feeding difficulties in toddlers later diagnosed with autism. *Journal of Developmental & Behavioral Pediatrics*, *41*(3), 165–171. https://doi.org/10.1097/DBP.0000000000000757

Bates, E. & Goodman, J. C. (1997). On the inseparability of grammar and the lexicon: Evidence from acquisition, aphasia, and real-time processing. *Language and Cognitive Processes*, 12(5-6), pp. 507–584.

Belmonte, M. K., Saxena-Chandhok, T., Cherian, R., Muneer, R., George, L., & Karanth, P. (2013). Oral motor deficits in speech-impaired children with autism. *Frontiers in Integrative Neuroscience*, p. *7.* https://doi.org/10.3389/fnint.2013.00047

Bhat, A.N., Landa, R.J., & Galloway, J.C. (2011). Current perspectives on motor functioning in infants, children, and adults with autism spectrum disorders. *Phys Ther;91*:1116–29.

Brisson, J., Warreyn, P., Serres, J., Foussier, S., & Adrien-Louis, J. (2012). Motor anticipation failure in infants with autism: A retrospective analysis of feeding situations. *Autism*, *16*(4), 420–429. https://doi.org/10.1177/1362361311423385

Cattaneo, L., Fabbri-Destro, M., Boria, S., Pieraccini, C., Monti, A., Cossu, G., & Rizzolatti, G. (2007). Impairment of action chains in autism and its possible role in intention understanding. *Proceedings of the National Academy of Sciences*, *104*(45), 17825–17830. https://doi.org/10.1073/pnas.0706273104

Cermak, S. A., Curtin, C., & Bandini, L. G. (2010). Food selectivity and sensory sensitivity in children with autism spectrum disorders. *Journal of the American Dietetic Association*, *110*(2), 238–246. https://doi.org/10.1016/j.jada.2009.10.032

Chenausky, K., Brignell, A., Morgan, A., & Tager-Flusberg, H. (2019). Motor speech impairment predicts expressive language in minimally verbal, but not low verbal, individuals with autism spectrum disorder. *Autism & Developmental Language Impairments*, *4*, 239694151985633. https://doi.org/10.1177/2396941519856333

Gisel E.G. (1991) Effect of food texture on the development of chewing of children between six months and two years of age. *Developmental Medicine;33* (1):69–79.

Gisel, E.G. (1988) Chewing cycles in 2-to 8-year-old normal children: A developmental profile. *American Journal of Occupational Therapy 42*(1):40–46.

Gladfelter, A., & Goffman, L. (2018). The semantic richness and word learning in children with autism spectrum disorder. *Developmental Science*, *21*(2), e12543 https://doi.org/10.1111/desc.12543

Gernsbacher, M. A., Sauer, E. A., Geye, H. M., Schweigert, E. K., & Hill Goldsmith, H. (2008). Infant and toddler oral- and manual-motor skills predict later speech fluency in autism. *Journal Child Psychology and Psychiatry, 49*(1), 43–50.

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He, M., Walle, E. A., Campos J. J. (2015). A cross-national investigation of the relationship between infant walking and language development. *Infancy* 20 283–305. 10.1111/infa.12071

Klein, U., Nowak, A.J. (1999). Characteristics of patients with autistic disorder (AD) presenting for dental treatment: A survey and chart review. *Spec Care Dentist;19*:200–207.

LeBarton, E. S., & Iverson, J. M. (2013). Fine motor skill predicts expressive language in infant siblings of children with autism. *Developmental Science, 16*(6), 815–827. https://doi.org/10.1111/desc.12069

Libertus, K., & Violi, D. A. (2016). Sit to Talk: Relation between motor skills and language development in infancy. *Frontiers in psychology*, *7*, 475. https://doi.org/10.3389/fpsyg.2016.00475

Moore, C. (2004). Speech motor control in normal and disordered speech. *Oxford University Press.*

Oudgenoeg-Paz O., Volman M. C., Leseman P. P. (2012). Attainment of sitting and walking predicts development of productive vocabulary between ages 16 and 28 months. *Infant Behav Dev.* 35733–736 10.1016/j.infbeh.2012.07.010

Pinder, G. L., & Faherty, A. S. (1999). Issues in pediatric feeding and swallowing in A. Caruso & E. A. Strand (Eds.), Clinical Management of Motor Speech Disorders in Children (pp. 281 -318). *New York, NY: Thieme Medical Publishers.*

Raiten, D. J., & Massaro, T. (1986). Perspectives on the nutritional ecology of autistic children. *Journal of Autism and developmental disorders*, *16*(2), 133–143. https://doi.org/10.1007/BF01531725

Sheppard, J. J., & Mysak, E. D. (1984). Ontogeny of infantile oral reflexes and emerging chewing. *Child Development, 55*(3), 831–843.

Shriberg, L. D., Paul, R., Black, L. M., & van Santen, J. P. (2011). The hypothesis of apraxia of speech in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *41*(4), 405–426. https://doi.org/10.1007/s10803-010-1117-5

Steeve, R.W. (2010). Babbling and chewing: Jaw kinematics from 8 to 22 months. *Journal of Phonetics*;*38*(3):445–458. doi: 10.1016/j.wocn.2010.05.001.

Schwaab, L.M., Niman, C.W., and Gisel, E.G. (1986). Comparison of chewing cycles in 2-, 3-, 4-, and 5-year-old normal children. *The American Journal of Occupational Therapy;40*(1):40–43.

Schreck, K.A., Williams, K., & Smith, A.F. (2004) A comparison of eating behaviors between children with and without autism. *J Autism Dev Disord*;34:433–438.

Szypulski, T.A. (2003). Interactive oral sensorimotor therapy: One more weapon in the arsenal fight to combat the primary deficits of autism. *Advance for Speech-Language Pathologists and Audiologist* 9-10.

Velleman et. al., (2010). Motor speech disorders in children with autism. *Speech sound disorders in children,* 141-180.

Walle, E. A., Campos, J. J. (2014). Infant language development is related to the acquisition ofwalking. *Dev. Psychol.* 50 336–348. 10.1037/a0033238

Williams, P.G., Dalrymple, N., & Neal, J. (2000). Eating habits of children with autism. *Pediatric Nursing;* 26:259–264.

Williams, K.E., Gibbons, B.G., & Schreck, K.A. (2005). Comparing selective eaters with and without developmental disabilities. *J Dev Phys Disabil*;17:299–309.

Wilson, E.M., Green, J.R., & Weismer, G. (2012). A kinematic description of the temporal characteristics of jaw motion for early chewing: preliminary findings. *Journal of Speech, Language, and Hearing Research;55*(2):626–38. doi: 10.1044/1092-4388(2011/10-0236).

Wilson, E.M. & Green, J.R. (2009). The development of jaw motion for mastication. *Early Human Development;85*(5):303–11. doi: 10.1016/j.earlhumdev.2008.12.003.

Webber, C., Blissett, J., Addessi, E., Galloway, A. T., Shapiro, L., & Farrow, C. (2021). An infant-led approach to complementary feeding is positively associated with language development. *Maternal & child. nutrition, 17*(4), e13206. https://doi.org/10.1111/mcn.13206

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