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EVIDENCE-BASED INTERVENTION FOR
TODDLERS WITH SENSORIMOTOR
FEEDING DISORDERS

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Structured Abstract

Clinical Question: For toddlers with feeding disorders characterized by oral-motor deficits and limited texture acceptance, would an intervention that specifically included at least one sensory processing component (e.g., tactile, proprioception) and an oral-motor component be more effective than only an oral-motor intervention?

Method: Scoping Review

Study Sources: PubMed, Cochrane.org, PsychInfo, CINAHL, and ASHA.org

Search Terms: *Oral-motor or sensory or sensorimotor, and feeding and intervention and therapy*

Number of Included Studies: 20

Primary Results:

1. Oral-motor interventions are modestly effective in improving oral motor skills in a heterogeneous group of children
2. Sensory interventions, combined with oral-motor interventions, are effective in improving oral motor skills and texture advancement
3. A direct comparison of the effectiveness of oral-motor only and sensory + oral-motor is difficult as every empirical study included both a motor and a sensory component to treatment

Conclusions: Currently, better evidence supports the use of oral-motor interventions combined with sensory interventions in a specific population. Such interventions may not be directly applicable to toddlers without other co-occurring etiologies. These conclusions should be considered with patient/family perspectives and clinical expertise to develop the best possible treatment plan.

Evidence-Based Intervention for Toddlers with Sensorimotor Feeding Disorders

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Clinical Scenario

Rachael provides early intervention services for children through a local agency in a Northeastern state. She recently started seeing Brian, whose parents are concerned with his feeding and swallowing. They report that he generally refuses solids. If he does accept some type of solid or a puree mixed with a solid, he does not attempt to orally prepare it in any way and usually chokes and gags. Although his parents have been concerned for some time, his pediatrician was never concerned because he was gaining weight and generally healthy (e.g., no respiratory illnesses). She referred Brian for an oral-motor feeding evaluation at 18 months, when his family could not wean him from the bottle and begin changing his diet to solids.

Brian's parents took him to the closest pediatric hospital for the initial assessment. An interdisciplinary feeding team conducted the clinical evaluation. Based on Brian's medical history and parents' information, the team concluded that Brian has gastroesophageal reflux disease (GERD). He was born at 30 weeks and remained in an intensive care unit for approximately 8 weeks due to concerns with weight gain and feeding. After he was discharged, Brian continued to have difficulty gaining weight. He was put on a protein pump inhibitor at approximately 5 months old (not age-corrected) and his feeding improved. His parents did not report any more problems until he was 10 months old, when they began introducing solid food in his diet. Brian's overall strength was within normal limits, but his oral-motor skills for feeding were delayed. Consistent with his diet, he only accepted purees during the clinical evaluation. The baseline video-swallow study revealed no penetration, aspiration, or other concerns with the pharyngeal phase of swallowing. The occupational therapist also reported a general sensory-processing disorder, specifying an oral-sensory processing deficit. All other areas of development, including speech, language, cognition, fine motor, and gross motor, were within functional limits for his age.

Though interdisciplinary teams often are recommended for assessing and managing children with feeding and swallowing disorders (Miller, Burklow, Santoro, Kirby, Mason, & Rudolph, 2001), there are logistical constraints. Brian's family cannot travel the 2 hours weekly to the local pediatric hospital and Rachael's current employer cannot provide interdisciplinary services. Rachael received some training on pediatric feeding and swallowing disorders (more than 10 years ago) in graduate school, but she knows she needs to do some additional discovery and consider the logistical constraints to determine the best approach(es) for Brian. Brian's parents both work and are very anxious for him to make progress because his feeding challenges limit their ability to find appropriate childcare. They would like Brian to be eating age-appropriate foods by his second birthday. Rachael knows she can target the development of oral-sensorimotor skills through oral-motor interventions. What she is unsure of, however, is if oral motor exercises alone will improve Brian's sensorimotor skills for feeding, accepting different foods and liquids, and preparing the bolus and transferring it for pharyngeal swallow initiation (Arvedson & Brodsky, 2002).

The Clinical Question

To begin her research, Rachael needed to develop a specific question that could be answered using an intervention-focused, evidence-based framework (Centre for Evidence Based Medicine, 2011; Sackett, Straus, Richardson, Rosenberg, & Haynes, 2000). She identified her patient (population, P), the alternative intervention (I), the comparison intervention (C), and the outcomes and measurement for these outcomes (O). Her specific question was: For toddlers (12 to 30 months old) with feeding disorders characterized by oral-motor deficits and limited texture acceptance (P), would an intervention that specifically included at least one sensory component (e.g., tactile, proprioception) in addition to an oral-motor

component be more effective (I) than only oral-motor intervention (C) for improving feeding skills, as measured by oral motor skill improvement and advanced texture acceptance (O)?

Search for Evidence

Because many disciplines are involved in the diagnosis and treatment of feeding disorders, Rachael operationally defined the terminology she would use to search for external evidence. The terminology is listed in Figure 1.

Rachael believed, based on her experience and awareness of the emerging knowledge base of feeding disorders, that her search would be more productive if she limited her exclusion criteria. Ideally, she wanted to know about premature children with a history of GERD. Because it was unlikely that she would find much research focused on this specific group, she decided to include studies of children with any condition similar to Brian's oral-motor delay. The feeding and swallowing disorders of children with autism or cleft palate have a different underlying primary etiology, so Rachael excluded studies of children with these disorders. The inclusion and exclusion criteria are shown in Figure 2.

Rachael began her search with PubMed. For any article identified as a "hit" in the PubMed database, Rachael reviewed the abstract to determine if the study met her inclusion criteria. She added studies that met the criteria to her review list. Rachael then searched the Cochrane Library, the PsychInfo Database, and CINAHL database. When she searched the American Speech-Language Hearing Association (ASHA) website, Rachael decided to include peer-reviewed articles that may not include an experimental condition. If Rachael found an article identified in more than one database (e.g., CINAHL identified articles also found in PubMed), then she included it in the hits count, but not as an article to review. The number in the Original Articles Selected column represents the number of articles included in the review. The full process and results of Rachael's search are located in Figure 3. An overview of all articles reviewed is located in Appendices A through C. Her search yielded 20 articles.

Rachael could access full-text articles in ASHA journals (e.g., *The American Journal of Speech Language Pathology*) as an ASHA member, but many of the journals she needed were in psychology and medicine. She contacted a local librarian who suggested that Rachael

contact her alma mater for help. Rachael contacted a librarian at her undergraduate institution (also affiliated with the medical school). She told Rachael that she could access some databases and full-text articles simply by joining the alumni association. Rachael also was able to purchase a library pass at a greatly reduced rate for 6 days of access per year. This gave Rachael access to all the articles she identified in her search.

Evaluating the Evidence

As Rachael reviewed the studies she had selected, she realized that their quality and specificity varied. She used the *Oxford Center for Evidence-Based Medicine 2011 Levels of Evidence* (OCEBM Levels of Evidence Working Group, 2011) to determine the quality of research and how it applied to her clinical question. The most scientifically robust studies (e.g., systematic reviews of randomized trials) are rated a 1 and the least robust (e.g., mechanism-based reasoning) are rated a 5. Using the Oxford system, Rachael also considered the type of study and other factors, such as sample selection and effect size. Systematic reviews on related topics are listed in Appendix A. Ratings for all the empirical studies Rachael reviewed and rated are listed in Appendix B. The expert opinion and mechanical-based reasoning papers reviewed are listed in Appendix C. Rachael created a graph of the Levels of Evidence quality of studies, as shown in Figure 4.

Considering the totality of the evidence, Rachael realized there was quite a range of evidence on the use of oral-motor exercises in potentially related populations. Three systematic reviews, specifically addressing oral-motor skills, identified a range of effectiveness for improving oral-motor skills; this range included determinations of mixed, conflicting, and moderate effectiveness. Oral-sensory interventions were also described as oral-motor interventions or grouped as oral-motor interventions in at least 1 review, such as tactile stimulation. None of the studies addressed using oral-motor or sensory interventions to advance textures. The application of these reviews to the proposed clinical population was also confounded by the population included in them, as two of the three focused on children with cerebral palsy.

Three studies were identified that were quasi-experimental in nature and considered Level 3 evidence; the lack of randomization prevented them from being truly experimental (randomized two groups but the third

included only children who aspirate). Overall, these studies found oral-motor exercises to be effective, based on a variety of measures of skill and efficiency (e.g., direct observation of chewing vigor, the *Functional Feeding Assessment (FFA)* (Kenny et al., 1989) time to orally prepare different foods, and mealtime duration). While there was always a reported improvement, statistical differences were inconsistent. Sensory interventions were not independently included in any of these studies. One study specifically identified oral-sensorimotor treatments (e.g., oral-motor combined and elicited with food; Gisel, 1994). In the remaining two studies, oral-motor treatment and sensory treatments could not be independently compared because children who received oral-motor treatment had their skills reinforced with foods and were presented with more challenging textures at mealtime, which introduced a sensory component to their treatment.

Seven single-subject or single-subject design studies (Level 4 evidence) provided support for oral-motor skills and sensory interventions for improving oral-motor skills and advancing textures. There was, however, great variation in how improvement was measured, such as the formal *FFA*, the duration of chewing, the time to clear the mouth of food, or the length of the meal. This variation in measurement makes it difficult to compare results and impossible to isolate oral-motor from oral-sensory components of an intervention because food was used in each one. Five of the six expert-opinion papers published by ASHA (Special Interest Group Newsletters or Policy Documents) also support the use of both oral-motor and oral-sensorimotor interventions. The Royal College of Speech Therapists (RSCLT) practice guidelines recommend oral motor exercises, but include/combine sensory components (e.g., thermal and tactile stimulation).

Two additional considerations are noteworthy in evaluating the evidence to answer Rachael's specific PICO question. First, because pediatric feeding and swallowing is a field with less research available than other conditions, Rachael included all types of interventions. As a result, she reviewed studies that included caregiver training programs. Six of the empirical studies included a parent-training component as part of the intervention package, preventing the direct comparison of oral-motor and oral-sensorimotor interventions as well. The second consideration is that the vast majority of the included studies, including two of the three systematic reviews,

focused on children with specific conditions such as CP, traumatic brain injury, and Down syndrome. These populations are very different than the one represented in Rachael's question. Though they may present with similar oral-motor skills, the potential for learning and neural plasticity is likely very different from Rachael's more general population.

There are various levels of evidence that support oral-motor interventions combined with sensory interventions as effective ways to improve oral motor skills and advance textures. Given the evidence presented and the inconsistent findings reported in the systematic reviews, the combination of oral-motor and sensory interventions has a Level 3 evidence base. Comparing combined interventions to oral-motor-only intervention is very difficult, as almost all included studies combined some aspect of sensory treatment in their oral-motor intervention. Only two expert papers did not advocate for including some type of sensory intervention. Although this review included studies of children with a variety of etiologies, the findings may still be applicable to children without overt neurological conditions.

The Evidence-Based Decision

After reviewing all the literature, Rachael had to make the decision about how the evidence applied to her PICO question. Not a single empirical article that Rachael reviewed included a patient population similar to Brian. Independent of the level of evidence, there were differences in treatment settings (e.g., inpatient hospital stay vs. home-based early intervention) and treatment intensity (multiple sessions per day vs. once to twice per week). Rachael used all three components of evidence-based practice, current practice, clinical expertise, and patient/family perspective, to make her decision.

Rachael's found more evidence to support the use of oral-motor interventions combined with sensory interventions than not. This was consistent with her previous clinical practice, in which she found children were more responsive to oral-motor activities that enabled them to explore their mouths on their own and could be incorporated into games, such as songs with a tooth brush on the tongue, games involving biting into foods, and exploring different textures of non-food items as well. She also thought Brian and his parents might be more likely to see a connection between the oral-motor activities if

they involved sensory input through food, and they might be more motivated to participate in therapy activities. This could also facilitate Brian's acceptance of foods and may be more efficient in improving his skills and introducing textures.

When Rachael discussed the options with Brian's family, she presented an overview of what she determined from the literature. To accomplish the goal of Brian eating specific foods by his second birthday, Rachael and his parents determined they would begin a treatment plan that included oral-motor and sensory components. Rachael discussed the need for reinforcement and ongoing practice at home. Brian's parents agreed that this would be important as well. They also agreed that he would continue occupational therapy as an additional sensory intervention. Rachael assured them that the SLP and occupational therapist would communicate to ensure the goals for Brian were aligned. At the end of the quest to find the best treatment options for Brian, Rachael and Brian's family were confident that they had made the most informed decision possible.

Author Note

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<p>Toddlers: Children 10–35 months; beyond bottle feeding, prior to starting preschool</p> <p>Transitional Feeding: Introduction of solid foods, textures, cups, etc. (Arvedson & Lefton-Grief, 1996)</p> <p>Oral-Motor: The skills necessary to bite, chew, and transfer boluses</p> <p>Sensory Intervention: Any intervention that impacts any one of the 7 sensory systems including tactile, smell, proprioception, etc.</p> <p>Texture Advancement: Progression from easiest texture of puree to regular solids</p>

Figure 1.

Chart detailing the operational definitions applied to this review.

<p>Participant Inclusion:</p> <ul style="list-style-type: none"> • Studies of children with oral-motor, feeding, texture delays • Studies with at least one child up to 5 years of age <p>Participant Exclusion:</p> <ul style="list-style-type: none"> • Studies primarily of children with autism • Studies primarily of children with cleft lip or palate <p>Independent Variable:</p> <ul style="list-style-type: none"> • Must include an independent variable • Must include an oral-motor or sensory component in treatment (may not be only component) • Must be a treatment that would be appropriate for toddlers <p>Dependent Variable (Outcomes):</p> <ul style="list-style-type: none"> • Must include oral-motor skill development or texture advancement as an outcome measure

Figure 2.

Specific inclusion and exclusion criteria applied to articles included in the review.

Database	Limiters	Terms	Hits	Original Articles Selected*
PubMed	Title/Keywords/Age-limit (1 month to 23 months, 2-5 years)	Oral-motor, sensory, sensorimotor AND Feeding AND Intervention OR therapy	67	8
Cochrane	Keywords/abstract	Oral-motor + feeding	1	0
		Feeding and Swallowing	13	
		Sensory + feeding	1	
PsychInfo	Title/Keywords/Age-limit Infant (1 month-23 months, preschool 2-5 years)	Sensorimotor + Feeding	0	2
		Oral-motor, sensory, sensorimotor AND Feeding AND Intervention OR therapy	36	
CINHAL	Title/Keywords/Age-limit (Infant 1 month-23 months, preschool 2-5 years)	Oral-motor, sensory, sensorimotor AND Feeding AND Intervention OR therapy	42	1
ASHA	Keywords Journals/Perspectives/EBP Compendium	Oral-motor, sensory, sensorimotor AND Feeding AND Intervention OR therapy	23	9*

Figure 3.

Search methodology for articles included in this review. This figure lists the search strategies and systematic steps used to identify all original articles included in this review. Three sources of the 9* were identified from searching other hits within the ASHA.org webpage.

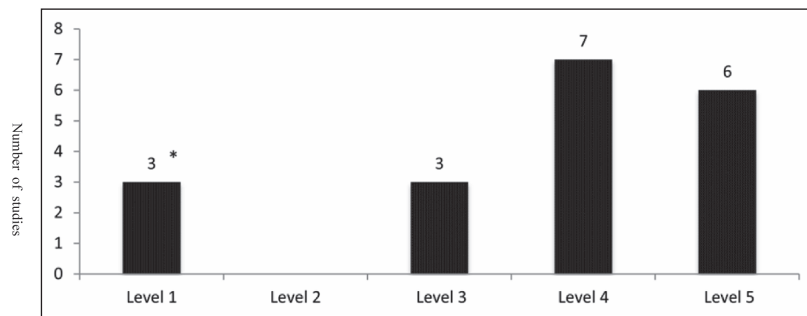


Figure 4.

The distribution of levels of evidence reported published articles reviewed. Level 1* findings were neither strong nor consistent.

Appendix A
Articles Reviewed and Relevant Findings

Review	Population	Included Oral-Motor Interventions	Included Sensory Interventions	Findings Relevant to PICO	Additional Information
Arvedson, J., Clark, H., Lazarus, K., Schooling, T., & Frymark, T. (2010). The effects of oral-motor exercises on swallowing in children: an evidence-based systematic review. <i>Developmental Medicine and Child Neurology</i> , 52, 1000–1013.	Children with swallowing disorders	Yes	No	–Mixed results for use of oral motor exercises to improve swallowing physiology	–Great deal of variation in application of oral motor exercises –Several studies were of children older than those included in this review –Additional outcomes not reviewed here
Davies, F. (2003). Does the end justify the means? A critique of oromotor treatment in children with cerebral palsy. <i>Asia Pacific Journal of Speech, Language, and Hearing</i> , 8(2), 146–52.	Children with cerebral palsy	Yes	No	–Moderate support for oral-motor exercises	–Difficult to evaluate effectiveness due to variation in outcomes –Limited literature base for recommendation –Additional outcomes not reviewed here
Snider, L., Majnemer, A., & Darsaklis, V. (2011). Feeding Interventions for Children with Cerebral Palsy: A Review of the Evidence <i>Physical and Occupational Therapy in Pediatrics</i> , 31(1), 58–77.	Children with cerebral palsy	Yes (oral and sensory combined into oral sensorimotor)	Yes, oral sensorimotor and food consistency	–Conflicting evidence for oral sensorimotor –May be evidence to decrease texture for safety, did not address advancing	–Identifies limitations of review including small size of most intervention trials –Additional outcomes not reviewed here

Appendix B
Selected Empirical Articles, Interventions, Outcomes, and Quality Ratings

Eckman, N., Williams, K. E., Riegel, K., & Paul, C. (2008). Teaching chewing: A structured approach. <i>The American Journal of Occupational Therapy</i>, 62, 514–521.	
Participants	$n = 2$; 9-year-old with Down syndrome and a 5-year-old with a complex medical history, both with identified oral motor deficits
Research Design	Single subject, multiple baseline
Experimental Intervention	Treatment package included 1) chewing intervention and 2) texture-fading intervention (actually increasing difficulty); package included positive behavioral reinforcement of desired biting and chewing, progression through specific protocol to advance biting, chewing, swallowing of foods of increasingly difficult textures
Outcome Measure	Primary: 1) observed chewing cycle 3 times in 5 seconds, 2) swallow resulting in a clean mouth within 30 seconds of acceptance. Secondary: Various different counts of acceptance behaviors, number of foods accepted
Treatment Intensity	124–149 meals during 19–20 days of inpatient treatment
Outcomes	All primary and secondary outcomes improved, also generalized to acceptance of several novel foods
Effect Size	Not able to be calculated.
Quality Rating*	Level 4
Additional Information Relating to PICO	Parent-training component; all interventions involved food thus included a sensory component as well
Clawson, E. P., Palinski, K. S., & Elliott, C. A. (2006). Outcomes of intensive oral motor and behavioral interventions for feeding difficulties in three children with Goldenhar Syndrome. <i>Pediatric Rehabilitation</i>, 9, 65–75.	
Participants	$n = 3$; ages 1:3–3:6, all tube-fed, only 2 children with any oral intake, all with co-occurring conditions including vision impairment, hearing impairment and GERD (2 of 3)
Research Design	Pre-post, single case study
Experimental Intervention	Multi-component package included 1) oral motor exercises 15–20 minutes prior to mealtime, 2) structured meals, 3) behavioral interventions, 4) caregiver training
Outcome Measure	Measurement of feeding acceptance including bites accepted, length of meal, bites expelled, calories, grams consumed
Treatment Intensity	Inpatient program, mean length of stay 37 days, range 28–44 days, 6 hours/day of intervention
Outcomes	Improvement in all feeding acceptance measures, oral calories, and grams consumed
Effect Size	Not able to be calculated.
Quality Rating	Level 4
Additional Information Relating to PICO	Included a caregiver-training component. All participants completed a VSS prior to beginning treatment; goals individually shaped as one child required thickened liquid. Only targeted pureed textures.
DeMatteo, C., Law, M., & Goldsmith, C. (2002). The effect of food textures on intake by mouth and the recovery of oral motor function in the child with a severe brain injury. <i>Physical and Occupational Therapy in Pediatrics</i>, 22(3/4), 51–71.	
Participants	$n = 3$; ages 3:0–14:0, all with acquired brain injury.
Research Design	Single case study with Latin square crossover design.
Experimental Intervention	Meals randomly comprised of increasingly difficult textures of pureed, minced, and soft-textured foods. All meals combined with positive verbal reinforcement and social interaction. Additional variables, including the feeder, day of treatment, and specific meal of the day investigated but not systematically manipulated.
Outcome Measure	Amount of food intake by mouth and oral motor function as measured by the <i>Behavioural Assessment Scale of Oral Functions in Feeding</i> .
Treatment Intensity	1 meal/day, up to 30 minutes, for 11 days.
Outcomes	Improvement noted for all participants for quantity of the puree, results for texture varied across individual participants. Additional variables (feeder, meal, day of treatment) varied across individual participants.
Effect Size	Not able to be calculated.
Quality Rating	Level 4
Additional Information Relating to PICO	Authors described the need for highly variable but patient-dependent interventions; programs needed to be tailored to individual patient needs.

Appendix B

Selected Empirical Articles, Interventions, Outcomes, and Quality Ratings (continued)

Gisel, E. G., Applegate-Ferrante, T., Benson, J., & Bosma, J. F. (1996). Oral motor skills following sensorimotor therapy in two groups of moderately dysphagic children with cerebral palsy: Aspiration vs. nonaspiration. <i>Dysphagia</i>, 11, 59–71.	
Participants	<i>n</i> = 27; ages 2;5–10;0; all with cerebral palsy, moderate to severe motor impairment, most quadraparetic.
Research Design	Quasi-experimental; 2 groups, not randomly assigned, based on aspiration status
Experimental Intervention	Oral motor skill development including 1) tongue lateralization, 2) lip control, 3) vigor of chewing; also advanced meal textures to reinforce oral motor skills at mealtime
Outcome Measure	1) Aspiration and penetration observed on VSS, 2) oral motor skills measured by the <i>Functional Feeding Assessment (FFA)</i> , 3) weight gain, 4) drooling
Treatment Intensity	20 weeks; 5–7 minutes, 5 days/week prior to mealtime
Outcomes	Results reported for aspirators vs. non-aspirators; 1) Descriptive improvement in aspiration/penetration in both groups (not quantitative), 2) significant improvement in spoon feeding, chewing, swallowing, 3) overall maintained weight, no catch-up growth, 4) inconsistent across groups
Effect Size	Not able to be calculated.
Quality Rating	Level 3
Additional Information Relating to PICO	Addressed treatment compliance based on number of days (67% participation); all were dependent feeders; reinforced oral-motor skills (primarily targeted with food) at lunch time by gradually increasing texture
Gisel, E. G., Applegate-Ferrante, T., Benson, J. E., & Bosma, J. F. (1995). Effect of oral sensorimotor treatment on measures of growth, eating efficiency and aspiration in the dysphagic child with cerebral palsy. <i>Developmental Medicine and Child Neurology</i>, 37, 528–543.	
Participants	<i>n</i> = 27; ages 2;5–10;0; all diagnosed with CP, moderate motor involvement. Participants assigned to 3 groups based on aspiration status; Group 1 and 2 randomly assigned non-aspirating children, Group 3 included all who aspirated.
Research Design	Quasi-experimental, 3 groups, 2 groups randomly assigned, third assigned based on aspiration status. Group 1 with 20 weeks of intervention, Groups 2 and 3 with 10 control weeks followed by 10 experimental weeks.
Experimental Intervention	Oral motor skill development including 1) tongue lateralization, 2) lip control, 3) vigor of chewing, 4) advancing lunch textures
Outcome Measure	1) Aspiration and penetration observed on VSS, 2) duration of preparation and consumption standard textures, 3) duration of mealtime, 4) weight gain and skin fold changes.
Treatment Intensity	10–20 weeks depending on group assignment; 5–7 minutes, 5 days/ week prior to meal.
Outcomes	1) Descriptive improvement in aspiration/penetration (not quantitative), 2) Group 3 only showed a significant decrease in puree consumption time 3) mealtime duration decreased across all groups but not significantly, introduced more complex textures throughout, 4) no significant improvement in weight gain, Group 2 with a significant increase in skin fold thickness during the control condition
Effect Size	Not able to be calculated.
Quality Rating	Level 3
Additional Information Relating to PICO	Included measure of treatment compliance based on number of days (16.7% across all groups, 62.2 to 70.0% across groups). All were dependent feeders. No parental training component.

Appendix B

Selected Empirical Articles, Interventions, Outcomes, and Quality Ratings (continued)

Gisel, E. G., (1994). Oral-motor skills following sensorimotor intervention in the moderately eating-impaired child with cerebral palsy. <i>Dysphagia</i>, 9(3), 180–192.	
Participants	<i>n</i> = 35; All children with cerebral palsy, moderate to severe motor involvement. Ages 4:3–13:3.
Research Design	Pre-post quasi experimental; 3 groups compared (not randomly assigned).
Experimental Intervention	1) sensory-motor intervention (tailored to needs of child, always included foods), 2) chewing only (progressively more difficult textures to chew), 3) control (standard classroom treatment)
Outcome Measure	1) Oral motor skills as measured by the <i>Functional Feeding Assessment (FFA)</i> , 2) weight gain & skin fold 3) drooling associated with eating, 4) oral-motor skills examined in detail
Treatment Intensity	20 weeks, 5–7 minutes/day, 5 days/week
Outcomes	1) All oral-motor skills improved as measured by the <i>FFA</i> , when adjusted for multiple comparisons not significantly, 2) weight gain and skinfold inconsistently improved across participants, no statistical comparisons, 3) drooling improved descriptively, no statistical comparisons
Effect Size	Not able to be calculated.
Quality Rating	Level 3
Additional Information Relating to PICO	Addressed treatment integrity; noted frequent absences across the groups
Clawson, E. P., Kuchinski, K. S., & Bach, R. (2007). Use of behavioral interventions and parent education to address feeding difficulties in young children with spastic diplegic cerebral palsy. <i>NeuroRehabilitation</i>, 22, 397–406.	
Participants	<i>n</i> = 8; ages 1:6–4:7; all with diplegia, have various other co-occurring conditions including oral dysphagia, prematurity, and developmental delay.
Research Design	Case series, pre/post design
Experimental Intervention	1) Oral-motor exercises, specifically Beckman oral motor exercises for 20–30 minutes, 2) various behavioral interventions (e.g. differential attention, positive reinforcement), & 3) parent training.
Outcome Measure	1) Child feeding behaviors, 2) caregiver feeding behaviors, 3) anthropometric data, 4) oral calories.
Treatment Intensity	Varied; most intense 5 days/week as an inpatient, mild-moderate 1–3x/week, 45–60 minutes; average of 5.8 weeks.
Outcomes	No inferential stats, all improved on measures of behaviors, calories, amount, decreased on tube fed if they were tube fed; long term still had improvement in weight and height.
Effect Size	Not able to be calculated.
Quality Rating	Level 4
Additional Information Relating to PICO	Included a parent-training component. Focused only on purees.
Luiselli, J. K. & Gleason, D. J. (1987). Combining sensory reinforcement and texture fading procedures to overcome chronic food refusal. <i>Journal of Behavioral Therapy and Experimental Psychology</i>, 18, 149–155.	
Participants	<i>n</i> = 1; 4-year-old child with rubella syndrome, visual and hearing impairment, and cognitive delay.
Research Design	Single-subject
Experimental Intervention	Dual component 1) texture fading across five levels from most likely to consume (1 = strained baby food) to least likely (5= finely diced foods), 2) sensory (proprioception and vision) components of provided via light and swinging for reinforcement. Also included physical guidance of food acceptance.
Outcome Measure	Frequency counts of acceptance vs. non-acceptance, texture advancement
Treatment Intensity	One meal/day, 20 minutes, five days/week, 25–30 feeding trials for 7 weeks, then 5-week summer break, then intervention for 8 weeks.
Outcomes	Improvement from 0 to 80–90% acceptance; in acceptance, also able to move along texture continuum, after 5 week break never fell below 80% on the Level 5.
Effect Size	Not able to be calculated.
Quality Rating	Level 4
Additional Information Relating to PICO	Specific sensory intervention (light, swinging) outside scope of practice for SLP. Tried to incorporate a home program but that was not possible.

Appendix B

Selected Empirical Articles, Interventions, Outcomes, and Quality Ratings (continued)

Tarbell, M. C., & Allaire, J. H. (2002). Children with feeding tube dependency: Treating the whole child. <i>Infants & Young Children, An Interdisciplinary Journal of Special Care Practices</i>, 15, 29–42.	
Participants	<i>n</i> = 83; mean age 2:7, all receiving nutrition via tube feeding. Various co-occurring conditions included prematurity, chromosomal disorders, cardiac, structural deficits, and 'other.' Included sensory disorders; hunger/satiety, inexperienced eaters, learning barriers, psychosocial issues, sensory/anxiety.
Research Design	Retrospective case description.
Experimental Intervention	Individually tailored approach including mealtime, occupational therapy, therapeutic recreation, preschool activities—specifically texture exploration and food play; included intensive oral functional therapy and whole body sensory intervention as needed
Outcome Measure	Reduction in tube feeding, increase in food consumption as measured by percentage of oral intake and texture.
Treatment Intensity	2–3 weeks of day treatment, 5 full days and 1 half-day comprised 3 meals and 2–3 snacks/day; other types of interventions provided during day treatment (e.g., occupational therapy, therapeutic recreation).
Outcomes	All reduced percentage of tube feedings and increased oral intake, only used percentages. At 5–7 months post-intervention, 75% were completely weaned from tube.
Effect Size	Not able to be calculated
Quality Rating	Level 4
Additional Information Relating to PICO	Also had a caregiver-training component. Cognition needed to be at least 18 months for admission to the program.
Kumin, L., Von Hagel, K., & Bahr, D. (2001). An effective oral motor intervention protocol for infants and toddlers with low muscle tone. <i>Journal of Infant-Toddler Intervention</i>, 11, 181–200.	
Participants	<i>n</i> = 4; ages 1:8–2:3. All treated for hypotonia secondary to Down syndrome. Began treatment between 1 and 4 months with variable frequency of intervention.
Research Design	Case series, post-test only
Experimental Intervention	Multi-component including 1) oral massage, 2) Beckman oral-motor exercises, 3) therapeutic feeding techniques, Sara-Rosenfeld Johnson Programs & jaw exercises.
Outcome Measure	<i>Oral-Motor Behavior in Children Scale</i>
Treatment Intensity	Varied; Ranged only sometimes; doing 1 component to 3 times daily of all 4 components. Intervention provided by the parent and supported by the treating SLP. Self-reported frequency by caregivers.
Outcomes	Post-test scores to rate skills in areas including jaw, lip, tongue movement and a total score.
Effect Size	Not able to be calculated.
Quality Rating	Level 4
Additional Information Relating to PICO	Also included an apraxia inventory, not reported here.

Appendix C

Expert Opinion and Mechanism-Based Reasoning Papers Rated Oxford Level 5

Expert Opinion Paper	Brief Description	Supports Oral-Motor Intervention	Supports Sensory Intervention	Previously Presented or Reported	Additional Information
Toomey, K. A., & Ross, E. S. (2011). SOS approach to feeding. <i>Perspectives on Swallowing and Swallowing Disorders (Dysphagia)</i> , 20, 82–87.	The Sequential Oral Sensory Approach (SOS) proposes a whole-child perspective. Tenets include 1) therapeutic progression that parallels the developmental sequence of eating (oral-motor and sensory), 2) uses systematic desensitization used to develop new skills, 3) encourages developmentally appropriate play, 4) believes therapeutic goals are most efficiently obtained when they include actual food (not tools/objects).	Yes, addressed through targeted intervention with food.	Yes, both oral-sensory and sensory system as a whole.	Yes. Multiple peer-reviewed presentations by authors. Also independent presentations and manuscripts but none peer reviewed.	Transdisciplinary; defines success to include motivation to eat, enjoyment with eating, caloric intake, and improved family functioning
Overland, L. (2011). A sensory-motor approach to feeding. <i>Perspectives on Swallowing and Swallowing Disorders (Dysphagia)</i> , 20, 60–74.	Advocates for an integrated approach; behavioral strategies paired with oral-motor and sensory approaches to facilitate acceptance and development. Discusses specific and separate oral-motor and sensory activities as part of a progression to improve acceptance.	Yes, both with and without food (e.g. oral-sensory tools, Beckman exercises, straws, tubes); viewed as a progression.	Yes, both with and without food, including massage, vibration, also paired with sensory system as a whole.	Yes. Single external presentation by author, not peer-reviewed.	
Roche W. J., Eicher, P. S., Martorana, P., Berkowitz, M., Petronchak, J., Dzioba, J., & Vitello, L. (2011). An oral, motor, medical, and behavioral approach to pediatric feeding and swallowing disorders, an interdisciplinary model. <i>Perspectives on Swallowing and Swallowing Disorders (Dysphagia)</i> , 20, 65–74.	Describes the use of a multi-disciplinary team to assess and treat children with feeding and swallowing disorders. Advocated including oral-motor, medical, motor, behavioral, and family contributors in the treatment plan.	Yes, both with and without foods.	Not specifically addressed.	No	
Sheppard, J. J. (2005). The role of oral sensorimotor therapy in the treatment of pediatric dysphagia. <i>Perspectives on Swallowing and Swallowing Disorders (Dysphagia)</i> , 14, 6–10.	Provides a historical perspective and overview of oral-sensorimotor therapy and its role in treating children with pediatric feeding and swallowing disorders (dysphagia). Specifically discusses theory and research behind the use of oral-sensorimotor therapy.	Yes, advocates for specificity of training if possible.	Yes, paired with motor skills to facilitate patterns.	N/A, review of other literature.	

*Appendix C**Expert Opinion and Mechanism-Based Reasoning Papers Rated Oxford Level 5 (continued)*

Expert Opinion Paper	Brief Description	Supports Oral-Motor Intervention	Supports Sensory Intervention	Previously Presented or Reported	Additional Information
Clark, H. M. (2005). Therapeutic exercise in dysphagia management: Philosophies, practices, challenges. <i>Perspectives on Swallowing and Swallowing Disorders (Dysphagia)</i> , 14, 24–27.	Review of the role of therapeutic exercise in dysphagia treatment; not specific to pediatrics. Also reviewed challenges extrapolating from exercise literature to head and neck muscles. Specificity of training (e.g. exercise simulating actions intended to ultimately execute), overload, intensity, and other principles not reviewed elsewhere included.	Yes	No	N/A, review of other literature.	
American Speech-Language-Hearing Association. (2001). <i>Roles of speech-language pathologists in swallowing and feeding disorders: technical report</i> [Technical Report]. Available from www.asha.org/policy .	Official ASHA document supporting the knowledge base needed for SLPs to treat feeding and swallowing disorders; specifically includes both oral-motor and sensory intervention.	Yes	Yes	N/A; summary of other literature, position paper	