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Tutorial

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Feeding Reflexes and Neural Control

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The evaluation of the feeding reflexes of an infant provides basic information on the neurological functioning of the oral-motor structures. It is an important component of the overall assessment of the oral-motor development of the infant. The determination of the presence of the reflex plus the quality of the response allows one to decide if the infant has the necessary neurological components for feeding. In some cases, the reflex may persist beyond the normal age of development and actually interfere with feeding behavior. Also, the absence of some of these reflexes may have some prognostic and diagnostic significance.

These feeding reflexes should not be evaluatéd only by artificially eliciting them individually. Rather they should also be assessed during an actual feeding situation where they are integrated one with the other to provide a coordinated feeding pattern.[1] Many clinicians have largely focused upon eliciting the individual reflexes and neglected the observation of this reflexive integration during the feeding session. Yet both types of evaluations of the feeding reflexes are necessary in providing valuable information in assessing total oral-motor functioning.

Hand-to-mouth behavior is also an important consideration during assessment of the feeding behavior. Phylogenetically, there is a functional unity between the hand and the oral-motor apparatus in higher animal forms such as man.[2 3] Lower animal forms take food directly with their mouths, while higher animal forms use their hands for feeding.[4] Several researchers have proposed that there is a reflexive basis for this behavior and that the Babkin reflex and the palmo-mental reflex demonstrate this functional connection between the hand and mouth in man.[2 3 4 5]

This paper provides a brief outline of the feeding reflexes such as the rooting, sucking, swallowing, gag, bite and Babkin reflexes and is based upon a review of the literature. It includes the stimulus to elicit the reflex, description of the response to be obtained, position of the infant during the evaluation, age of onset and integration, developmental significance and a proposed neural mechanism for the reflex. Several interpretations from the literature are provided for each of these categories. Each of these reflexes is presented as if to be evaluated in isolation. However, one must keep in mind the importance of considering the interrelationship between all of the oral-motor reflexes during the actual feeding session.

1. ROOTING

POSITION: Place the infant supine, head in midline, and hands held on the chest.[6]

STIMULUS: Stroke the perioral skin outward at the corners of the mouth, upward from the middle of the top lip to the nasolabial area, and downward from the middle of the lower lip toward the chin;[7] tap or stroke the perioral skin up to 15 mm from the mouth even extending to the cheek area.[8]

RESPONSE: 1. Side-to-side head turning response: alternate head turning toward and away from the stimulus, finally stopping near the stimulus;[8] occasionally occurs without stimuli in a hungry infant (termed "vacuum activity").[4]

2. Direct head turning response: head turns in the direction of the stimulus, grasps it with lips and sucks it;[8] if the stimulus is applied to the corners of the mouth, the bottom lip lowers, the head and tongue orient toward the stimulus;[7] if the stimulus is applied to the upper lip and nasolabial area, the upper lip and tongue elevate, the mouth opens, and the head extends;[7 8] *if the stimulus is applied to the lower lip and chin area, the lower lip and tongue depress, the mouth opens, and the head flexes.*[8 9]

ONSET AND INTEGRATION: Side-to-side head turning response begins at birth and persists up to 2-3 weeks of age;[1 8] direct head turning response begins at 2-3 weeks of age and persists up to 3 months old;[8] also, all the lip, tongue and head components of the response are present at 28 weeks of gestation, except the lower lip depression and head flexion which are first present at 30 weeks of gestation.[10]

SIGNIFICANCE: 1. Weak response observed during first two days of life.[9]

2. Absent response often observed in depressed, satiated, or crying infant; also satiated infant may turn away from the stimulus.[9]

3. Response is best elicited if the infant is alert and hungry; if in a deep sleep or drowsy states, no response is elicited unless the infant is vigorously stimulated.[11]

4. Persistence beyond 3 months old is observed in brain injured children.[12]

5. Response seen in normal sleeping 7-year-old children.[4]

6. Rooting response assists the infant in finding the breast or bottle nipple for feeding.[4]

7. Asymmetry of response indicates insult to one side of the brain, or facial injury.[13]

PROPOSED NEURAL MECHANISM: Medulla, pons and cervical spinal cord.[14]

1. Sensory input: from the maxillary and mandibular branches of cranial nerve V to the primary sensory

nuclei of V.[8 14]

2. Motor output: cranial nerves V (motor nucleus), VII, XII, XI (spinal portion), and C1-C5 for movement of mouth opening, lip elevation or depression, tongue orientation to the stimulus, and head extension, flexion or rotation.[8 14]

2. SUCKING

POSITION: Place the infant supine with head in midline.

STIMULUS: Place a finger or nipple between the infant's lips;[7] insert a finger 3-4 cm into the infant's mouth; [6 9] touch the anterior part of the tongue, gums, hard palate, or mucous membrane of the mouth;[1] a sugar coated finger inserted into the infant's mouth can also be effective.[7]

RESPONSE: Alternation of bursts of sucking movements and rest periods;[15] note the rate, groupings of burst and rest periods, and the strength of sucking;[6 9] if an attempt is made to withdraw the finger or nipple from the mouth, the infant's head flexes toward the stimulus.[7]

ONSET AND INTEGRATION: Nonaudible sucking observed in the fetus of 22 weeks of gestation, and audible sucking at 27 weeks of gestation;[5] also has been first seen in infants of 28 weeks of gestation though the response is weak and not fully synchronized with swallowing;[10 16] at 40 weeks of gestation the response is perfected;[16] sucking is integrated by 2-5 months of age.[12]

SIGNIFICANCE: 1. Infants of mothers receiving barbituates or anesthesia during delivery show depressed or absent sucking during the first four days after birth.[17]

2. Sucking is often weak during the first one to four days after birth.[6 9 11]

3. Sucking is absent during deep sleep unless the infant is vigorously stimulated; response is elicited occasionally during light sleep and is best observed when the infant is awake and alert.[11]

4. More effective sucking is elicited in room temperatures of 80°F rather than 90°F.[18]

5. Sucking consists of two phases, suction or negative pressure and expression or stripping of the stimulus with the tongue.[4 19 20]

6. The rate of sucking increases with age.[15 21]

7. Nutritive sucking pattern differs from nonnutritive sucking in that the former shows a more continuous pattern of sucking with more suction.[15 22]

8. Infants are able to adapt and modify the components of nutritive sucking as early as two days old.[23]

9. Sucking often persists beyond five months in brain injured children.[12]

10. Inability to suck is often an early sign of CNS dysfunction.[12]

11. Satiated infants will often exhibit weak sucking.[13]

12. Strong suck response is highly correlated with a strong palmar grasp and rooting.[6]

13. Infants get increased palmar grasp during sucking.[24 25]

14. It is difficult to separate lip responses and swallowing from sucking as these components are highly interrelated.[1]

PROPOSED NEURAL MECHANISM: Medulla and pons

1. Sensory input: from the mandibular and maxillary branches of cranial nerve V to the chief sensory nucleus of V for sensation of the lips, hard palate, gums and mucous membranes of the mouth; also from cranial nerve IX to the medial nucleus solitarius for tongue and upper pharynx sensation and cranial nerves VII and IX to the lateral nucleus solitarius for taste sensation to the tongue.[14]

2. Motor output: from the motor nucleus of cranial nerve VII for the labial and buccinator muscles used in sucking, and the hypoglossal nucleus of cranial nerve XII for tongue movements.[26]

3. SWALLOWING

POSITION: Place the infant supine, head in midline and slightly flexed.

STIMULUS: Saliva, food or liquid in contact with the back of the tongue, soft palate, pharynx and epiglottis;[1 27] light moving pressure applied simultaneously to soft palate, posterior tongue and pharyngeal walls;[28] saliva serves as the best stimulus;[28 29] easiest way to elicit swallow is by stimulating suck which throws saliva back toward posterior pharynx;[1] cough, sneeze, hiccough, sudden change in position or sharp tap to the distribution of cranial nerve V in the face will also elicit swallowing.[1]

RESPONSE: Swallowing observed by the visible elevation of the hyoid bone; difficult to separate sucking and swallowing since swallowing either precedes a suck or follows the first or second suck.[1]

ONSET AND INTEGRATION: Swallowing first observed in a fetus of 10 weeks of gestation;[5] pattern of suck-swallow varies with age such as from birth to six weeks, one sees the infantile pattern with jaws separated, much tongue thrust, less jaw movement, sucking during swallowing, and predominant use of facial muscles; while from 6 to 12 weeks of age and older, one sees the mature pattern of no tongue thrust, more jaw movement and jaws brought together;[1] others believe the infantile pattern occurs from birth to 18 months and the mature pattern from 18 months onward.[26]

SIGNIFICANCE: 1. Poor coordination of breathing and swallowing often seen in brain injured children.[12]

2. Persistence of infantile suck-swallow pattern occurs in brain injured children.[12]

3. Drooling in brain injured children is due to uncoordinated lip movements which allow saliva to escape, inability of anterior two-thirds of the tongue to form trough to contain saliva, and weak swallowing.[27 30 31]

4. The brain injured child cannot adjust lips to seal the sides of his mouth for leaks during drinking and cannot coordinate his jaws and tongue for effective swallowing.[12]

5. Full-term normal infants less than 12 hours old and all normal premature infants show an uncoordinated esophageal response to swallowing with rapid peristalsis, and frequent simultaneous contraction of esophageal muscles.[32]

PROPOSED NEURAL MECHANISM: Reticular formation in medulla (dorsal and rostral to inferior olive).[33]

1. Sensory input: from cranial nerves X and IX (with IX playing a more important role[34]) to the medial nucleus solitarius where the input is integrated with connections with other cranial nerves in the dorsal reticular formation in the brainstem.[35]

2. Motor output: from the motor nucleus of cranial nerve V, the nucleus ambiguus (IX and X) and the hypoglossal nucleus (XII) to muscles of the pharynx, soft palate, esophagus and tongue.[14 36]

4. GAG

POSITION: Place the infant supine with head in the midline.

STIMULUS: Pressure applied to the posterior one-half of the tongue and back toward the uvula, the posterior wall of the pharynx and soft palate.[4 5 12 27]

RESPONSE: Contraction of thyroary

tenoid, cricopharyngeal, cricothyroid, cricopharyngeal and esophageal constrictor muscles;[37] mouth opens, head extends, floor of mouth depresses, larynx and diaphragm elevate and face grimaces.[5]

ONSET AND INTEGRATION: Present at 16.5 weeks of gestation and continues throughout life;[5] slight decrease at seven months of age when chewing begins.[12]

SIGNIFICANCE: 1. Gagging serves as a protective mechanism for the esophagus.[27]

2. This response is similar to the vomiting response except that there is not as large an increase in pressure during gagging.[37]

3. Brain injured children often show exaggerated gag response with pressure to the anterior tongue even eliciting a response.[12]

4. Hypoactive gag is present in the ataxic brain injured child as it is weakly elicited when the oral cavity is stimulated as far back as the uvula.[12]

5. Increased response is observed in gavage fed infants,[12] though it has also been seen to be decreased.[14]

6. A strong gag is associated with the inability to suck and swallow.[4]

7. There is a close relationship between gag and increased oral tactile sensitivity which can interfere with feeding.[12]

8. Lesions to cranial nerve IX results in loss of gag reflex.[36]

PROPOSED NEURAL MECHANISM: Medulla and pons

1. Sensory input: cranial nerve IX and X to nucleus solitarius, and cranial nerve V to chief sensory nucleus.[36]

2. Motor output: mediated by the nucleus ambiguus (cranial nerves IX and X) and cranial nerve XII for movement of muscles of pharynx, palate, larynx, and tongue;[36] also cranial nerve VII for facial movements, cranial nerve V for mouth opening, and C1-C5 for head extension.[14]

5. BITE

POSITION: Place the infant supine or sitting with head in the midline.

STIMULUS: Moderate pressure on the lateral side and anterior part of the upper and lower gums;[27] rubbing of the anterior palate near teeth and between the labial surface of the teeth;[38] moderate pressure to anterior palatal mucosa.[39]

RESPONSE: Jaw closes and bites vertically until stimulus is released;[27 38] is heavy pressure is applied, the jaw opens.[39 40]

ONSET AND INTEGRATION: Present at birth; weakens and disappears by three to five months of age;[12] others say it disappears by eight to nine months of age when replaced by chewing.[27]

SIGNIFICANCE: 1. Not strong in the normal newborn.[27]

2. Exaggerated persistence in the brain injured child and elicited with a slight pressure to the gums; interferes with feeding and dental care.[12]

3. Persistence inhibits the development of lateral chewing movements.[27]

4. Function of the bite reflex is obscure, but may occur in normal chewing.[41]

PROPOSED NEURAL MECHANISM: Pons and lower midbrain

1. Sensory input: from the maxillary and mandibular branches of cranial nerve V to the mesencephalic nucleus of V.[41]

2. Motor output: from the motor nucleus of V to the masseter muscle.[41]

6. BABKIN

POSITION: Place the infant supine, head rotated to one side, elbows slightly extended.[2]

STIMULUS: Strong sudden pressure applied with examiner's thumb on the palms of both hands simultaneously;[2] can also apply pressure to just one palm, but it is more difficult to elicit a response.[4]

RESPONSE: Mouth opens, slight tongue elevation, head flexes and rotates to the midline;[2] forearm flexes and occasionally the eyes close;[4] pressure to one palm elicits a weak response with head rotation to the side of the stimulus.[4]

ONSET AND INTEGRATION: First observed in fetus of 15 weeks of gestation;[5] elicited in premature infant of 26 weeks of gestation;[2] weakens in the first month of life and disappears by three to four months old.[4]

SIGNIFICANCE: 1. Response elicited best if the infant is awake; not seen when the infant is in a deep regular sleep state; occasionally observed when the infant is in a light irregular sleep state.[42]

2. More easily elicited in the premature infant of smaller weight, but the intensity of the response is greater in the premature infant of a larger weight.[2]

3. This response demonstrates the phylogenetic importance of the functional unity of hand and mouth in man.[4]

4. Suppression of this response at three months coincides with hand to mouth behavior in feeding.[2]

PROPOSED NEURAL MECHANISM: Medulla, pons and cervical spinal cord. 1. This response demonstrates the close relationship between the sensory fibers of the cervical nerves from the hand and the caudal end of the spinal track of the cranial nerve V in the cervical area.[5]

2. Sensory input: sensory fibers of C6, 7, 8 to the spinal tract of cranial nerve V.[5 14]

3. Motor output: cranial nerves VII and V for mouth opening, cranial nerve VII for eye closure, cranial nerve XII for tongue elevation, motor fibers of C5-6 and spinal accessory (XI) for head flexion and rotation.[14]

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