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Original Article

ORIGINAL ARTICLE

Apraxia in children and adults with obstructive sleep apnea syndrome

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Abstract

Study Objectives: Early in life impairment of orofacial growth leads to sleep-disordered breathing (SDB). Normal lingual gnosis and praxis are part of this early development related to the normal sensorimotor development of the tongue and surrounding oral musculature. The aim of this retrospective study was to explore if lingual praxia is impaired in both SDB children and adults and if there is an association to craniofacial morphology.

Methods: The ability to perform simple tongue maneuvers was investigated in 100 prepubertal SDB children and 150 SDB adults (shown with polysomnography). All individuals had a clinical investigation by specialists to assess any orofacial growth impairment and the elements potentially behind this impairment. In a subgroup of individuals both able and unable to perform the maneuvers, we also performed a blind recognition of forms placed in the mouth.

Results: A subgroup of pediatric and adult SDB patients presented evidence not only of orofacial growth impairment, but also apraxia independent of age and severity of OSA.

Conclusions: By 3 years of age, children should be able to perform requested tongue maneuvers and have oral form recognition. Abnormal gnosis–praxis was noted, independent of age in SDB children and adults, demonstrating that an abnormal functioning of the tongue in the oral cavity during early development can be detected. Both children and adults with SDB may present similar absences of normal oral development very early in life and a similar presentation of apraxia, suggesting that the distinction of SDB in children versus adults may not be relevant.

Statement of Significance

Subtle abnormalities of oropharyngeal growth in infancy and early childhood may contribute significantly to sleep-disordered breathing and obstructive sleep apnea (OSA) later in life. Our research provides new support for the idea that abnormal oropharyngeal development is associated with sensory changes in the tongue and apraxia, which in turn potentiates further maladaptation of the palate and jaw that can result in sleep-disordered breathing. Such apraxia may be found in pediatric and adult cases with OSA. Recognition of oropharyngeal structural abnormalities and associated apraxia in childhood may permit timely interventions and thus avoid the progression to sleep-disordered breathing and OSA.

Key words: sleep-disordered breathing; pediatric; adult; gnosis; praxis; orofacial impairment

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Introduction

We previously reported that the adult obstructive sleep apnea syndrome (OSAS) that began very early in life was traced to abnormal development of anatomic structures supporting the upper airway (UA) [1, 2]. This abnormal development may be related to genetic, epigenetic, environmental, or the interactions of all factors (Figure 1). We stated there is a continuous interaction between normal orofacial development and orofacial motor functions, with involvement of the sensorimotor innervation of the orofacial region, particularly the tongue and the mouth.

Our current report brings new evidence to support our previous publications [1, 2]. Speech-language pathologists dealing with speech remediation know that normal lingual gnosis and praxis are necessary for normal speech and language development [3]. This report focuses on the tongue. Normal tongue proprioception (i.e. proprioception is the inner awareness in the muscles of the tongue as well as the muscles and joints of the mouth) that begins in fetal life is required to develop normal sensorimotor tongue function. Conversely, normal motor function strengthens proprioceptive acuity [4].

Definitions

"Gnosis" (i.e. the capability to recognize an object, to have a representation of it, and understand its significance) will progressively and spontaneously develop by regular exposure to the environment or through explicit training. Gnosis occurs with recognition of mother's nipple/breast at birth.

"Praxis" (i.e. typical coordination of movements to accomplish a specific goal—often called motor planning or programming) is a higher-level motor function predicated on gnosis. Normal gnosis is necessary to have normal praxis. To accomplish a specific goal in a timely manner, a brain program is created to coordinate movements toward the specific goal. Normally, there is intention and goal. Repetition of a brain program usually leads to automatic use of a motor plan or program if appropriate training occurs (e.g. proper breastfeeding).

A "dyspraxia or an apraxia" may be seen if a disturbance of movement coordination for a specific activity occurs without an obvious sensorimotor deficit or intellectual deficiency. Lingual gnosis and praxis become "automatic" between birth and 2 years of age. This is an important time period when nasal breathing, sucking, swallowing, and chewing develop. The unique motor plans or praxis for speech also develop during this critical period but will take longer to reach completion along with development of language. The normal development of the above functions is concurrent with normal stimulation of the orofacial growth structures [2] (i.e. primarily intermaxillary synchondrosis and periodontal ligaments), as well as the occurrence of normal nasal breathing during wake and sleep.

This retrospective analysis of anonymized data was approved by the Stanford University Institutional Review Board.

Protocol

Retrospective examination of records of 150 successively seen OSAS adults and 100 successively seen prepubertal OSAS children were evaluated at two different time points. The first time point was the intake exam where these patients were referred to the sleep clinic for suspicion of abnormal breathing during sleep or frank OSAS and the second time point was after the in-lab polysomnogram. The records were excluded if at home sleep testing was rendered.

Information taken at intake was reviewed, including demographics, body posture, and development. The developmental history included feeding and speech development. The

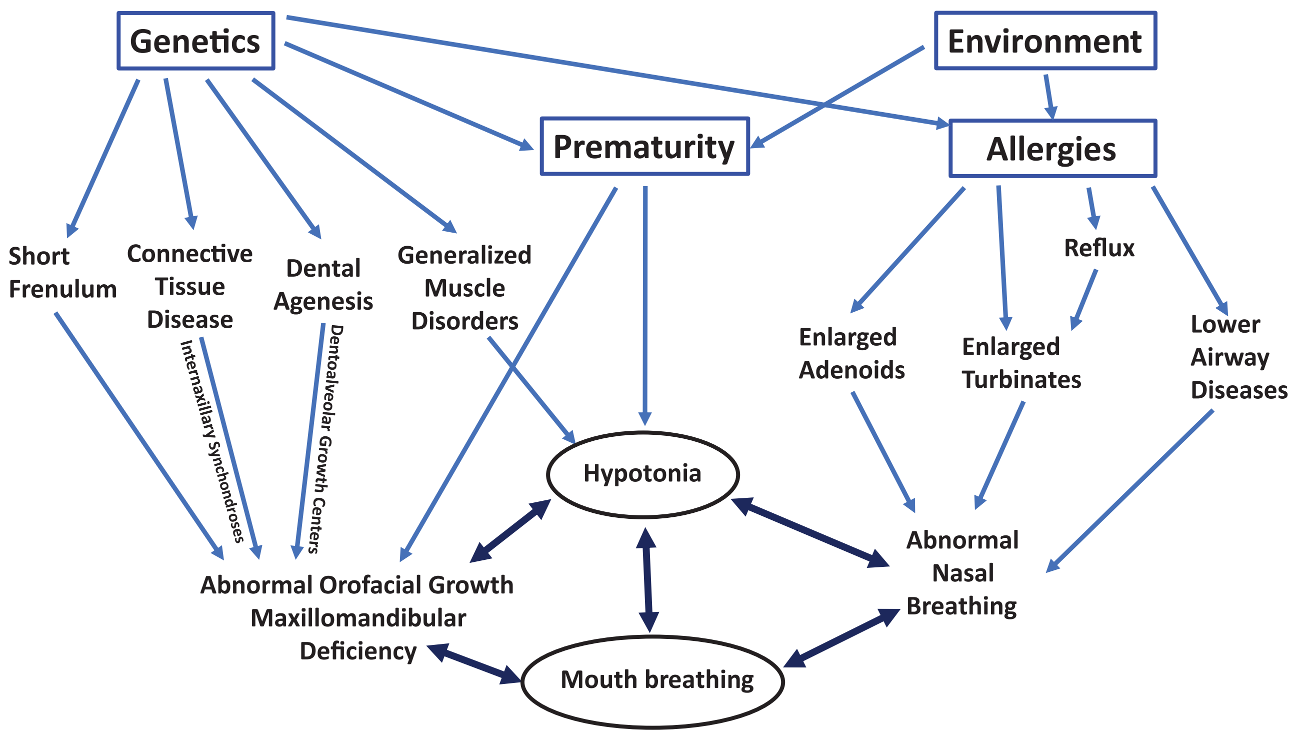

Figure 1. Concomitant issues in early infancy. Graph performed from text in references 1 and 2: Health problems present in early infancy leading to mouth breathing during sleep and impacting normal orofacial growth.

clinical history included history of premature birth, family history, pharmacological history, as well as past and present sleep history. The clinical evaluation systematically involved evaluation of the face, including measurement of "harmonic facial distribution" measured in millimeters and the presence of any facial asymmetry. The evaluation of the mouth included dental development and position, classification of occlusion, determination of the Mallampati airway score, the Friedman tonsil scale [5–8], tongue motility, and determination of frenum location and length [9]. During the nasal evaluation, the nasal valves, nasal septum, size of inferior nasal turbinates considering the horizontal width of each nostril, as well as head and body posture were assessed. Frontal facial photographs were obtained with patients' consent. The following clinical scales were measured: Epworth Sleepiness Scale or Pediatric Sleepiness Scale [10, 11]; the Fatigue Scale (FFS) for adults; the Pediatric Sleep Questionnaire for children, and the Sleep Disorders Questionnaire for adults [12, 13].

At intake, patients were asked to perform specific maneuvers with the tongue as outlined in Table 1. These maneuvers were performed twice. If the subject was unable to perform a maneuver, the subject was shown what to do and asked to do the maneuver after visual demonstration. (These maneuvers are seen on the web, as they are used in "myofunctional-therapy.") [14] Tongue maneuvers were scored as "normal or abnormal."

The in-laboratory nocturnal polysomnography (PSG) included the monitoring of four electroencephalogram (EEG) leads to include two for eye movements, one chin muscle lead in association with the monitoring of two leg muscle EMG leads, as well as one electrocardiogram (ECG or EKG) lead (V2 derivation). Respiration was monitored with intercostal-diaphragm electromyography (EMG), oblique, and straight abdominal muscle EMG, a nasal cannula—pressure transducer, oral thermistor, thoracic and abdominal inductive plethysmography bands, pulse oximetry measuring oxygen saturation, finger-pulse-photo-plethysmography (PPG), as well as a neck-microphone (measuring noise power). There was continuous video-monitoring synchronized with the PSG (polysomnography) recording. Data were recorded on a Somnomedics Computerized Sleep System with electric and biologic calibrations performed at the beginning and the end of recording. Recordings were scored, and subjects had follow-up visits postrecording and scoring.

At the follow-up visit after the PSG, patients were asked to perform the tongue maneuvers again (Table 1) and were also asked to perform a clinical test of recognition of forms placed in the mouth (commonly known as oral or lingual stereognosis testing). The test was derived from reports evaluating lingual gnosis–praxis in children [3, 15, 16]. Three small balls (5, 7.5, and 10 mm in diameter) were held on a stick similar to a lollipop. They were placed in the mouth while hidden from the patient's view. Then the subject was asked to recognize the largest and the smallest balls by pulling the requested ball out of the mouth (Figure 2A); and the gnosis–praxis test was also scored as a "pass or fail." The inability to recognize one item on this test led to a "fail" rating.

The second test for shape stereognosis was also performed with objects hidden from the patient's view. It consisted of recognizing six different flat plastic forms held in the middle of the form by a small plastic string (Figure 2B). This test was derived from a well tested 20-item test developed in 1970 to evaluate lingual praxis [15, 16]. Each form is the size of a 1 cent United States coin known as a "penny." The forms used in this study were a star, a completely round form, a square form, a half-disc form, a half square form, as well as a square with a finger-like projection. The shapes were placed into the subject's mouth in random order and subjects were asked to identify each object in their mouth on a piece of paper. Subjects were expected to recognize all six forms. The test was done twice with a 5 min interval between tests. Any identification error led to a "failed test" rating. Control subjects were those with normal tongue maneuvers.

Table 1. Tongue maneuvers (TM) evaluated at initial clinical exam (16)

Maneuver
1 Pull tongue straight out of mouth as far as you can
2 With your tongue out and touch the right cheek
3 With your tongue out and touch your left cheek
4 With your tongue out go up to try touching your nose
5 Place the tip of the tongue in the middle of the roof of your mouth
6 Place your tongue of the top of your upper-teeth
7 Place your tongue between your teeth and gently hold it

Analyses

All patients were seen by the same attending physician who was directly involved in all orofacial evaluations of children and adults. All scales were scored following the published norms [8].

PSGs were scored by two different well-trained polysomnographists and reviewed by the same attending physician. Sleep was scored following the American Academy of Sleep Medicine guidelines (AASM, 2012) [17]. Apnea, hypopnea, respiratory event–related arousals (RERAs), and type of event (obstructive, mixed, or central) were also scored following the recommendations made in the same resource.

Additionally, the attending physician scored "flow limitation." Flow limitation in adults was scored as outlined by Palombini, *et al.* [18] and in children as outlined by Guilleminault and Huang [2]. The end result of the flow limitation calculation was the percentage of time spent in flow limitation as calculated by comparing the number of 30 second intervals scored with flow limitation (i.e. time spent in flow limitation to total sleep time). The time-spent-mouth-breathing during sleep was also scored following the criteria outlined in Lee *et al.* [19].

Chi-squared analysis was performed on percentages obtained between the different control/affected subjects as shown in Table 2.

Results

All of the patients in this study were successively seen, and the subgroups were based on age. The adults were between 20 and 45 years of age and the children's ages were between 4 and 11 years. No patient was excluded in the selection criteria and unlike other studies, none of the adults were noted to be obese (see Table 2).

Tongue maneuver testing

All patients underwent the tongue maneuvers testing. Only the "tongue-maneuver-failure" subgroup was submitted to the gnosis-praxis test (also known as a stereognosis test). Control test subjects were those with normal tongue maneuvers (Table 2).

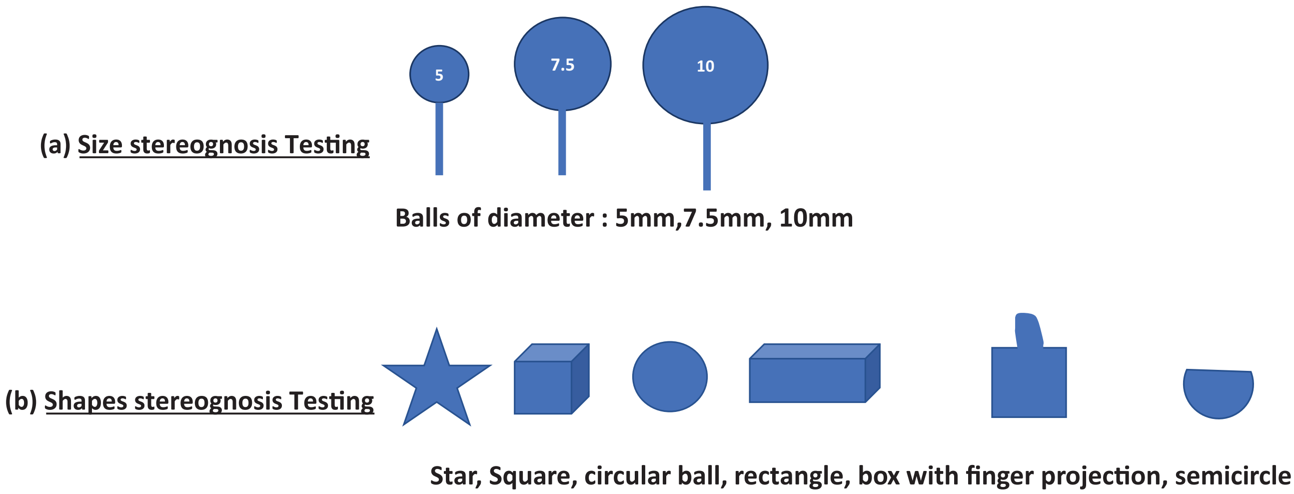

Figure 2. Stereognosis testing to distinguish differing sizes of the same shape and to distinguish different shapes [3, 15, 16].

Table 2. Clinical findings and polysomnogram results separated by the ability to perform the tongue maneuvers and stereognosis testing in OSA adults (*N* = 150) and OSA children (*N* = 100)

Category		Adults N = 150 31 ± 5.2 years BMI = 25.4 kg/m² (21.6–29.1 kg/m²)		Children N = 100 6.0 ± 1.8 years All children were with normal BMI for age mean BMI = 17.8 kg/m²	
Relevant Medical History	TM: Tongue Maneuver	Abnormal TM & Stereognosis N = 17 (100%)	Normal TM & Stereognosis N = 133 (100%)	Abnormal TM & Stereognosis N = 18 (100%)	Normal TM & Stereognosis N = 82 (100%)
	Age	29.7 ± 6.1 years	31.1 ± 5.3 years	6.3 ± 2 years	5.9 ± 2.2 years
	Prematurity < 37 weeks GA	4 (23.5%)	28 (21%)	4 (22%)	11(13.4%)
	Septal deviation	1 (0.6%)	9 (6.7%)	0	5 (6.1%)
	Late /no adenotonsillectomy >8 yo	1(0.6%)	8 (6%)	2 (11%)	9 (11%)
	Continuous untreated allergies back to early childhood	6 (35.3%)	53 (40%)	2 (11%)	7 (8.5%)
	Repetitive sinusitis in childhood*	7 (41.2%).	39 (29%) *	N/A	N/A
Clinical and functional findings	Difficulty sucking at birth*	3 (18%)	18 (13.5%)	2(11%)	6 (7.3%) *
	Speech difficulties*	5 (29%)	34 (25.6%)	7 (38.9%)	10 (12.2%)*
	Speech reeducation in early childhood*	3 (17.7%)	27(20.3%)	3(16.7%)	4 (4.9%) *
	Chewing difficulties: one side chewing*	12 (70.6%)	101 (76%)	11 (61.1%)	35 (42.7%) *
	Short frenulum	11 (64.7%)	88 (66%)	10 (55%)	49 (59.75%)
Orthodontic findings and history	Narrow palate – Maxillary deficiency	10(56.8%)	80 (60.15%)	16 (89%)	61 (74.4%)
	Maxillomandibular retrusion	7(41.2%)	53(39.9%)	2(11%)	21(25.6%)
	Crossbite	7 (41.2%)	59 (44%)	N/A	N/A
	Deep overbite (>4 mm)	9 (53%)	48 (36%)	N/A	N/A
	History of braces as teen	15 (88%)	99(74.4%)	N/A	N/A
	History of headgear as teen	7 (41.2%)	51 (38%)	N/A	N/A
	History of wisdom-teeth extraction between 15 and 25 yo	16 (94%)	121 (91%)	N/A	N/A
PSG	AHI mean ± SD	15.8 ± 3.2	18.4 ± 3.7	5.3 ± 1.6	7.5 ± 2.8
	Lowest SaO_2	88.1.6 ± 1.5%	87 ± 2.4%	91 ± 1.2%	90 ± 2.4%
	Time mouth breathing/TST*	95 ± 4.2 %	91 ± 6.4%*	89.5 ± 5.9%	82 ± 7.3%*
	Flow limitation/TST*	79.5 ± 8.3%	69.6 ± 9.7%*	67 ± 11%	62 ± 16%*

PSG = polysomnography; TST = total sleep time, SaO_2 oxygen saturation; % percentage, GA = gestational age; N/A = Not applicable.
*$p < 0.05$ (Chi-square statistics).

Adults

The average age of the adult records examined was 31 ± 5.2 years and mean BMI was 25.4 kg/m^2. This average age is younger than the usual age reported for patients with OSA, particularly those with co-morbidities. Seventeen out of 150 patients with OSA (11.3%) failed to perform the tongue maneuvers even when visually shown the maneuvers. All 17 subjects also failed the size and shape lingual stereognosis evaluations. "I do not know where my tongue is in my mouth" was a comment of an adult patient who failed to perform the required tongue maneuvers in the study.

Children

The records of the children reviewed had a mean age of 6.0 ± 1.8 years, which was within the same age range as all children referred to the clinic for suspicion of sleep disordered breathing with 18 out of 100 children (18%) failed to appropriately perform the tongue maneuvers and also failed the gnosis–praxis test. This was in contrast to pediatric subjects with OSA who had normal ability to perform tongue maneuvers.

Clinical assessment

The clinical evaluations of adults and children are presented in Table 2. As previously described, adults and children in both subgroups presented with anatomic features that may explain the development of abnormal orofacial growth early in life (e.g. history of prematurity, short lingual frenum never recognized, and not treated at birth). When speech was deficient, as well-documented in the adult group, it seemed to be a known consequence of a short lingual frenum, the presence of significant nasal obstruction with untreated allergies early in life, as well as untreated or late-treated enlarged adenotonsils. These were all factors known to affect normal maxillary osteochondral ossification through inactivity on the intermaxillary cartilage (e.g. the tongue should be kept in a high position against the hard palate during sleep).

Regardless of the ability to perform the tongue maneuvers, the majority of the OSA patients with had narrow palates (60% in OSA adults; 77% in OSA children) and short frenulums (66% in OSA adults; 59% in OSA children), confirming the negative impact of the underlying problems on orofacial growth. In the adult group, there was also the clear presence of orthodontic abnormalities related to abnormal orofacial growth. Jaw retrusion was common among OSA adults (40%) and OSA children (23%), but not as prevalent as a narrowed palate. All patients had abnormal breathing during sleep, an expected consequence of orofacial growth impairment.

At a level of significance of $p < 0.05$, there were clear distinctions between the subgroups in their clinical history (Table 2). Even those adults (29%) with a history of chronic childhood sinus disease were able to perform the tongue maneuvers. Interestingly, tongue motor function in children showed a significant association between sucking, chewing, and speech and the ability to perform the tongue maneuvers and stereognosis testing. The same pattern was not evident in the adult population.

Polysomnography

As expected from previous publications, flow limitation and mouth-breathing were more demonstrative of abnormal breathing during sleep than the findings indicated by the apnea–hypopnea index (AHI) and the lowest oxygen saturation (Table 2). All groups were nonobese with a mean body mass index—BMI—of 25.4 kg/m^2 (range 21.6 to 29.1) in the adult subjects. Based on age and standardized tables of height and weight, the children in the study were noted to be in their expected range for age.

Discussion

The children and young adults examined had the clinical presentation of many of our patients with SDB [2, 20]: Our adult subjects were younger than frequently reported in the literature and no obese patients were present in this group. In many clinical settings, obese patients are more commonly recognized with adult SDB at an older age. Obese patients represent a specific subgroup, and no data were available on this subgroup in our study. The group of patients investigated were representative of the patients seen in our clinic: no preselection was made. Ethnically the large majority of our pediatric and adult cases were Caucasians, Far-East Asians, and from the Indian peninsula, whereas African-American were uncommon; and our subjects were younger than the often seen older middle aged adult, tending to a higher socioeconomic middle to high middle class social group in "Silicon Valley." In this very competitive professional environment, subjects seek treatment for poor sleep causing a secondary impact on daytime work performance. As previously reported in our prior work, the subjects in this study presented with anatomical orofacial features that could explain the presence of abnormal breathing during sleep, namely, a narrow palate and bimaxillary retrusion [1, 2, 20].

We reviewed in this and former articles, the succession of events that can occur during early childhood which may cause orofacial myofunctional and airway problems [1, 2, 19]. The tongue has a crucial role in the normal osteochondral ossification process, particularly through the involvement of the intermaxillary cartilage and maxillary synchondroses for normal orofacial growth between birth and 6 years of age [2, 21, 22]. The identified causes of growth impairment in normal orofacial growth and development were previously detailed, and the clinical evaluation in this study found these known factors in both children and adults (Table 2). The same underlying factors affecting orofacial growth were found in this group of patients with SDB, suggesting a continuous link between child and adult impairments.

The tongue is a crucial organ with many receptors. It allows proprioception in the fetus and the newborn [23, 24] and this sensory system becomes refined in adolescence and into adulthood. Proprioception involves both "kinesthesia" (i.e. conscious recognition of movements active or passively done) and "stathestesia" (i.e. conscious perception of the position of a given organ [tongue] in space independent of active or passive placement of the organ in space). It is the second largest sensory system in the body, behind the tactile sensory system. The many receptors located on the tongue surface, particularly the tactile mechanoreceptors, allow the recognition of object forms and object surfaces and play an important role in the defense of the tongue against injury and in eating, drinking, and speaking.

The subset of children and adults that were unable to execute the tongue maneuvers suggest an early impairment in gnosis. "Lingual gnosis" (the ability to recognize an object) is acquired in utero. This ability develops in association with repetition of exposure to items touching the tongue (e.g. fetal hands and feet placed at the lips and in the mouth). "Lingual praxis" (often called motor planning or programming) is the normal coordination of movements to realize a specific goal. Lingual gnosis occurs first, and then lingual praxis develops with specific movement experiences [15, 16]. For example, to have normal breastfeeding, a newborn must have normal lingual gnosis and praxis with recognition of the nipple/breast and how to latch onto it.

The primitive sucking–swallowing reflexes begin between 10 and 12 weeks of gestation and a complete suckling appears in the 18–24th weeks [23]. It is between the 34th and 36th week that the fetus produces efficient swallowing, able to contribute to volume adjustment of the amniotic fluid starting with 1 cc, then ending with 500 cc of amniotic fluid just before birth [25]. The sucking–swallowing reflexes become immediately active at birth, triggered by stimulation of the lip and mouth region when any part of the body touches the lips during fetal movements [2, 25].

Similar to gnosis, a specific praxis will become automatic with repetitions of exposure to human activities. By 2 years of age, a child recognizes many forms and objects placed in the mouth. There are changes over time relative to age as shown by studies performed in children with speech and feeding problems [26]. The tests used in this study involving tongue maneuvers and discrimination should be performed without difficulty by children 3 years of age and older [15, 16], as muscle spindles responsible for position/proprioception sense are known to be mature by this age [23].

A dependent relationship emerged between sucking, chewing, and speech difficulties and the ability to perform the tongue maneuvers in children, suggesting lingual impairments of normal gnosis–praxis involving these oral functions. However, these same difficulties were not as dependent in the adult population as the differences were not significant. Speech difficulties and chewing difficulties were reported in adults subjects with both normal and abnormal lingual maneuvers, indicating a difference between the defect leading to apraxia and the development of normal gnosis–praxis (also called stereognosis, haptic perception, or tactile gnosis).

Our results of PSG findings emphasize the potential role of the tactile–proprioceptive sensory tongue system in the development of SDB (Table 2). Our previous reports emphasized the vital role of appropriate motor activity of the tongue in premature infants and in children with short frenums [2, 27]. Sensory feedback is required for motor learning and motor learning not only reinforces somatosensation, but it is needed to execute a motor skill. The absence of proper contraction of the buccal muscles in addition to the absence of appropriate tongue movement to appropriate locations in the mouth was also previously noted (i.e. contraction and movement sufficient to stimulate the intermaxillary cartilage or the periodontal ligament). Early life sensorimotor oral organization plays an important role in normal orofacial development. Abnormal stimulations and lack of stimulation of these orofacial growth sites during infancy and early childhood lead to abnormal orofacial growth, potentiating an increased risk of upper-airway collapse during sleep. Although there was no significance in AHI or Lowest SaO_2 between groups, the majority of OSA patients with abnormal TM showed significant mouth breathing and flow limitations on polysomnography. The majority of the patients with OSA presented with narrow palates (60% in OSA adults; 77% in OSA children) and short frenulums (66% in OSA adults; 59% in OSA children), regardless of any impairment in stereognosis. In this study, we suggest SDB occurrence if this abnormal development occurs, as the functions of normal gnosis, and the higher-level functions such as normal praxis, speech, swallowing, and chewing may be altered.

We highlight in this study the difference between normal development versus impairment of gnosis–praxis in SDB children and adults. This work is the first description of apraxia impairment associated with OSA. The development of gnosis–praxis in children has been well studied as there are specific tests to investigate oral sensory disorders and measured improvements when re-education of oral perception was successful. We acknowledge that our retrospective clinical study did not indicate why subgroups of patients with SDB had an impairment of lingual gnosis–praxis, requiring further investigation. However, we had long ago showed that even in elderly adults with dementia, object recognition of forms placed in the mouth is a function that is very resistant to neurodegenerative diseases. Even when a form or object cannot be recognized when placed in the dominant hand, it can be identified when placed in the mouth [26]. Although we identified an unrecognized deficit, we were unable to explain why gnosis–praxis was abnormal in only some of our subjects and not all of them. To affirm the clinical validity of the forms recognition test, one subject with normal tongue maneuvers was submitted to the same testing as subjects with abnormal maneuvers, but we could not find why there were two different developments and brain imprinting [28–30], with the strong caveat that not all subjects with normal maneuvers were tested.

Finally, orofacial myofunctional therapy has been advocated as a technique to improve airway function in adults and children with SDB. The presence of the gnosis–praxis deficit shown in this study is a clear handicap when applying such therapy [27]. This study may open up a new avenue in orofacial myofunctional treatment.

This study needs further investigation but has clear limitations. Although the study group is small and retrospective, it is a beginning evaluation of the relationships between tongue maneuvers and gnosis–praxis to SDB, speech and feeding disorders, and other oral sensorimotor dysfunctions (e.g. orofacial myofunctional disorders). Investigation of specific sensory tongue responses has been published in studies of adults with OSAS by different teams [31–34]. The best approach was obtained using an "air-jet" [31, 33] where abnormal responses were shown using all presented protocols. In this current clinical investigation, we did not test the sensory responses using any of the previously described techniques and such investigation needs to be done.

Conclusions

An early infant/childhood cortical imprinting involving tongue activity was absent not only later in childhood, but also in adulthood in some patients with SDB [28–30]. Somatosensory processing develops in utero, continuing at birth, into adolescence and extends into adulthood [4, 35] as cortical networks mature. This work emphasizes the presence of an early neurological impairment of lingual gnosis and praxis processing that may persist as dysfunction in adulthood, so perhaps the subdivision of SDB children and SDB adults is not really relevant as it may be the same disorder. As already mentioned, the same basic abnormalities affecting normal orofacial growth are clearly found in children and adults with SDB [2, 8, 20]. However, the dysfunction occurs much earlier than the age at which clinical symptoms evoked the possibility of SDB. Our findings here highlight the presence of tongue dysfunction early in life in subjects with SDB. We must recognize and address the risk factors that lead to occurrence of SDB early in life and not wait for the development of co-morbid OSAS to reduce the frequency of the syndrome.

Acknowledgments

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Conflict of interest statement. None declared.

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