International Journal of Pediatric Otorhinolaryngology 109 (2018) 72–77

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Effect of vowel context on test–retest nasalance score variability in children with and without cleft palate

Seunghee Ha[a,*], Seungeun Jung[b], Kyung S. Koh[c]

[a] Division of Speech Pathology and Audiology, Audiology and Speech Pathology Research Institute, Hallym University, South Korea
[b] The Department of Plastic Surgery, Asan Medical Center, Seoul, South Korea
[c] Department of Plastic Surgery, Seoul Asan Medical Center, University of Ulsan College of Medicine, Seoul, South Korea

ARTICLE INFO

Keywords:
Nasalance score
Test–retest variability
Vowel context
Cleft palate

ABSTRACT

Objective: The purpose of this study was to determine whether test–retest nasalance score variability differs between Korean children with and without cleft palate (CP) and vowel context influences variability in nasalance score.

Participants: Thirty-four 3-to-5-year-old children with and without CP participated in the study.

Methods: Three 8-syllable speech stimuli devoid of nasal consonants were used for data collection. Each stimulus was loaded with high, low, or mixed vowels, respectively. All participants were asked to repeat the speech stimuli twice after the examiner, and an immediate test–retest nasalance score was assessed with no headgear change.

Results: Children with CP exhibited significantly greater absolute difference in nasalance scores than children without CP. Variability in nasalance scores was significantly different for the vowel context, and the high vowel sentence showed a significantly larger difference in nasalance scores than the low vowel sentence. The cumulative frequencies indicated that, for children with CP in the high vowel sentence, only 8 of 17 (47%) repeated nasalance scores were within 5 points.

Conclusions: Test–retest nasalance score variability was greater for children with CP than children without CP, and there was greater variability for the high vowel sentence(s) for both groups.

1. Introduction

Nasalance, an objective measure of nasal acoustic energy within a speech signal, is used to identify the acoustic correlates of nasality and supplement perceptual ratings of nasality. Clinicians compare an obtained nasalance score with perceptual ratings of nasality as well as published normative data or a score obtained during a previous assessment of the same speaker to evaluate resonance disorders or determine objectively the effectiveness of speech therapy and surgical procedures [1,2].

Many studies have reported that nasalance scores showed some degree of variability influenced by several factors [3–7]. Those factors considered to be sources of normal variability in nasalance score include machine, test procedure, speech stimulus, and speakers' factors such as dialect, language, age, gender, and speakers' inherent performance variability. It is important for clinicians to know sources or reasons for such variability and identify whether it can be interpreted as normal or typical variability. Nasalance scores associated with normal variability must be distinguished from differences induced by an actual change in the speaker's resonance condition. In particular, within-subject variability could be a critical issue when making a clinical decision based on nasalance scores. Speakers' demonstrated variability in nasalance scores can be accepted as normal variability or interpreted as actual changes in the resonance condition following speech therapy or surgery. Furthermore, some speakers may show variability in nasalance scores due to inconsistent movements of the velopharyngeal and other articulatory mechanisms.

Several studies have reported that nasalance scores are not identical even when individuals immediately repeat the same speech stimulus [6–10]. Speakers may variably articulate identical speech stimuli within acceptable ranges. This variability related to a speaker's speech performance may increase due to the phonetic context. Ha and Shin (2017) [10] investigated the effect of vowel context on test–retest nasalance score variability in 3-to-5-year-old Korean children with normal speech. The researchers used sentences loaded with mixed, high, or low vowels, and they examined an immediate test–retest nasalance score

* Corresponding author. Department of Speech pathology and Audiology, Audiology and Speech Pathology Research Institute, Hallym University, Life Science Hall # 8606, 39 Hallymdaehak-gil, Chuncheon-si, Kangwon-do, South Korea.
E-mail address: shha@hallym.ac.kr (S. Ha).

https://doi.org/10.1016/j.ijporl.2018.03.018
Received 18 December 2017; Received in revised form 21 March 2018; Accepted 21 March 2018
Available online 23 March 2018
0165-5876/

with no headgear replacement. The study found that speech stimuli in the high vowel contexts had significantly greater variability than other stimuli in the low and mixed vowel contexts.

Watterson et al. (2005) [6] investigated nasalance score variability between the old Nasometer 6200 and the Nasometer II 6400. As part of the experimental design, the researchers also evaluated test–retest subject performance variability and the effect of headgear change for each machine. The participants were 60 adults with normal speech who recited each of two stimuli (Turtle Passage and Mouse Passage) two times in succession on each machine. On the third time, each speaker read each stimulus after the removal and replacement of the headgear. The study found that within-subject performance variability and variability associated with headgear replacement were more significant sources of variation within the nasalance scores than machine variability. The researchers suggested that 5 nasalance points would be a reasonable standard for typical variation considering these two significant sources of variation. However, the researchers also pointed out that it was not known to what extent their findings would apply to a population of hypernasal children.

Furthermore, Watterson and Lewis (2006) [5] investigated test–retest nasalance score variability related to within-subject performance and headgear replacement in a population of hypernasal speakers. Although there was no statistically significant difference in test–retest nasalance scores, the researchers found that the nasalance variation from one test to another for each participant was of clinical importance. The study showed that hypernasal speakers tend to show greater variation of nasalance scores than normal speakers. The researchers concluded that repeated scores within 10 nasalance points of each other might be considered to fall within the normal range of variation in the headgear replacement condition. Moreover, they suggested that one reason for the more variable nasalance scores for hypernasal speakers than for normal speakers could be inconsistent hypernasality, which could perceptually categorize some cleft palate speakers as “Sometimes But Not Always” (SBNA) [11]. Some speakers categorized as SBNA show inconsistency in the degree of hypernasality when repeating the same speech stimulus. Other speakers in the category tend to show variability in hypernasality caused by changes in the phonetic context or the size of the linguistic unit that is assessed. In particular, hypernasal speakers' variability in nasalance scores might increase depending on the vowel context as the Nasometer is designed mainly to measure the acoustic energy in vowels, and nasalance scores are influenced by the vowel context of the speech stimulus [12–16]. The results for the clinically normal speakers showed that variability in nasalance scores increased with the proportion of nasal consonants and high vowels in speech stimulus [3], [10]. Given that the degree of variability in speakers with normal speech changed depending on the phonetic context, the variability of nasalance scores among hypernasal speakers might be more influenced by the phonetic context. However, studies investigating the effect of the phonetic context on the degree of nasalance variation in hypernasal speakers or speakers with CP are lacking. More efforts are needed to examine the effect of phonetic contexts or other related factors on test–retest variability of nasalance scores in populations who have high risks for resonance disorders, especially in young children. Most studies on test–retest variability of nasalance scores have been conducted with adults with normal speech or hypernasal speech. It is possible that children may show greater variability of nasalance scores than adults due to their articulatory movement variability resulting from the still-developing speech mechanism [17–21]. In addition, nasalance scores are most frequently obtained from children with CP between 3 and 5 years old in clinical settings, especially children considering speech therapy or surgical procedures due to persistent velopharyngeal dysfunction. As it is possible that the degree of variability changes with age, the findings obtained from the same age groups should be used as reference criteria. Therefore, the present study was designed to investigate the effect of the vowel types among phonetic contexts on test–retest nasalance score variability in 3-to-5-year-old Korean speakers with and without CP.

2. Methods

2.1. Participants

The participants were 17 children born with CP and 17 children without CP; all participants were 3–5 years old. Children without CP were matched with the children with CP based on age and gender. Children with CP ranged in age from 3 years 4 months–5 years 10 months, with a mean of 4 years 8 months. Children without CP ranged in age from 3 years 6 months to 5 years 9 months, with a mean of 4 years 8 months. Each group consisted of 10 boys and 7 girls. All participants were native Korean speakers.

All children with CP received primary palatal repair by one plastic surgeon (the third author) at Cleft Palate Clinic, the Seoul Asan Medical Center, and were followed by a craniofacial team. They received primary palatal surgery at 10–13 months of age (M = 11.23 months; SD = 0.83) using one of four surgical techniques for primary palatal repair selected based on preoperative cleft anatomy. One child received a two-stage palatoplasty, that is, soft palate closure at 13 months of age and hard palate closure at 10 months of age. Table 1 provides detailed information for the CP group including age, gender, cleft type, and types of palatal repair.

None of the children without CP had a history of congenital anomalies, neurological involvement, intellectual deficits, or hearing impairments according to their caregivers' reports. An examiner screened all subjects without CP for resonance balance by engaging them in simple conversations and asking them to practice speech materials before collecting the data. Children without CP were excluded if they exhibited resonance problems or reported a cold or nasal blockage on the day of the data collection. The Institutional Review Boards of Hallym University and Seoul Asan Medical Center approved this study, and signed consent forms were obtained from children's caregivers.

2.2. Materials and procedures

The Nasometer data and the audio recordings for perceptual assessments in this study were obtained from each child with CP's follow-up speech and language assessment session in the Cleft Palate Clinic, the Seoul Asan Medical Center. Speech stimuli for the Nasometer tests consisted of three 8-syllable sentences containing no nasal consonants. One sentence was mainly loaded with low vowel/a/, and another was mainly loaded with high vowel/i/. The sentences with low and high vowel contexts also contained some central vowels (e, o, ʌ). The third sentence was loaded with mixed vowels; it contained low and high

Table 1
Distribution of age, gender, cleft type, and surgical techniques for palatal repair in children with CP.

	Age (years)			Gender		Cleft type			Surgical techniques			
	3	4	5	Boy	Girl	UCLP	BCLP	CP	(Modified) two flap palatoplasty	Three flap palatoplasty	DOZ	Two-stage palatoplasty
n	5	5	7	10	7	7	6	4	9	5	2	1

Note. UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate; CP = cleft palate; DOZ = double opposing Z-plasty.