Nasality in healthy Dutch children

Master Thesis Clinical Language Speech and Hearing Sciences
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July 2nd, 2010

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CONTENTS

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ABSTRACT

Objective: The aim of this study was to determine the percent nasalance for a group of healthy Dutch speaking children aged 4;8-6;3 years, and to investigate differences in percent nasalance based on gender, age and regional dialect.

Design: Children imitated the speech-language therapist, who read aloud each sentence of three standard Dutch texts. These texts were a nasal text (a text with many nasal consonants), an oral-nasal text (a passage containing approximately the same percentage of nasal consonants as found in standard Dutch speech), and an oral text (a passage excluding nasal consonants).

Participants: Thirty-eight healthy children were included. The children were inhabitants of Alkmaar, a city in the north part of the Netherlands and they were recruited from three primary schools in Alkmaar. The children have Dutch as native language, normal speech and language development, no history of tonsillectomy and/or adenoidectomy, and no common cold on the day of the evaluation.

Intervention: Nasometry is used for calculating the percent nasalance.

Main Outcome Measures: Mean nasalance scores, standard deviations of the mean and range of scores were calculated for the nasal, oral-nasal and oral texts.

Method: The Nasometer II 6400 was used for data collection. The three texts were designed specifically for the Nasometer in the Netherlands. The data from Alkmaar was analyzed with an Analysis of Variance, a repeated measures ANOVA. To determine differences in percent nasalance between the data from the south region of the Netherlands and the data from Alkmaar, three one sample t-test comparisons were performed.

Results: Normative percent nasalance values were obtained for the nasal text (53.47%) oral-nasal text (27.11%), and the oral text (11.66%). No significant differences to dialect, gender or age were found in this study.

Conclusions: This study demonstrated no dialect, gender or age effect on three Dutch texts. Results from this study have clinical significance for speech-language therapists working with resonance disorders in the Netherlands.

KEY WORDS: Dutch, nasality, dialects, gender differences, age differences, healthy children

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INTRODUCTION

Hypernasal speech is a major symptom of children with palatal abnormalities such as seen in children with a cleft palate (Hogen Esch and Dejonckere, 2004). Hypernasality in relation to palate abnormalities should be examined objectively, especially for patients whose velopharyngeal function may have altered in association with their treatment course (Tachimura et al., 2000). One of the clinical methods to detect hypernasality is by auditive perception (Hogen Esch and Dejonckere, 2004). Speech pathologists are required to evaluate the severity of hypernasality caused by velopharyngeal inadequacy in a course of speech therapy sessions after surgery (Brunnegård and Van Doorn, 2009).

A number of instrumental devices are available to supplement clinical judgment of velopharyngeal impairment (Seaver et al., 1991). Some devices enable clinicians to view the velopharyngeal mechanism directly, for example the endoscopy and radiography, and others provide information from which activity can be inferred (pressure-flow and ultrasound) (Seaver et al., 1991).

Since its commercial introduction in 1986, it is possible to quantify nasality objectively by using the Nasometer by Kay Elemetrics (Van Doorn and Purcell, 1998). Other systems to measure the nasality are the NasalView and the OroNasal (Brunnegård and Van Doorn, 2009). The Nasometer, developed by Fletcher and Bishop in 1973, has become the most frequently reported

instrument in the literature (Brunnegård and Van Doorn, 2009) and is known as an indirect, easy to use, non-invasive and objective assessment instrument (Seaver et al., 1991; Van Zundert et al., 1999; Mishima et al., 2008; Brunnegård and Van Doorn, 2009). With this microcomputer based device, the oral and nasal components of speech are sensed by microphones mounted on either side of a sound separator plate, which rests on the subject's upper lip. The signal from each of the microphones is individually filtered and digitized by custom electronic modules (Van Lierde et al., 2001). The acoustic computer-based system computes a nasalance percentage. Nasometry has become commonplace in clinical and research settings (Hogen Esch and Dejonckere, 2004).

Normative values of nasalance scores have been published for several languages, such as variants of English, French, Thai, Flemish, Hungarian, Spanish, Finnish, Cantonese, and Japanese (Brunnegård and Van Doorn, 2009). Several studies have examined nasalance score variations in relation to differences in race, language, gender and age (Seaver et al., 1991; Van Doorn and Purcell, 1998; Tachimura et al., 2000; Van Lierde et al., 2001; Mishima et al., 2008; Brunnegård and Van Doorn, 2009). Differences in nasalance values between men and women were found in the study form Van Lierde et al. (2002). In this study the percent nasalance from the oral-nasal text and the nasal text were higher for the female subjects. These data suggest that the female subjects have significantly more nasalization when the reading stimuli included nasal consonants and when a coordinate opening and closing function of the velopharyngeal mechanism is

asked (Van Lierde et al., 2002). Also Seaver et al. (1991) found significantly higher nasalance scores for the female subjects on those passages that contained nasal consonants. Based on these studies it can be assumed that gender has an influence on percent nasalance. Gender-related differences in nasalance values can possibly be related to basic structural and functional differences between sexes. A large number of laryngeal and velopharyngeal anatomical, physiological, and aerodynamical sex-related differences that affect the functioning of the larynx have been reported (Van Lierde et al., 2002).

Trindade et al. (1997) studied the effect of age on nasalance scores in a normative study. They studied three groups of speakers: children younger than eleven years, adolescents eleven to seventeen years, and adults over seventeen years. They reported that compared with adults, children had significantly lower nasalance scores during the production of oral text. There was no statistically significant difference in percent nasalance between children and adolescents. Other studies reported no significant differences between nasalance scores for children (Van Zundert et al., 1999).

Seaver et al. (1991) have reported nasalance scores that show dialect differences between one dialect of American English and three other dialects of North America. The purpose of the study from Seaver et al. (1991) was to obtain nasalance values for a large number of normal adult subjects, speaking patterns of one of four geographical regions (Mid-Atlantic, Southern, Mid-Western, Ontario Canada). The Mid-Atlantic speakers were found to have significantly

higher nasalance scores on three reading passages than speakers from the other three dialects. Based on Seaver et al. (1991) it can be assumed that dialect has an influence on percent nasalance, which is relevant for clinical and scientific interpretation of data obtained with nasometry in the Netherlands. However, no research has been conducted in the Netherlands on the effect of dialect on percent nasalance.

A large number of different dialects are spoken in the Netherlands and there are audible differences between southern and northern dialects. Speech in de south part of the Netherlands is historically more influenced by the Flemish language than speech in the north part of the country (Wijnen, 1991). A dialect is a variety of a language that is distinguished from other varieties of the same language by features of phonology, vocabulary, grammar, pronunciation and by its use by a group of speakers who are set off from others geographically or socially (Brunnegård and Van Doorn, 2009). The importance of dialectal differences in nasalance scores may have an impact when speech outcomes are evaluated (Mishims et al., 2008).

Van Zundert et al. (1999) determined normative values on percent nasalance for children aged 4;0-6;0 years old only in Nijmegen, a city located in the south part of the Netherlands, with the Nasometer. Based on the demonstrated effects of gender, age and dialects on percent nasalance, this study aims to determine normative data on the percent nasalance of healthy children in Alkmaar (a city in the province Noord-Holland in the northern part of

the Netherlands) and will look at the effect of dialect in a comparison between the data collected from the north part of the Netherlands and the south part that Van Zundert et al. collected in 1999.

Most of the cleft palate teams in the Netherlands used the standard nasalance values from Van Zundert et al. (1999) but no research has been conducted in the Netherlands yet on the effect of dialect on percent nasalance. The results from this study have clinical significance for speech-language therapists working with resonance disorders and theoretical significance for studying features of dialects.

The following research questions were formulated: What are the percent nasalance scores from Alkmaar, are there significant differences due to gender and age and are there differences in nasality between the nasalance data from the south region of the Netherlands compared to the data from the north?

METHOD

PARTICIPANTS

In this study, 38 young children (21 boys and 17 girls) were included. The children are inhabitants of Alkmaar. The children were recruited from three primary schools in Alkmaar. According to parent report the recruited children had Dutch as native language, normal speech and language development, no history of tonsillectomy and/or adenoidectomy, no current therapy for speech-language difficulties and no common cold on the day of the evaluation. Thirty

subjects were excluded; five bilinguals, thirteen with common cold on the day of testing, two four years old children could not imitated the speech-language therapist, ten were known with speech-language difficulties and five children were too old. The final group of participants included 21 healthy Dutch boys and 17 healthy Dutch girls. The subjects ranged in age from 4;8 to 6;3 years, with a mean age of 5;3 years. The participants were selected when they satisfied the inclusion criteria and participate based on informed consent from their parents or caretakers.

INSTRUMENTATION

The Nasometer II 6400, a microcomputer-based system by Kay Elemetrics, was used for data collection. Before initiating data collection, the Nasometer was calibrated following the procedures outlined in the manual (Kay Elemetrics, 2001). The Nasometer software was installed on a computer.

STIMULI

The Dutch stimuli for adults designed by Van de Weijer and Slis (1991) and used in their normative study were comparable to the type of English passages that are designed specifically for use with the Nasometer. The English passages, the Rainbow passage, the Zoo passage, and nasal sentences are generally used for developing normative data of adults. Van Zundert et al. (1999) introduced three standard Dutch texts for young children in 1999. The first text included oral

(denasal) sentences, the second included oral-nasal (normal) sentences, while the third included nasal sentences. The normal sentences have an oral-nasal balance close to the frequency of phonemes in general Dutch with 11.63 percent of nasal consonants and the nasal sentences contained 56.0 percent nasal consonants (Van Zundert et al., 1999). The speech stimuli consist of these three texts that were also used in the research from Van Zundert et al. (1999). It is common clinical practice in the Netherlands for the cleft palate teams to use these texts in clinical evaluation of velopharyngeal functioning. The specific Dutch passages used for children are presented in the Appendix.

PROCEDURE DATA COLLECTION

Recording was done in a quiet room at three different schools in Alkmaar by one speech-language therapist; the first author of this article, who lives in Alkmaar and speaks the regional dialect. The Nasometer was calibrated at the beginning of each dataset collection. Children have imitated the speech-language therapist, who read aloud each sentence of the three texts. If the participants made an imitation error, the speech-language therapist repeated the passage. The stimuli were presented at a comfortable pitch and loudness level. Imitation for all children was chosen as the most uniform way of data collection because not all children are able to read yet. The speech-language therapist gave the children a standard introduction, the headset was fitted and the recordings were done according to a standard protocol from Kay Elemetrics (2001).

STATISTICS

SPSS was used for the statistical analysis of the nasalance values. Data were examined for normality with histograms and Q-Q plots and tested with a Kolmogorov-Smirnov test. The data from Alkmaar was analyzed with an analysis of variance, a repeated measures ANOVA. The within-subject factor was text and the between-subject factor was gender. To determine differences in percent nasalance between the data from the south part of the Netherlands and the data from Alkmaar, three one sample t-test comparisons were done, with the significance set at $p<0.05$. The data from Nijmegen were the standard test values.

RESULTS

NASALANCE VALUES

Table 1 shows group data on percent nasalance and age. Mean nasalance values and standard deviations are calculated for each text by 38 normal children. The mean score for the nasal text was 53.47 percent with a range between 32 and 69 percent. For the oral-nasal text, the mean percent nasalance was 27.11 percent with a range between 15 and 48 percent and the mean value of the oral text was 11.66 percent (range between 5 and 26 percent). The mean

age for all children was 63.8 months (5;3 years). The youngest child was 4;8 years and the oldest child was 6;3 years old.

Table 1. Means and standard deviations of nasalance values and age for the whole group

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Age in months	38	49	75	63,84	6,934
Nasal percent	38	32	69	53,47	9,290
Oral-Nasal percent	38	15	48	27,11	6,880
Oral percent	38	5	26	11,66	5,610
Valid N	38				

The correlation coefficients Pearson r between the three texts were all significant different and positive. The correlation between the nasal text and the oral text was r=.408, the correlation between the nasal text and the oral-nasal text was r=.688 and the correlation coefficient between the oral-nasal and the oral text was r= .698.

GENDER DIFFERENCES

To detect gender differences in percent nasalance, the data from the boys and girls are separately calculated with SPSS. Table 2 shows the nasalance mean values and the standard deviations between boys and girls for the three texts. The girls were found to have higher nasalance values on the nasal and the oral-nasal texts. The boys have a higher percent nasalance on the oral text, but the analysis of variance (repeated measures design) explores there are no significant

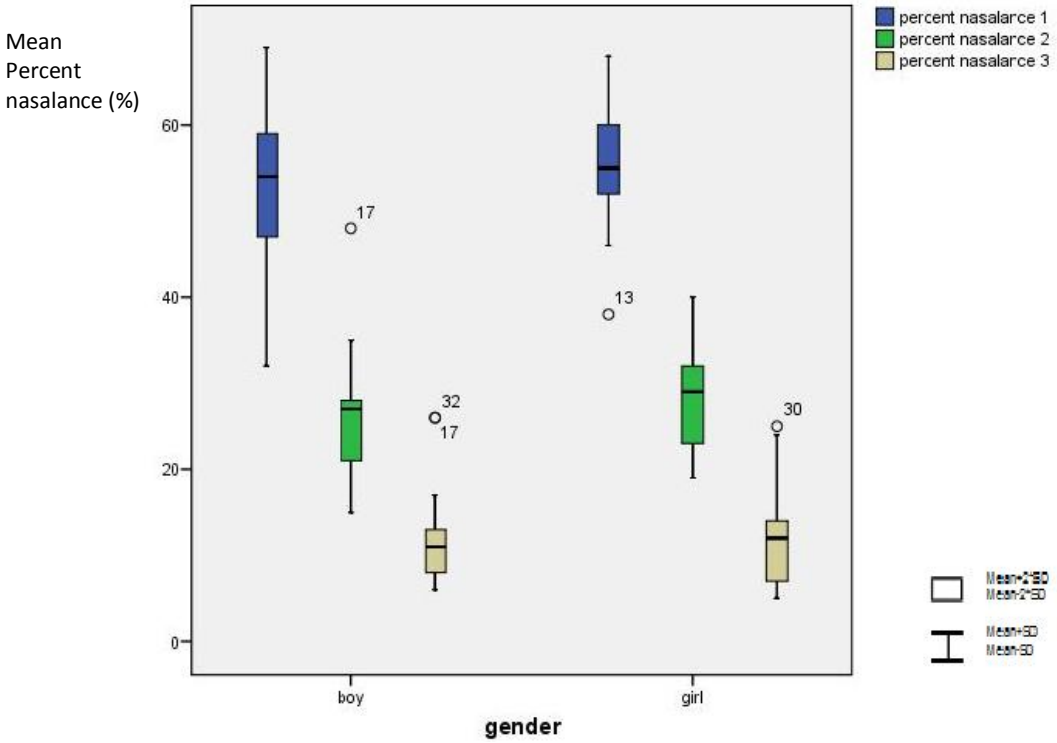
differences between boys and girls (p=.298). When we looked separately at each text, the independent sample t test indicated no differences for nasalance scores on the three texts either. The nasal text has a p value of .283, for oral-nasal text p=.321 and the oral text has a p value of .901. No significant differences between boys and girls were found.

Table 2. Means and standard deviations of nasalance values for boys and girls

Gender		*Nasal percent*	*Oral-nasal percent*	*Oral percent*
Boys	Mean	52,00	26,10	11,76
	N	21	21	21
	Std. Deviation	10,070	6,774	5,585
Girls	Mean	55,29	28,35	11,53
	N	17	17	17
	Std. Deviation	8,153	7,008	5,811
Total	Mean	53,47	27,11	11,66
	N	38	38	38
	Std. Deviation	9,290	6,880	5,610

Figure 1 shows the mean nasalance values for boys and girls with a box plot. The percent nasalance are graphically showed, were percent nasalance 1 is the nasal text, percent nasalance 2 is the oral-nasal text and percent nasalance 3 is the oral text is. In addition, the standard deviation, and the 95% prediction interval for the three texts are provided. This interval comprises 95% of the normal cases.

Fig 1. Nasalance values for boys and girls



AGE DIFFERENCES

There is no significant effect of age in the three texts. The correlation between nasalance values and age is calculated with Pearson r correlation coefficient. For the nasal text the correlation value is r=-.220 with a p= .185. For the oral-nasal text is the Pearson correlation coefficient r=-.104 with a p value of .533 and the oral text is the correlation r=-.085 with p= 0.610.

DIALECT DIFFERENCES

To determine differences in percent nasalance between the data from Nijmegen and the data from Alkmaar a two-tailed comparison is calculated with three one sample t-test, with the significance set at $p<0.05$. The nasalance data from Nijmegen were standard test values. No significant effect of dialect for the three percent nasalance values (nasal text $p=.825$, oral-nasal text $p=.321$ oral $p=.094$) was found.

DISCUSSION

The main purpose of the present research was to determine the percent nasalance for a group of healthy Dutch speaking young children, and to examine differences in percent nasalance based on gender, age and regional dialect. No research has been conducted in the Netherlands yet on the effect of dialect on percent nasalance. The reported normative nasalance data could be important reference information for several clinicians who assess nasality disorders and who are interested in the influence of dialects on percent nasalance. Normative percent nasalance values can also be of benefit to clinicians working in cleft palate teams in the Netherlands.

In this study thirty-eight boys and girls were included. Group mean percent nasalance, standard deviations and ranges of the nasalance for three standard Dutch texts are calculated. The mean percent nasalance of all participants for the nasal text was 53.47 percent; for the oral-nasal text, 27.11 percent; and for the

oral text, 11.66 percent. This nasalance values are in line with the measurements in same aged Dutch speaking, normal children by Van Zundert et al. (1999). Three normal speaking participants (no. 17, 30 and 32) scored above the upper boundary, while one participant scored below the lower boundary (no 13).

The correlations between the three texts were all significant. Each text was positively correlated with the other texts. This means that when a speaker had a high score for the nasal text, the other two texts also showed high percent nasalance scores.

The collected data can be used as a reference for normality with the pathological 95% boundaries defined as: mean ± 2 × S.D. The upper boundary represents hypernasality, while the lower one represents hyponasality (Whitehill, 2001).

No statistically significant gender differences in nasalance values between boys and girls were found in this study. No significant differences were found in the Dutch study from Van de Weijer and Slis (1991) either, who obtained normative nasalance scores for subjects older than seven years. Watterson et al. (1996), Van Zundert et al. (1999) and Brunnegård and Van Doorn (2009) found no gender differences either. These are all studies of Germanic languages, which is the group of language which Dutch stems from. Several other authors reported differences between nasalance scores for men and women. Van Lierde et al., (2001) who provided typical nasalance values for normal Flemish speakers of various ages, reported higher nasalance values for women on the normal and

nasal text. However, this study included older participants and no children, like this study does. Mishima et al. (2008) presented significant differences between boys and girls in Japanese, but this is not a Germanic population, which might have an impact.

In this study, no significant correlation between age and percent nasalance was found. The explanation for this could be the range of the age between the children was too small; one year and seven months. Most studies with children found no significant differences due to age when percent nasalance of children is compared. Brunnegård and Van Doorn (2009) found a statistically significant difference between their youngest (4-5 years) group and the other two groups (6-7 years and 9-11 years) for nasal sentences. In this study they have a few outliners in the group of 4-5 years old, which could explain the significant difference.

The dialects results from this study were similar to the results from Brunnegård and Van Doorn (2009). Brunnegård and Van Doorn (2009) found no significant difference between three Swedish regional dialects. The study from Brunnegård and Van Doorn (2009) was conducted to establish normative nasalance values for Swedish speaking children and investigate differences in regional dialect from three cities, in gender, and in age. Other studies of dialects in the past have the same results as this study, for example in Canadian English (Kavabagh et al., 1994), Japanese (Mishima et al., 2008), Irish English (Sweeney et al, 2004) and Hungarian (Hirchberg et al., 2006).

The fact that differences in percent nasalance were not found for the two different regions in the Netherlands suggests that researchers do not need to establish regional norms for each cleft palate team in the north and south region of the Netherlands.

Several possible explanations as to why there are no dialect differences can be thought of. Firstly, we did not have access to the exact data from each individual participant from the study executed in Nijmegen, so the data from Alkmaar were compared with the standard mean nasalance data from Nijmegen. Secondly, selecting the children was not specifically done on the basis of dialect alone. When children were inhabitants of Alkmaar and when they met the inclusion criteria, they were included. It is possible that more dialects are included in the sample group and many dialects have variations. We selected children from three different schools in three different regions of Alkmaar, but we did not have information concerning the socioeconomic status of each participant. It is possible that the social group an individual belongs to has influence on the phonology of a dialect (Irvine, 1994). Lastly, this study has only selected schools in Alkmaar in order say something about dialects and nasality in the north and south part of the Netherlands in general.

Further large sample studies are needed to test hypotheses concerning nasalization associated with all dialects of Dutch, also in the west and the east region.

CONCLUSION

This study aimed to determine the percent nasalance for normal Dutch children from the northern part of the Netherlands (Alkmaar) and compared these data to the percent nasalance scores in the southern part of the Netherlands (Nijmegen). Data from this study did not detect significant differences for gender, age and dialect. This new outcomes have clinical significance for speech-language therapists working with resonance disorders in cleft palate teams and for speech pathologists working with resonance disorders in the north of the Netherlands.

ACKNOWLEGEMENTS

My sincere thanks are due to Drs. Judith Reijman Hinze for bringing the topic of nasality to my attention, for her practical and theoretical advice and for supervising this Master thesis. I want to thank Dr. An Greven and Prof. Dr Dejonckere for being my supervisors. Thanks are due to Drs. Wendy Eeltink for correcting my English and Bas Heijnen for having a solution to my technical problems. I also thank Gerben, my family, friends and colleagues who encouraged me in accomplishing this study.

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APPENDIX

Texts

The nasal text:

Mama gaat naar oma.
Zij neemt een mand mee.
In de mand zijn bananen
en ook mandarijnen.
Oma heeft honger,
zij neemt een mandarijn (Van Zundert et al., 1999).

The oral-nasal text:

Miep is op school.
Nu gaat zij kleuren.
Zij tekent de juf.
Dat wordt heel mooi.
Juf geeft Miep stickers (Van Zundert et al., 1999).

The oral text

Jos heeft feest.
Hij is jarig.
Hij krijgt veel kadootjes.
Ook is er taart.
De taart heeft vijf kaarsjes.
Jos blaast ze uit (Van Zundert et al., 1999).