THE IMPACT OF EMOTIONAL PROSODY ON NASALANCE SCORES

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1. INTRODUCTION

Nasalance is a commonly used acoustic measure that allows a speech-language pathologist to validate and quantify the perceptual assessment of a speaker's nasal resonance. It is particularly useful for the assessment of the hyper- or hyponasal resonance disorders that are often associated with conditions such as cleft palate or neurogenic dysarthria. The nasalance score is calculated as a ratio of the nasal sound pressure level to the combined nasal and oral sound pressure level (Fletcher, 1978). There are currently three commercially available instruments that measure nasalance: the Kay Nasometer 6200/ 6300 (Kay Elemetrics, Lincoln Park NJ), the NasalView (Tiger Electronics, Seattle WA), and the OroNasal System (Glottal Enterprises Inc., Syracuse NY).

Researchers and clinicians have noted that there is some variability between repeated nasalance measurements in the same patients (Bressmann, 2005). Watterson et al. (1994) studied the influence of speaker loudness on nasalance values. While the authors did not find significant differences in nasalance magnitudes for different loudness conditions they noted that nasalance scores tended to be lower when the speakers used a louder voice. Lewis et al. (2000) demonstrated that the vowel content in test sentences can significantly impact the nasalance magnitudes.

A factor that has not been investigated but that may contribute to the variability of nasalance scores is the emotional prosody of the speaker during an utterance. The purpose of the present study was to investigate the impact of different types of emotional prosody on nasalance scores. It was our hypothesis that different emotions would be associated with consistently different nasalance scores. As a co-variable, we investigated the impact of emotional prosody on different phonetic materials. Nasalance testing for hypernasality is usually carried out with non-nasal test sentences because these materials have a higher diagnostic value (Dalston & Seaver, 1992). We hypothesized that the impact of emotional prosody would be more pronounced for phonetically balanced materials because they allow a higher level of vocal plasticity than non-nasal stimuli.

Previous studies on emotional prosody have employed professional or amateur actors (Banse & Scherer, 1996). The advantage of using actors is that these individuals are trained to portray different emotional states on command.

We therefore decided to conduct our experiment with a group of speakers who had acting experience.

2. METHODS

The participants were 6 females and 4 males with a median age of 29 years (SD 7.37 years, range 18-42 years). who were recruited from a university drama club. All recordings were made with the NasalView System in the same quiet office environment. The test items were recorded directly to hard disk at a sampling rate of 44.1 kHz stereo (16 bit). The noise filter threshold was set to 18dB to reduce the effect of ambient noise on the nasalance recordings. The mean nasalance values and the corresponding standard deviations were recorded from the computer screen. Two sentences were used as stimuli for this study. The sentence 'Hat sundig pron you venzy' was taken from Banse & Scherer (1996). This sentence contains syllable structures that may be found in several indogermanic languages. It is a nonsense sentence, which has been found to be advantageous for the portrayal of emotions. The second sentence that we used was the sentence 'He had two rock lizards'. This sentence is balanced for vowel content, contains no nasal sounds and has been used in previous research (Lewis et al., 2000). The emotional states that were portrayed by the speakers were hot anger, sadness, happiness, interest, boredom, and contempt, as well as neutral intonation. These particular emotions were chosen because Banse & Scherer (1996) demonstrated that they had the most salient perceptual cues for listeners and could be portrayed most convincingly by the actors. The order of presentation was randomized.

3. RESULTS

The participants read two repetitions of the two sentences in six portrayed emotions and in a neutral intonation, resulting in a total of 28 recordings for each participant. We calculated mean values for the two repetitions of each token. The nasalance scores for all sentences in the different emotional states can be found in Table 1 and in Figures 1 and 2. For the non-nasal sentence 'He had two rock lizards', there was not much variability between the different portrayed emotions. The nonsense sentence 'Hat sundig pron you venzy' showed more variability. The highest nasalance values were observed for the 'neutral' and the 'sad' conditions, the lowest values were found for 'anger' and 'happiness'. In order to determine whether any of the

observed changes in nasalance scores were significant, we calculated two series of t-tests between the neutral condition for each sentence and the corresponding six portrayed emotions. The alpha was Bonferroni-adjusted accordingly to $p < 0.008$. We did not find any significant differences between the neutral and the emotional conditions for the sentence 'He had two rock lizards'. For the sentence 'Hat sundig pron you venzy', we found significantly lower nasalance values for the emotions hot anger ($p < 0.002$), happiness ($p < 0.005$) and interest ($p < 0.002$).

Tab. 1. Mean nasalance scores and standard deviations for the sentences 'He had two rock lizards' and 'Hat sundig pron you venzy', spoken with different portrayed emotions.

	'He had two rock lizards'	'Hat sundig pron you venzy'
Neutral	Mean 22.0 SD 3.11	Mean 46.34 SD 2.76
Hot anger	Mean 23.68 SD 2.24	Mean 37.79 SD 3.09
Sadness	Mean 24.25 SD 5.72	Mean 45.86 SD 8.57
Happiness	Mean 22.95 SD 2.24	Mean 38.79 SD 4.96
Interest	Mean 22.32 SD 3.42	Mean 39.78 SD 5.07
Boredom	Mean 22.85 SD 5.11	Mean 44.98 SD 6.23
Contempt	Mean 24.70 SD 4.21	Mean 43.21 SD 6.40

4.   DISCUSSION

The amateur actors who participated in this study were able to portray the different emotions with relatively little variability in nasalance values across repeated measurements. The nasalance magnitudes for the non-nasal sentence 'He had two rock lizards' demonstrated that different portrayed emotions did not affect the nasalance values. The level of variability was higher for the nonsense sentence 'Hat sundig pron you venzy'. The paired t-tests demonstrated that the portrayed emotions 'anger', 'happiness' and 'interest' had significantly lower nasalance values. A number of subjects shared the feedback that they found it considerably easier to portray the different emotions when they were reading the nonsense sentence 'Hat sundig pron you venzy'. It is possible that the vocal and articulatory adjustments that are made in the vocal tract to convey an emotional state also affect the oral-nasal balance of the speaker. The conclusion drawn from the present study is that some types of affective prosody can impact on nasalance magnitudes. However, this impact is more pronounced for phonetically balanced materials than it is for non-nasal stimuli. This is good news for clinicians because diagnostic materials usually consist of non-nasal phonetic materials (Dalston & Seaver, 1992). When recording phonetically balanced materials, it is important to remember that affective prosody can confound the nasalance measurements. In order to obtain reliable nasalance

recordings, subjects should be instructed to read or repeat passages in an intonation that is as emotionally neutral as possible.
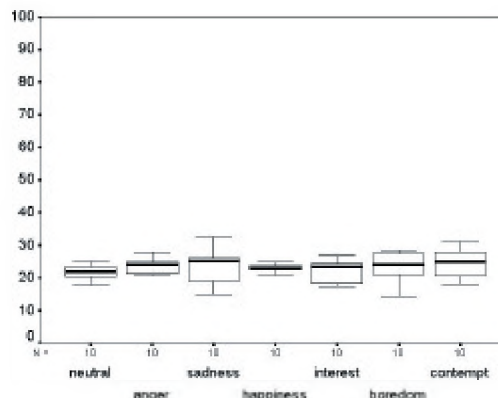

Fig. 1. Boxplots of the nasalance scores for the sentence 'He had two rock lizards', spoken with different portrayed emotions.
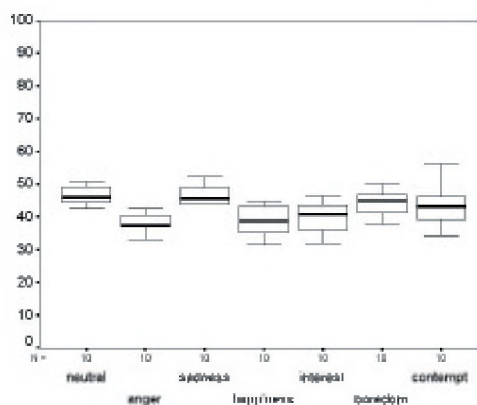

Fig. 2. Boxplots of the nasalance scores for the sentence 'He had two rock lizards', spoken with different portrayed emotions.

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