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Brief communication

Simulation of hypernasality levels using trained actors: A brief communication

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ABSTRACT

Purpose: to report an experience of simulation applied to a research context and assess the feasibility of using trained actors' audio recordings to simulate nasality levels.

Methods: two clinical simulation actors selected and subsequently trained to simulate three nasality levels (non-nasal, mild to moderate hypernasal and severe hypernasal), resulting in a total of 6 audios. These files were analysed through a Praat script to obtain the measures A1-P0 compensated and the first formant's bandwidth. Afterwards, they were rated by two expert SLPs, according to their nasality and intelligibility, using perceptual scales.

Results: according to A1-P0 and F1 bandwidth values in most conditions and the expert SLP's nasality and intelligibility ratings, the actors were able to simulate the previously defined nasality levels.

Final Considerations: based on the preliminary data, it can be concluded that the use of clinical simulation in experimental contexts, offering new opportunities and benefits for researchers, is feasible. In this experience, the actors were able to simulate different nasality levels corroborated by acoustic analysis and experts' ratings.

Keywords: Patient Simulation; Velopharyngeal Insufficiency; Voice Quality; Speech Perception

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INTRODUCTION

Currently, many universities resort to the implementation of actors trained in clinical simulation as an educational resource in the different health sciences careers. This provides a safe environment for the students to practice and make mistakes, allowing them the opportunity to refine their skills before facing a clinical environment with real patients[1].

Among the benefits reported in the literature regarding the implementation of clinical simulation in the context of teaching in health careers, it is possible to mention that it enhances clinical skills, teamwork, it has even been shown to improve clinical outcomes, and the development of other skills such as social interaction, communication, stress management, professional ethics, decision making and problem solving[2-4].

The availability of these resources in universities could be beneficial for researchers also by offering a wide variety of possible pathologies to simulate, while providing greater control over possible confounding variables.

In the literature it is possible to find experiences where nasality simulation has been used with different objectives. A group of researchers from the University of Toronto has reported success using hypernasality simulation in two different articles where they trained a group of undergraduate students to simulate different levels of nasality in order to design predictive formulas to facilitate the diagnosis of oral-nasal balance disorders[5,6]. Previous studies have dabbled in the use of hypernasality simulation to assess the influence of the nasality degree in perceptual judgements while coexisting with other speech disorders and vice versa[7,8]. Other authors have opted to manipulate acoustic signals to add a breathy source and thus study its effect on hypernasality severity ratings[9]. In the previously described experiences, it is possible to note that greater precision was achieved in the control of variables such as the severity and other coexisting characteristics from the different speech subsystems that could impact perceptual judgements, which would not be possible to replicate with real patients since they have no control over these features whereas in simulation a single person is capable of producing different levels of nasality thus reducing the effect of individual variability in the stimuli[8].

Although its possible benefits for research have been described[10], it is more common to find literature where pathology simulation is used for teaching purposes[2,10,11], Some authors have applied it for the development of research aimed at simulating certain speech characteristics to present auditory stimuli to listeners or to elaborate predictive formulas[6-8,12]. However, there is still a literature gap regarding the use of clinical simulation-trained actors for research purposes. It is for this reason that the present study aims to report an experience of simulation applied to a research context and to assess the feasibility of using stimuli made with actors trained to simulate nasality levels.

METHODS

This study was approved by the *CEISH* (Human Research Ethics Committee) of the Medical School of the University of Chile on December 6th of 2022, Chile, under the project number 232-2022, record file Nº 181.

Participants

Two clinical simulation-trained actors were selected from the Trained Patients Unit from the UC Simulation Centre, which was asked to recommend two actors, according to the following criteria:

Inclusion Criteria: Aged between 20-55 years old, experienced in simulation of voice or speech pathologies, being a Chilean Spanish native speaker, and have time availability to attend to the *USACH* Phonetics Laboratory.

Exclusion Criteria: Voice disorders (corroborated by acoustic and perceptual assessment executed by the first author, who is a Speech Language Pathologist (SLP) with clinical experience in voice disorder diagnosis), marked timbral characteristics such as a breathy or strident, markedly nasal, hypo nasal or cul-de-sac-like sounding voice, etc., previous diagnosis of speech disorders, hearing disorders, being a native speaker of a language different from Chilean Spanish.

Only three actors were recommended by the Simulation Centre, one of them was excluded for having a very strident voice according to the perceptual analysis, so only two actors met the previously mentioned criteria, a male and a female, which were subsequently subjected to a hypernasality simulation training protocol.

Training

The training for simulating hypernasality was based on the program described by De Boer and Bressman in 2015[12]. This protocol consisted of three stages, in the first stage the actors listened to recordings of real

patients with cleft palate with different levels of nasality to familiarize them with the desired sound, in the second stage they explored the sensation of hypernasality by placing a finger below the nose to feel the airflow when speaking syllables with nasal consonants and progressing to phrases using a hypernasal balance. In the third stage, they simulated three levels of nasality: 1. non-nasal or basal voice; 2. Mild to moderate hypernasality; and 3. Severe hypernasality, in two sentences designed without nasal consonants, with an extension between 8-11 syllables using declarative voice. Once the actors and the SLP in charge were satisfied with the results of the simulation, the process of recording the stimuli began.

Each actor was scheduled to be trained and record independently. Prior to starting the recording process, the actors were asked if they felt congestion, which was later corroborated using a Glatzel Mirror and a nasal patency examination to evaluate the permeability of the nasal passages. Then they were instructed to enter the soundproof booth and read two sentences written on paper with the three previously practiced levels of nasality:

- "Caro corre hasta el paradero"
- "El estudio es positivo"

These sentences were designed without nasal consonants, with an extension of 8-11 syllables, with a syllabic structure preferably consonant-vowel, in declarative voice, and in absence of proparoxytone words. The sentences used in this study were randomly selected from a pool of 12 sentences designed under the criteria mentioned above.

Instruments

The recording of the stimuli was carried out in a soundproof booth located at the USACH Phonetics Laboratory using the microphone RØDE NT1-A with a cardioid polar pattern, wide and flat frequency response, positioned 30 cm from the mouth, and accompanied by a Presonus Audiobox USB audio interface. The audios were recorded using the Audacity software version 3.1.3. in a Mac computer, with a sampling frequency of 44.100 Hz. The acoustic analysis was carried out using the Praat software (version 6.1.53, NL).

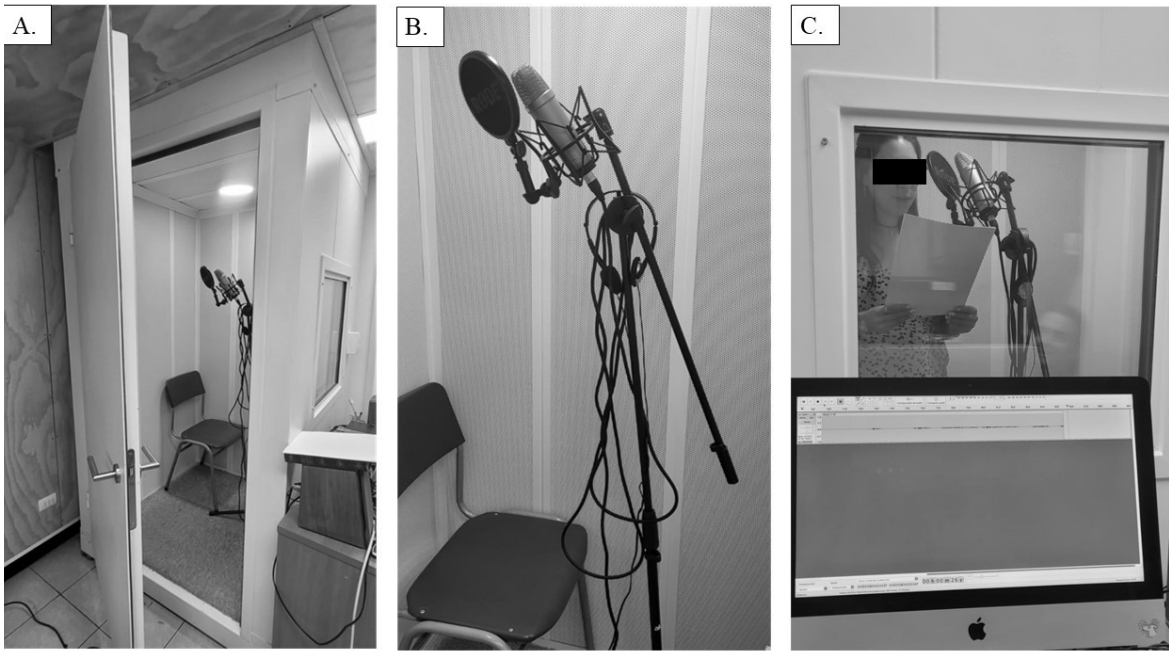

Figure 1. Equipment used for the audio recordings at the USACH Phonetics Lab. A. Soundproof booth; B. Microphone model RØDE NT1-A; C. Audio recording using the software Audacity version 3.1.3. for Mac.

Acoustic analysis

To corroborate compliance with the nasality levels previously proposed, some measurements were calculated through acoustic analysis using the Nasality Automeasure Script version 5.9. designed for this purpose using the program Praat[11]. It was developed at the University of Colorado by Will Styler and Rebecca Scarborough and its function is to calculate a large set of measurements associated with nasality in a matter of minutes. To make the script work correctly according to its instructions of use, the lower vowels (a, e, o) were labelled on each of the six audios using the Textgrid tool.

From the large set of measurements calculated by the script, only two were selected in order to analyse the nasality levels on the stimuli. These measurements were A1-P0 compensated according to Chen's algorithm and the bandwidths of the first formant (F1), as these measures have been reported to be the most robust for evaluating nasality using acoustic analysis[13,14]. These measures behave according to the degree of nasality, since an increased nasality, caused by the coupling of the nasal cavity will produce a greater damping of the sound by increasing the contact surface and a higher temperature of the air which results in a decrease of A1-P0 and an increase of the bandwidths[15,16].

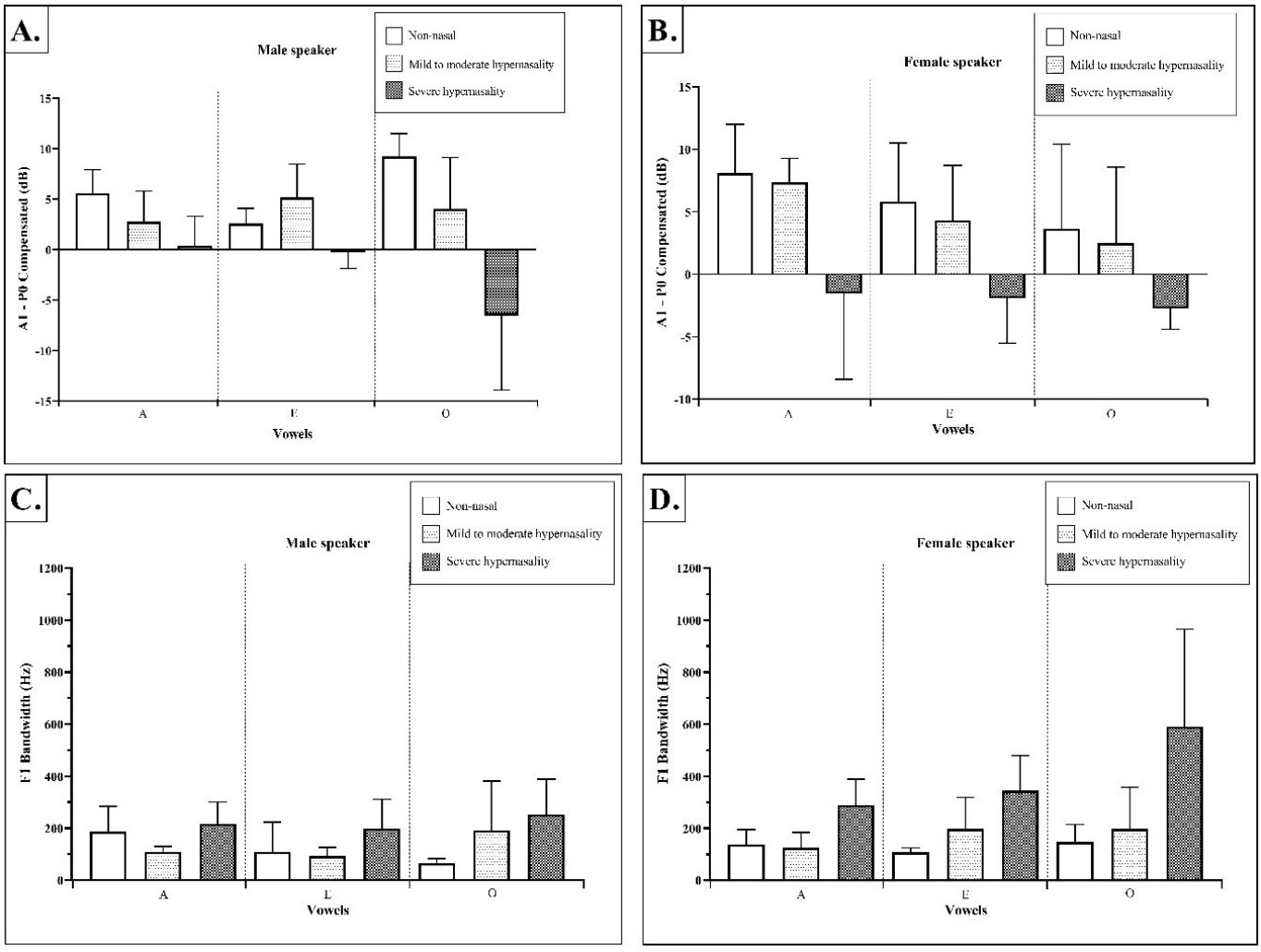

Figure 2. A & B showcase the A1-P0 compensated values according to Chen's compensation algorithm (dB) for male (A) and female (B) speakers, while C & D illustrate F1 Bandwidths (Hz) for male (C) and female (D) speakers. These values were calculated using the mid-point of the low vowels (a, e and o) previously labelled using Textgrid.

In Figure 2, it is possible to note that, for both actors, according to the calculated values of A1-P0 compensated (dB) and F1 bandwidths (Hz) they reached the required nasality levels for most of the conditions.

Expert judges

After the acoustic analysis, the stimuli were rated by two SLPs with years' worth of experience both academic and in the diagnosis and treatment of patients with velopharyngeal insufficiency at *Fundación Gantz* (Hospital for Children with Cleft Palate, Santiago, Chile). Each of them rated the audios independently, according to nasality degree using a 3-point scale (1 = non-nasal; 2 = mild to moderate hypernasality; 3 = severe hypernasality) and intelligibility using a percentage scale from zero to a hundred percent in two different occasions one-week apart[17-20]. The stimuli were presented randomly, and the judges were not aware of the proposed nasality degree nor the fact that they were actors and not actual patients with cleft palate. The order of the procedures performed is illustrated in Figure 3 for ease of understanding.

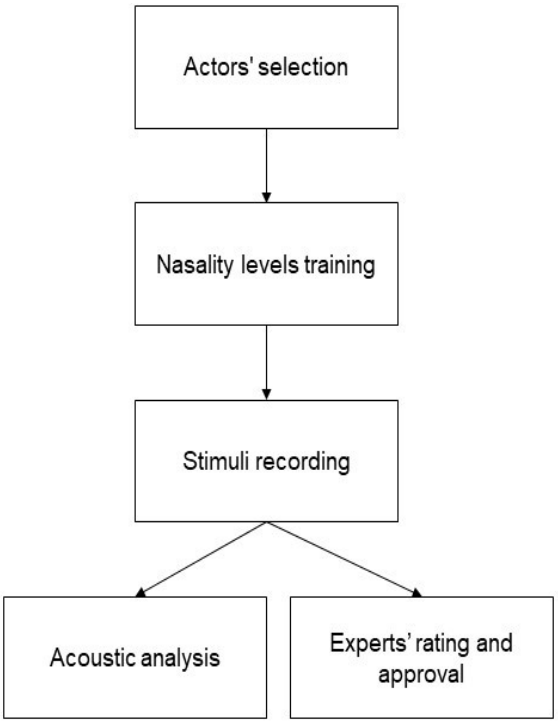

Figure 3. Flowchart illustrating the procedure of building the auditory stimuli

Statistical analysis

The software R version 4.0.5 (2021, The R Foundation for Statistical Computing) was used to develop the statistical analysis presented in this article. The software GraphPad Prism version 8.0.2 was used to elaborate the graphics.

To determine the reliability of the scales, an intraclass and inter-rater reliability calculation was performed for the perceptual variables of nasality and intelligibility between the two judges.

RESULTS

A1-P0 compensated and F1 bandwidths were calculated using acoustic analysis to determine if the trained actors reached the proposed nasality levels. Regarding the results of the acoustic analysis, it is possible to observe in Figure 2, that there was a decrease in A1-P0 compensated as the nasality increases in most of the conditions for both speakers. In addition, it is possible to note a gradual increase of the F1 bandwidths as the nasality increases in most of the conditions for both speakers.

Expert Judges

The expert judges rated the nasality of the audios coinciding in a 100% with the proposed nasality level during the simulation, in other words, the non-nasal audio was rated with 1 point, the mild to moderate was rated with 2 points, and the severe hypernasality was rated with 3 points. Whereas the intelligibility was rated gradually according to the nasality levels, resulting in a 100% for the non-nasal voice in both speakers, an 80% for the voice with mild to moderate hypernasality, and a 60% for the one with severe hypernasality.

When calculating the interclass reliability for nasality and intelligibility, we obtained for the first judge a 100% and a 95% respectively, while the second judge got a 100% and a 95% respectively. For the inter-rater (inter-judge) reliability we obtained a 100% for nasality and 82% for intelligibility. Which indicates that there was a high coincidence in the ratings of each of the two judges in the two opportunities where they rated the audios, a high coincidence between the ratings of both judges for the two variables, and hence, a high reliability of the perceptual scales used.

DISCUSSION

The purposes of this work were to share an experience on the use of clinical simulation in a research context and to assess the feasibility of implementing actors trained to simulate different levels of nasality. According to the results of both the acoustic analysis and the experts' rating of the stimuli, it is possible to say that the actors were able to simulate different nasality levels successfully. As reflected by the resulting A1-P0 compensated, F1 bandwidth values and the two expert SLPs' nasality and intelligibility ratings.

Moreover, it is important to mention that only two actors and two expert SLPs participated in this experience, therefore this would most likely vary in other contexts and with a larger number of participants. In this study actors were selected with great care, who were also experienced in clinical simulation and underwent training, which might not be generalizable to other contexts. Other authors such as De Boer and Bressmann used simulation of levels of nasality in their study aiming to develop predictive formulas for the different levels of nasality using a nasometer with a successful experience, however, these simulations were made by university students and not by professional actors as in the present work[12].

In other experiences, the use of trained actors has been highlighted as an alternative to control other factors that might impact nasality perception on listeners, such as compensatory articulation, and other coexisting speech alterations. Besides it provides the researcher with greater control over the degrees of severity, something that would be impossible to achieve with real patients and provides control over individual variability considering that a single actor could simulate several nasality levels[8].

Finally, the use of trained actors for research contexts in the areas of voice and speech emerges as a new opportunity by providing greater control over confounding variables, especially in the manufacturing of stimuli to be used perception studies on specific characteristics of speakers, where greater precision might be required to isolate certain characteristics that would be harder or even impossible to achieve with real patients[6-8,12]. Therefore, it is necessary to continue contributing to the generation of knowledge regarding this useful tool to generalize its use to other speech and voice pathologies of interest to researchers working in the study of communication sciences and thus facilitate the development of new research.

FINAL CONSIDERATIONS

In this work, an experience using the voices of trained actors to simulate different nasality levels, has been reported. According to this preliminary data, it is possible to conclude that clinical simulation is a tool that can contribute to the development of research, since the use of clinical-simulation actors can benefit researchers allowing a greater control over confounding variables by using the same subject to simulate different conditions. Further research is needed to continue generating evidence regarding the implementation of this tool in research contexts oriented to other pathologies of interest to those who study human communication sciences.

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Authors' contributions:

FF: Conceptualization; Data curation; Formal analysis; Methodology; Project administration; Writing – Original draft; Writing – Review & editing.

PV: Supervision; Writing – Review & editing.

DR: Supervision; Validation; Writing – Review & editing

Data sharing statement:

The authors declare that individual participant data will not be available.