Development of an Ergonomic Nasometer:
Effect of Separator-Mouth Gap on Nasalance

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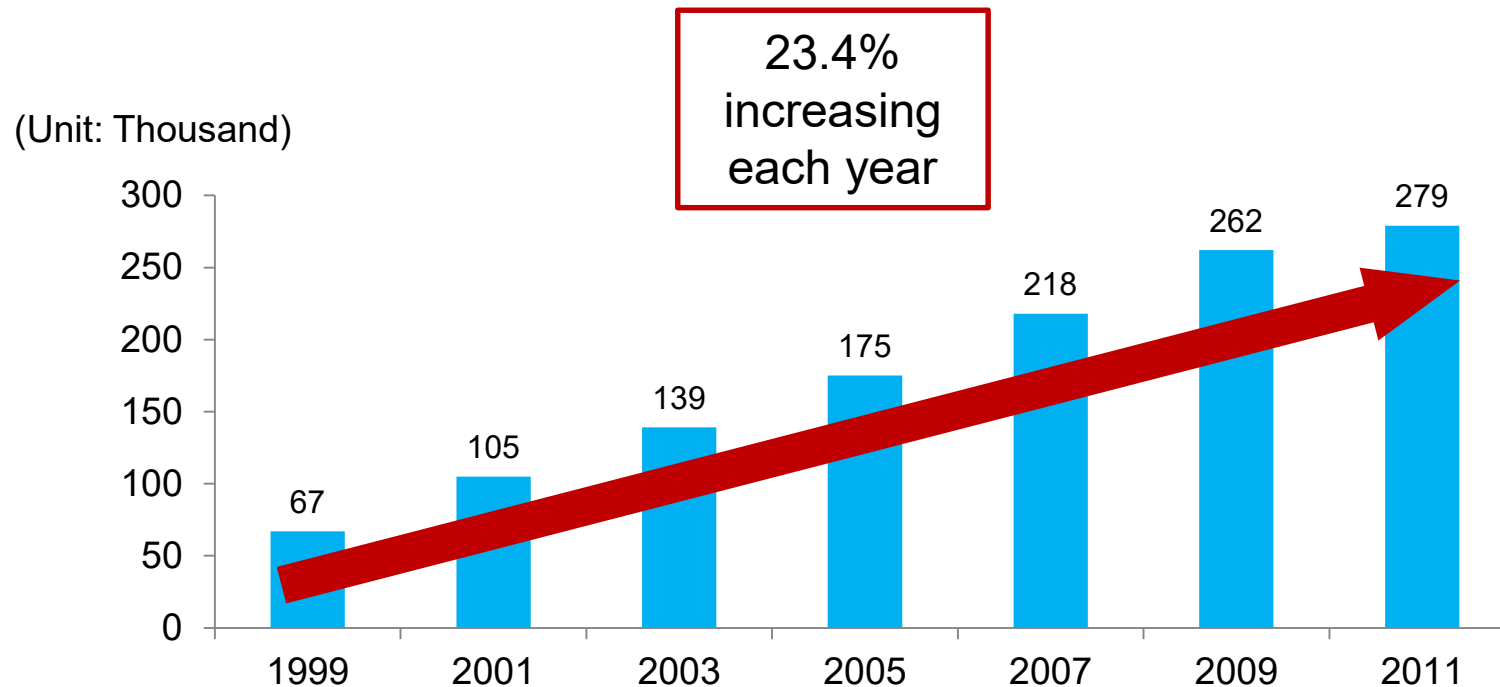[2] Humanopia, Inc.
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Agenda

- ❑ Introduction
  - ➢ Background
  - ➢ Objectives of the Study
- ❑ Method
  - ➢ Experiment
  - ➢ Nasalance Adjustment
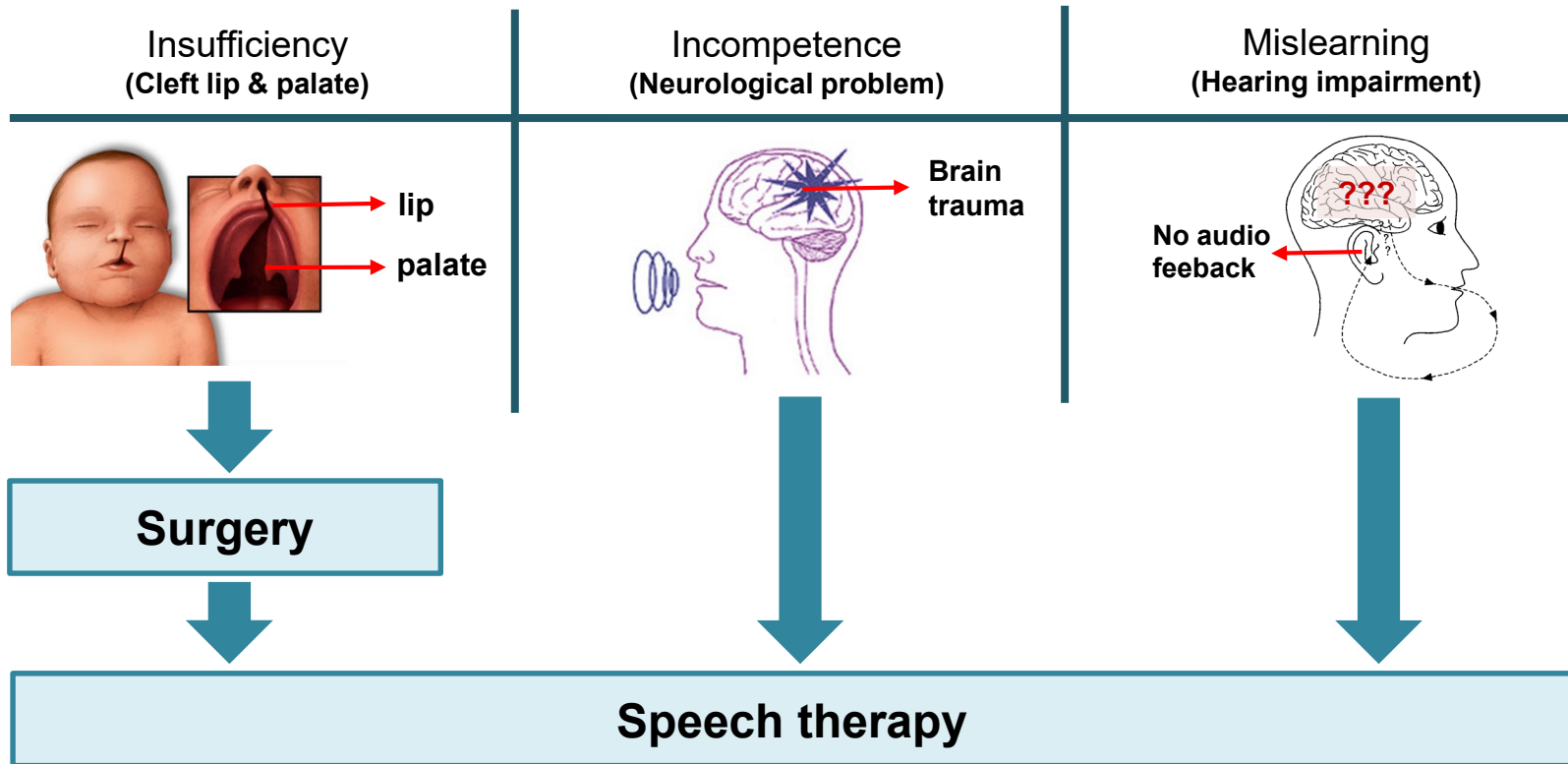- ❑ Results
- ❑ Discussion

Increase of Speech Disorders

❑ Number of people with **speech disorders** in Korea is **increasing** significantly.

❑ People recognition on disorders might trigger the number of case reports

23.4% increasing each year

(Unit: Thousand)

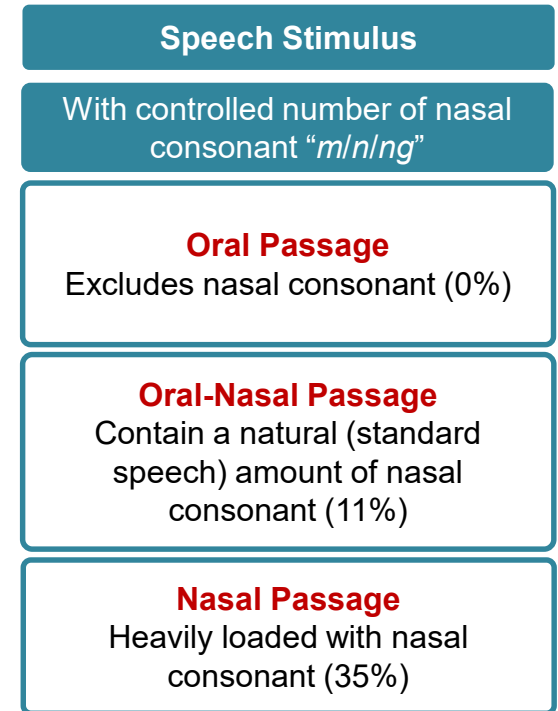| Year	Value
1999	67
2001	105
2003	139
2005	175
2007	218
2009	262
2011	279

Source: Departement of Health and Human Service

Nasality Problem
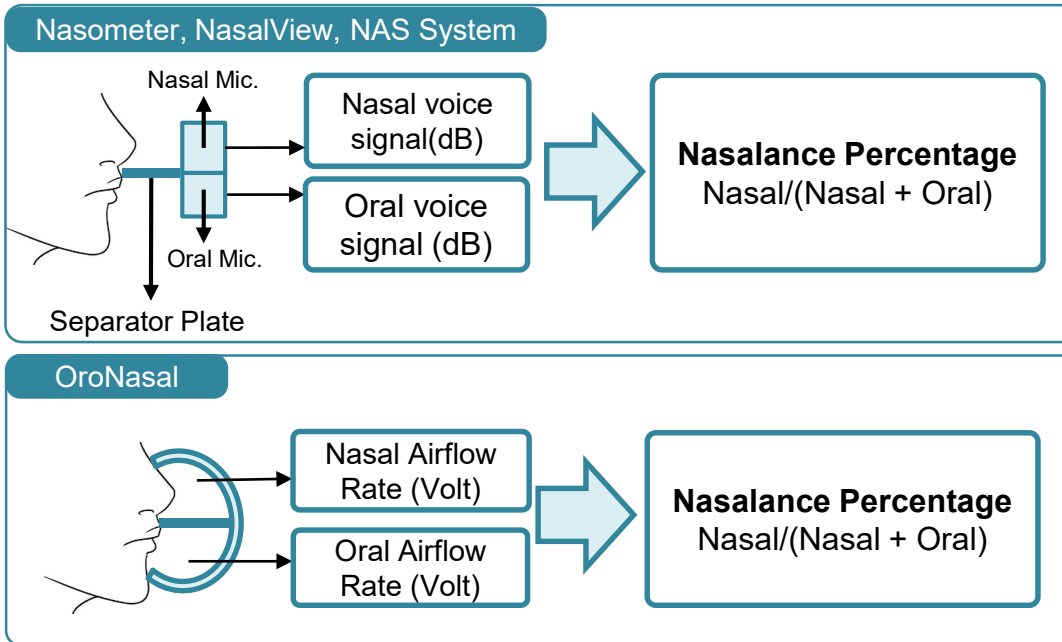
❑ People with resonance disorder can NOT produce a proper degree of nasality.

❑ Speech therapy is needed to help patient recovering from the disorder or post-surgery program.

Insufficiency (Cleft lip & palate)	Incompetence (Neurological problem)	Mislearning (Hearing impairment)

lip
palate

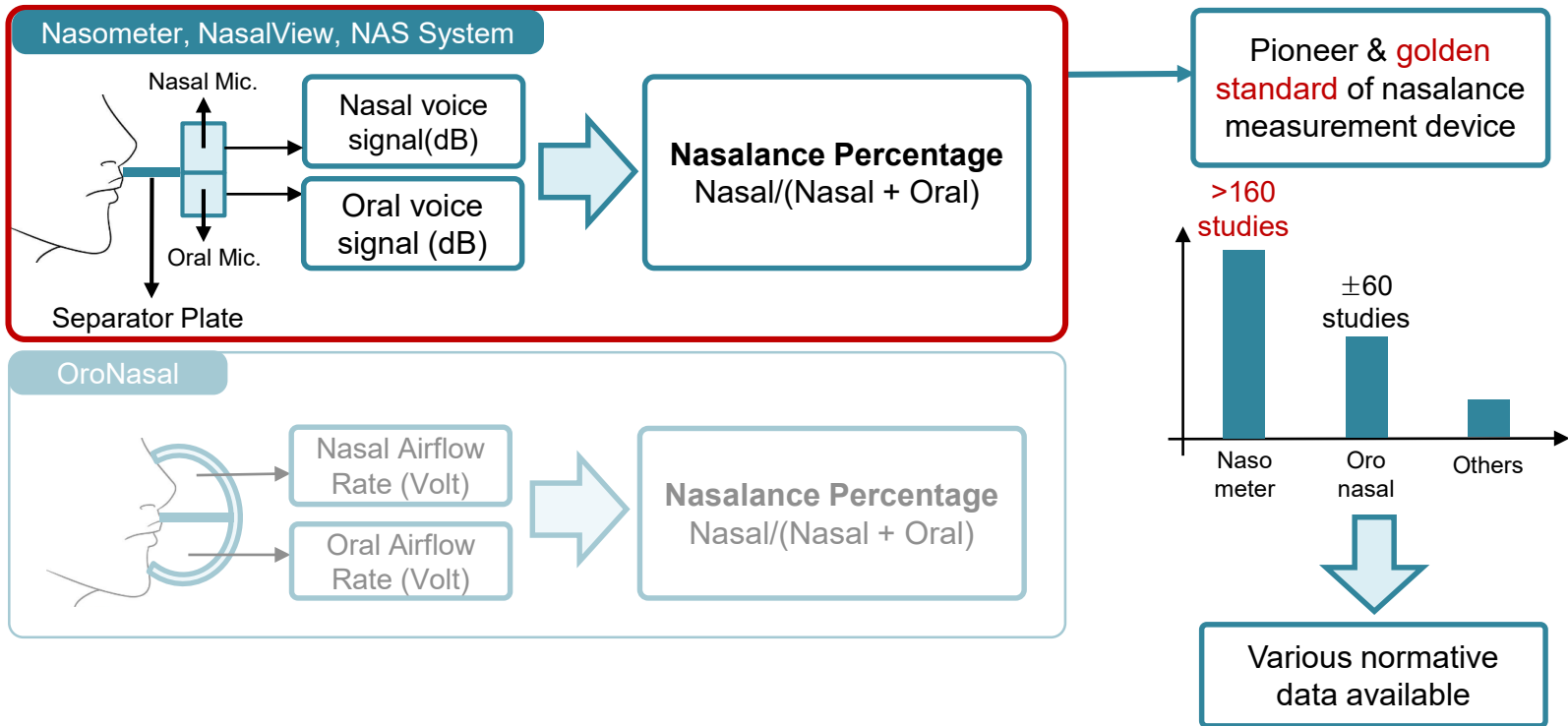Brain trauma

No audio feeback

???

Surgery

Speech therapy

❑ Degree of nasality measurement is important to evaluate the progress of patient.

❑ Nasalance factors: Age, gender, dialect, and language.

Increase font size

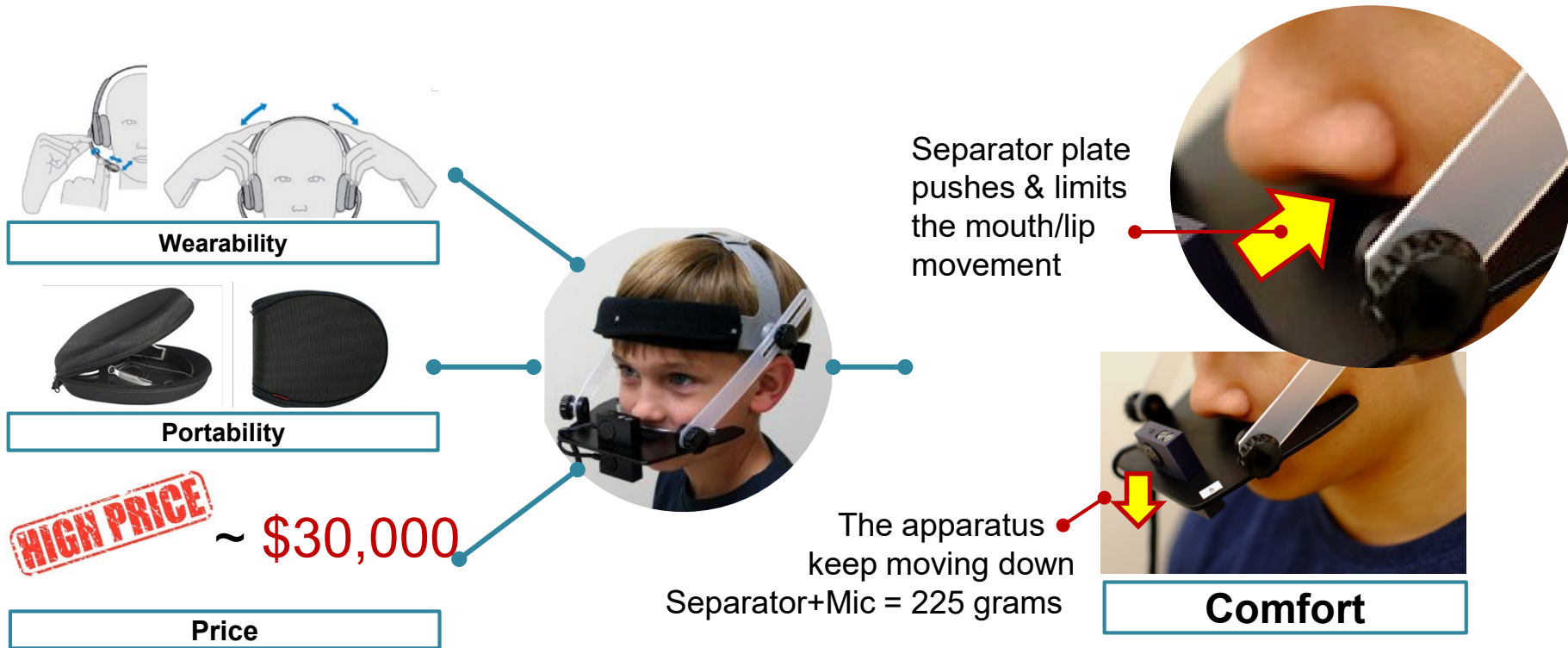**Nasometer, NasalView, NAS System**

Nasal Mic.

Nasal voice signal(dB)

Oral voice signal (dB)

Oral Mic.

Separator Plate

Nasalance Percentage
Nasal/(Nasal + Oral)

OroNasal

Nasal Airflow Rate (Volt)

Oral Airflow Rate (Volt)

Nasalance Percentage
Nasal/(Nasal + Oral)

Speech Stimulus

With controlled number of nasal consonant "*m*/*n*/*ng*"

Oral Passage
Excludes nasal consonant (0%)

Oral-Nasal Passage
Contain a natural (standard speech) amount of nasal consonant (11%)

Nasal Passage
Heavily loaded with nasal consonant (35%)

❑ Degree of nasality measurement is important to evaluate the progress of patient.

❑ Nasalance factors: Age, gender, dialect, and language.

Nasometer, NasalView, NAS System

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Nasal Airflow Rate (Volt)

Oral Airflow Rate (Volt)

Nasalance Percentage
Nasal/(Nasal + Oral)

Pioneer & golden standard of nasalance measurement device

>160 studies

±60 studies

Naso meter | Oro nasal | Others

Various normative data available

❑ Nasometer still has several disadvantages mainly in terms of comfort.

❑ Cause: Separator plate and microphone heavy and bulky design.

❑ Interference of separator → may affect the assessment results.

Wearability

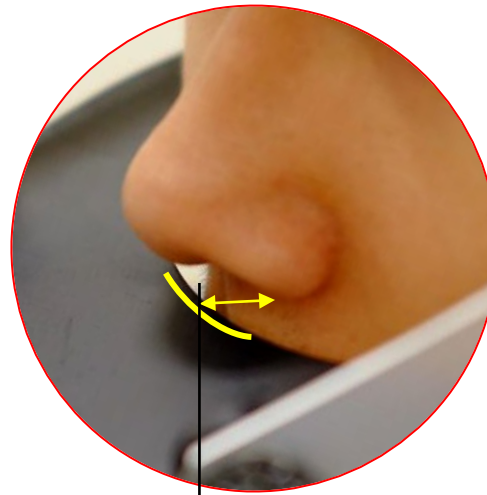**Portability**

HIGH PRICE

~ $30,000

Price

Separator plate pushes & limits the mouth/lip movement

The apparatus keep moving down
Separator+Mic = 225 grams

Comfort

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Objectives

❑ Develop an ergonomic nasometer with better comfort and reliability.

❑ Provide a distance between separator plate and mouth/lip.

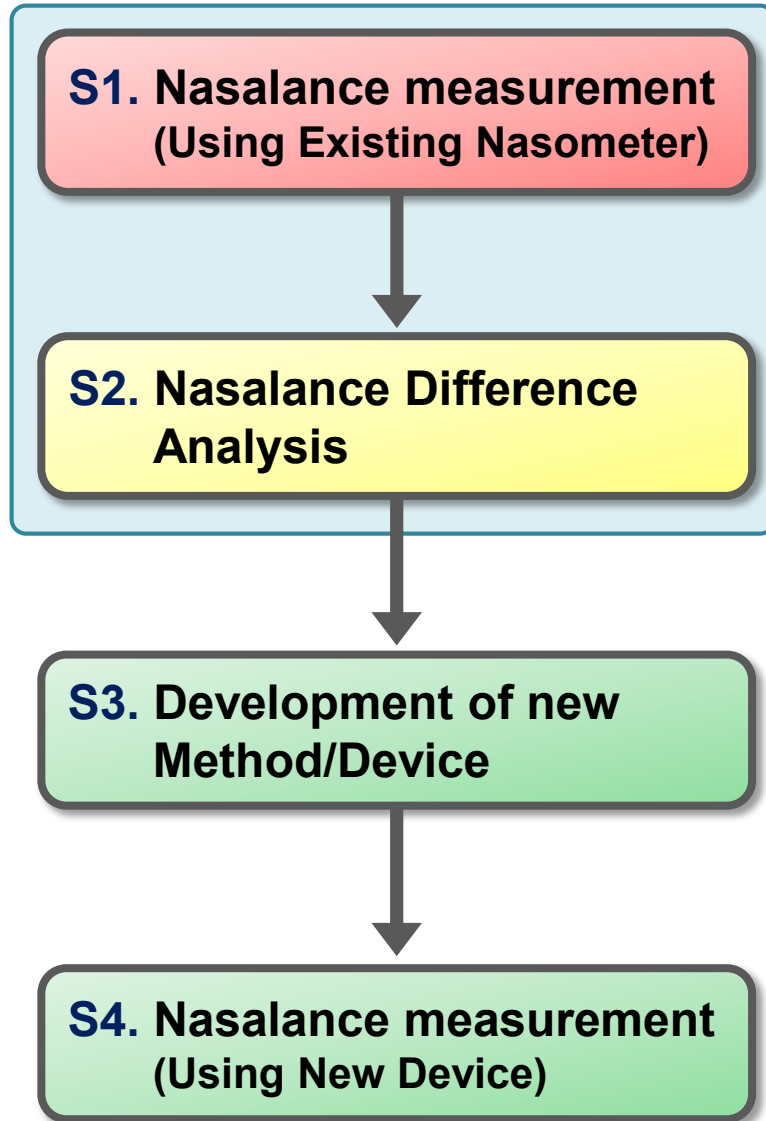❑ Identify the effect of separator-mouth distance on nasalance

Touched Separator
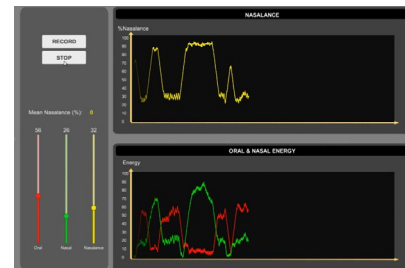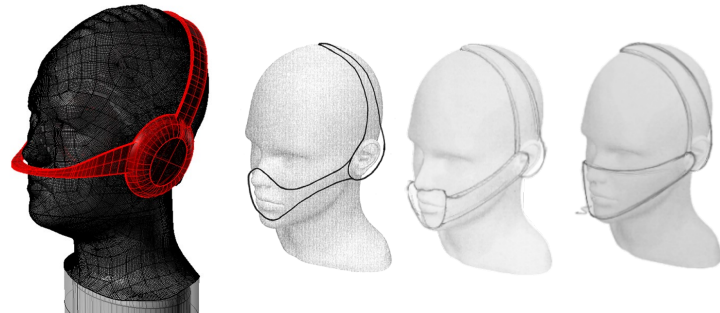
Untouched Separator

Separator gap

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S1. Nasalance measurement (Using Existing Nasometer)

S2. Nasalance Difference Analysis

S3. Development of new Method/Device

S4. Nasalance measurement (Using New Device)
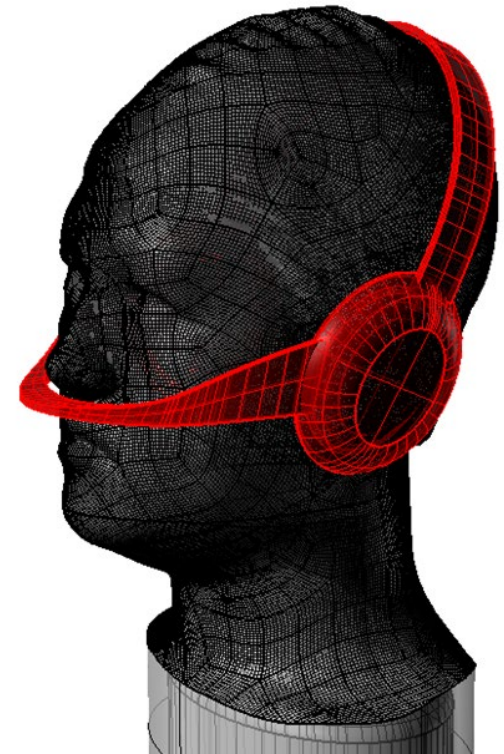
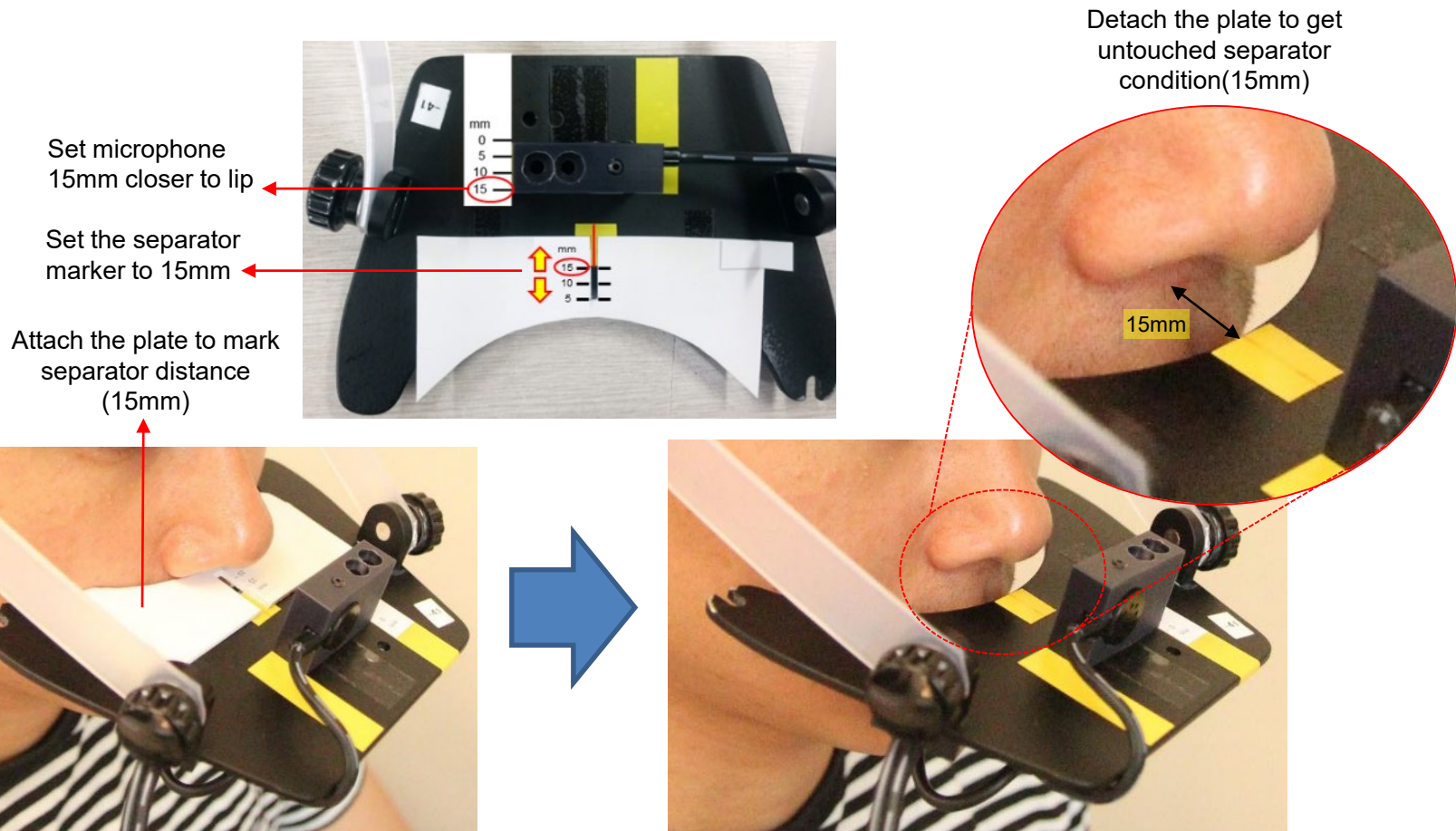Separator condition
- Touched
- Untouched

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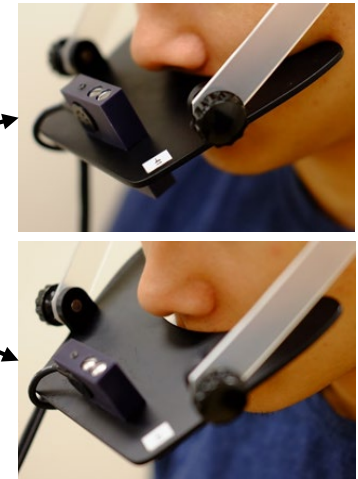
❑ Hypothesis: Using untouched separator will result in different nasalance value due to nasal and oral voice signal leakage.

❑ Nasalance value should be adjusted to obtain a comparable result with touched separator.

❑ Find a certain individual multiplier to adjust the nasalance value.

✓ Individual factors: Age, gender, and dialect may affect nasalance value.

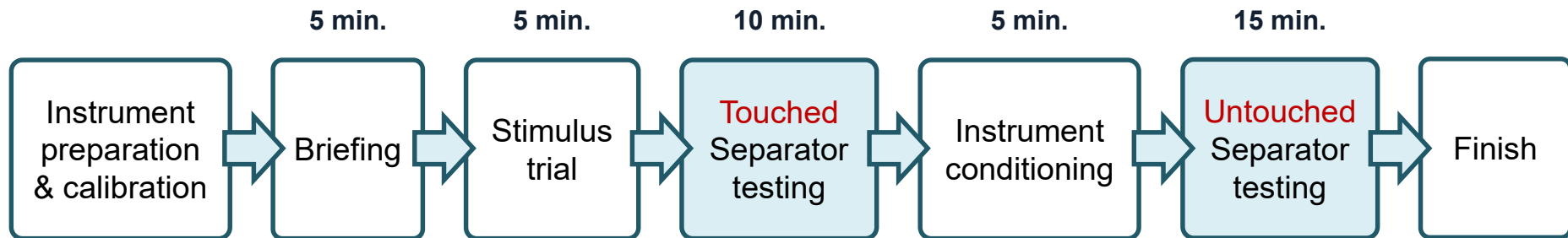| Touched	Untouched
	Separator gap? 5mm 10mm 15mm
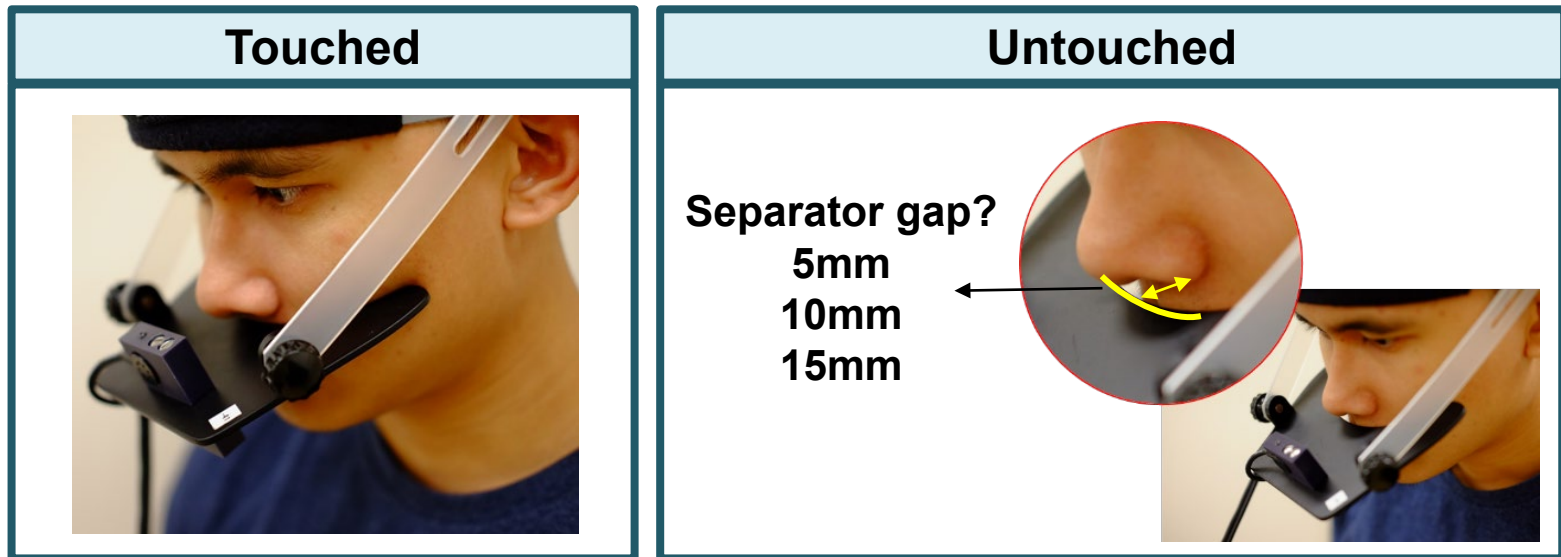
Experimental Setup

❑ Factor: Distance between separator and lip (philtrum).

❑ Different microphone distance will affect the nasalance value → distance between microphone and lip should remain steady during testing.

Set microphone 15mm closer to lip

Set the separator marker to 15mm

Attach the plate to mark separator distance (15mm)

Detach the plate to get untouched separator condition(15mm)

15mm

Experiment Procedure

❑ **Condition**: Touched separator & Untouched separator (5/10/15mm).

❑ **Participants**: 1 male & 1 female (pilot test)

❑ **Stimulus**: Nasal sentence & Zoo passage (3 repetition each passage).

❑ **Time/session** = 40 min.

|	5 min.	5 min.	10 min.	5 min.	15 min.	
Instrument preparation & calibration	Briefing	Stimulus trial	Touched Separator testing	Instrument conditioning	Untouched Separator testing	Finish

Nasal Sentences (35% nasal consonant):

"Mama made some lemon jam.

Ten men came in when Jane rang.

Dan's gang changed my mind.

Ben can't plan on a lengthy rain.

Amanda came from Bounding, Maine"

Zoo Passage (0% nasal consonant):

"Look at this book with us. It's a story about a zoo. That is where bears go. Today it's very cold out of doors, but we see a cloud overhead that's a pretty white fluffy shape."

Nasalance Adjustment

❑ Obtain nasalance data from touched and untouched (5/10/15mm) separator within subject.

❑ Multiplier = $\dfrac{Nasalance\ of\ Touched\ Separator}{Nasalance\ of\ Untouched\ Separator}$

❑ Obtain mean ratio of touched and untouched nasalance → individual multiplier.
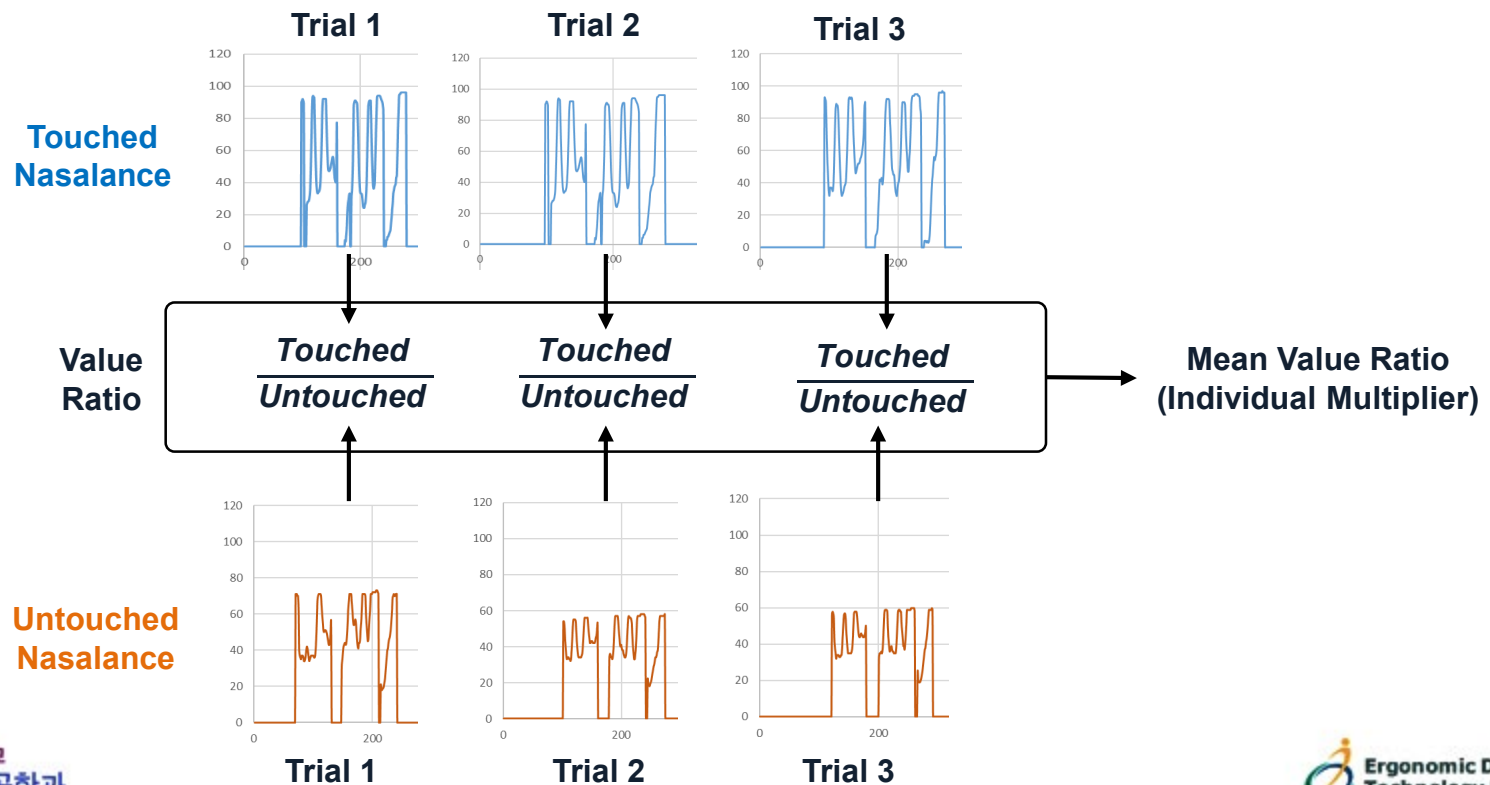
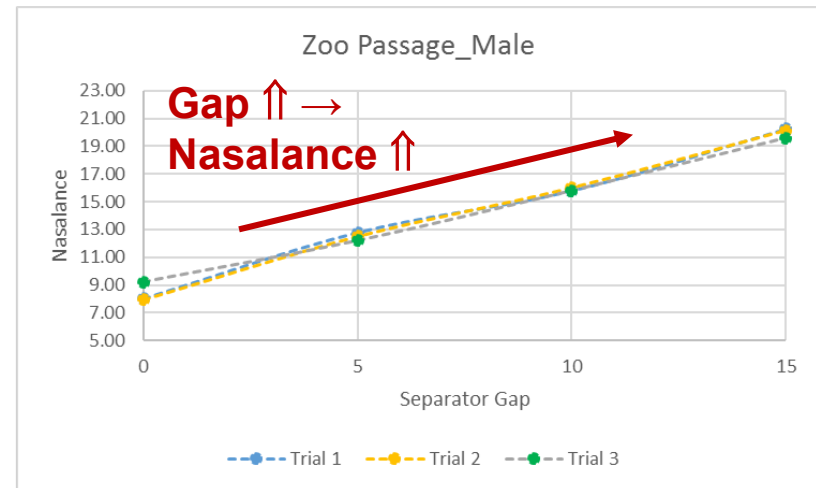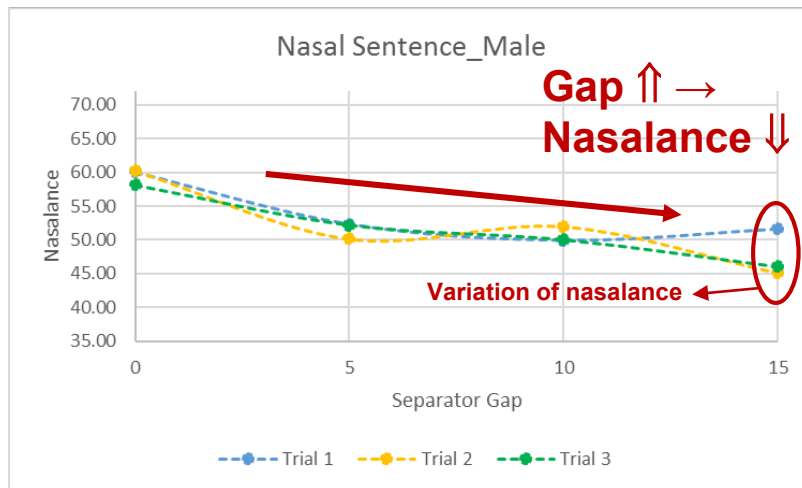# Nasalance: Male

❑ Nasalance value of touched separator agree with normative data.

❑ The variation within subject is relatively small (except in the 15mm: SD = 3.51).

Gender	Trial	Nasalance: Nasal Sentence				Nasalance: Zoo Passage			
		0mm	5mm	10mm	15mm	0mm	5mm	10mm	15mm
Male	1	60.05	52.33	49.92	51.61	8.01	12.79	15.80	20.25
	2	60.19	50.15	51.97	45.13	7.95	12.50	16.00	20.12
	3	58.15	52.20	50.03	46.01	9.21	12.19	15.80	19.60
	Mean	**59.47**	51.56	50.64	47.58	**8.39**	12.49	15.87	19.99
	SD	1.14	1.22	1.16	3.51	0.71	0.30	0.12	0.35
	Normative Nasalance	59.55				11.25			

Normative Data KAYPENTAX

Test passage	Mean Nasalance	SD of Mean
Nasal Sentence	59.55	7.96
Zoo Passage	11.25	5.63

Nasal Sentence_Male

Gap ⇑ → Nasalance ⇓

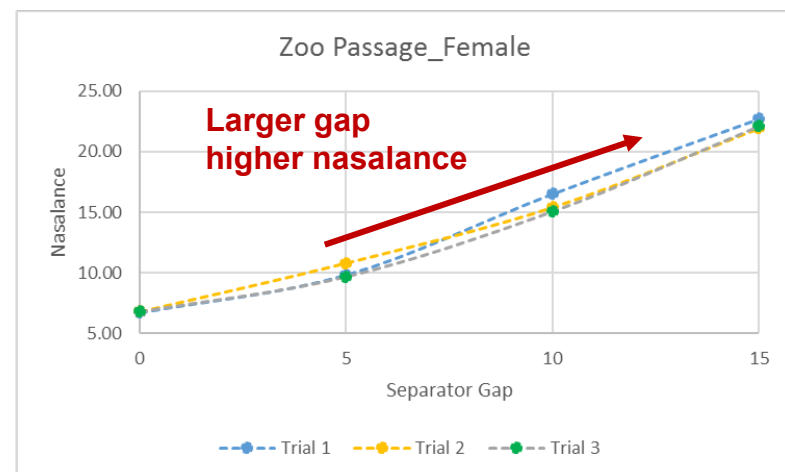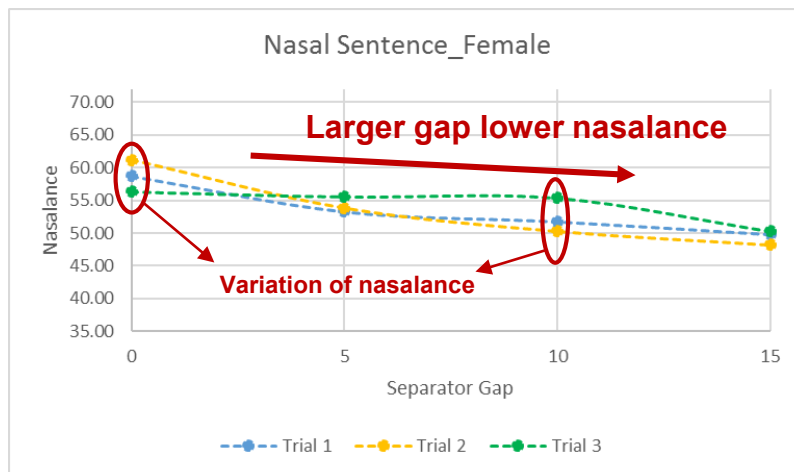Variation of nasalance

Zoo Passage_Male

Gap ⇑ → Nasalance ⇑

Nasalance: Female

❑ Nasalance value of touched separator agree with normative data.

❑ The variation within subject is relatively small (except in the 10mm: SD = 2.12).

Gender	Trial	Nasal Sentence Nasalance				Zoo Passage Nasalance			
		0mm	5mm	10mm	15mm	0mm	5mm	10mm	15mm
Female	1	58.71	53.28	51.75	49.80	6.71	9.84	16.53	22.73
	2	61.18	53.85	50.30	48.23	6.81	10.83	15.42	21.93
	3	56.32	55.55	55.35	50.25	6.79	9.70	15.10	22.14
	Mean	58.74	54.22	52.47	49.43	6.77	10.12	15.68	22.27
	SD of Mean	1.98	0.96	2.12	0.87	0.04	0.50	0.61	0.34
	Normative Nasalance	59.55				11.25			

Normative Data KAYPENTAX

Test passage	Mean Nasalance	SD of Mean
Nasal Sentence	59.55	7.96
Zoo Passage	11.25	5.63

Nasal Sentence_Female

Larger gap lower nasalance

Variation of nasalance

Zoo Passage_Female

Larger gap higher nasalance

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Nasalance: Trend Analysis
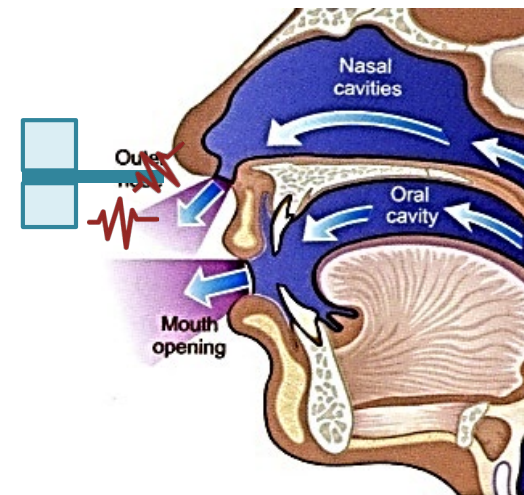
❑ On **oral passage**

✓ Nasalance increases linearly

✓ Constant increase of oral voice leakage.

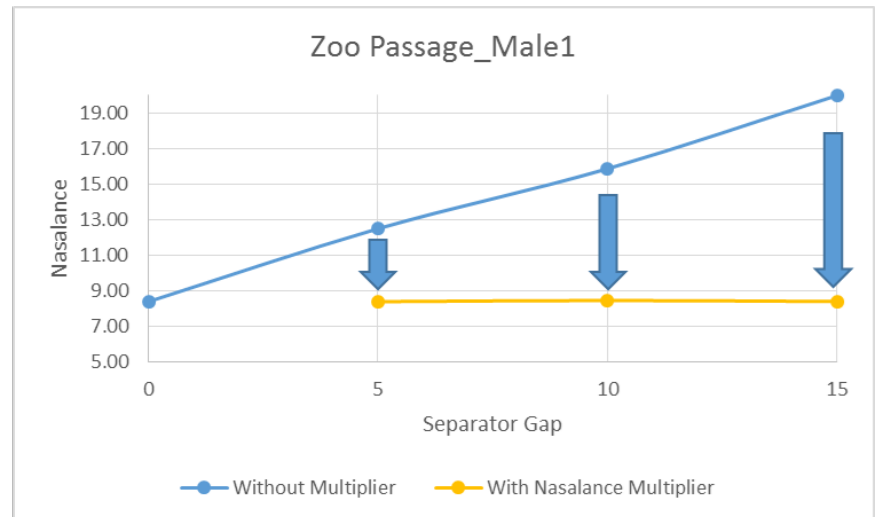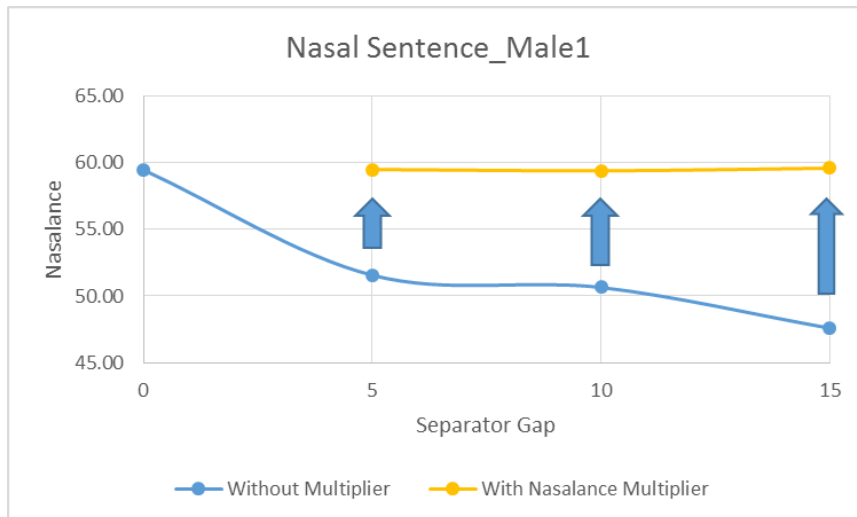Nasalance

Separator Gap

Sound wave straight
to microphone
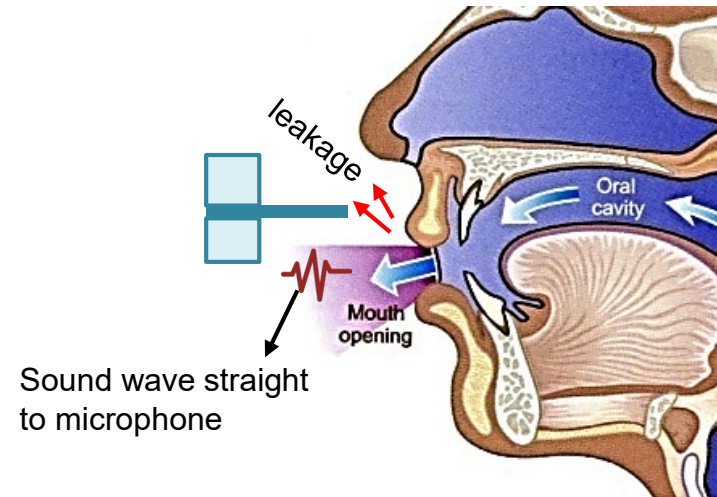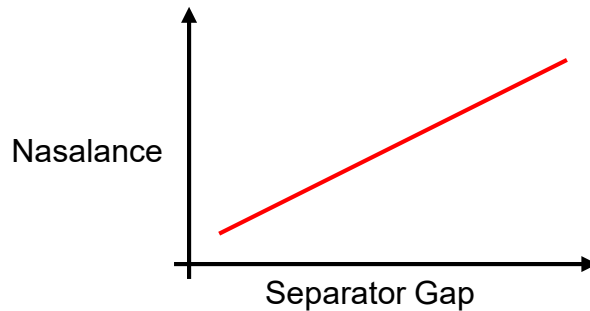
❑ On **nasal sentences**

✓ Nasalance decreases significantly from 0 to 10 mm gap due to nasal voice leakage and then become steady after 10 mm gap.

✓ Effect of leakage is decreased in 10 mm and 15 mm gap

Nasalance
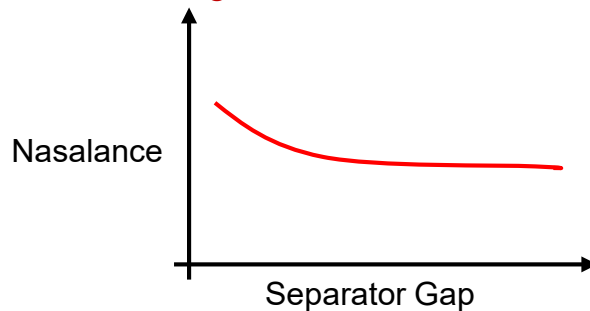
Separator Gap

Applying Individual Multiplier

❑ Calculate the multiplier from the nasalance difference among different separator gap within subject.

❑ Effect of the multiplier: Adjust the nasalance in untouched separator condition (5/10/15mm gap) → comparable with touched separator condition (0mm gap).

Discussion

❑ **Contribution**

➢ Proposed a method to reduce the disturbance of separator on nasalance

➢ Examine the effect of separator-lip distance on nasalance measurement

➢ Identify the cause of nasalance trend in 5/10/15mm separator gap

➢ Provide a method to adjust the nasalance in untouched separator

❑ **Limitations**

➢ Used only small sample size (need more subjects)

❑ **Further Study**

➢ Identify the effect of individual factors (intonation, speech tempo, nasal vowel voice etc.) on nasalance

➢ Use Korean passages in evaluation for Korean users

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Acknowledgement

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