Introduction to the SmartPalate

SMART PALATE INTERNATIONAL

Introduction to the SmartPalate
March 2012
AK Speech Consultants. CCC-SLP
Learner’s Objective

- Learner will know the purpose of the SmartPalate
- Learners will be able to cite a few past and present research using EPG (SmartPalate)
- Learners will be able to list different populations that would benefit from using SP system
- Learners will be able to list several pros and cons using the SP system
Dr. Samuel G. Fletcher

- Researcher and Speech Language Pathologist
  - 50+ years
- Former Professor at BYU
- Developed The Palatometer
  - 35+ years ago
  - Visual speech tool for those with Hard of hearing/Deaf population
What is the SmartPalate? Why use it?

- “Palatometery” was coined by Dr. Samuel Fletcher.
- Worldly known as Electroplatograph (EPG). Currently also known as “SmartPalate”
- “Palatometery” measures where the tongue makes contact on the palate. The mouthpiece has 126 gold sensors that are evenly spaced.
- SmartPalate technology is a visual feedback speech tool that displays real-time tongue-to-roof-of-mouth (Palate) contacts on a computer screen during speech production.
SmartPalate System

- The SP system provides “real-time” feedback.
- **Best Visual Tool.** Shows lips & tongue-palate contact.

www.CompleteSpeech.com
SMARTPALATE System

- The SP system provides “real-time” feedback.
- Shows lips & tongue-palate contact with 126 sensors.

www.CompleteSpeech.com

http://www.down-syndrome.org/reports/2093/
SmartPalate Components

- It has three major components.
  - 1. **Smart Palate** - custom made mouth piece for each person. Fits in the user’s mouth like an orthodontic retainer with the addition of 126 conductive sensors
  - 2. **Data Link** (Microprocessor/input/output device) that is worn around the user’s neck and interfaces between the SmartPalate and the computer
  - 3. **Computer software** (PalateView) that displays tongue-to-palate contacts and the audio spectrogram of the person’s speech

- See [www.completespeech.com](http://www.completespeech.com) for demo of each item
SmartPalate System

- USB Cable
- DataLink
- SmartPalate
- Lanyard
- Computer
SP parts

- External Casing
- Mouth Impression with Sensor Array
- Mini USB Connection
Q #1. Is there any research that supports the use of EPG?
Electropalatographic Assessment of Tongue-to-Palate Contact Patterns and Variability in Children, Adolescents, and Adults

Hei Yan Cheng
Bruce E. Murdoch
Justine V. Goozée
Dail Scott
University of Queensland, Brisbane, Queensland, Australia

Purpose: To investigate the developmental time course of tongue-to-palate contact patterns during speech from childhood to adulthood using electropalatography (EPG) and a comprehensive profile of data analysis.

Method: Tongue-to-palate contacts were recorded during productions of /t/, /l/, and /k/ in 48 children, adolescents, and adults (aged 6–38 years) using the Reading Electropalatograph system.

Results: A protracted course of development for lingual control was indicated, with significant changes occurring until age 11 years; the adolescent period was in turn characterized by continual refinement of articulatory control. With maturity, a reduction in the amount of palatal contact and an anterior shift in the place of articulation was evident during anterior consonant productions, whereas the tongue-back-to-palate contact pattern became more consistent for the velar stop /k/.

Conclusion: These results support that maturation of the speech motor system is nonuniform.

KEY WORDS: articulation, EPG, motor control, tongue, speech development

Speech production is a remarkable and unique motor accomplishment. In the span of 2 s, six to nine syllables may be produced, which is faster than any other single motor output in humans (Kent, 2000). For the simplest speech act, more motor fibers may be recruited than for any other human mechanical activity (Fink, 1986; Kent, 2000). Above all, with the precise complement of articulator motions, distinct acoustic signals may be generated to be perceived as linguistic information. Mature speech production is a skilled action that requires many years of development and fine-tuning of the human cognitive, linguistic, and motor systems.

There has been a long tradition of acoustic studies with the aim of uncovering the speech acquisition process. Early acoustic studies have generally indicated children’s speech to have greater and more variable segment durations compared with adults’ speech. Depending on the age of the child, durations have been reported to average as much as 50% greater for young children than for adults (B. L. Smith, 1978), with duration variability stabilizing by 11 or 12 years of age (Kent & Foss, 1990). Mature control of voice onset time has also been suggested to emerge at age 11 years (Whiteside, Dobbin, & Henry, 2003). There is no doubt that acoustic analyses have played an important role in our understanding of speech development.

BIBLIOGRAPHY OF ELECTROPALATOGRAPHIC (EPG) STUDIES IN ENGLISH (1957-2005)

Fiona Gibbon
September 2005
Speech and Hearing Sciences
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fgibbon@qmmc.ac.uk

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References describing the different EPG systems

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General bibliography of EPG studies in English (1957-2001)

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Bibliography of clinical applications of EPG

28-33

1 Review articles on the use of EPG in speech and language therapy

2 Functional articulation disorders

3 Cleft palate

31-33

4 Down’s syndrome

33

5 Dysarthria

33-34

6 Glottal stop

34

7 Hearing impairment

35

8 Laryngectomy

35

9 Microglossia and cleft palate

35

10 Neurological (acquired)

35-36

11 Neurological (developmental)

36

12 Eating and swallowing

37

13 Accent reduction

37

14 Typically Developing Children

38

15 Plate making

38

Let me know of any additional EPG references that you think should be included. For further information, why not visit the Speech and Hearing Sciences’ website? http://shs.qmmc.ac.uk/
Universities and Public Schools
SmartPalate Enabled

- Brigham Young University: Utah
- Utah State University
- University of Utah
- Washington State University
- California State University, (Sacramento)
- Arizona State
- New Mexico State
- Texas State
- University of Central Missouri
- University of Arkansas (Medical Science)
- University of Pittsburg
- Dalhousie University, Nova Scotia, Canada
- University of Alberta
- Perryton School District, TX
- Murray School District
- Salt Lake City School District

www.CompleteSpeech.com
Collected speech samples from 20 native born American English speaking young adults for the study. Representing all the regions of the U.S. country. Gave 10 responses producing CV, VC phonetic context.
Figure 12. Contact across all speakers in /u/ vowel context. Darker shades indicate an increased frequency of contact.
Palate View & Sound Wave

TT, Library

Sensors

Auditory Sound Waves
Q #2. Who can benefit from the SmartPalate?

- Tongue issues
- Speech sound disorders
- Apraxia
- Stroke recovery
- Syndromes
- Autism
- Hard of Hearing
Different Populations Studied with EPG

By Fiona Gibbon  http://www.articulateinstruments.com/EPG.htm
How do we use it?

- Target sounds: /l/ & /r/
- Probe Words: Hard, Earlier, Thirsty

- Display shows a diagram of palate and teeth
- Blue dots represent location of tongue on the palate.
- Clinician and client uses display for information
  - To identify placement
  - To support accurate production
  - To monitor productions

KD, age 12
Q #3. When do you see progress?

Neural typical users make progress in 10-20 sessions (which is a typical set of therapy with SP) with 80-100% accuracy at sentence level.

Those with multiple disabilities with less than 50% speech intelligibility have improved to 75-85% speech intelligibility over multiple sets of therapy.

Those with acquired speech disorders re-gained their speech quicker with the Smart Palate.

Those wanting accent reduction made better progress when they could “see” what their tongue needed to do.
# Research to Application

## Summary of paper titled: Evaluating a new clinical palatometer system

By: ANNA MARIE SCHMIDT  
*Kent State University, Kent, Ohio, USA*

### Overall results for clients

<table>
<thead>
<tr>
<th>Client # and conditions</th>
<th>Age</th>
<th>Years in therapy prior to EPG</th>
<th>Specific EGP Target</th>
<th>Initial Score (%)</th>
<th>Final Score (%)</th>
<th>Number of Sessions</th>
<th>Notes</th>
<th>Re-Evaluation after 1 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>10</td>
<td>5</td>
<td>initial /r/</td>
<td>85</td>
<td>17 (8.5 weeks)</td>
<td>83% accurate for all types of /r/ in spontaneous speech</td>
<td>no errors</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>8</td>
<td>4</td>
<td>initial /r/</td>
<td>0</td>
<td>100</td>
<td>1 personal 5 vicariously C1 was brother</td>
<td>pseudopalte malfunctioned and was not able to be repaired quickly</td>
<td>no errors</td>
</tr>
<tr>
<td>C3</td>
<td>12</td>
<td>3</td>
<td>consonantal /r/</td>
<td>57.5</td>
<td>100</td>
<td>12</td>
<td>unable to continue treatment after 12 sessions</td>
<td>errors noted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>post-vocalic /r/</td>
<td>15</td>
<td>70</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>12</td>
<td>4</td>
<td>consonantal/r/</td>
<td>57.5</td>
<td>90</td>
<td>14</td>
<td>no errors in 5 min. of spontaneous speech</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>post-vocalic/r/</td>
<td>5</td>
<td>100</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5 hypotonia</td>
<td>10</td>
<td>5</td>
<td>initial /r/</td>
<td>65</td>
<td>95</td>
<td>17</td>
<td>overall articulation precision and intelligibility in spontaneous speech also improved.</td>
<td>continued working with school SLP to maintain his improved articulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>post-vocalic /r/</td>
<td>80</td>
<td>100</td>
<td>17</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>final /ŋ/</td>
<td>5</td>
<td>100</td>
<td>17</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>intervocalic /r/</td>
<td>15</td>
<td>100</td>
<td>8</td>
<td></td>
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<td></td>
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<td></td>
<td>15</td>
<td>100</td>
<td>15</td>
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<tr>
<td>C6 hypotonia expressive and receptive language delays</td>
<td>10</td>
<td>5</td>
<td>consonantal /r/</td>
<td>25</td>
<td>100</td>
<td>6</td>
<td>overall articular precision improved, as did intelligibility in spontaneous speech</td>
<td>continued to be variable in production as he continued to work with school SLP</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>post vocalic /r/</td>
<td>5</td>
<td>55</td>
<td>19</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>final /ŋ/</td>
<td>5</td>
<td>100</td>
<td>19</td>
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<tr>
<td>C7</td>
<td>11</td>
<td>3</td>
<td>alveolar posture</td>
<td>0</td>
<td>100</td>
<td>7</td>
<td>By the final session she was able to produce undistorted /s z/ consistently in 5 min. of spontaneous speech</td>
<td>not possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>initial /l/</td>
<td>0</td>
<td>100</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>initial /t/</td>
<td>0</td>
<td>100</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>initial /s/</td>
<td>0</td>
<td>100</td>
<td>20</td>
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</table>
### Anna Schmidt’s Research Summary

<table>
<thead>
<tr>
<th>Condition</th>
<th>Initial /s/ intervocalic /s/ final /s/</th>
<th>20</th>
<th>65</th>
<th>40</th>
<th>100</th>
<th>100</th>
<th>16</th>
<th>15</th>
<th>15</th>
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</thead>
<tbody>
<tr>
<td>C8 C9 repaired unilateral cleft lip</td>
<td>initial /d/ initial /l/ initial /r/ initial /l/</td>
<td>10</td>
<td>6</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>15</td>
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<td>He was able to visualize for himself the position and consistency of his productions</td>
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<tr>
<td>C9 C10 velo-cardio-facial (VCF) syndrome</td>
<td>initial /g/ initial /k/</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>21</td>
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<td>Generalized production to phrases and was 100% accurate in 5 min. of spontaneous speech</td>
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<tr>
<td>C10 C11 expressive language delays and delayed in reading</td>
<td>placement /k/ placement /g/ velar nasal post-vocalic /r/</td>
<td>8</td>
<td>4</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>1</td>
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<td></td>
<td>Articulatory treatment continued focusing on generalizing and velar production in spontaneous speech</td>
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<tr>
<td>C10 C11 expressive language delays and delayed in reading</td>
<td>placement /k/ placement /g/ velar nasal post-vocalic /r/</td>
<td>8</td>
<td>6</td>
<td>100</td>
<td>100</td>
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<td>4</td>
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<td>Unable to continue treatment at the Palatometer Clinic but returned to his school SLP to focus on spontaneous speech work with multisyllabic words</td>
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</table>
Summary of Errors Produced
AB, age 6  (A. Schmidt, 2007)

Velar fronting of /k/, /g/
Difficulty co-articulating many clusters
Derhoticized or weak word final /r/, /s/, /z/
3rd person present verbs /s/ and /z/ Frequent omission of often incorrectly used
Intermittent articulation errors
examples: “th”, “ng”

"With" produced "winth"
Sample Result from AB, age 6, (A. Schmidt, 2007)

/ k /
Sample Result from AB, age 6, (A. Schmidt, 2007)

\(/ g /\)

# correct / 10

session

- initial
- medial
- final
Sample Result from AB, age 6, (A. Schmidt, 2007)

"ng"

# correct / 10

session

medial
final
When AB started producing her /k/s and /g/s in conversational speech, her mother said that she had the same feelings of amazement and pride she had when AB first began to speak when she was a baby.
Responses from AB’s Teacher and Therapist

When AB's teacher first heard AB use the correct productions of the / k / and / g / sounds, she was so happy for her that she began to cry.

AB's school speech language pathologist reported that AB was reading at a Kindergarten level at the beginning of the palatometer therapy with her.

- After less than 8 months of therapy with the palatometer, with improved articulation and language proficiency, AB was reportedly reading at a 2nd grade reading level.
Other On-Going Studies

- For more lists go to [www.completespeech.com](http://www.completespeech.com)
  - They have a map that will show those using the SP system.
- VA hospitals
- Public schools
  - Murray School District
- BYU research
  - Dr. Nissen, studying neurotypical school age children with the palatometer technology
Summer 2009 Intensive Speech Therapy
pilot program with 5 clients, two volunteers, two graduate clinicians and one certified therapist.
5 sessions per week for 4 weeks = 20 sessions
30 minute sessions

Switched to
4 sessions per week for 5 weeks = 20
Benefit; better generalization of target sounds.
Meet JJ

- 14-year-old male
- Brief Overview: JJ had a moderate articulation disorder secondary to deafness.
  - Bilateral cochlear implants (implants received at two different ages)
  - Cul-de-sac speech
  - Resonance issues
  - Multiple sounds in error
  - JJ used speech and ASL signs with parents to communicate.

Speech errors:
- General speech intelligibility was impaired.
- Grandparents understood him less than 50% of the time.
- Others understood only occasional words.
- Distorted primarily /j/, /l/, /r/, /θ/, /ð/ and /s, l, r / blends.

Evaluation included:
- GFTA-2
  - Standard Score: 68
  - Percentile: <1%
- Intelligibility: 50-60%
- Iowa Pressure Test: 50%
  (Primarily on /b/ and /l/ Words)
- LING Sound Check: WNL
- Maximum Phonation of /ɑ/: Below Average
- /pʌtɛkə/: Below Average
JJ’s progress on 20 originally misarticulated words containing the /l/, /r/, /ð/, /θ/ & /s, l, r/ blend sounds.

- Five 30-minute sessions per week were held.
- JJ attended a total of 20 sessions.
- JJ showed progress on the second session.
- JJ used the Palatometer during all the sessions and for his homework. He had access to the Palatometer on his home computer.
- The Nasometer was used to check his nasality progress.
- The Visi-Pitch was used to check his prosody progress.
Meet EF

- 17 years old
- DX: Tongue thrust
- Tongue protrusion on swallows
- Tongue rests outside teeth
- Speech errors:
  - Frontal lisp on /s, z/
  - Absent /l/
EF’s progress

- Three 30-minute sessions per week
- Total: 10 sessions
- She came 3X week for 3 ½ weeks.
Video Samples of self practice
Look at the lights, not in the right place, then after 10 sessions much better.

C-2 trying to say bike

C-2 can say /k & g/ in “The dog got the stick”
Kr- blend

Speaker 1: Client M -3
Treatment Approaches

- Speech textbooks teach about 8-10 main articulation/phonological approaches
  - What are they? (Saved for another webinar)
  - Articulation approaches are motor base, works on single sounds, deep, placement, manner and voicing.
  - Pattern approaches are cognitive linguistic base, works on system wide change of sounds and rules.

- Q. Can you use any of these with Smart Palate?
- A. ?????
## Q #4. What are the Pros and Cons?

### PROS
- Motivates clients
- Takes the guess work out - visual
- Streamlines TX prep for therapists
- Measures progress well
- Provides accurate practice
- Increases practice productivity
- Builds confidence for clients
- Builds confidence for therapists
- Supported by research

### CONS
- Requires investment, upfront $cost
- Requires skilled SLP
- Requires SP for each person
SmartPalate Summary

- SP Supports many treatment approaches
- Works with a variety of clients.
- Increases speech motor skills
- Applies multi-modal approach-
  - visual, auditory, tactile, & kinesthetic.
- Improves almost all sounds; has sensors for lip and tongue-palate sounds
  - [m, b, p, k, g, t, d, n, ng, th, s, z, l, r, sh, ch, j]
- Eliminates tongue thrust and corrects lisps.
- Works for accent reduction
- Research supported for evidence-base practice
Ending Thought

Thank you for your attendance.

“If all my possessions were taken from me with one exception, I would choose to keep the power of communication, for by it I would soon regain all the rest.”

— Daniel Webster
References

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- Sander, Dromey, (2007), Inter-and Intra-Speaker Variability, A Palatometric Study
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- Woods, S http://www.down-syndrome.org/reports/2093/