Palatography workshop
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These are tutor’s notes for a palatography workshop. The aim of the workshop is to introduce students and field linguists to doing palatography in the field so that they are in a position to identify sounds that can be investigated with palatography, put together a list of words that can be used to record these sounds and take linguograms and palatograms of the sounds in questions and evaluate and improve the quality of the linguograms and palatograms they have taken. In addition, we discuss ethical issues in conducting palatography work with consultants.

What is not included in the workshop is the description, interpretation and analysis of linguograms and palatograms. This can become part of a follow-up workshop or can be done together with a trained phonetician upon return to the university.

The workshop is designed for participants who know the basics of articulatory phonetics. The participants are not expected to have detailed knowledge of the articulatory phonetics or remember everything they learned about the subject at some stage of their training. Therefore, a brief review of articulatory phonetics is included as part of the workshop.¹

1 Brief background and introduction

- There are three broad areas within phonetics: articulatory, acoustic, auditory phonetics.

- The study of articulation involves investigating the position and movement of the speech organs above the larynx.

- There are static and dynamic aspects to articulation: palatography catches the target position for a speech sound, that is static side of articulation.

2 What is palatography?

- a group of techniques to record contact between the tongue and the roof the mouth to get articulatory records for the production of speech sounds

- In brief, it involves putting a marker paint on the tongue, pronouncing a word and seeing where ink rubbed off onto the roof of the mouth. This gives the place of articulation. Also, the roof of the mouth can be painted and it can be investigated where the ink rubbed off onto the tongue. These two types of records are called palatograms and linguograms respectively.

¹ I am grateful to Justin Watkins and Bonny Sands for comments and feedback on this workshop.

Sophie Salffner, SOAS, May 2010
Palatography workshop outline

- There are many other techniques and more sophisticated techniques, we will get back to them later.

As the teacher, here you can show a slideshow of the tools and steps in doing palatography.

3 Review of articulatory phonetics

In phonetics, we make a broad distinction into vowels and consonants. Broadly speaking,

- vowels involve no obstruction of airflow (although for high vowels there is contact between the side of the tongue and the teeth/the top of the mouth)
- consonants have an obstruction of airflow somehow, somewhere
- since palatography requires contact, i.e. some kind of obstruction, for the paint to rub off, palatography is most suitable for looking at consonants – so let’s look at consonants in more detail

The features that characterise consonants are

1. airstream mechanism (pulmonic, glottalic, velaric)
2. direction of airstream (egressive, ingressive)
3. state of the glottis (voiced, voiceless, creaky, breathy, whisper)
4. tongue (apical, laminal, retroflex, dorsal, radical)
5. place of articulation (bilabial, labiodental, labiovelar, (labiolingual), dental, alveolar, retroflex, palato-alveolar, palatal, velar, uvular, pharyngeal, glottal)
6. centrality (central, lateral)
7. nasality (oral, nasal)
8. manner of articulation (stop, fricative, affricate, approximant, trill, flap, tap)
9. secondary articulations (labialisation, palatalisation, velarisation, nasalisation)

Since palatography requires contact between the painted articulator and the articulator where the paint will rub off to, not all types of consonants can be investigated with...
Palatography workshop outline

palatography – only those where there is contact between the tongue and one of the articulators opposite the tongue. Of the features above, this disqualifies

- pulmonic and glottalic airstream mechanism, though the place of articulation in consonants produced with these airstream mechanisms can still be investigated
- the direction of airstream
- voicing contrasts, though there may still be differences in degree of occlusion in voiceless vs. voiced fricatives for example which can be seen in palatograms
- places of articulation of articulation that are too far front or too far back (bilabial, labiodental, pharyngeal and glottal, and for some speakers velar and uvular because there is only so far back that you can paint the tongue before people start gagging)
- nasality
- the distinction between some manners of articulation because they all involve total closure (plosives, nasals, affricates, trills)

After all the disqualified bits have been taken out, we can determine the place and to some degree the manner of articulation for these pulmonic sounds of the IPA shown in the red boxes in Figure 1.
Figure 1: Sounds and features that can be investigated with palatography
4 Deciding what words to use

Not all words are suitable for palatography. For example, if you did a palatogram of the word ‘sprinkle’ – what would you get? Of the word ‘onion’? Of ‘Dshengis Khan’? A mess! So you can’t just have any word with any combination of sounds.

Requirements for test words
- includes the sound you want to investigate
- other sounds should be vowels or bilabial or glottal consonants
- vowels should be the same for words that are compared – minimal pairs are good
- preferably not high vowels because you get contact at the sides
- common words that the speakers are familiar with

Task for the participants

Choose a language to look at (preferably one you speak yourself), get the consonant inventory and identify all the sounds you can investigate with palatography. Compile your own word lists with the sounds to test for. Include a few bad choices to see why they are bad and some examples where you are not sure where they are good or bad. If you want, include some examples to try out how far back in the mouth you are comfortable to go – palatals, velars, maybe even uvulars?

5 DIY

5.1 Equipment

- intraoral mirrors (I buy cheap small metal-encased hand mirrors for travelling, e.g. in the UK from Muji, or expensive dentist supply intraoral mirrors)
- brushes (children’s paint brushes will do, softer ones feel nicer on the skin)
- charcoal powder, chocolate powder or other material for making the paint (chemists and health stores have activated charcoal intended as a digestive aid, absolutely not toxic, even good for you, in the UK Holland & Barrett sells it)
Palatography workshop outline

- vegetable oil
- antiseptic spray (the type that can be used on skin but needs to be rinsed off carefully as it should not be ingested)
- photo camera or video camera
- tripod
- a source of light (flash light on the camera or extra light)
- pineapple, fruit juice or drink mix to wash the paint out off the mouth
- cloths, tissues, detergent, hot water

5.2 Preparations

- get your equipment together and set up
  o word list
  o mirrors, paste, brushes, tissues, cloths and towels, water, pineapple
  o make sure you have one set of pot, brush, mirror, cloths and pineapple per speaker (hygiene!)
  o camera on the tripod

- prepare the paint
  o in separate pots for each speaker
  o charcoal powder and oil roughly 1:1
  o it shouldn’t drip, it shouldn’t have lumps anymore either, it shouldn’t be too thick, the idea is to have a smooth paint that is easy to brush on quickly and won’t drip off the tongue – an “eye” for the right consistency develops with time

- practice putting in the mirror to take records of the palate
  o head tilted back, mouth wide open
  o mirror rests at the edge behind the upper teeth, 45° angle to the plane of the upper teeth so that all teeth from the front teeth to the last molars can be seen
  o as little breathing through the mouth as possible to avoid fogging the mirror
Palatography workshop outline

- fingers should not be in the way of the palatograms
- there should be enough light to actually see the inside of the mouth

- practice taking records of the top, sides and underneath of the tongue
  - let tongue rest on the lower lip
  - move the tongue right, left and up to show the sides and underneath of the tongue

- shoot test films and test photos without the paint
- if you are recording with a video camera, it is best to just start recording and let the camera run, that way you don’t miss any words and don’t have to wait or worry
- if you take photos with a still camera, be ready to take photos the moment the speaker finished pronouncing the word and get a number of shots from all angles of the tongue

- have a look at your test photos and evaluate their quality
  - Are they light enough or too dark?
  - Is the whole mouth visible or are parts missing, like the front or the back teeth?
  - Is the angle okay?

- if you can, let one person do the recording and note keeping and one person do the instructing, painting and cleaning

- it may help to have the words written on a sheet of paper and to take a photo of the speaker holding the sheet with the word before taking a photo of the linguogram/palatogram so as not to lose track of which picture is which word, alternatively you can have a numbered word list and take pictures of the speaker showing 1, 2, 3 etc. with their fingers to see which word is the next to be pronounced

Preparing and testing equipment even before going out to a field session is very important. It should never be assumed that all the equipment will work in the field.


5.3 Linguograms

It’s best to start with linguograms, i.e. with painting the palate to look at the part of the tongue that is involved in the pronunciation. That’s because it may be that after a few palatograms the tongue doesn’t get very clean anymore and there simply isn’t enough contrast for you to see anything.

The procedure is as follows:

- let the speaker rest the head back
- paint the roof of the mouth quickly, as far back as necessary
- be careful, some speakers have very ticklish palates
- let the speaker pronounce the test word once
- the speaker must not swallow or do anything else with his or her tongue
- let the speaker rest the tongue on the lower lip and take photos, let the speaker move the tongue to the right, to the left and up to show the sides and underneath and take photos
- write down the word you recorded, the speaker and the file name
- let the speaker clean up by chewing a chunk of pineapple and swooshing it around in his or her mouth

Task for the participants: Look at the differences and similarities between

- [t] and [ʈ] – the alveolar and the retroflex voiceless stop
- [ʈ] as retroflex plosive and [ɽ] as retroflex tap/flap
- different people’s [s] sounds, for example English vs. Greek speakers, or many different speakers of the same language

5.4 Palatograms

For palatograms, it is the tongue that is painted and the roof of mouth that is recorded.

- pad the tongue dry with kitchen towel or a cloth
- apply the paste quickly, from the front to the back of the tongue including the sides, also underneath the tip of the tongue for some sounds such as retroflexes
Palatography workshop outline

- let the speaker pronounce the test word once
- the speaker must not swallow or do anything else with their tongue
- let the speaker insert the mirror at the edge behind the upper teeth at a 45° angle
- the speaker must avoid breathing through the mouth so as not to fog the mirror
- take photos of the reflection in the mirror, using additional lighting if necessary
- write down the word you recorded, the speaker and the file name
- let the speaker clean up by eating a chunk of pineapple

Suggested tasks for the participants

Look at the differences and similarities between
- [ s ] and [ ɬ ] – central and lateral airflow
- [ l ] and [ ɬ ] – approximant and fricative
- [ n ] and [ t ] – no difference
- [ t ] and [ s ] – difference
- [ t ] and [ ts ] – no difference
- Arabic and Spanish [ t̪ ] and English [ t ] – dental and alveolar
- [ θ ] and [ s ] – dental and alveolar
- different people’s [ s ] sounds – all are central phonetically speaking but some are median, i.e. also central physiologically speaking in that the gap is by the front teeth whereas others are a bit “off target” where the gap is not in the middle physiologically speaking but maybe a bit to the side
- Korean contrast in fortis – lenis – aspirated [ ʰ t tʰ ]

5.5 Potential problems

- Speaking with your mouth painted is very strange and the first few palatograms are likely to go wrong. The consultant can practise saying the word in isolation until he or she feels comfortable and then have the tongue painted to say the
Palatography workshop outline

word. Another way is to think of what the word means and then say is rather that being overly worried about the pronunciation.

- Getting the angle of the mirror right and opening the mouth far enough to get a full view of the palate until the last molars may take some practice. In Figure 2, the mouth is not open far enough and the angle is so that we cannot tell if the sound produced here is [ l ] or [ t ] because we cannot see if there is contact at the last molars. In Figure 3, the angle is so that we cannot see the front teeth.

- Also, the consultants may be covering the mirror with their hands. For example in Figure 3, the fingers cover part of the imprint on the palate.

It may help to structure the workshop so as to take some linguograms and palatograms, then come together to look at the photographs, evaluate their quality, discuss problems that occurred and give advice on how to improve the photographs. The participants can then return to making more (and hopefully better) linguograms and palatograms.

5.6 Metadata

It is important to note down the speaker and the test word for each photograph that is taken because this is not easy to work out afterwards if you have forgotten. Else you can take pictures of the word itself or the number as mentioned above.
In addition, it is useful to have a picture of the palate without any imprints for reference. Ideally, you should also have a cast of the palate but we will not cover this here. For notes on how to take palate casts see the reading at the end of these notes.

### 5.7 Hygiene and cleaning up

- for each consultant have a clean brush, clean pot, clean mirror, clean cloths and tissues and new paste, all clearly separate from each other
- wash, disinfect and let everything dry completely after use
  - brushes: hot soapy water until no more black charcoal comes out, soak in disinfectant solution for at least 15min, let them dry completely, then rinse off disinfectant solution and let dry completely again
  - mirrors: clean with hot soapy water and possibly a toothbrush to get the paint out of the corners if there are any, treat with disinfectant spray and let dry, rinse off disinfectant spray and let dry again
  - consultants: pineapples
- depending on the consultants and the special requirements of potential human subjects committees at the institution you are working with, re-using sterilised equipment may not be enough, you may have to use new brushes and mirrors for each participant

### 6 Data interpretation

Data interpretation is not covered in this workshop, though it is useful to collect records taken throughout the workshop and look at their quality – can the whole mouth be seen? Is there enough light? Is the angle correct? Do the fingers obstruct the view? For examples of palatograms see Straka 1965.

### 7 Ethical issues and involving your consultants

#### 7.1 Ethical issues

While palatography is not as invasive as other techniques in experimental phonetics, it is more invasive than many fieldwork methodologies in other areas of linguistics and therefore more sensitive. Still, the guidelines for working with palatography are fairly common sense and should be familiar to trained and culturally sensitive fieldworkers. Some helpful guidelines are
Palatography workshop outline

- wait with doing palatography until you have established a good working relationship with the consultants and until they have seen you do work that might seem a bit strange from their perspective
- observe and learn from
  - how people prepare food
  - how people touch each other (in particular around the head and in the face)
  - how people deal with and react to body liquids such as saliva
  - how people use their left and right hand (again in particular around the head and the mouth, especially if you are left-handed)
- don’t put anyone under pressure

7.2 Involving consultants

Explain to your consultants what you are doing and motivate why you are doing this.
- demonstrate similarities with handprints – people’s handprints are all different
- explain what you’ll be doing, what materials you are using, show on yourself, let them try, let them pull out at any point that they wish
- appeal to people’s sense of fun – you or your participants may want to paint your eyebrows, you could do face painting, people might end up trying to tease each other by getting the paint on each other’s faces, …
- show the results and explain how people differ in their pronunciation
- let people paint their own tongues and insert the mirrors themselves

8 Articulatory phonetics beyond palatography

Other techniques for investigating articulation are
- imaging techniques
  - film and photography
  - X-ray film and photography
  - ultrasound
  - magnetic resonance imaging (MRI)
Palatography workshop outline

- point-tracking techniques
  - optical systems: LEDs attached to face
  - electromagnetic systems: sensor coils attached to tongue, velum, …
  - X-ray microbeam: metal pellets attached to tongue, … and traced

- electromyography (EMG)
  - recording the activity of muscles by detecting the electrical activity associated with muscle contraction

- electropalatography

9 Further reading


