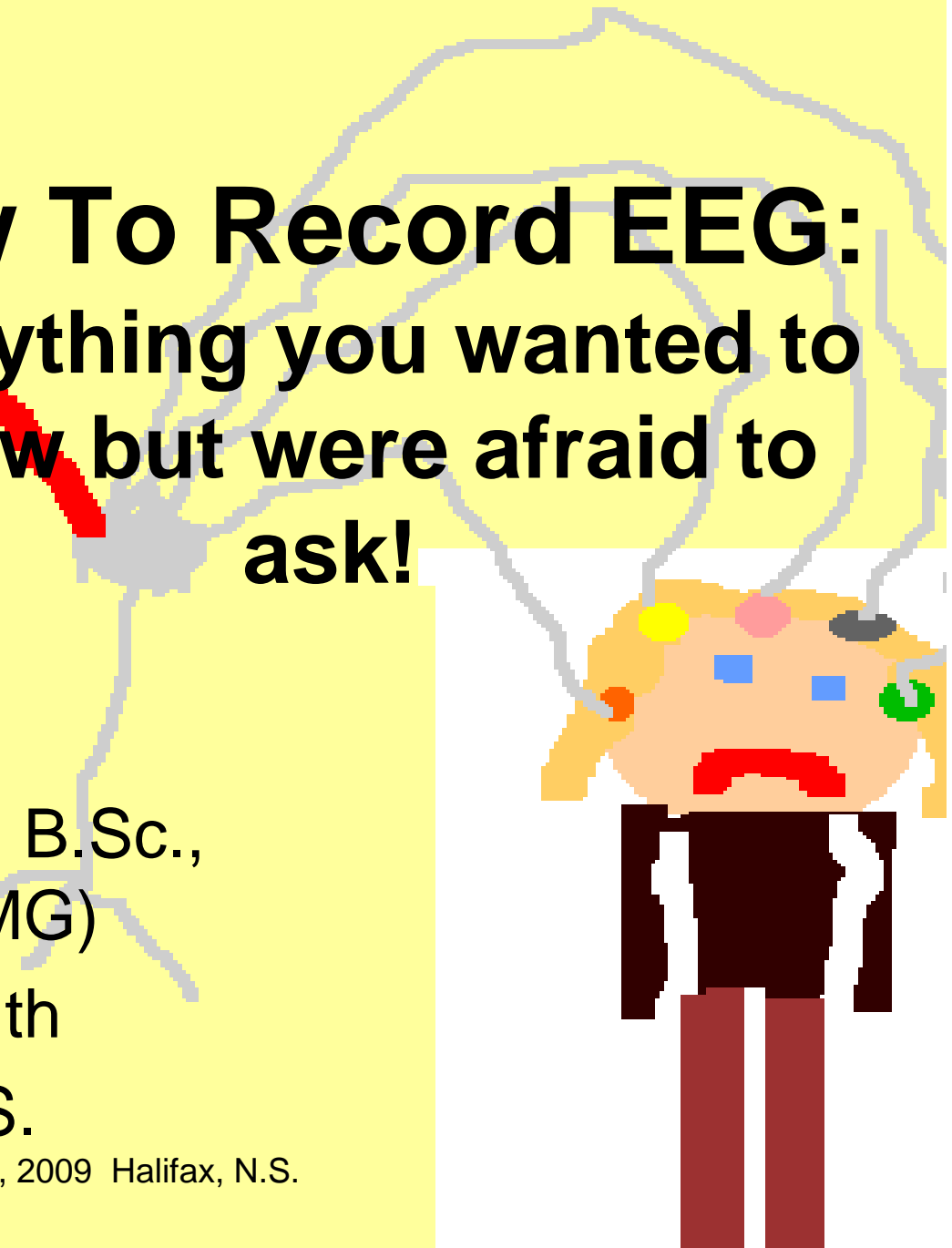
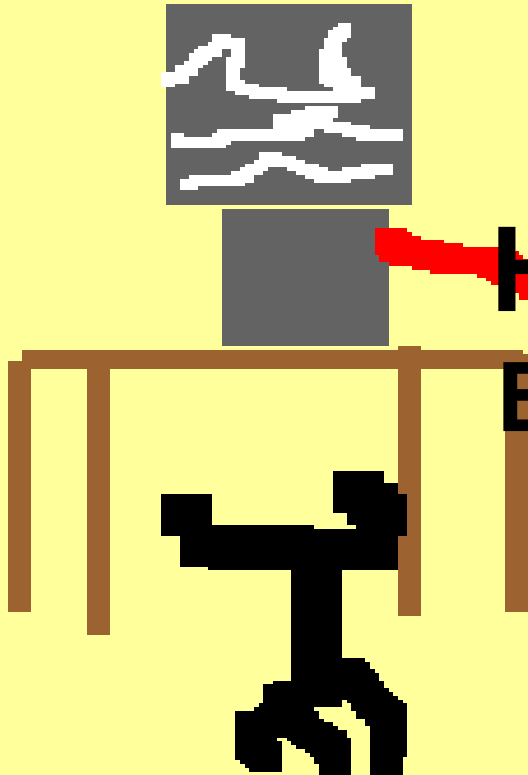


# How To Record EEG: Everything you wanted to know but were afraid to ask!



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June 12, 2009 Halifax, N.S.

# Learning Objectives

At the end of this presentation, the learner will:

- Understand the principles of the 10-20 System of Head Measurement and Electrode Placement
- Receive an introduction to electrode application methods
- Understand the basic principles of montage design
- Recognize common sources of artefact
- Appreciate standard activation procedures, selected contraindications and how to obtain optimal cooperation from the patient

**Program:** 44th Congress of the Canadian Neurological Sciences Federation

**Course:** EEG Course

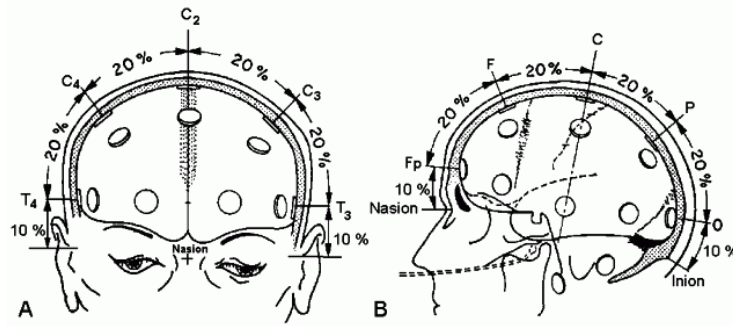
**Title of Presentation:** How To Record EEG

**Presenter's Name:** Susan R. Rahey

**I have nothing to disclose**

# Learning Objective:

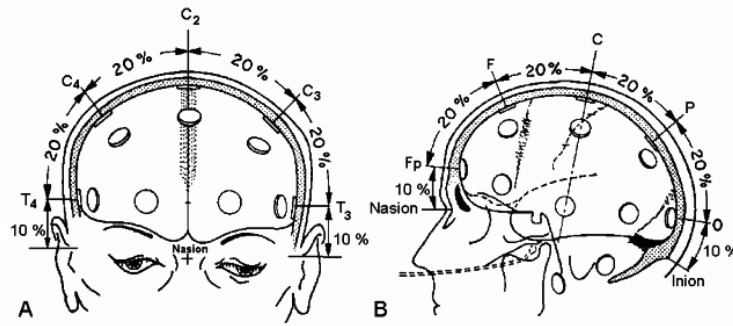
Understand the principles of the 10-20 System  
of Head Measurement and Electrode  
Placement



Dr. H. Jasper

# The 10-20 System of Head Measurement and Electrode Placement

- Standardized the placement of EEG electrodes
- Based on proportional measurements between easily identified skull landmarks
- Meant to facilitate communication and provide for comparison of results
- Provides for adequate coverage of all parts of the head; allows for special circumstances (head wound, asymmetric skull)
- Relationship of electrode positions to underlying cortical regions confirmed with anatomical studies
- Designed with the future in mind!



# The 10-20 System of Head Measurement and Electrode Placement



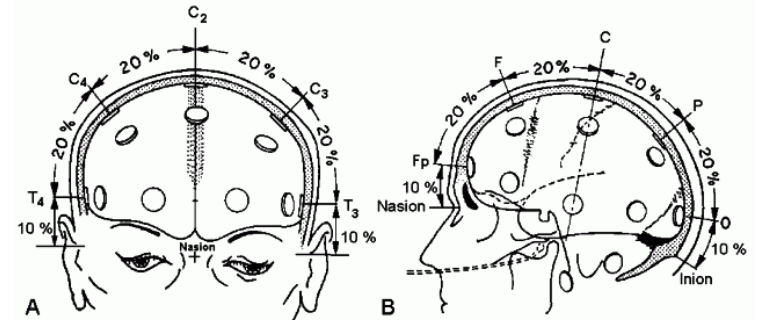
2 simple tools, a measuring tape and a grease pencil, + minimal math skills =



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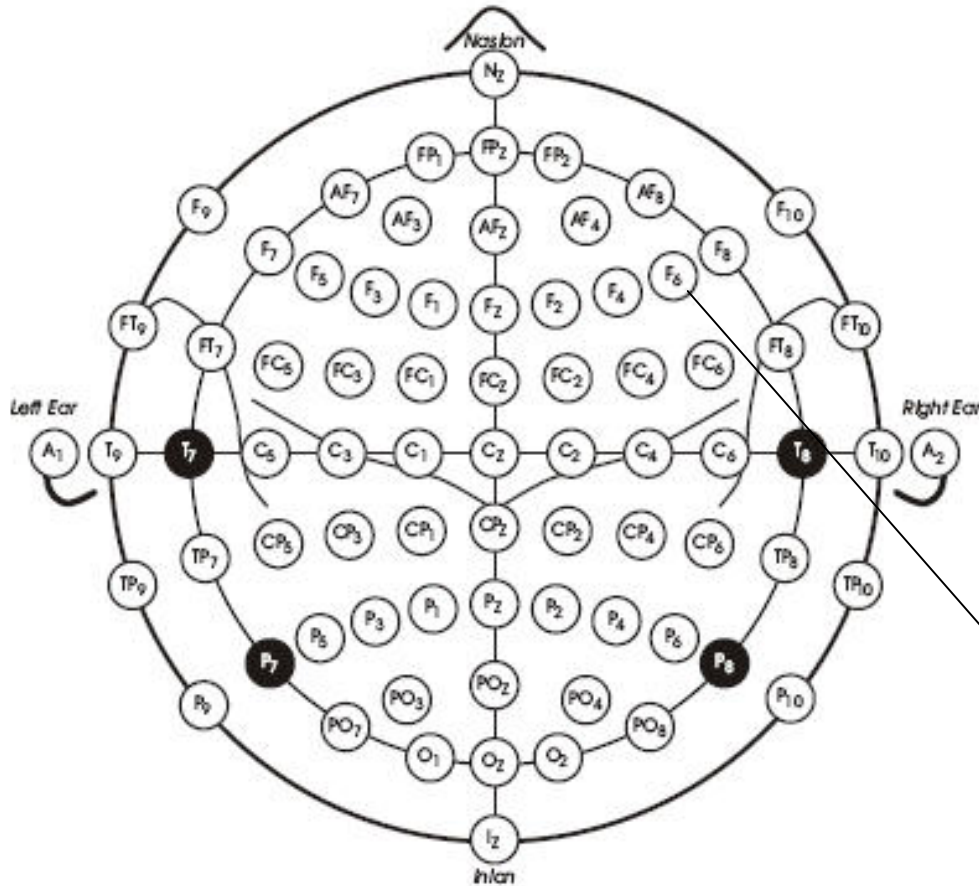
# 10-20 System: Basic Steps

- Locate the nasion, inion and preauricular points
- Using those four landmarks, find the midline and mark CZ; proceed to marking the 10 and 20% positions along the midline and from ear to ear
- Measure the circumference, taking care to ensure that the tape measure intersects the four landmarks; mark the electrode positions along the circumference, each one at 10% of the total
- When measuring to place electrodes on the parasagittal lines, the interelectrode distances are now 25% of the total



Note: A student technologist may fail the C.B.R.E.T. practical examination if three or more electrodes are misplaced.

# Expanded Nomenclature



“Additional electrodes may be placed between any of these principal standard positions for especially refined localization studies”

**F6**

Additional Localizing Electrodes: T1/T2 (Silverman), Mandibular Notch, Sphenoidal, Nasopharyngeal

# And Now For Something Completely Different.....

a measured placement for mandibular notch electrodes



Courtesy of the two Mikes –  
Whitehead and Megeney

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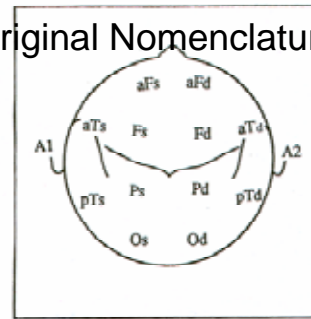
# Special Circumstances

12.5 – 25%

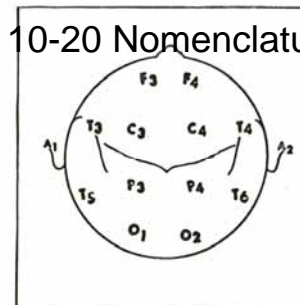
## Neonates

- Anatomical correlates differ (Blume et al)
- ACNS Guideline Two
  - Generally agreed that a reduced array acceptable for premature infants with small heads
  - Minimum reduced array = Fp1, Fp2 (alt. Fp3 and Fp4), C3, CZ, C4, T3, T4, O1, O2, A1 and A2

Original Nomenclature



10-20 Nomenclature



*Recommendations for the Practice of Clinical Neurophysiology,*  
The IFSECN, Elsevier, 1983, p.58.

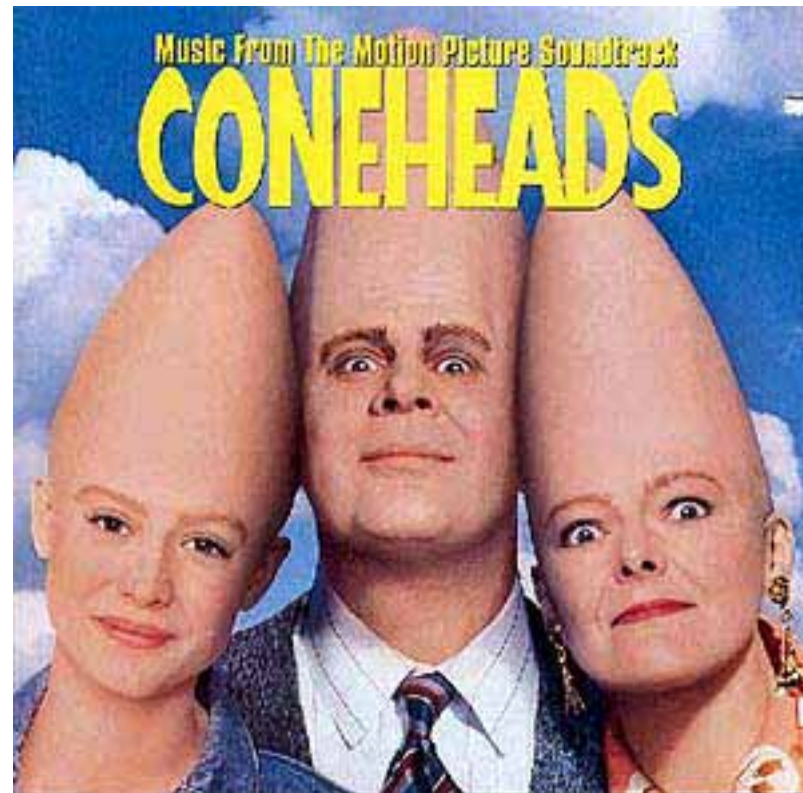
# Special Circumstances: Scalp Lesions

- Displace the electrode by the least amount necessary to clear the lesion
- Relocate the homologous electrode to correspond to the location of the altered side
- If a midline electrode must be moved, move it anteriorly or posteriorly along the midline. If this is not possible, omit that midline position and place electrodes on both sides



# Special Circumstances: Head Deformities

- If a choice must be made between equal spacing of electrode pairs and anatomy, choose anatomy
- Identify as many locations as possible according to standard procedure
- Depending on the location of the deformity (anterior, posterior, left or right hemisphere), the usual rule of thumb is to measure accurately the areas where this is possible and estimate where it is not.
- All deviations from standard positions must be documented on the record and/or tech notes



# Learning Objective:

Receive an introduction to electrode application methods

# Scalp Electrode Types

- Reusable disks (preferred)



- Various metals with different recording properties; require a conducting medium and a method of secure attachment

- Electrode caps



- Quick application, cannot ethically be said to use 10-20 system, and may be an infection control risk

- Subdermal needles

- Not recommended due to safety risk and discomfort; attention to direction of insertion is critical to avoid amplitude asymmetry



# Electrode application- reusable disks

Step 1 - skin preparation

Step 2 - adhesion



# Electrode application

## Skin preparation to ensure good contact and low impedance

- commercial preparations readily available
- mild abrasive action strips away dry, dead skin and moistens the corneum (horny) skin layer, improving conductivity
  - Commonly used substance includes water, aluminum oxide, 1,2 propanediol, sodium polyacrylate, methylparaben, propylparaben, FD&C Blue 1, FD&C Red40 and FD&C Yellow 5.
  - No health hazards beyond over-abrasion of skin or minor sensitivity. Permanent scarring can result if over-abraded. Should not be used on non-intact skin or if a history of sensitivity to cosmetics or lotions. Carries risk of infection at electrode site (source- MSDS)

# Electrode application

- Collodion is the “gold standard” for adhesion
- Excellent adhesive; no conducting properties
- “Timex” of electrode application methods
- Difficult to apply and difficult to remove (either spontaneously or when required)
  - Ingredients include nitrocellulose, diethyl ether and ethyl alcohol. Extremely flammable liquid and vapor. Harmful if swallowed, inhaled or absorbed through skin (source – MSDS)

# Electrode application

Other adhesive methods sufficient, or even preferred, for routine recording or even long-term recording.

- readily available commercially
- conductive and adhesive
- no drying required
- easily removed with soap and water
  - Contents may be proprietary. One available MSDS lists contents as polyoxethylene 20 cetyl ether, water, glycerin, calcium carbonate, 1,2 propanediol, potassium chloride, gelwhite, sodium chloride, polyoxethylene 20 sorbitol, methylparaben and polyparaben. Should not be used on non-intact skin or on patients with a history of skin allergies or a history of sensitivity to cosmetics and lotions. Use may result in skin irritation or infection at the electrode site (source – MSDS)

# The Importance Of Impedance

- Impedance measures how easily a circuit conducts current when a voltage runs through it.
- Measured in ohms
- Depends on other qualities of electricity, such as resistance, reactance, inductance, and capacitance.

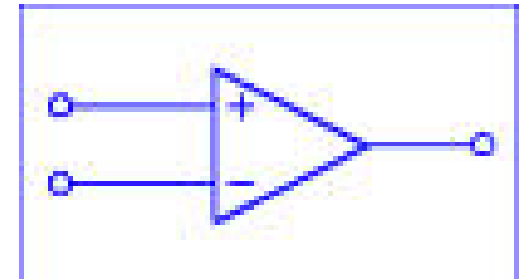
# The Importance Of Impedance

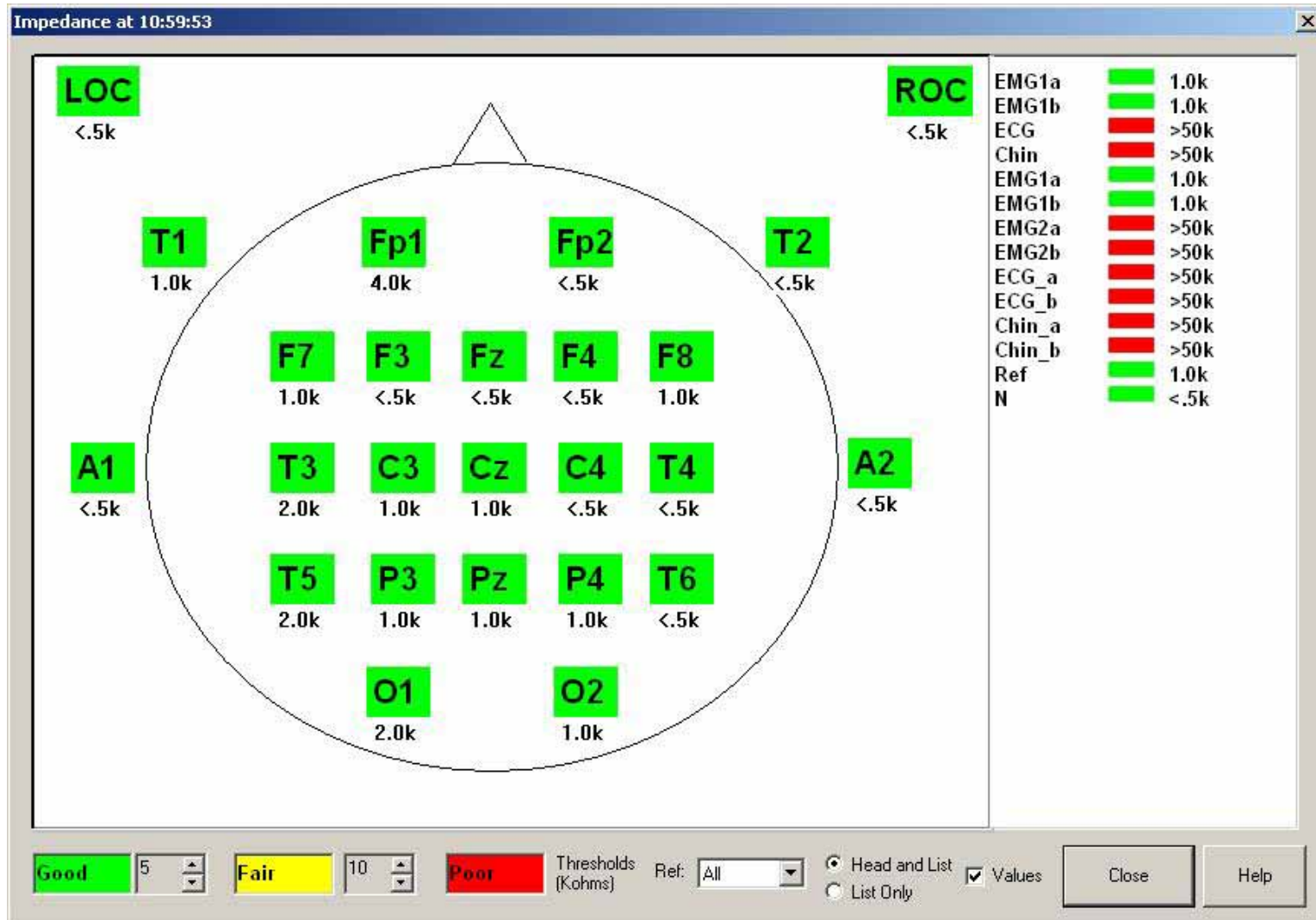
In EEG:

- Low impedance is preferred

BUT

- Equal between two inputs is best, because unequal impedance disrupts the ability of the differential amplifier to reject common mode signals (CMRR), such as 60 hz artefact





Example of a visual display of an electrode test – all electrodes have an impedance of 5 kohms or less

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# Learning Objective:

Understand the basic principles of  
montage design

# Montage

In art, making one composition by combining parts or the whole of other pictures, objects, or designs. *Dictionary.com*

- In EEG, a logical and reasoned arrangement of electrode derivations designed to enhance recognition of EEG waveforms. *Rahey*

# Selected Recommendations for Standardized Montages

American Clinical Neurophysiology Society Guideline

- Both bipolar and referential montages used
- Electrode connections for each channel clearly indicated
- The pattern of electrode connections simple and easily understood
- Electrode connections (bipolar) run in straight unbroken lines and interelectrode distances kept equal
- Anterior over posterior
- Left over right
- A maximum number of electrodes represented in each montage, limited only by the number of recording channels

# Selected Recommendations for Standardized Montages

American Clinical Neurophysiology Society Guidelines

## Why left over right?

- Habit
- All the odd numbered (left) electrodes have lower numbers than do the right
- Most publications have this sequence.

W.T. Blume, 2009

# Common Montage Types

- **Bipolar montage**
  - Each channel of recording represents the difference between two adjacent electrodes. The entire montage consists of a series of these channels.
- **Referential montage**
  - Each channel represents the difference between a certain electrode and a designated reference electrode. There is no standard reference position.
- **Average reference montage**
  - The outputs of all of the amplifiers are summed and averaged, and this averaged signal is used as the common reference for each channel. Frontopolar, frontal and occipital electrodes are often omitted from the average reference to reduce contamination.
- **Laplacian montage**
  - Each channel represents the difference between an electrode and a weighted average of the surrounding electrodes (“nearest neighbours”).

# Montage Selection

- All montages have advantages and disadvantages
- You don't know what's happening at an electrode not on display
- Never neglect the midline
- Any reference electrode can be contaminated
- Always use correct nomenclature
- You have the channels – why not use them?

# Learning Objective:

Recognize common sources of artefact

# Artefact

- Definition: any feature that is not naturally present but is a product of an extrinsic agent, method, or the like *Dictionary.com*
- Types: Physiologic and environmental

# Common Artefacts: Physiologic

- Eye movement
- ECG
- Pulse
- EMG
- Glossokinetic
- Movement
- Sweat

# Common Artefacts: Environmental

- Unbalanced impedance (60 hz)
- Poor grounding/electrode contact
- Interference from other electrical devices
- Movement in the environment

# Artefact Avoidance Techniques:

Attention to detail

AND

See “Skin Preparation”

# Learning Objectives:

Appreciate standard activation procedures,  
selected contraindications and how to  
obtain optimal cooperation from the patient

# Standard Activation Procedures:

- **Hyperventilation:**

- Deep, slow breaths, exhaling fully between inhalations.
- Standards recommend 2 minutes recording prior to beginning HV to establish a baseline, 3 minutes of HV (with good effort), followed by 2 minutes post-HV. Encourage effort.
- HV may be contraindicated in patients with recent cardiac illness, recent stroke, COPD, extreme hypertension, pregnancy

# Standard Activation Procedures:

Canadian Journal of Neurological Sciences. 2008 May;35(2):133-9.

- **Photic Stimulation**

- high intensity lamp is placed 30 cm above the patient's eyes
- Trains of various flash frequencies are delivered with eyes open and closed, following the standard protocol
- If an abnormality is elicited, “bracketing” is recommended
- Photic Stimulation may be contraindicated in pregnant females in order to avoid the risk of activating a generalized tonic clonic seizure

# Standard Activation Procedures:

- **Sleep Deprivation/Sleep**

- The patient is asked to maintain wakefulness for a prolonged period of time, avoid caffeinated beverages and come to the laboratory having had a full breakfast
- Other activation procedures, if carried out, should be performed at the onset of the recording to avoid interfering with spontaneous sleep. If the patient presents in a drowsy state, sleep should be encouraged; other activation procedures can be carried out later.
- All efforts should be made to make the patient as comfortable as possible
- Sedating medications should be avoided if at all possible
- The patient **MUST** be accompanied and **NOT** drive himself to or from the test site\*

\*CDHA Sleep Deprivation Protocol

# “Special” activation procedures

- For patients with reflex epilepsies, the seizure trigger may be introduced to activate a clinical event (Music, patterns, reading, etc.)
- In some laboratories, non-invasive activation of nonepileptic psychogenic seizures may be attempted. This is a contentious and non-innocuous process and should only be carried out by skilled staff, following established laboratory protocols. Patient trust should never be compromised.

# Cautionary Note



Activation procedures may cause a clinical seizure. Technologists should be skilled to handle such circumstances and policies on the handling of emergencies are required.

# References/Recommended Readings

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- American Clinical Neurophysiology Society Guidelines
- Material Safety Data Sheets



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