

Manual of Procedures for
Neuroelectric Measurement Training

v2

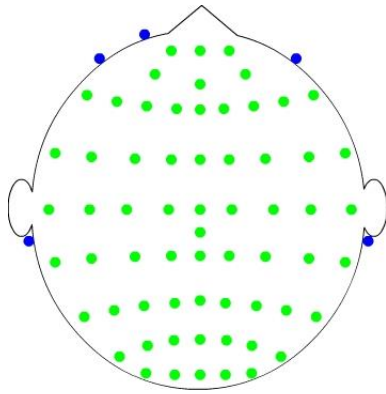


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Introduction to the International 10-20 System

The Health Behaviors and Cognition laboratory uses the International 10-20 system for placing electrodes. It is called the 10-20 system because the electrodes are placed at sites that are 10% or 20% of a measured length from known landmarks on the

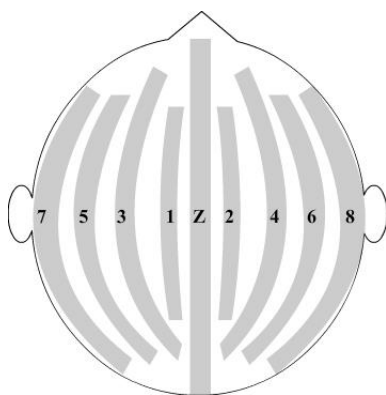
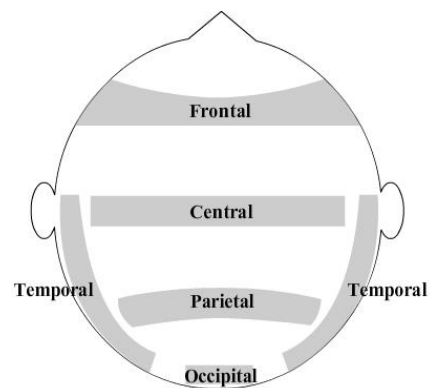


skull. Percentages are used because different individuals have different skull sizes. The 10-20 system ensures that electrode sites and EEG recordings can be compared across laboratories worldwide. This system may appear complicated initially. However, the 10-20 system can be broken down into two main components: Regions and Sites.

The scalp is divided into 5 main regions (Frontal, Central, Parietal, Temporal, and Occipital).

These regions correspond with anatomical brain regions. These regions can also be combined. For instance an electrode placed between the Frontal and Central regions is referred to as the Fronto-Central

Region. There are four main combinations of regions (Anterio-Frontal, Fronto-Central, Centro-Parietal, Parieto-Occipital).



The scalp is further divided into 9 main sites labeled according to number (with an exception of the midline sites which are labeled z) with odd numbers to the left of midline and even numbers to the right of midline.

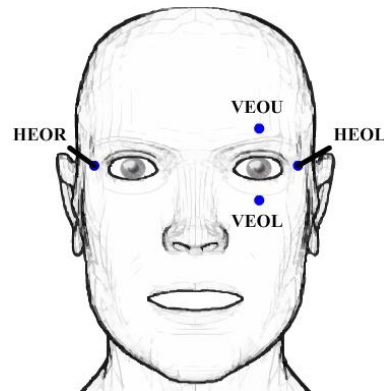
Combining these components results in the naming conventions for the International 10-20 system, with the electrode region abbreviated first combined with the site number/letter. Some examples are listed below.

An electrode in the Central region along the midline would be referred to as Cz (also known as the vertex).

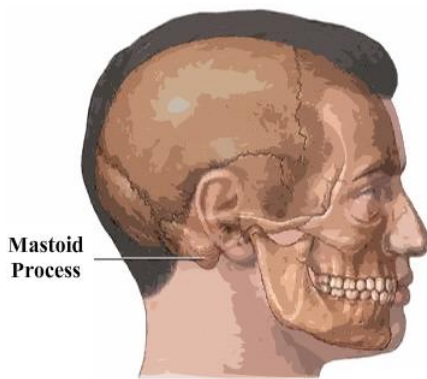
An electrode in the frontal region along the left side 7 site would be referred to as F7.

Lastly an electrode in the Centro-Parietal region along the right side 4 site would be referred to as CP4.

In addition to the scalp electrodes, electrodes referred to as “drop electrodes” are also used. There are 6 main “drop electrodes” comprised of Vertical Electrooculargraphic (VEOG), Horizontal Electrooculargraphic (HEOG), and Mastoid (M) electrodes. The VEOG electrodes are used to measure eye blinks, the HEOG electrodes are used to measure horizontal eye movement, and the Mastoid electrodes are used as a reference. The VEOG electrodes can be divided into two electrodes, Upper and Lower, with the upper electrode (VEOU) being placed above the eyebrow ridge of the left eye and in line with the center of the pupil. The lower electrode (VEOL) is placed below the lower eyelid at the bottom of what is known as the “bag under the eye”, and in line with the center of the pupil. The participant’s pupil should line up with VEOU and VEOL when the participant is



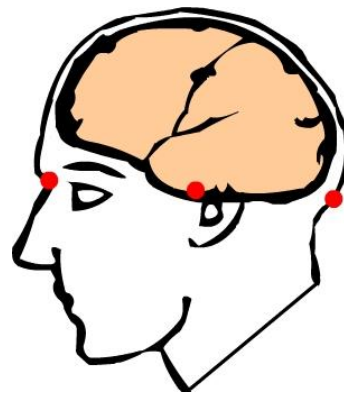
looking straight ahead. The HEOG electrodes can be divided into two electrodes as well, the Left (HEOL) and Right (HEOR), with each electrode being placed just outside the corner of each eye in the area known as “Crows Feet”. The Mastoid electrodes are divided into two electrodes, M1 on the left and M2 on the Right. These electrodes are placed on the bony protuberance posterior to the ear known as the Mastoid Process. In children you must make sure that you do not place the Mastoid electrodes too low as it may be possible to detect a pulse. The Mastoid electrodes represent an inactive



neuroelectric region and there should not be any electrical activity associated with the brain present at the Mastoid Process. This allows for a reference between electrical activity associated with the brain to be distinguished from other types of (electrical) activity associated with the body (e.g., heart activity) and the environment (ambient noise from the lights or computer monitor).

Measurements and Cap Placement

To make the application of these electrodes easier, the HBCL uses Neuroscan Quik-caps. These caps are made of an elastic material with electrodes already placed in the proper 10-20 positions. Near the head of each sensor is a white label that lists the electrode name according to the 10-20 positions. However, to align the cap correctly a few measurements must be made. Before you can make these measurements you must locate the fiduciary points. These are landmarks in which the brain is most directly located underneath the scalp. The fiduciary points are comprised of the Nasion, Inion, and Periauricular points. The first measurement is from the Nasion, bridge of the nose, to the Inion, the bony protuberance that can be felt as you run your finger up the back of the neck to the skull. A mark should then be made on the forehead above the Nasion at 10% of the total measurement from the Nasion to the Inion. The next measurement is made from the Right Periauricular point to the Left Periauricular point. To find the Periauricular points, the tragus must first be found. The tragus is the little triangular shaped tissue at the front of the ear. Place your fingers immediately in front of the tragus and ask the participant to open their mouth. When they do, you will feel an



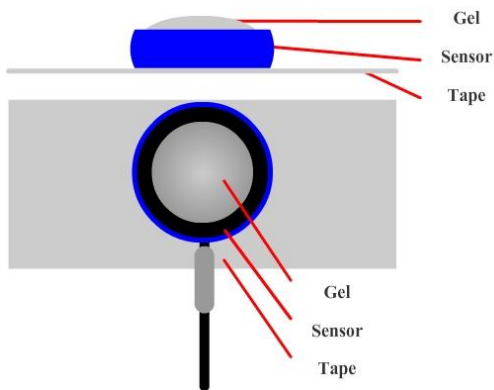
indentation between the jawbone and the skull. You should measure from the indentation on the right side to the indentation on the left side, being sure to cross the top of the scalp. The last measurement that must be taken is the circumference of the participant's head. This measurement is made in the same way that you would measure someone for a hat with the tape measure passing over the mark you made on the participant's forehead.

Following these measurements, you should have the participant remove any jewelry, hair clips, and/or pony tails. If the participant wears glasses, it is also beneficial to have the participant remove them until after you have placed the facial electrodes. The EEG cap should then be placed on the participant's head by finding the midline electrodes and lining them up with the middle of the participant's scalp. Once the midline electrodes have been lined up the cap should be placed on the head by placing the front of the cap on first, lining up the front elastic ridge on the mark you made on the forehead, and sliding the rest of the cap onto the rest of the head. Once the cap is on the head you should ensure that the midline electrodes are still lined up correctly with the middle of the scalp and you should measure to be sure that Cz is at the midpoint of the measurements between Periauricular points.

Drop Electrode Placement and Cleaning

Once the cap has been properly fitted, the next task is attaching the "drop electrodes" (VEOU/VEOL, HEOR/HEOL, & M1/M2). To do this you must first clean the area in which the electrodes will be placed. Because you are attempting to clean the oils and dead surface cells from the skin it is important that you try to keep things as sterile as possible; therefore, you must wear gloves. You should start by cleaning the mastoids. To do this, we first take an alcohol prep pad and starting with the point at which you want to place the electrode, clean in a spiral pattern outward. Next, place a small drop of NuPrep, a gel with a sandy texture similar to facial exfoliate, on a gauze

pad. Then clean the area you just cleaned with the alcohol pad by slightly abrading the skin so as to remove the top layer of dead skin as well as any dirt or makeup on the surface of the skin. After you are done cleaning the area with NuPrep, use a clean gauze pad and remove any excess NuPrep from the area. The cleaning for the VEOG and HEOG electrodes is very similar with the exception that you do not use alcohol pads. For older adult participants or those participants without any hair the same procedure used for the Mastoid electrodes should be used for the entire scalp prior to applying the cap to the head. After the area is clean you should tear off a piece of tape approximately an inch to an inch and a half long and apply it to the back of the electrode with the concave side facing up and the tape at the edge of the electrode. Then carefully fill the electrode using a syringe filled with Quik-gel, being careful to go from the side so as to avoid any risk of



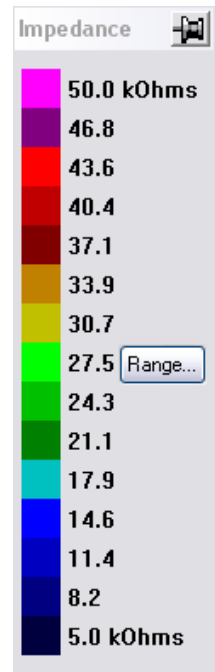
scraping the surface of the electrode and avoiding any air bubbles. When you finish filling the electrode with Quik-gel there should be a slight convex shape when looking at the sensor from the side. Then place the electrode over the area that was cleaned previously and

tape it to the skin, being careful to avoid taping hair or the Quik-cap. This is done for all 6 “drop electrodes”, being careful to place the correct electrode in each area.

Drop Electrode Impedance and Troubleshooting

After you have applied all 6 “drop electrodes” you should apply the chin strap to the cap then check the impedance of the signal. Impedance measures the electrical contact (i.e. resistance) between the electrode and the scalp.

Neuroscan tests the contact between the electrode and scalp by sending a miniscule amount of current and collecting it back. Distortions in the return signals are measured to quantify the quality of the electrode-scalp junction and give us a measure of electrical resistance. Neuroscan displays these impedance levels using a color-coded scale from 50 kOhms (in pink) to 5 kOhms (in black). The goal of this entire procedure is to get the impedance level for all of the electrodes to 5 kOhms. If the impedance is higher than 5



kOhms, it is possible that the dermo-abrasion (cleaning) was insufficient or the contact between the gel and the skin is poor. The procedure for rectifying this problem is to first check that the tape is tight and secure and is holding the electrode firmly against the skin. Next, check the volume of the gel: there should be enough gel in the electrode so that it makes a good connection between the electrode and the skin but not so much gel that it is smearing out the sides of the electrode. If neither of these is the case, then you will need to take the electrode off, repeat the cleaning process and repeat the application process.

Filling the Cortical Electrodes

After all 6 “drop electrodes” are applied and have impedances of less than 5 kOhms and you have attached the chin strip, your next task is to fill the cortical electrodes. If you are working with a partner, the more experienced partner is responsible for measurements and application of the cap. They will then begin filling the cortical electrodes while the less experienced partner attends to the “drop electrodes”. The less experienced partner, upon completion of all facial sensors, will then assist in filling the cortical sensors. The first electrode that should be filled is the reference electrode

(marked REF) located between Cz and CPz. However, on certain caps there is no REF electrode. In this case, the ground (GND) electrode is the important one to be filled first. To do this, grasp hold of the electrode between your thumb and forefinger. With your other hand take the syringe filled with conductive gel and insert the tip into the hole in the top of the electrode. Next, perform ample but light back and forth and up and down movements with the tip of the syringe. The purpose of this is two-fold: first, you want to part the hair so that it does not obstruct the path from the electrode to the scalp and second, you want to slightly abrade the skin below the electrode. After you have done this, start filling the electrode, slowly pushing down on the plunger of the syringe with your thumb while slowly pulling the needle out. The purpose of this is to build a continuous column of gel that bridges the scalp-electrode junction. If the column is irregular or if the gel does not reach properly, the electrode's impedance will be poor. You should fill the electrode with just enough gel so that when you push down on the top of the electrode, gel slightly comes out the hole in the top. You will need to be careful not to overfill the electrodes as that could cause the gel from multiple electrodes to combine, causing electrolytic bridges ("spatial smearing"). Further it is important to wipe the syringe tip frequently to keep the gel from getting everywhere.

Cortical Electrode Impedance and Troubleshooting

After you fill the reference electrode (marked REF), the next most important electrode is the ground electrode (marked GND). Following the filling of those two electrodes you should work in a pattern so that you ensure that you have filled all of the required electrodes in the cap. After you have inserted gel into each electrode you will next need to check the impedance level of the cortical electrodes. This is done in the same way that you check the impedance for the "drop electrodes". If you find that all of the electrodes have poor impedance, you should check the reference and ground

electrodes. The procedure for rectifying poor impedance levels in the cortical electrodes is to first check alignment of the electrode to ensure that the bottom of the electrode is facing the scalp. Next you should check the volume of gel within the electrode. If you push down and no gel comes out then you will need to put more gel in. If there is plenty of gel in the electrode and the alignment is correct then you should check to make sure that the plug is firmly connected to the head box. If none of this works you may need to take a wooden Q-tip and, using the wooden side, insert the stick into the hole in the top of the electrode and twist the stick several times. After you do that, repeat the cortical electrode filling procedure. Once all electrodes have an impedance of less than 5 kOhms, a 10 cm long strip of mesh elastic gauze is placed over the cap in order to keep the electrodes tight against the scalp. To do this, place both hands inside the mesh elastic gauze and expand the gauze to stretch it out. Next, have your partner grab one side of the gauze while you grab the other side and stretch the gauze as you place it over the cap. The mesh elastic gauze should cover all cortical electrodes. The cap is now complete.

Cleaning the EEG Cap

Following the completion of the testing session the EEG cap must be cleaned. To remove the cap from the participants head, first take the chinstrap off. Then, slowly peel the tape off of the 6 “drop electrodes” and remove them from the participants face and ears. Make sure that when you do this you hold onto the head of the electrode; otherwise, you might tear the wire from the electrode head. After all 6 “drop electrodes” have been removed and the tape has been removed from their backs, you should slowly peel the cap off the participant’s head, lifting straight up by the ear flaps. You should have the participant refrain from touching their hair as it will have gel in it. You can provide the participant with a towel and escort them to the nearest sink or bathroom to rinse out their hair. Cleaning the cap is particularly important for both sanitary reasons as well as to

preserve its elasticity and conductance. An inappropriate cleaning can ruin the next recording or destroy the cap.

First, place the cap in warm, soapy water for 5-10 minutes to loosen the gel from the sensors/cap. Be sure to not get the end of the plug wet and try to keep as much of the main wire out of the water as possible. After the cap has soaked, rinse off any electrolyte on the outside of the cap and electrodes. Next, turn the cap inside out to expose the electrodes that are held inside the rubber holders. Run a tight stream of warm or hot water from the faucet and use it like a drill to remove the electrolyte from the holder cavity, making sure not to let the cap connector get wet (holding the cap low in the sink will help blast the gel out of the sensor cavity). Make sure that you do not forget to clean the gel from the hole in the top of the electrode as this could cause problems filling the electrode upon later use. This action should remove the electrolyte completely, however you should make sure that you do not attempt to remove gel by placing anything in the electrode as this could destroy the electrode. Turn the cap back out and use the water to remove any additional electrolyte from the outside of the cap. Finally, rinse all electrolyte gel from the 6 drop down electrodes, collecting all 6 in your hand to ensure they are all clean. When you are satisfied that all electrolyte has been removed, rinse the Quik-Cap with warm water and place it into a disinfecting solution for no longer than 10 minutes. After disinfectant, rinse the cap thoroughly and hang it up to dry. For faster drying, the cap can be set in front of a fan; however, direct heat sources should not be used to dry the cap. Compressed air may be used to blow moisture from the electrodes and wire entry points and is very useful for extending the life of the Quik-cap.

Appendix A: Quick Reference Checklist

- Put on Personal Protective equipment

Clean the areas where the facial sensors go

Ears (in order)

- Alcohol
- NuPrep
- Wipe dry

Face (in order)

- NuPrep
- Wipe dry

Placement of Drop Electrodes

- Line up VEOG with pupil
- Line up HEOG with crease of eye

Filling Cortical Electrodes

- Insert needle into sensor straight in
- Abrade back and forth and up and down (not too hard or too long)
- Slowly inject gel into sensor (if you can push down lightly on the sensor and gel comes up through the hole then that is enough)

Impedance

- Impedance (Pink to Black) if not blue or black then must be repeated

Troubleshooting (if poor impedance)

Facial Electrodes

- Check taped tightly & securely
- Check volume of gel
- If does not work, take off, clean, repeat application

Cortical Electrodes

- Check volume of gel
- Check Reference & Ground
- Check plug
- Insert wooden plug and twist several times, repeat standard application

Cleaning the Cap

- Soak in soapy water for 5 to 10 minutes
- Rinse outside of cap and electrodes
- Turn cap inside out and rinse inside of electrodes
- Rinse drop down electrodes
- Rinse cap again completely
- Place in disinfecting solution for no longer than 10 minutes
- Rinse cap thoroughly
- Hang to dry