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REPORT CARD



# **AUDITORY ELECTROPHYSIOLOGY**

## **PART 2 - 10/20 SYSTEM AND ELECTRODES**

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In the March 2022 newsletter we started on the topic of the electrophysiology of hearing with a description of the basic concepts. In this bulletin, we will continue learning about auditory electrophysiology, a tool that provides important information when making auditory diagnoses.

Electrophysiological assessments are based on the 10/20 system, but what does this refer to? The emergence of the 10/20 system stems from a need to standardize the electrode placement points in electroencephalogram (EEG) procedures.

As described in the March 2022 bulletin, an electrophysiological assessment is made from an EEG in response to some type of sound stimulus. The 10/20 system was developed by Jasper (1958). Following his lead, evaluations carried out anywhere in the



world can be interpreted and compared if all researchers use the same parameters established by him. The correct positioning of the electrodes is extremely important, as it ensures the proper collection and recording of signals.

Before presenting the 10/20 System in detail, it is important to recall from anatomy classes about

coronal and sagittal sections (see figure 1). Each section provides different information.

## THE SAGITTAL CUT

divides the human body between the right and left sides. This helps in understanding, for example, whether a particular structure of the human body is medial or lateral.

## THE CORONAL CUT

in turn, is positioned perpendicular to the sagittal cut and divides the human body between the ventral/anterior (front) and dorsal/posterior (back) parts.

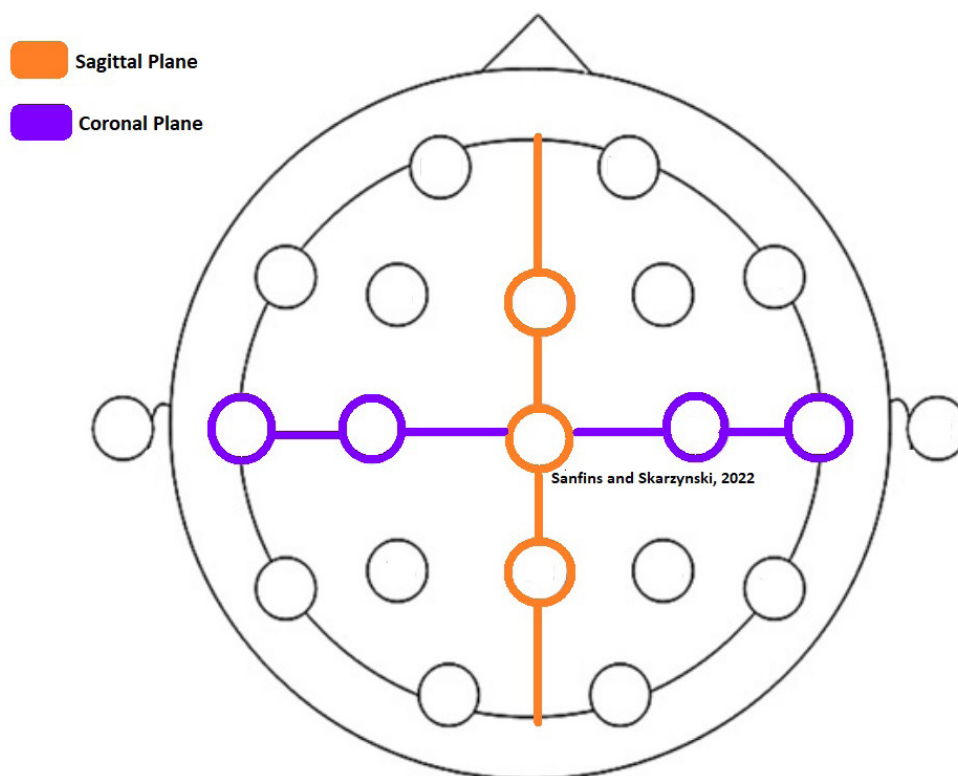


Figure 1: Representation of the sagittal and coronal sections.

Bearing in mind this division, we return to the 10/20 system. This system uses 21 points of electrode placement, but it is not the only standard system. There are other

arrangements such as the 10/10 and 10/05 systems which work with a greater number of electrodes, but the 10/20 system is the most popular.

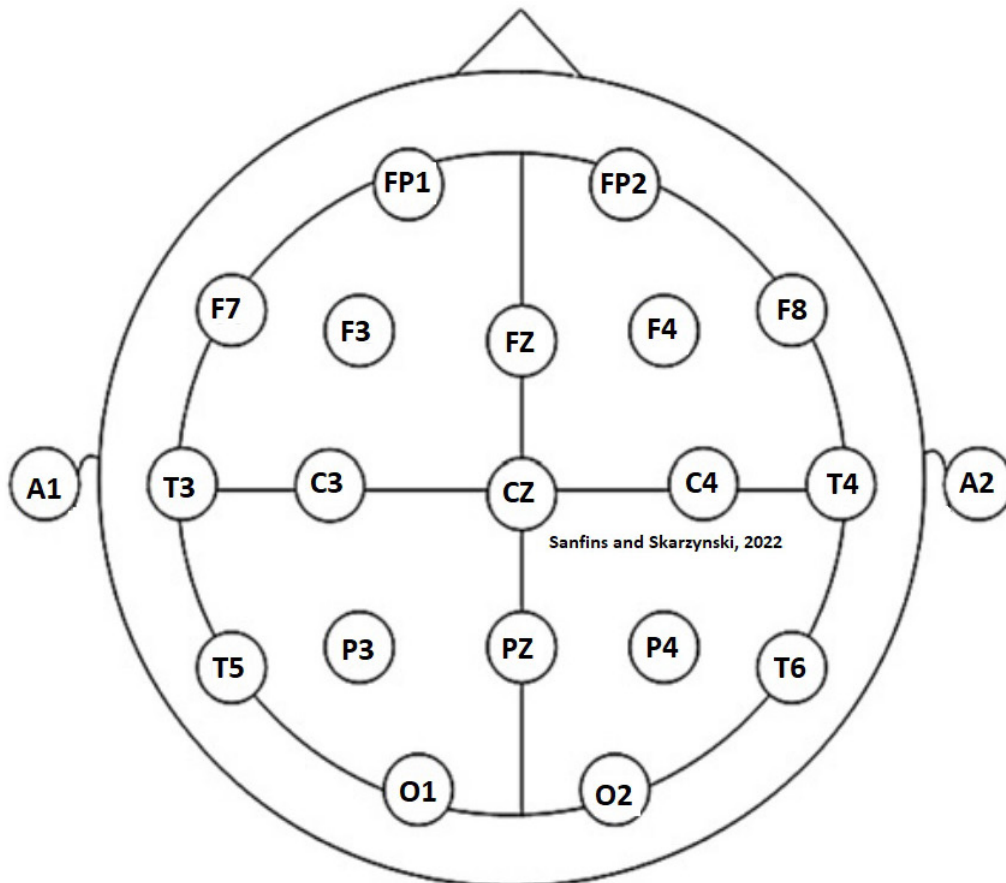


Figure 2: Arrangement of the 21 electrodes within the 10/20 system.

The American Clinical Neurophysiology Society (ACNS) recommended the replacing the T3/T4 points with T7/T8, as well as the replacement of T5/T6 points with P7/P8. Figure 3 shows how the 10/20 system looks after these

changes. It is important to check that there is a correspondence between the letter of the electrode and the lobe over which it is positioned, as listed in the table below.

POSITION	ELECTRODE LETTER COLOR AS SHOWN IN FIGURE 3
Frontal Lobe	<b>F - Red</b>
Temporal Lobe	<b>T - Green</b>
Midline (Center) Coronal plane	<b>W - Yellow</b>
Parietal Lobe	<b>P - Blue</b>
Occipital Lobe	<b>O - Pink</b>

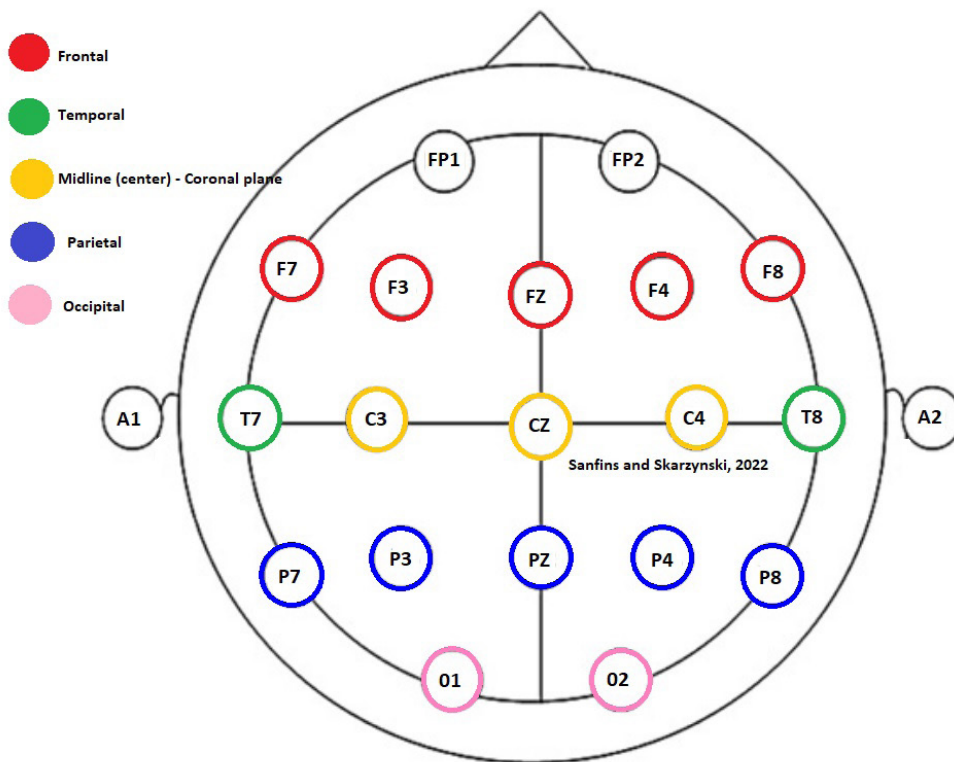


Figure 3: Layout of the 21 electrodes of the 10/20 system in accordance with the American Clinical Neurophysiology Society recommendations. Compare with Figure 2. Figure developed by the authors.

In addition, there are other types of labelling within the 10/20 system as shown in Figure 4.

- **THE LETTER A** represents electrodes positioned on the earlobe.
- **THE LETTER Z** represents the electrodes that appear in the midline of the head (dividing the right and left sides) of the patient through the sagittal slice.
- **THE LETTER C** represents electrodes that appear on the midline of the head (dividing the anterior and posterior part) of the patient through the coronal cut.
- **ODD NUMBERS** represent electrodes positioned on the left side of the patient's head.
- **EVEN NUMBERS** represent electrodes positioned on the right side of the patient's head.

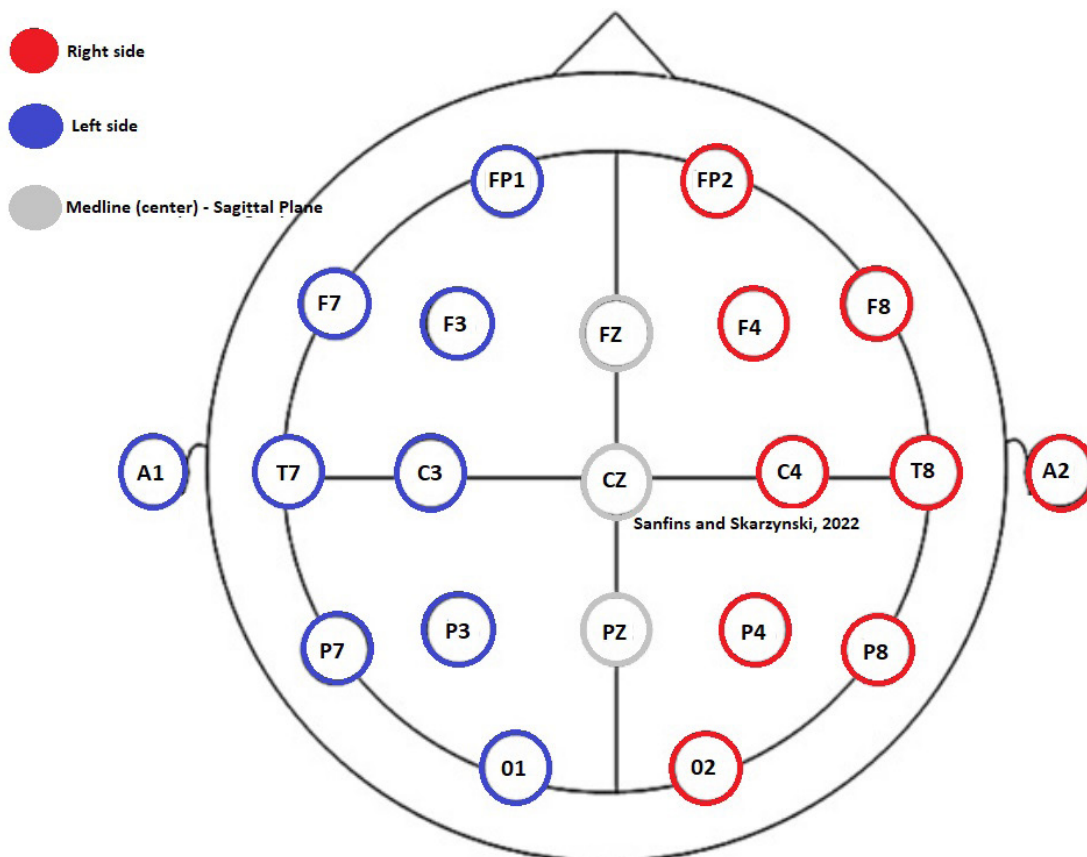


Figure 4: Alternative colour-coding of the 10/20 system. Figure developed by the authors.

**Professionals who work in the area of hearing electrophysiology need to be familiar with the guidelines of the 10/20 system.**

They can choose to place individual electrodes or use caps to perform the procedure, of which there are several brands available. An important aspect is that the caps need to be well adjusted to the patient's head. The evaluator should ideally measure the circumference

of the patient's head and choose the appropriate size. An advantage of using a cap is that the positions of the electrodes are clearly identified according to the 10/20 system (see Figure 5), reducing the possibility of incorrect placement of the electrodes.

In addition, the cap usually comes with a band that allows some further adjustment to the head of each patient. The band is tied around the chin and has a Velcro strap on both ends (Figure 6) which allows suitable adjustment for each patient.



Figure 5: Cap for performing EEG in two sizes. Size M (red) and L (blue). Figure developed by the authors.



Figure 6: Adjustable strap for cap.  
Figure developed by the authors.

In terms of electrodes, there are different types available, from disposable to reusable. Again, one needs to know the 10/20 system and what positions will be required.

There are several materials that can be used in the manufacture of reusable electrodes, such as gold chloride, silver chloride, lead wire, tin. The type of electrode material should be considered, as some materials have better conduction, which can ensure a better quality of the response.

Gold, for example, has excellent electrical conduction and is non-oxidative, and in that sense is superior to any other type of material.

Another material highly recommended is silver, which has an even greater conductivity than gold; however, it can oxidise. Some researchers advise using gold-coated silver electrodes, which would ensure the best of both materials - the best conductivity (silver) and the best non-oxidation power (gold). The choice of electrode material type is a technical issue that must be decided by the evaluator.



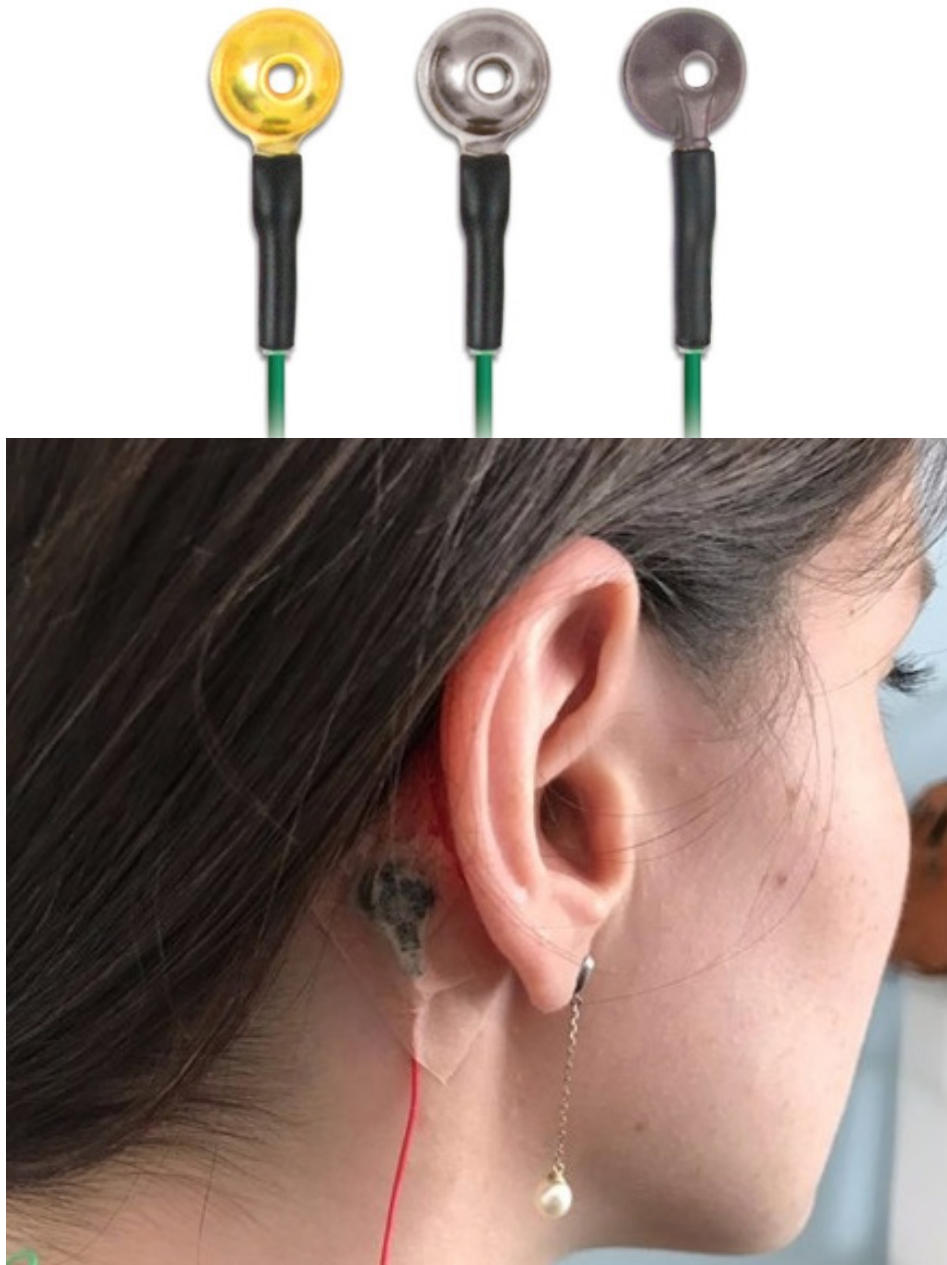


Figure 7: Different types of reusable electrodes. Figure developed by the authors.

Disposable electrodes come in different sizes and shapes suitable from neonates to the elderly. The electrodes are often consist of a liquid gel of high conductivity in order to give good signal quality. The evaluator needs to analyze the different types on the market and choose the one that gives the best

electrical performance. In times of a pandemic, the use of disposable electrodes is highly recommended for electrophysiological procedures, improving hygiene. Proper disposal of the electrodes is needed after the evaluation is complete.

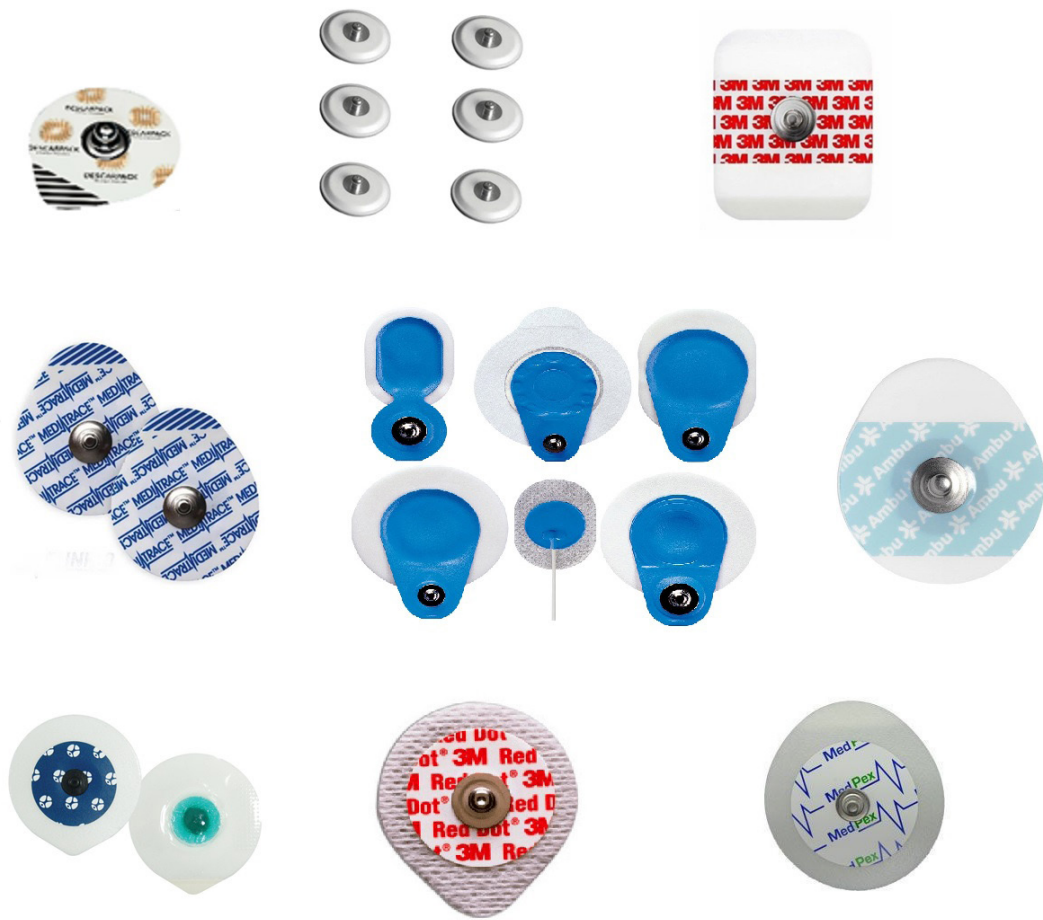


Figure 8: Different types of disposable electrodes. Figure developed by the authors.

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