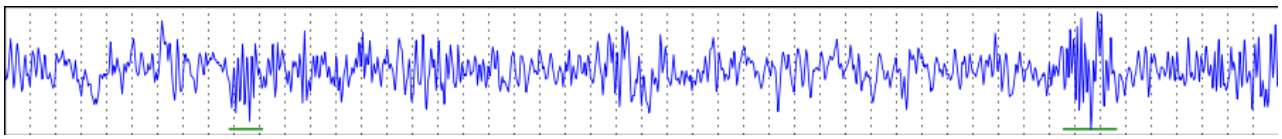
Supplementary Figure 7: Written instructions and training protocol for experts and non-experts.

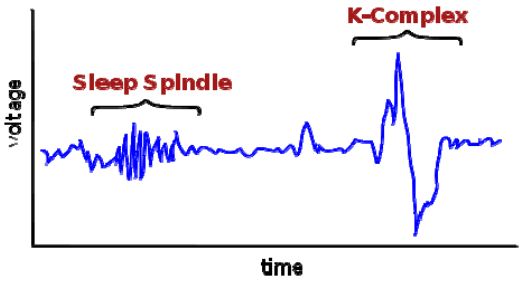
Identify Sleep Spindles

Your task is to identify exactly where the spindles begin and end by drawing a colored bounding box around them. Here is an example of a window containing two spindles (underlined in green). Not all windows will contain spindles. **You must read the detailed instructions at least once.**



Detailed Instructions

You will be presented with EEG data that measures the brain activity of a person that is in stage 2 sleep. The goal is to identify patterns in the data that are known as **Sleep Spindles.** Your task is to identify exactly where the spindles begin and end by drawing a colored bounding box around them. A description and examples of sleep spindles are presented below.



source: wikipedia

Figure 1: An example of a sleep spindle and a K-complex. These features are seen in the EEG during stage 2 sleep. Note that over time (moving to the right in the horizontal axis) a change in voltage of the EEG signal has caused the line to go up and down (vertical axis).

Definition of a Sleep Spindle:

For the purpose of this study, we are defining a sleep spindle based on its shape, speed, duration, and height. **It is most important that the spindle stands out as being different from the surrounding EEG signal.**

1. Shape of spindle:
The spindle is usually shaped like a diamond or football (this is sometimes referred to as a 'waxing/waning' shape). Note that sleep spindles are often found near K-complexes (see Figure 1). Sometimes the K-complex wave might be so close to the spindle that it changes the shape of the sleep spindle. A certain amount of deformation in the shape of sleep spindle (ie the axis of spindle is not completely flat) is ok (Figure 2).

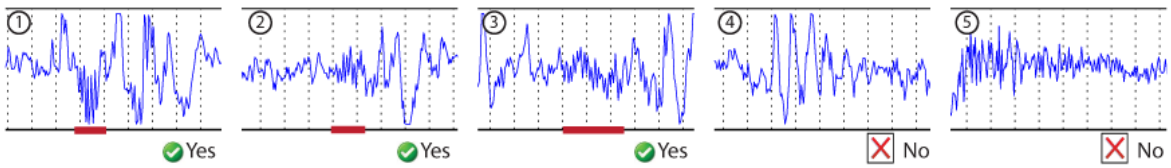


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Figure 2: Shape of the spindle (underlined in red) is acceptable in the first three examples, but not the fourth or fifth. Note that the third spindle shape is changed slightly because of other waves.

2. Speed of waves:
A sleep spindle is a group of waves that oscillate (go up and down) at approximately 12-15 cycles per second (this can be said as having a frequency of 12-15Hz). It can be difficult to estimate the speed. However, because the vertical dashed lines in the display mark 0.5 second intervals, one way to determine the speed is to count the number of wave peaks between the dashed lines: between 6 and 7.5 wave peaks in 0.5 seconds would be equal to 12-15 cycles per second (Figure 3). It is important that the spindle appears as a 'burst' of waves that are slightly faster (closer together) than the waves around it (Figure 4).

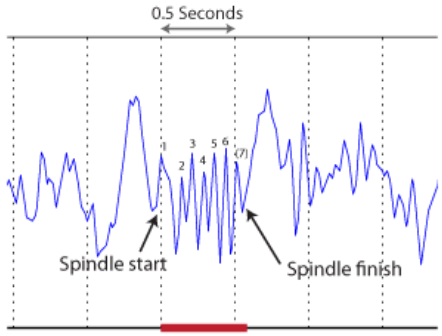

Figure 3: Estimating the speed of the spindle by counting the number of waves. In this enlarged picture, it is easy to see there are between 6 and 7 waves in 0.5 seconds, which is equal to 13 cycles per seconds. This is within the 12-15 cycle per second range of sleep spindles.

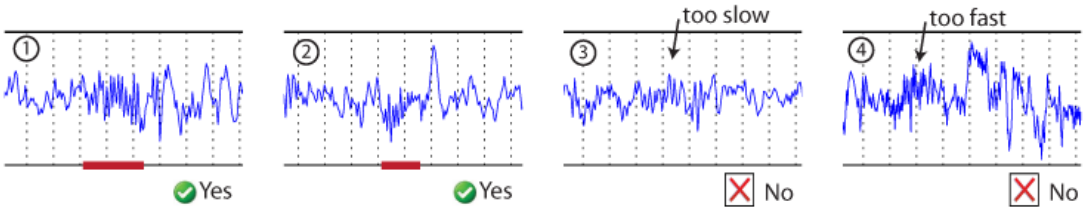

Figure 4: The first two examples are appropriate speeds for a sleep spindle. The third example is too slow, and the fourth example too fast (too many cycles per second) to be a sleep spindle. Notice that you can clearly see gaps between the waves in the third example, and you can see no gaps at all between the waves in the fourth example.

3. Duration of spindle:
Most commonly, spindles are around 0.5 to 1.0 seconds in length (duration), but can be as short as 0.4 seconds and as long as 5 seconds (Figure 5).

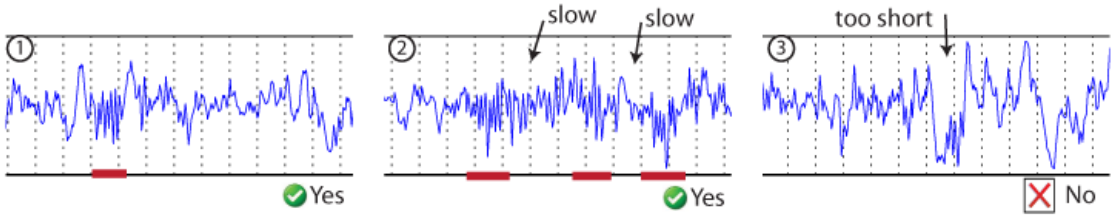

Figure 5: Example spindles of different durations. The second example could be considered one single long spindle, but there are slow segments in the middle, and in this case, it has been considered three

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separate spindles of shorter duration. The duration of the third example is too short to be considered a spindle (< 0.4 seconds).

3. Height of waves in spindle:
The height (amplitude) of the spindle is less important than the other criteria. The height of the waves in the spindle is usually a little larger than the waves around it. The spindle should be distinct from the other waves around it.

How to annotate Spindles:

To create a bounding box around the spindles, you need to **left click and drag** with the mouse around the spindle. In this case, a menu appears where you can select how sure you are of it:

- **Definitely**: "I am sure that this is a Spindle. It meets all of the criteria of shape, speed, duration and height and is very distinct from the surrounding waves."
- **Probably**:"I would bet that this is a Spindle, although I am not completely sure because one of the criteria is not quite right. There are some imperfections in the spindle, but I still think it is a sleep spindle."
- **Guessing**: "I think this could be a spindle, but I am not positive. Two or more of the criteria are not perfect. It would be best to have someone have a second look at this."

If you just click on the "Spindle" button, it will be assigned "Definitely".

Accuracy is important, so be sure to size the bounding box so that it only includes the spindles, not surrounding EEG waves. You can resize and move the bounding box (Figure 6) by clicking in the middle or on the edges and dragging. You can change the spindle certainty, or delete the bounding box by right clicking on it. There may be multiple spindles, or none within a window (Figure 7). If there are no spindles in the window, indicate this by clicking the box marked "There are no Spindles in the image" found at the bottom left of your screen before moving on to the next window.

If the spindle runs into the end or beginning of the window, just draw the bounding box right up to the edge of the window.

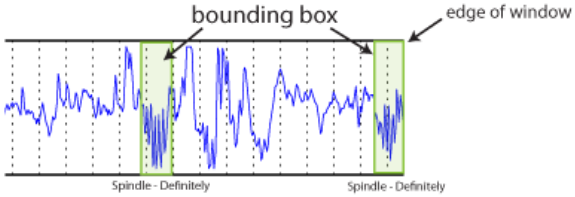
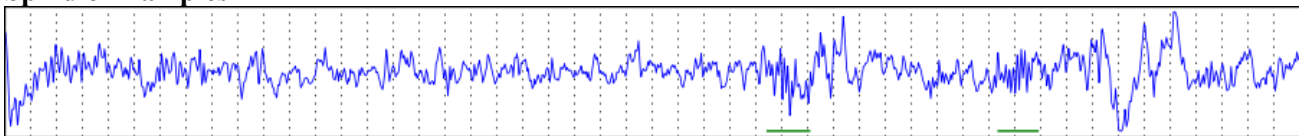


Figure 6: Use your mouse to draw a bounding box around the spindle. The size of the bounding box can be changed by clicking on the middle or on the edges of the box and dragging. In this case, the certainty of the spindle has been judged as "Definitely". *If the spindle runs into the end or beginning of the window, just draw the bounding box right up to the edge of the window.

Spindle Examples



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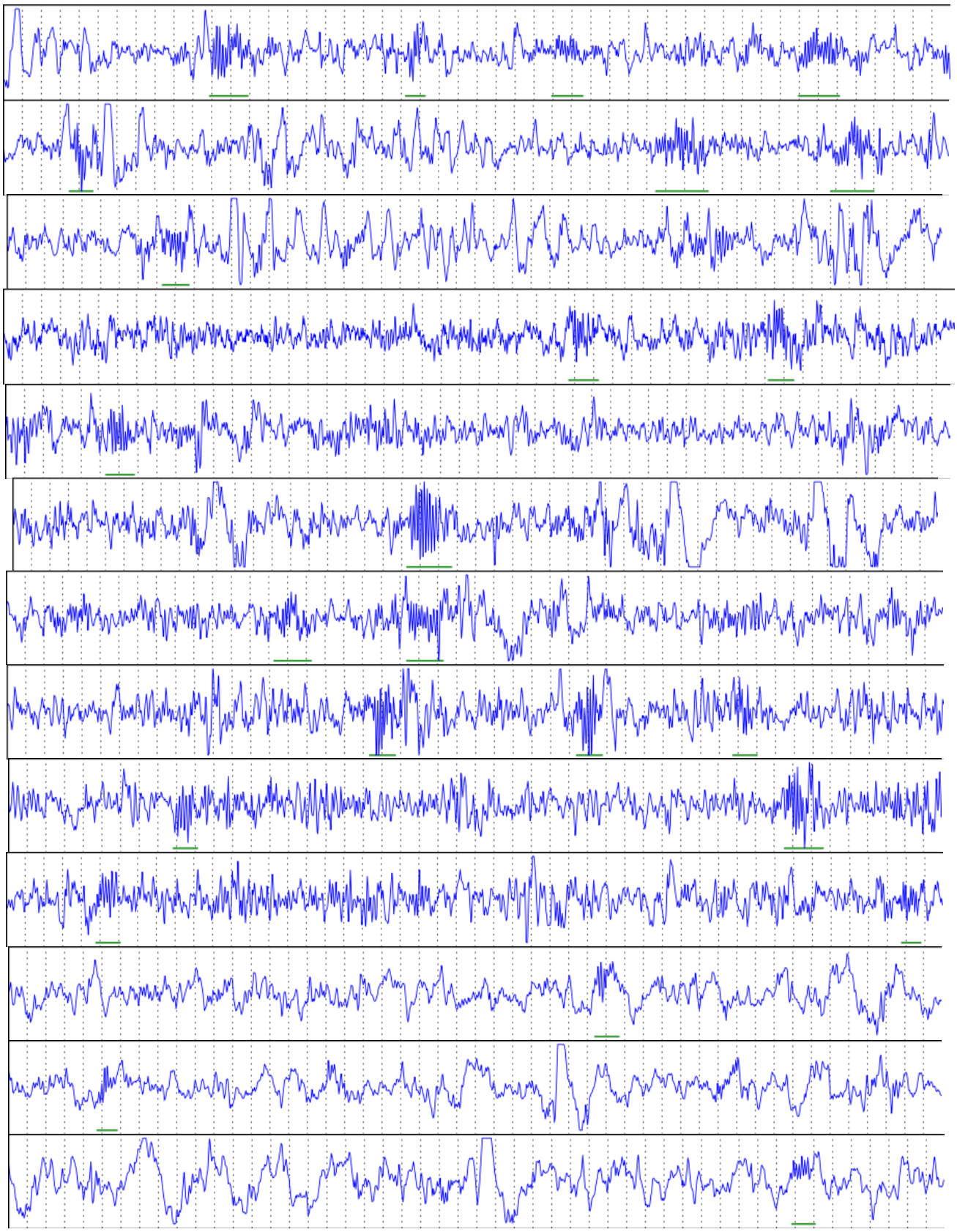

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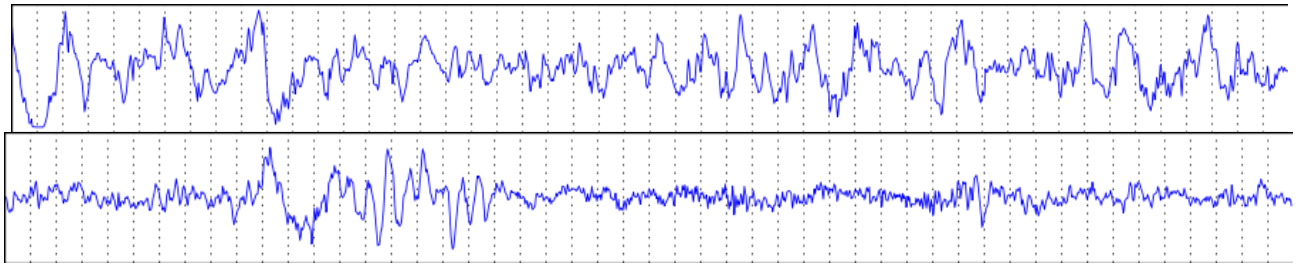

Figure 7: Here are some examples of sleep spindles, indicated with a green bar below them. These are the events you will want to identify by drawing a bounding box around them with your mouse. There are also other events that are not identified as spindles, because they are too short, too small, or don't have the correct shape. As a reference, the gridlines in the display are spaced at 0.5 seconds so that you can approximate the number of cycles by counting the number of waves. Some windows do not have any spindles.

Remember, you need to select the spindles precisely. Do not include any noise around them. **You will only get paid if you do a careful job in selecting the spindles.** We will double check some of your jobs to make sure you select events that fulfill the criteria.

The goal is to very accurately identify the spindles. Try as best you can to identify where the spindle begins and ends. Quality is more important that quantity.

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