13 Complex Morlet Wavelets and Extracting Power and Phase

13.1 The Wavelet Complex

In the previous chapter you saw that Morlet wavelet convolution can be used as a bandpass filter for EEG data. In this chapter you will learn how to use complex Morlet wavelets to extract estimates of time-varying frequency band–specific power and phase from EEG data.

To extract power and phase information from EEG data, *complex* Morlet wavelets are necessary. They are called complex because they have a real part and an imaginary part. A complex wavelet thus occupies a three-dimensional (3-D) space: time, real, and imaginary (figure 13.1). You can conceptualize real and imaginary dimensions the way you conceptualize x and y planes on a Cartesian graph.

After examining figure 13.1, try to conceptualize wavelets not as curvy lines that go up and down but rather as corkscrews that go around in a circle over time. This is illustrated in figure 13.2. If you run the online Matlab code to generate figure 13.2, you will be able to rotate the wavelet on all three dimensions with the mouse. The online Matlab code will also generate a movie that allows you to see both the Cartesian and the polar representations of a complex wavelet evolving over time.

Now that you appreciate what a wavelet looks like visually, it is time to take a closer look at the numbers. First examine the size of the wavelet. If you type `size(wavelet)` in the Matlab command window, you will see that the variable `wavelet` is a 1×1001 matrix, in other words, a vector, or a single stream of numbers. However, if you look at the contents of the variable `wavelet` by typing `wavelet'` (the transpose will print a column vector for visual convenience), you can see that each element in the wavelet actually comprises two numbers, the second of which has an "i" behind it. What does this mean? Is this the new iWavelet?

This is the representation of a complex number. A complex number has the form "$a + ib$." The first part of the number (a) is the real component, and the second part of the number

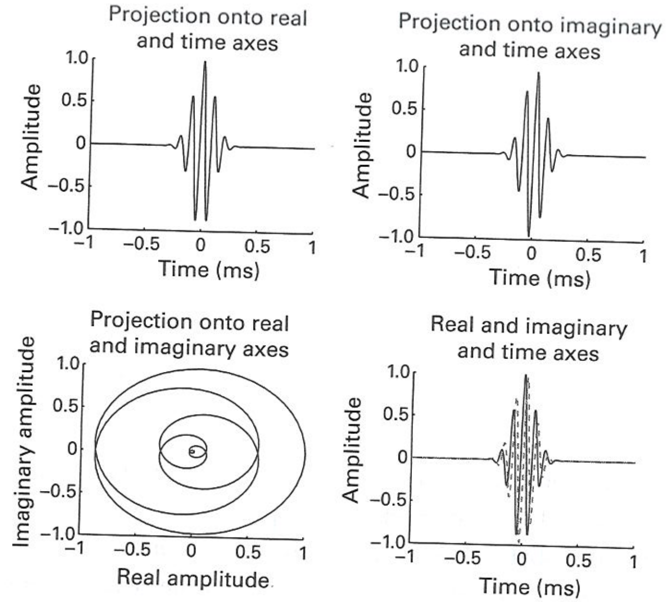

Figure 13.1
A complex wavelet is a 3-D (time, real, imaginary) function. Plotted here are projections onto various pairs of those dimensions.

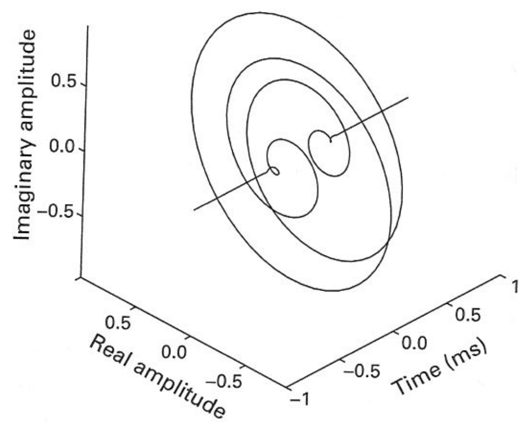

Figure 13.2
Three-dimensional view of a complex wavelet.