We describe the signal processing (SP) and analysis subsystem of an operational model of an insect central nervous system (CNS) feeding decision center capable of predicting caterpillar responses to specific chemical mixtures. Our model includes: (1) a demultiplexer; (2) neuron activity encoder; (3) predictor of the feeding behavior. Detection of a chemical mixture is performed by two taste sensilla each containing four taste neurons. The insect uses this information to choose among acceptable and unacceptable plants. Extracellular electrophysiological recordings obtained from the taste sensilla, quantify the activity of the constituent taste neurons in response to chemical mixtures. Recordings may contain action potentials (AP) produced by all four of the constituent taste neurons of each sensillum. Known chemical reference compounds activate specific neurons. A different shaped AP is produced by each of the four neurons of a sensillum in response to its reference compound. Thus shape can be used to estimate the origin of each AP. The demultiplexer employs conventional SP techniques and an expert system to detect the presence of an action potential within the signal. Once an AP has been detected, the demultiplexer module uses an artificial neural network (ANN) to estimate which of the taste neurons is active. The ANN classifier is trained with spikes elicited by reference compounds. The trained classifier is highly successful in identifying spikes, evoked by reference compounds, that were not part of the training set. Analysis of inter-spike interval and spike shape using statistical SP methods are being incorporated to improve the classification results.