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A Neurodynamical Model of How Prior Knowledge Influences Visual Perception

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Abstract: Recent behavioral studies showed that prior knowledge can directly influence visual perception. In the current work, we offer an explanation of the observed findings based on the adaptive resonance theory (ART). The ART neural network was designed to solve the problem of catastrophic forgetting during learning in non-stationary environment. In the ART, stability of learning is achieved by matching bottom-up sensory signals with top-down expectations. Resonant state that corresponds with conscious perception develops in the network when the bottom-up and top-down signals are closely aligned. On the other hand, mismatch produces global reset signal that clears the traces of erroneous top-down expectations. Therefore, prior knowledge can influence conscious perception only when it already closely matches with sensory signals. We performed computer simulations with real-time implementation of the ART circuit that confirm our analysis. Simulations also showed how observed behavioral findings arise from response bias.