Mechanisms underlying simple perceptual choices

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In perceptual decision-making, subjects are typically asked to make a binary categorical judgement about the magnitude of a perceptual feature across two stimuli. The accuracy of such judgements can be probed by measuring the smallest intensity difference that can be reliably discriminated, or just-noticeable-difference (JND). A long tradition in psychophysics has demonstrated certain regularities in these kinds of discriminations. The oldest and most general, noticed by Weber in 1836, states that the JND is not a difference, but a certain ratio between the two stimulus intensities which is constant across a wide range of absolute stimulus magnitudes. Although Weber's law is the most firmly established regularity in sensation, no principled way has been identified to choose between its many proposed explanations. We studied how accurately rats could discriminate the lateralization of sounds, which relies on a comparison of intensity across the two ears, at various absolute levels. These experiments revealed the existence of a novel psychophysical regularity – which we term time-intensity equivalence in discrimination (TIED) – describing how reaction times change as a function of absolute intensity while intensity-ratios, and thus discrimination-accuracy, are kept fixed. The relationship between absolute intensity and reaction time is so stringent that it allows us to mathematically specify the computational basis of the sensory discrimination process, placing strict requirements on how stimulus intensity is encoded in the stochastic activity of sensory neurons, and revealing that discriminative choices must be based on bounded exact temporal accumulation of sensory evidence. This mechanism is not only necessary for the TIED to hold, it is also sufficient to provide a virtually complete quantitative description of the rats' behavior. For this reasons, it provides a unique opportunity to guide the search for the neural basis of simple perceptual choices, a task we are currently pursuing.