“Dipper function” for bimodal and unimodal visual-tactile motion discrimination and facilitation between modalities

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We investigated visual, tactile motion perception and multimodal integration by measuring velocity discrimination thresholds over a wide range of base velocities and spatial frequencies. The stimuli used were two physical wheels etched with a sinewave profile that was both seen and felt, allowing for the simultaneous presentation of visual and haptic velocities, either congruent or in conflict. The subject were presented in two separate intervals and required to report the faster motion in 2AFC, using visual, tactile or bimodal information. We found an overall improvement (about root two) in the bimodal detection and discrimination thresholds. These were well predicted by the maximum likelihood estimation model, but this was not specific for direction. Interestingly, both bimodal and unimodal visual and tactile thresholds showed a characteristic “dipper function”, with the minimum at a given “pedestal duration”. The “dip” (indicating facilitation) occurred over the same velocity range (0.05 – 0.2 cm/sec) at all spatial frequencies and conditions. Most interestingly, a tactile pedestal facilitated a visual test and vice versa, indicating facilitation between modalities. Our results suggest that visual and tactile information of motion are analyzed with similar sensitivities, integrated in an optimal fashion and that the thresholding of these signals occurs at high levels after cross-modal integration.