Incomplete compensation for visual self-motion in the perception of object velocity

When observing a moving target while the observer themself is moving, the same retinal speeds can correspond to vastly different physical velocities. When the observer moves in the same direction as the target, the retinal speed is disproportionally lower than the physical velocity, and vice-versa. Observers must thus obtain an accurate estimate of their own velocity, and subtract it from or add it to the retinal speed elicited by the target to obtain an accurate estimate of the object velocity. When self-motion is experienced visually only, this compensation is likely incomplete, leading to biases in judgments of object motion during visual self-motion. Furthermore, added compensatory computations should decrease precision. To test these hypotheses, we devised a Two-Interval Forced Choice task. In a 3D virtual environment, we presented two motion intervals per trial, one of which consisted in a target moving linearly to the left or to the right in the fronto-parallel plane, while the other consisted in a cloud of smaller targets travelling in the same direction. The single target moved at one out of two constant speeds, while the speed of the target cloud was determined by a PEST staircase procedure. While observing the single target, participants were moved in the same direction, in the opposite direction, or remained static. After the second interval, participants were asked to judge which motion was faster. In support of our first hypothesis, we find differences in PSE between static, congruent and incongruent motion; target motion during congruent self-motion was judged as slower and vice-versa. Furthermore, we found some support for the hypothesis that self-motion during target motion observation also increases JNDs. Overall, our results indicate that humans compensate incompletely for visually experienced self-motion when judging the speed of observed motion. This has implications for everyday situations such as driving a car.