How different types of action constraint the precision of sensory measurements

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The uncertainty principle in physics asserts a limit to the precision with which position and momentum (velocity times mass) can be known simultaneously at the very same moment. Humans have often to interact with objects that change position and need to obtain measures about this objects (velocity or position) for a successful interaction. Intercepting moving objects is such an example. Interception at given positions within a temporal window requires precision in predicting future positions (to avoid sensorimotor delays) and knowing the temporal error that we can afford based on target velocity. In two tasks subjects had to synchronise a key press with moving Gabors (0.9 c/deg) crossing a designated position at different speeds or intercept the Gabors by controlling a cursor. To test the reliance on perceived position I induced position shifts (forward/backwards) by adding local drift (same/opposite) to the global displacement. The perceived position accounted for the initiation of the interception but not its end point. This was consistent with subjects monitoring the position to start the action but relying on velocity to perform the motor movement. Interestingly, when subjects only had a single moment (synchronisation task) the responses reflected a compromise between position and velocity. This trade-off resulted in a U-shape of the combined (position and temporal) variability that was more prominent in the synchronisation task. Single time responses reflect then an uncertainty principle when minimising temporal and position errors. This clearly that the type of action constraints the precision of the acquired mesures.