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Perceptual and performance biases in action selection

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Abstract

When we see an object in the world, there may be a large number of different ways to interact with that object. This large 'visuomotor space' can be constrained through affordances (perceptually available object properties defining potential uses), task demands and the actor's intentions. The effects of perceptual biases can be modified by performance factors, such as a limb's end-state-comfort (ESC; Rosenbaum et al. 1990). We investigated how two other potential performance biases affected interaction with a perceptually under-constrained object: hysteresis (H) and minimal forearm rotation (MR). Experiment 1 found H and MR operating in adult participants who reached-to-grasp a doweling placed at different orientations either randomly or systematically (orientation changed by 30° every five reaches either clockwise or counter-clockwise). In the random condition, participants switched between pronation and supination depending on which required minimum forearm rotation, but a systematic reach history delayed the transition from pronation to supination in the counter-clockwise condition (and vice versa). This effect was more pronounced in 5-15 year old children. Experiment 2 placed ESC and
MR in opposition. Participants reached-to-grasp a doweling at one of two initial orientations and rotated it clockwise or counter-clockwise by 180°. On half the trials, ESC could only be achieved at the expense of MR. Adults reliably acted to achieve ESC when reaching with their preferred hand (100% of trials but less so with the non-preferred hand at circa 80%). Younger children (5-8 years) and children with developmental coordination disorder (5-13 years) were primarily driven by MR and to a lesser extent H. Older children (9-13 years) showed a clear developmental trend towards adult behaviour. Thus, action selection is a dynamic process subject to numerous performance biases even in skilled adult participants. Importantly, the effect of performance biases on perceptually under-constrained objects varies with skill level and developmental status.

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