Fitt's Law and associated gaze behaviour in upper limb amputees

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Abstract

Fitt's law describes the speed-accuracy trade-off when aiming with constant accuracy to point to an ever smaller target area: total movement duration is inversely related to the logarithm of target width. Previous studies found that Fitt's law holds for motor imagery and applies to saccadic eye movements. Here, we systematically investigated speed-accuracy effects in amputees' imaginary pointing movements (either with their phantom hand or with the imagined former limb) while tracking their gaze. We studied movement execution (ME) and movement imagery (MI) in 9 upper limb amputees and 9 able-bodied individuals using the method reported in Sirigu et al. (1996)[#]: Eight cycles of horizontal movements from a specified location to a target of varying width (1.25, 2.5, 5, 10, or 20 mm) were performed and the start and end of each cycle were indicated by a pedal press. ME and MI of the amputees' intact hand and the control participants' dominant hand were assessed. The linear mixed model procedure showed a clear effect of target width and condition (MI vs ME) for completion time (CT). Furthermore, visual inspection revealed that the data distributions for CT (both ME and MI) of the dominant/intact hand and for MI of the phantom limb adhered to Fitt's Law. Notably, in the cohort of amputees, Fitt's law applied to the distribution of the number of saccades for MI of the intact hand but not for MI of the phantom hand, suggesting that following an amputation, eye-hand coordination might undergo substantial modifications, detectable with implicit gaze indices. These preliminary results shed new light on the alteration of MI capacities and visuo-motor integration processes due to amputation, which could be exploited for the design of appropriate prostheses.

References

Sirigu, A., Duhamel, J. R., Cohen, L., Pillon, B., Dubois, B., & Agid, Y. (1996). The mental representation of hand movements after parietal cortex damage. *Science*, *273*(5281), 1564-1568.