

## Supplementary material

Table S1. Quantitative model performance for range of feedforward vs. feedback combinations. Each column of table is for one combination, with pure feedforward in left-most column, pure feedback in right-most column. Relative sensory gain is expressed as ratio of covariances  $W$  and  $V$  (process noise and sensor noise), and with relative gain  $|L|/|L_{lqe}^*|$ . Performance measures include COT (mechanical cost of transport, dimensionless), COT excluding energy spent during falls, step length (root-mean-square) variability, MTBF (mean time between falls), Mean steps between falls, average walking speed, average step length, and baseline COT with no noise (using same step length and speed as with noise). Model walks 20 trials of 100 steps for each condition, yielding average results across trials and steps.

Feed-forward vs -back:	Pure FF	← More FF	Optimal	More FB →	Pure FB		
Rel. cov(w)/cov(v)	0	$10^{-4}$	$10^{-1}$	1	$10^{0.5}$	$10^{0.8}$	inf
Rel. L gain	0	0.82	0.88	1.00	1.16	1.44	inf
COT	0.339	0.091	0.082	0.077	0.080	0.082	0.090
COT excluding falls	0.102	0.069	0.066	0.063	0.065	0.066	0.072
Step length Var.	0.066	0.053	0.048	0.046	0.051	0.052	0.056
MTBF	1.000	6.151	8.501	9.611	8.420	7.275	6.412
Mean steps between falls	0.750	4.545	6.283	7.101	6.241	5.390	4.761
Avg. speed	0.275	0.357	0.367	0.371	0.368	0.365	0.362
Avg. step length	0.563	0.566	0.564	0.560	0.560	0.561	0.562
Baseline COT	0.039	0.043	0.045	0.046	0.045	0.044	0.044