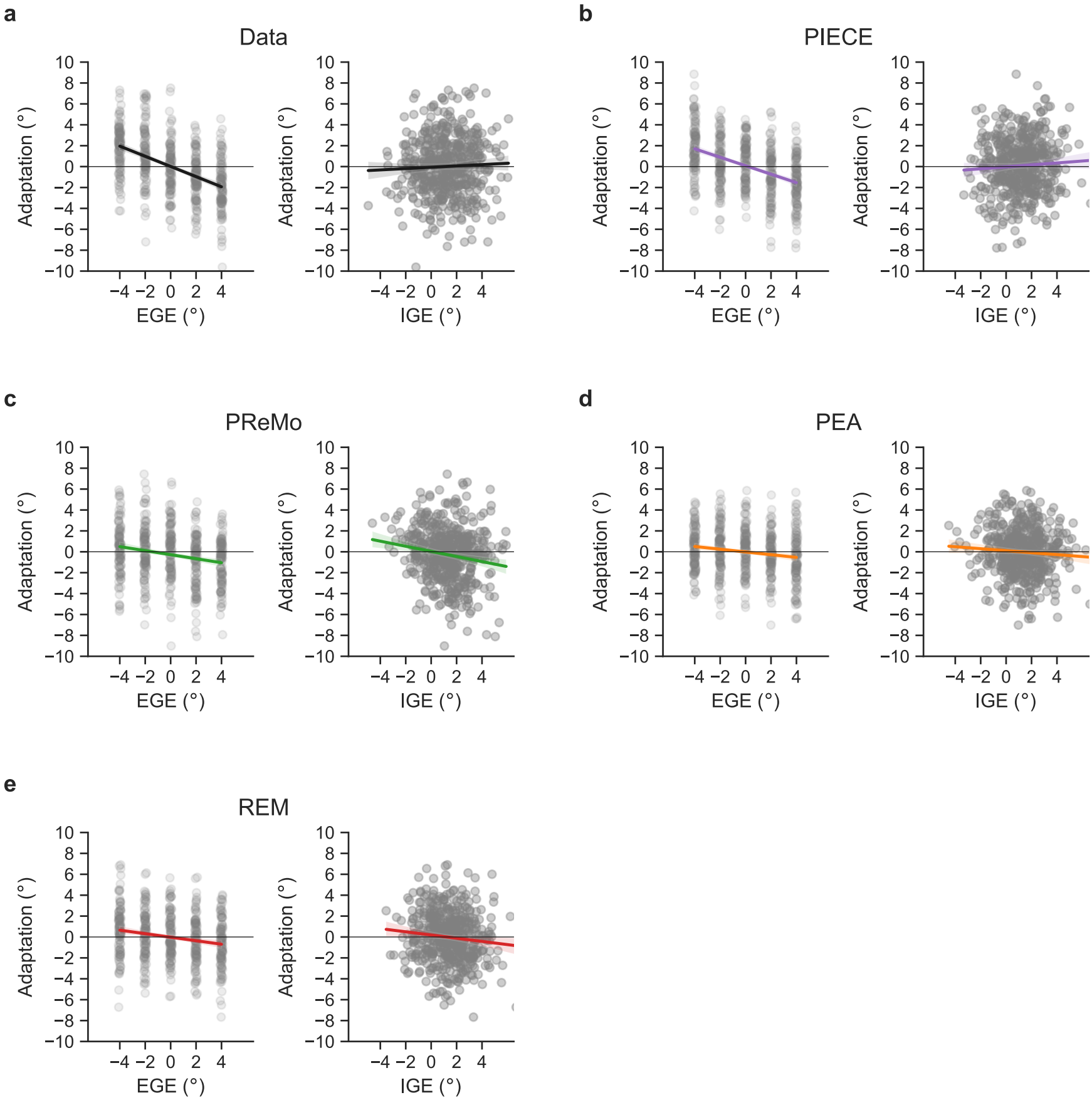
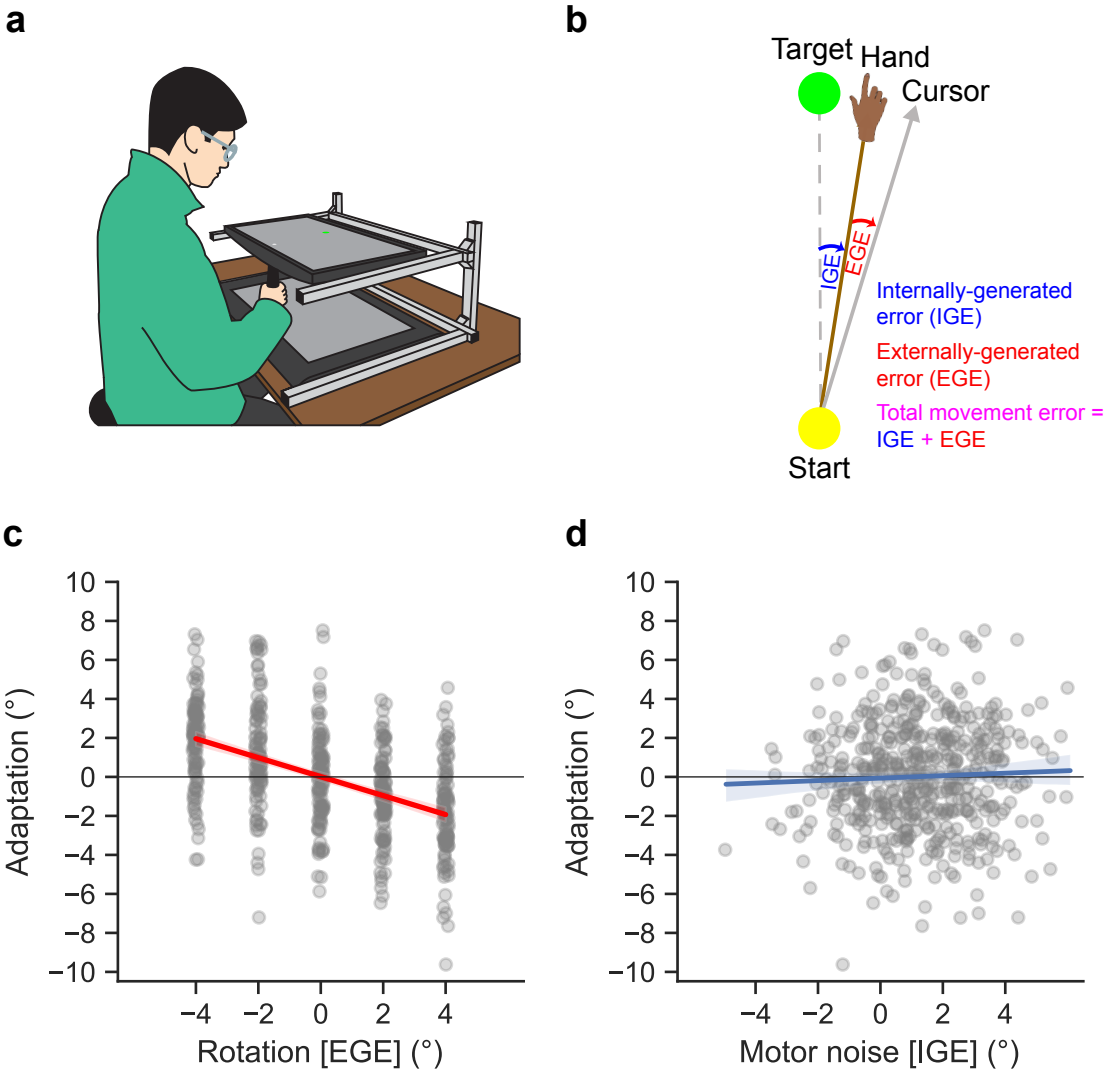
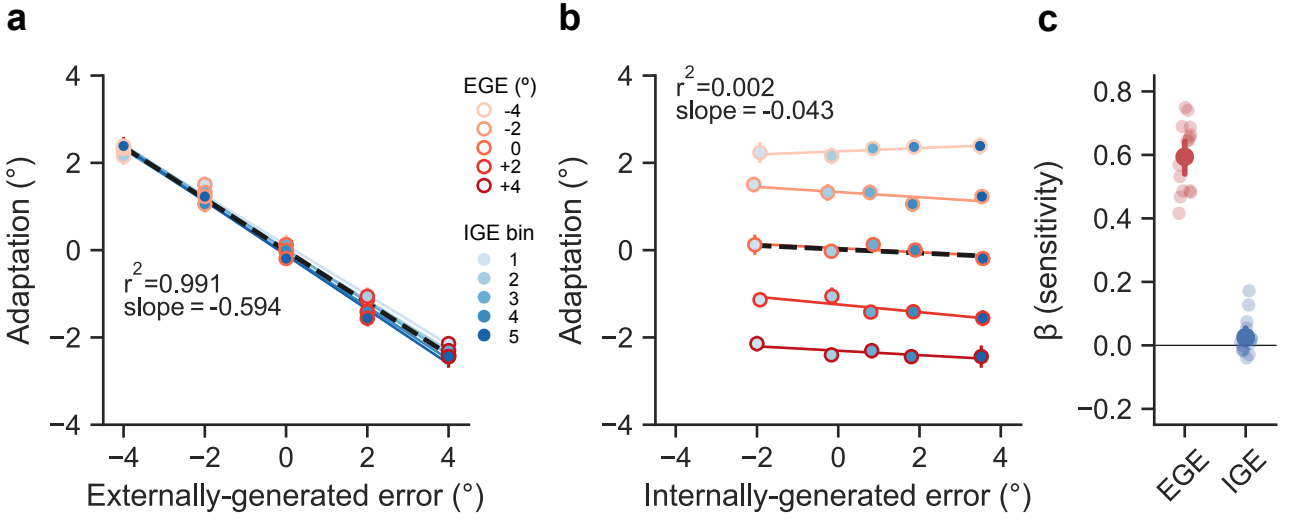
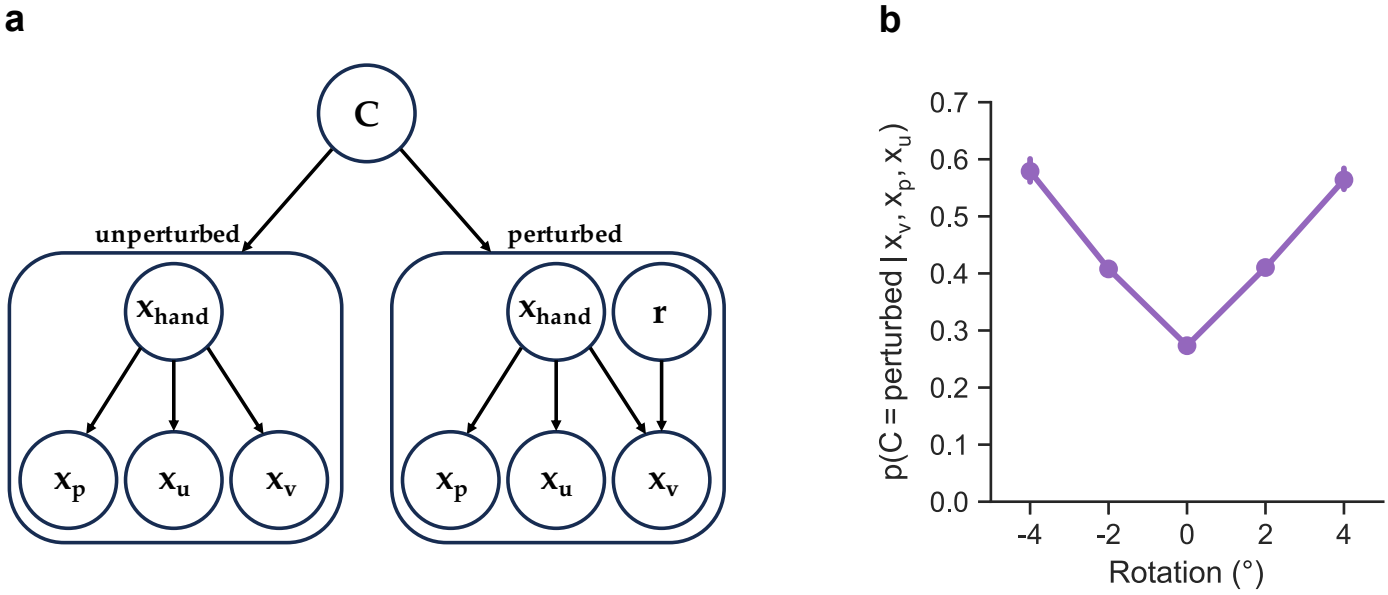
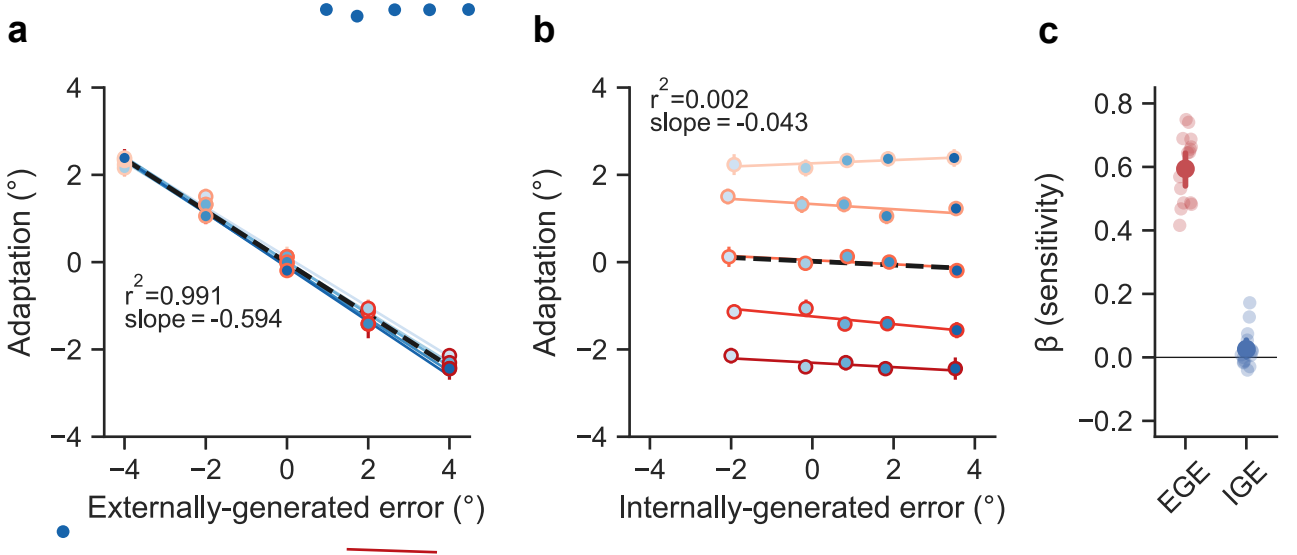
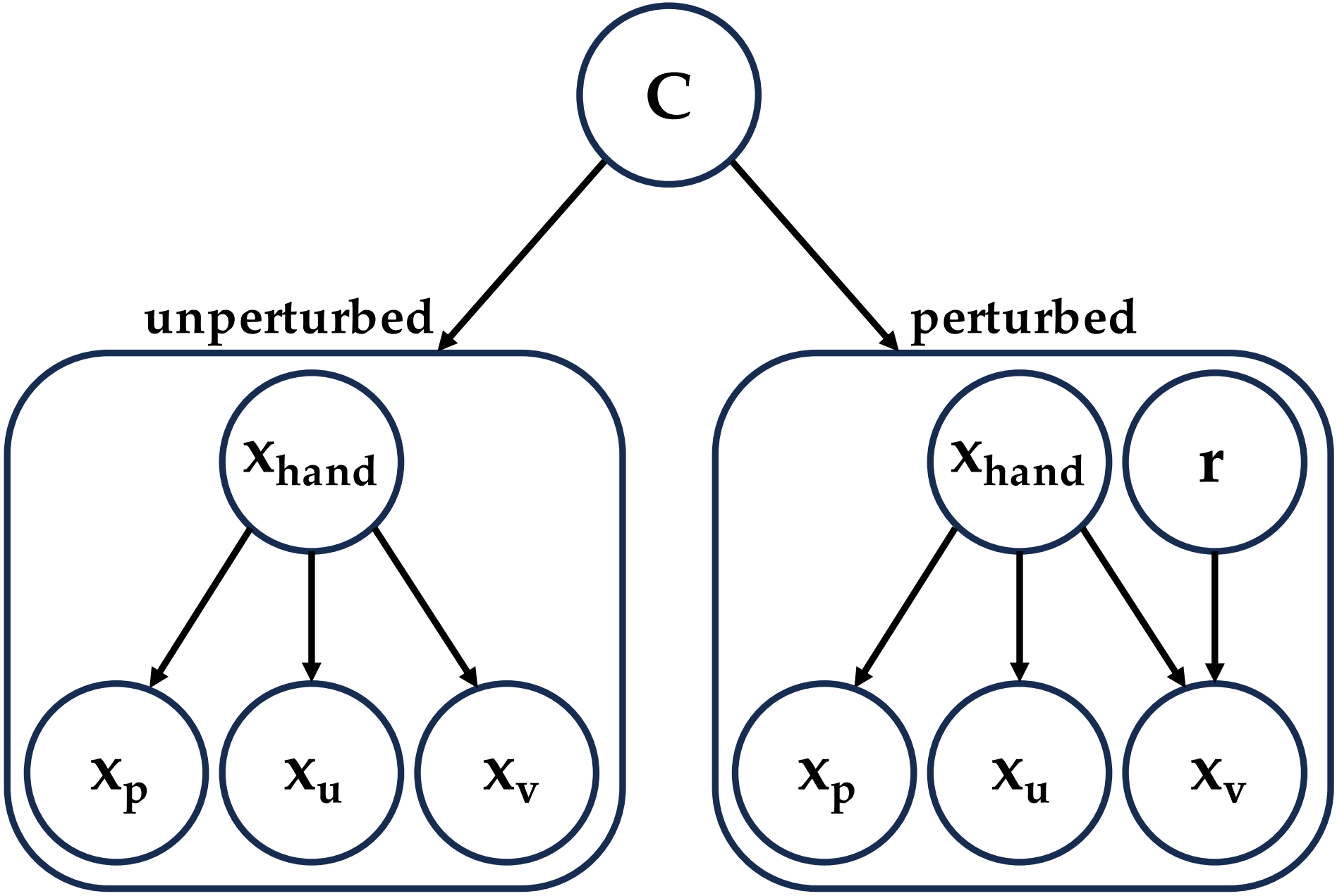

a
Data
b
PIECE
c
PReMo
d
PEA
e
REM
Adaptation (°)
EGE (°)
IGE (°)
10
8
6
4
2
0
−2
−4
−6
−8
−10
−4 −2 0 2 4

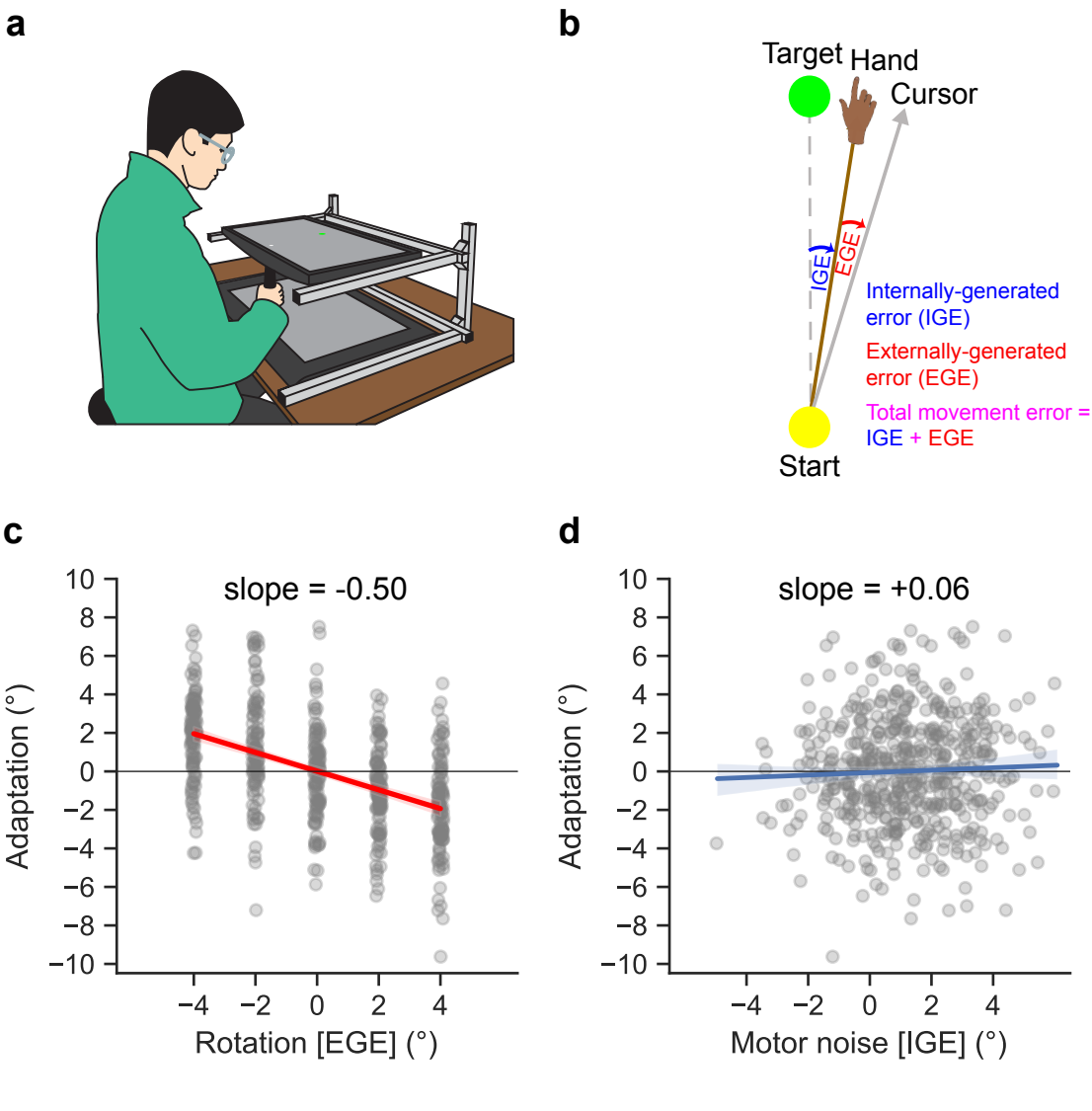

a
b
Target
Hand
Cursor
IGE
EGE
Internally-generated error (IGE)
Externally-generated error (EGE)
Total movement error = IGE + EGE
Start
c
d
Adaptation (°)
10
8
6
4
2
0
−2
−4
−6
−8
−10
−4
−2
0
2
4
Rotation [EGE] (°)
Motor noise [IGE] (°)

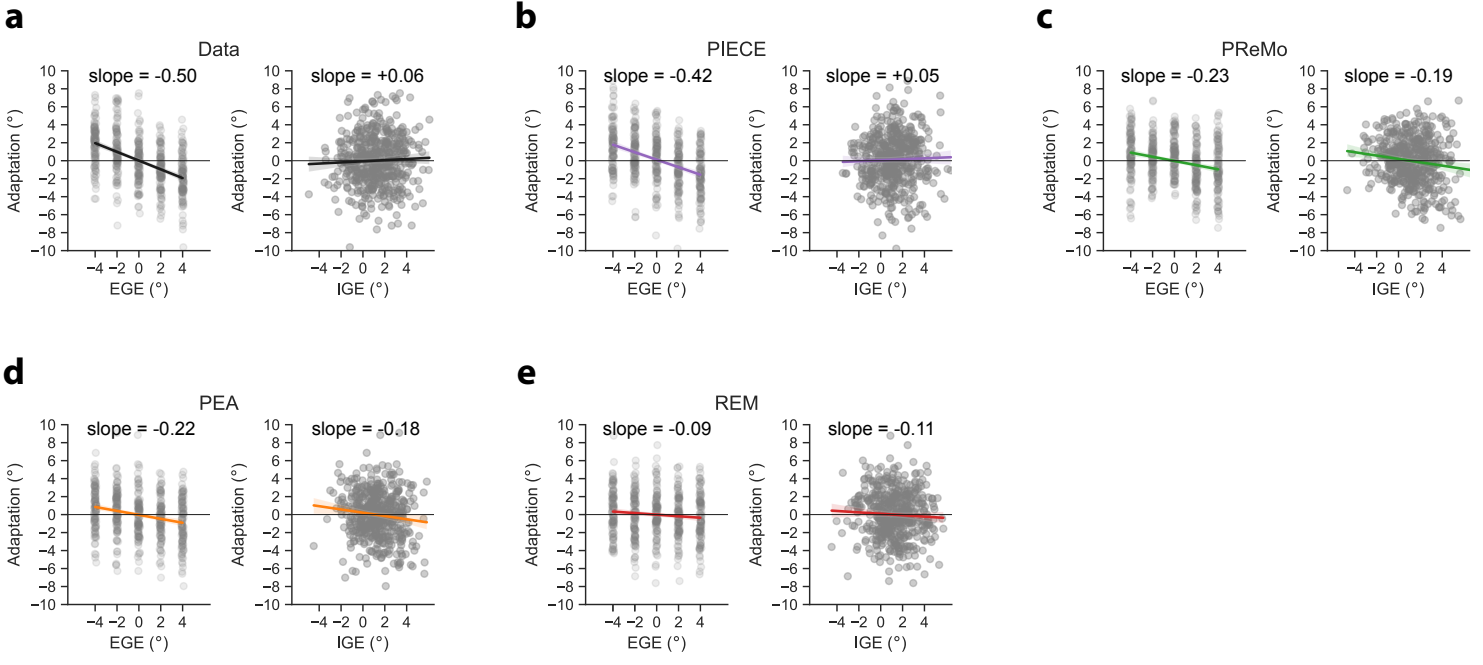

a
b
c
Adaptation (°)
Externally-generated error (°)
r2=0.991
slope = -0.594
EGE (°)
-4
-2
0
+2
+4
IGE bin
1
2
3
4
5
r2=0.002
slope = -0.043
Internally-generated error (°)
β (sensitivity)
EGE
IGE

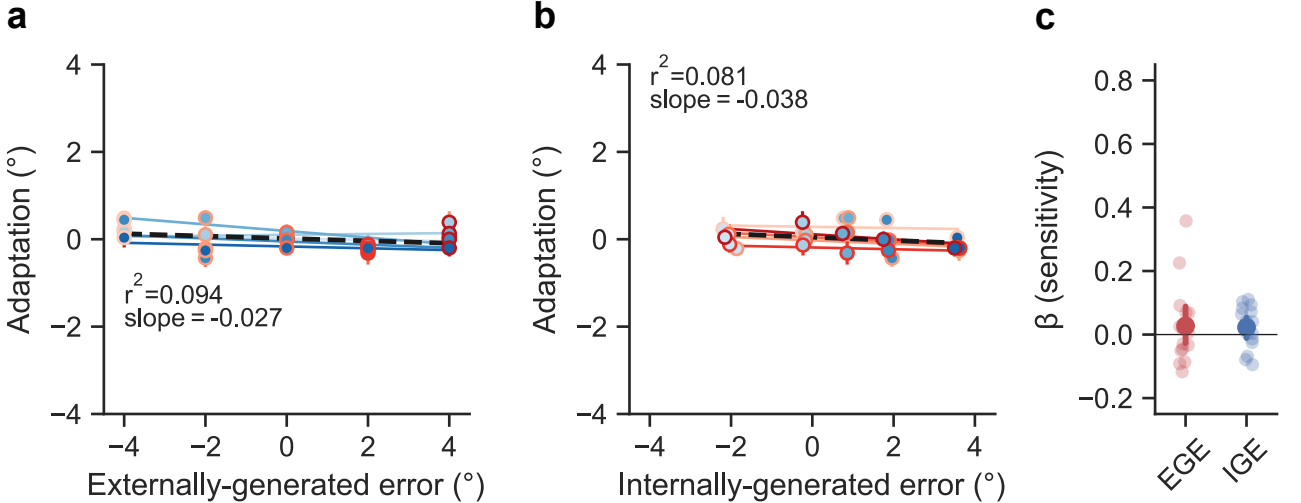

a
C
unperturbed
perturbed
x_{hand}
x_{hand}
r
x_p
x_u
x_v
x_p
x_u
x_v
b
p(C = perturbed | x_v, x_p, x_u)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
-4
-2
0
2
4
Rotation (°)


a
b
c
Adaptation (°)
Externally-generated error (°)
r2=0.991
slope = -0.594
Internally-generated error (°)
r2=0.002
slope = -0.043
β (sensitivity)
EGE
IGE

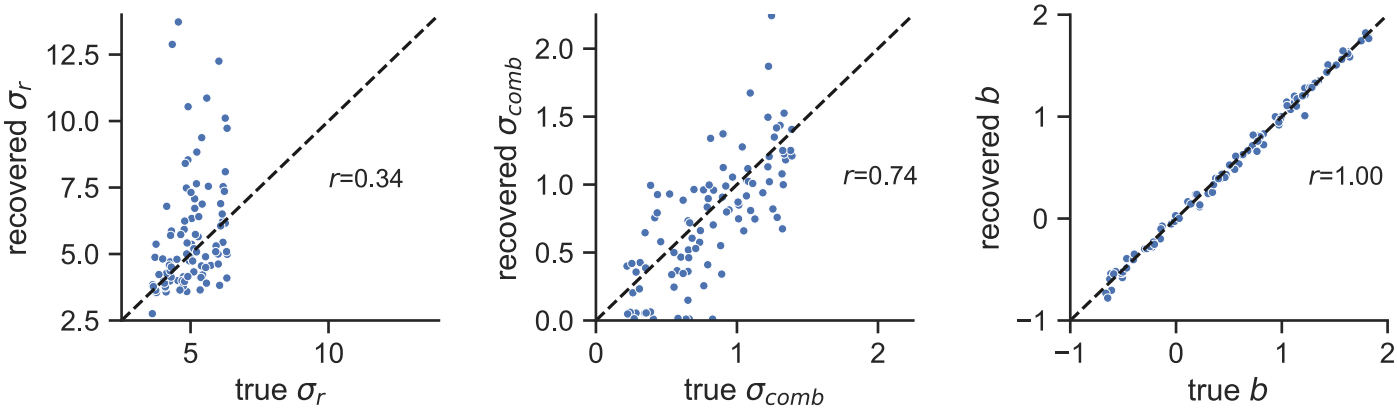

C
unperturbed
perturbed
x_{hand}
x_{hand}
r
x_p
x_u
x_v
x_p
x_u
x_v


a
b
Target
Hand
Cursor
IGE
EGE
Internally-generated error (IGE)
Externally-generated error (EGE)
Total movement error = IGE + EGE
Start
c
slope = -0.50
Adaptation (°)
Rotation [EGE] (°)
d
slope = +0.06
Adaptation (°)
Motor noise [IGE] (°)

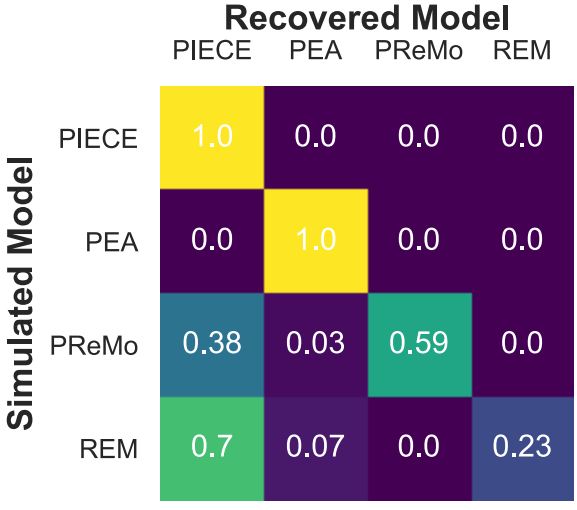

a
Data
slope = -0.50
slope = +0.06
b
PIECE
slope = -0.42
slope = +0.05
c
PReMo
slope = -0.23
slope = -0.19
d
PEA
slope = -0.22
slope = -0.18
e
REM
slope = -0.09
slope = -0.11
Adaptation (°)
EGE (°)
IGE (°)

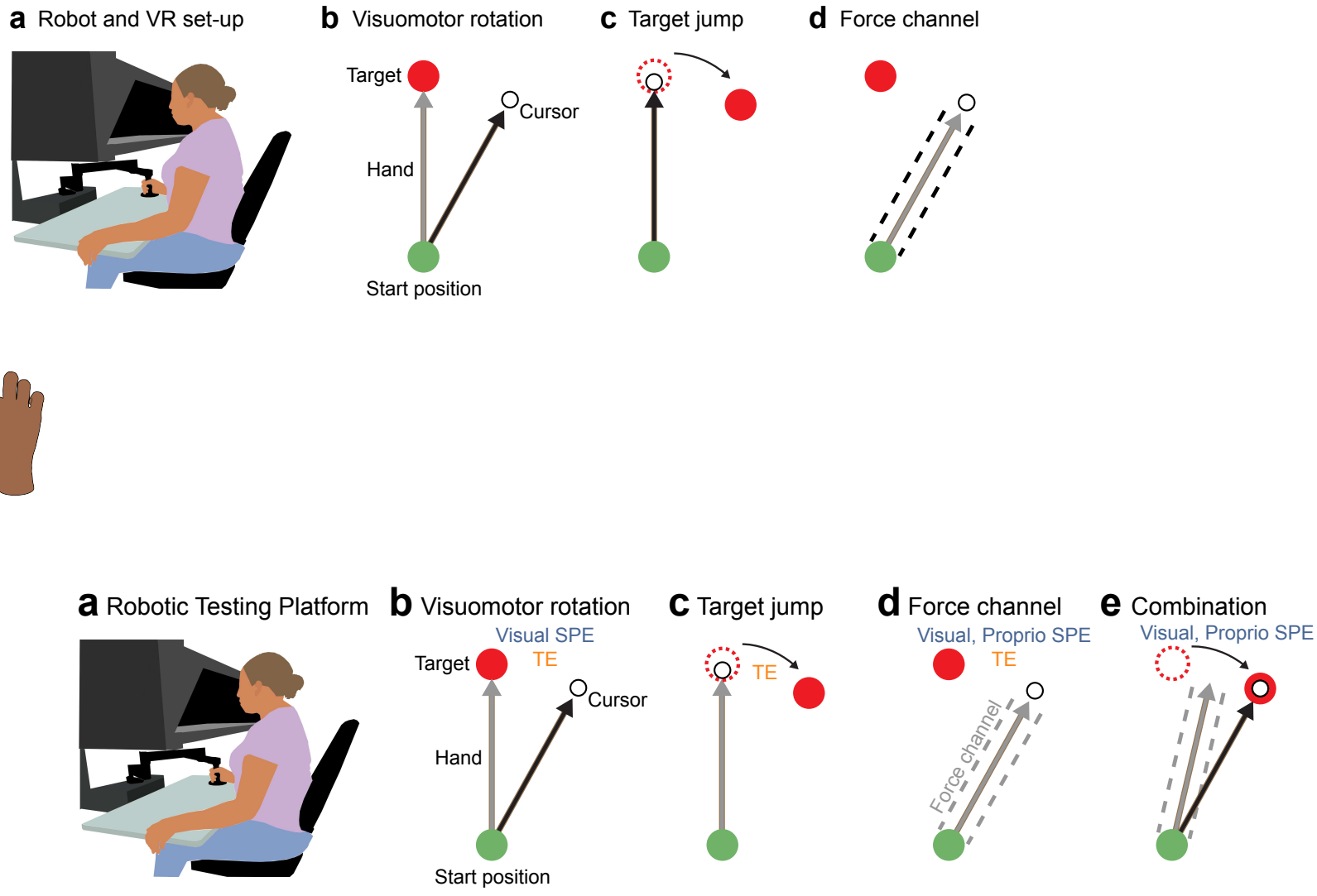

a
b
c
Adaptation (°)
Externally-generated error (°)
r2=0.094
slope = -0.027
Internally-generated error (°)
r2=0.081
slope = -0.038
β (sensitivity)
EGE
IGE

a


recovered σ_r
true σ_r
r=0.34
recovered σ_{comb}
true σ_{comb}
r=0.74
recovered b
true b
r=1.00

b


Recovered Model
PIECE
PEA
PReMo
REM
Simulated Model
PIECE
PEA
PReMo
REM
1.0 0.0 0.0 0.0
0.0 1.0 0.0 0.0
0.38 0.03 0.59 0.0
0.7 0.07 0.0 0.23


a Robot and VR set-up
b Visuomotor rotation
Target
Cursor
Hand
Start position
c Target jump
d Force channel
Force field
a Robotic Testing Platform
b Visuomotor rotation
Visual SPE
TE
Target
Cursor
Hand
Start position
c Target jump
TE
d Force channel
Visual, Proprio SPE
TE
Force channel
e Combination
Visual, Proprio SPE