RacLab

Simultaneous intracranial recordings of interacting brains reveal neurocognitive dynamics of human cooperation

Nature Neuroscience; 2025

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Introduction

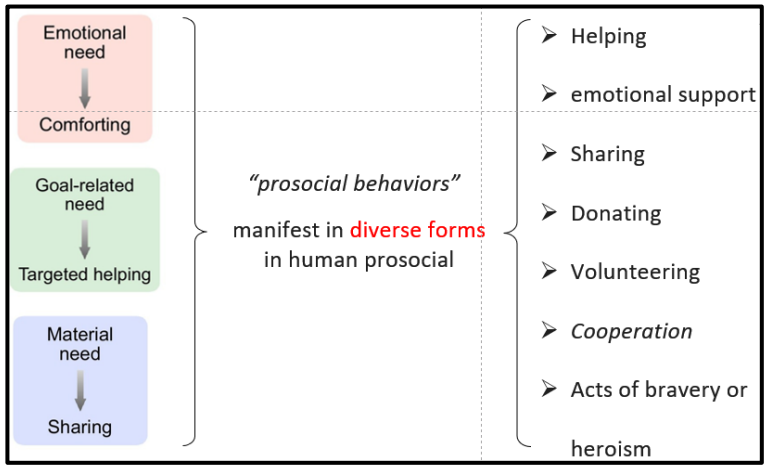
"Cooperation"

monitor each other's intentions and behaviors for synergistic actions

(interpersonal coordination)

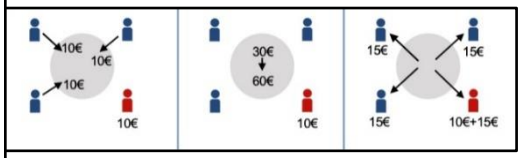
strive toward a collective goal

(collective goal pursuit)



Wu et al., 2023;
Trends in Neuroscience

Prisoner 1 \ Prisoner 2	Confession	No Confession
Confession	5 Years, 5 Years	0 Years, 10 Years
No Confession	10 Years, 0 Years	1 Year, 1 Year



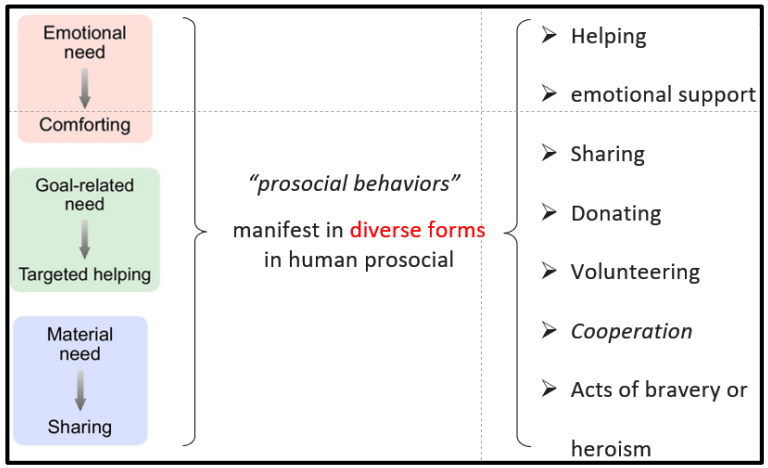
Introduction

"Cooperation"

Cooperation

OR

defection



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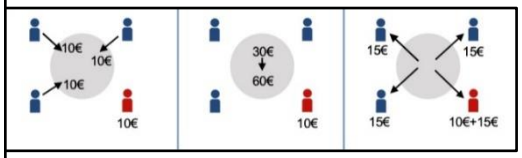
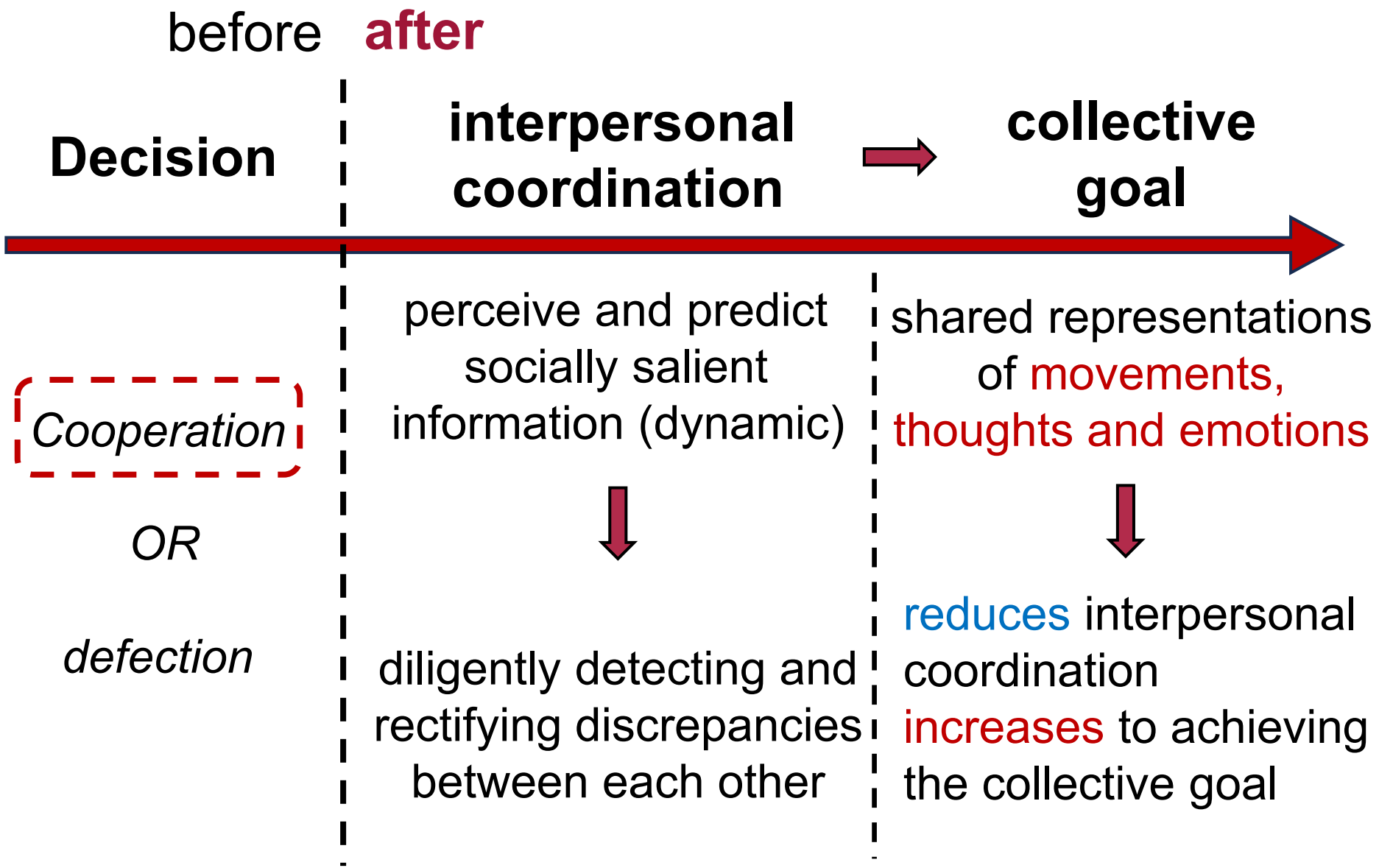
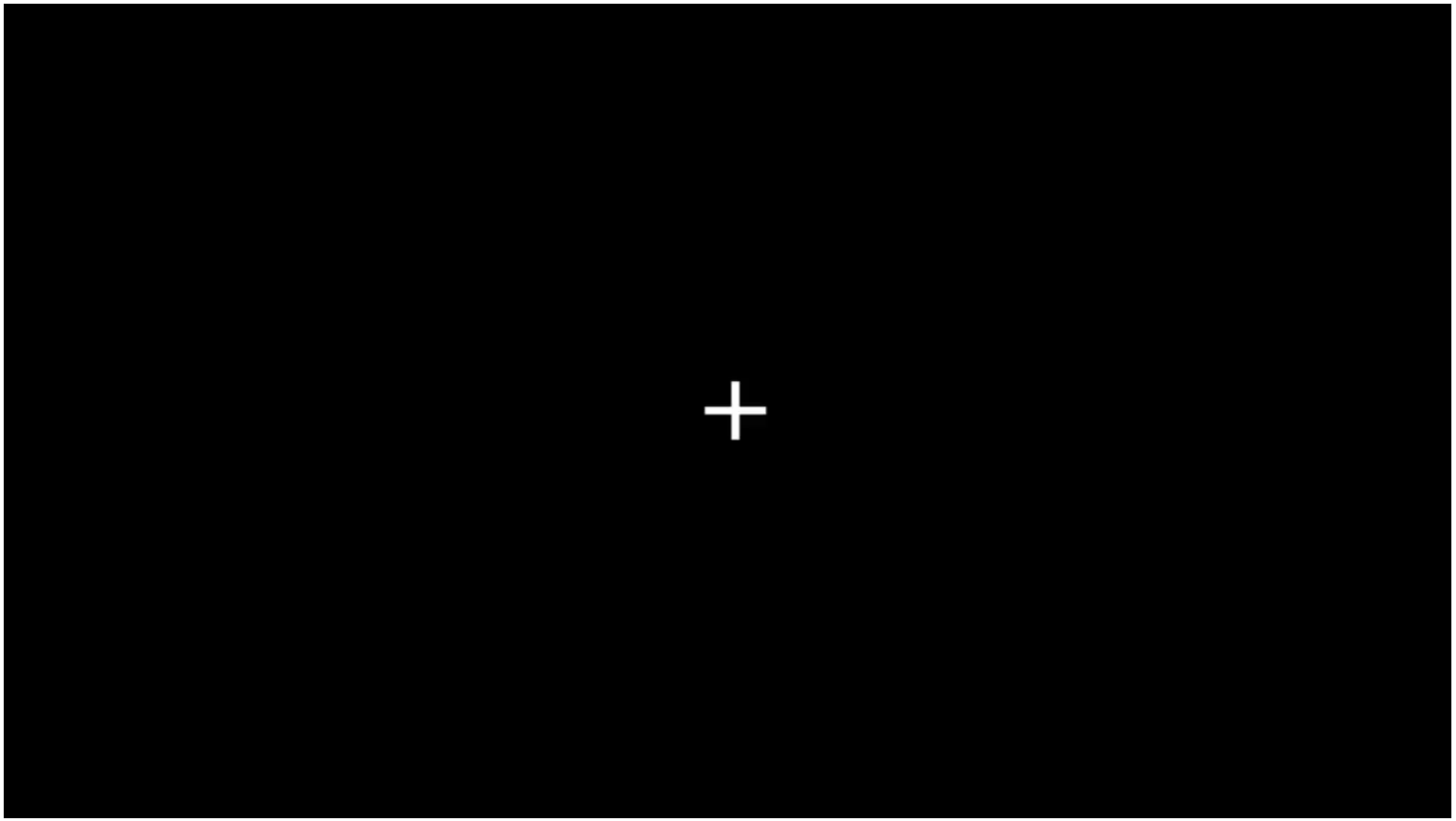


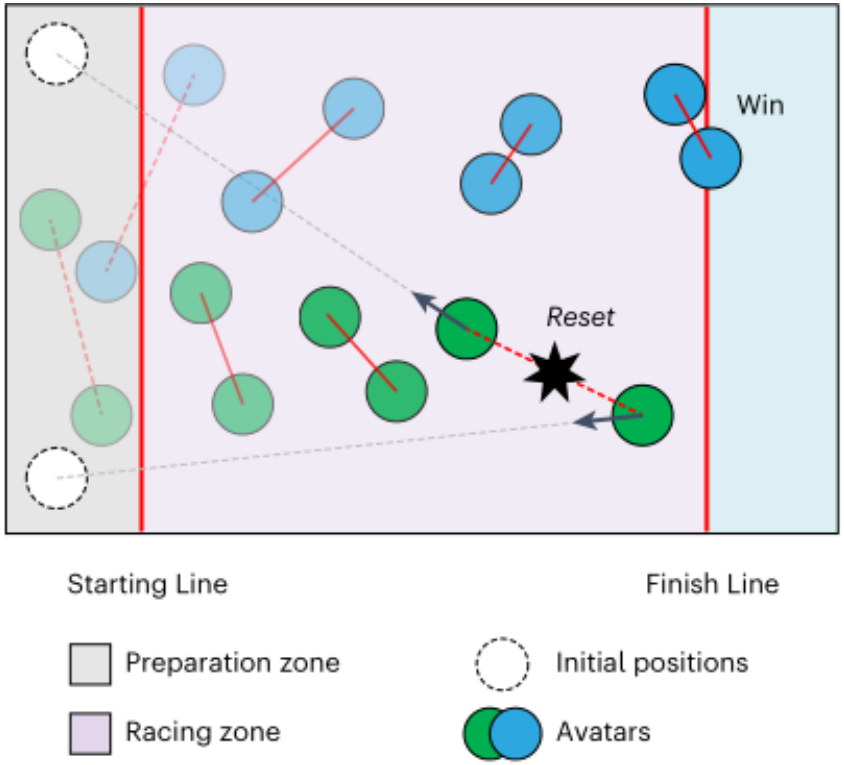
Introduction

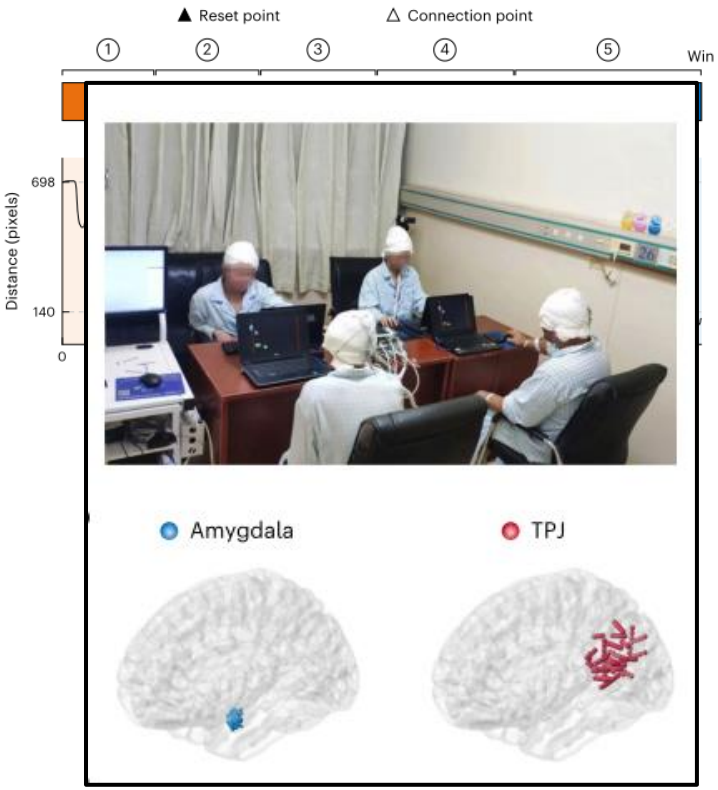


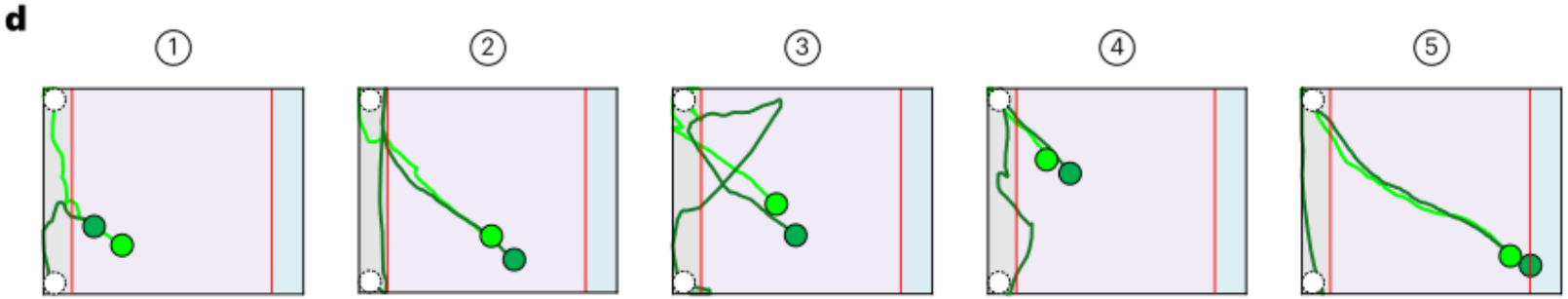
Design



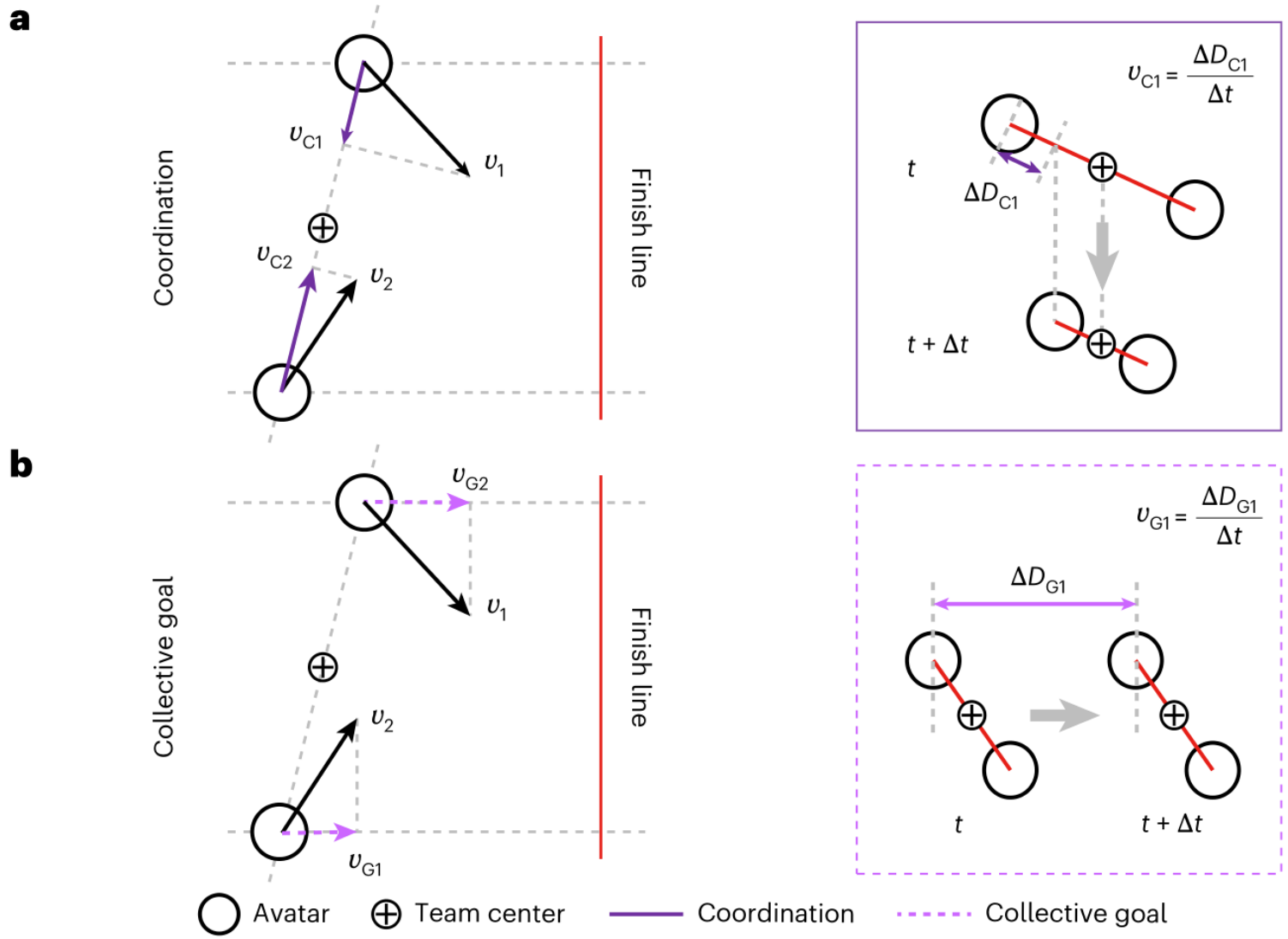
Design


Win
Reset
Starting Line
Finish Line
Preparation zone
Racing zone
Initial positions
Avatars

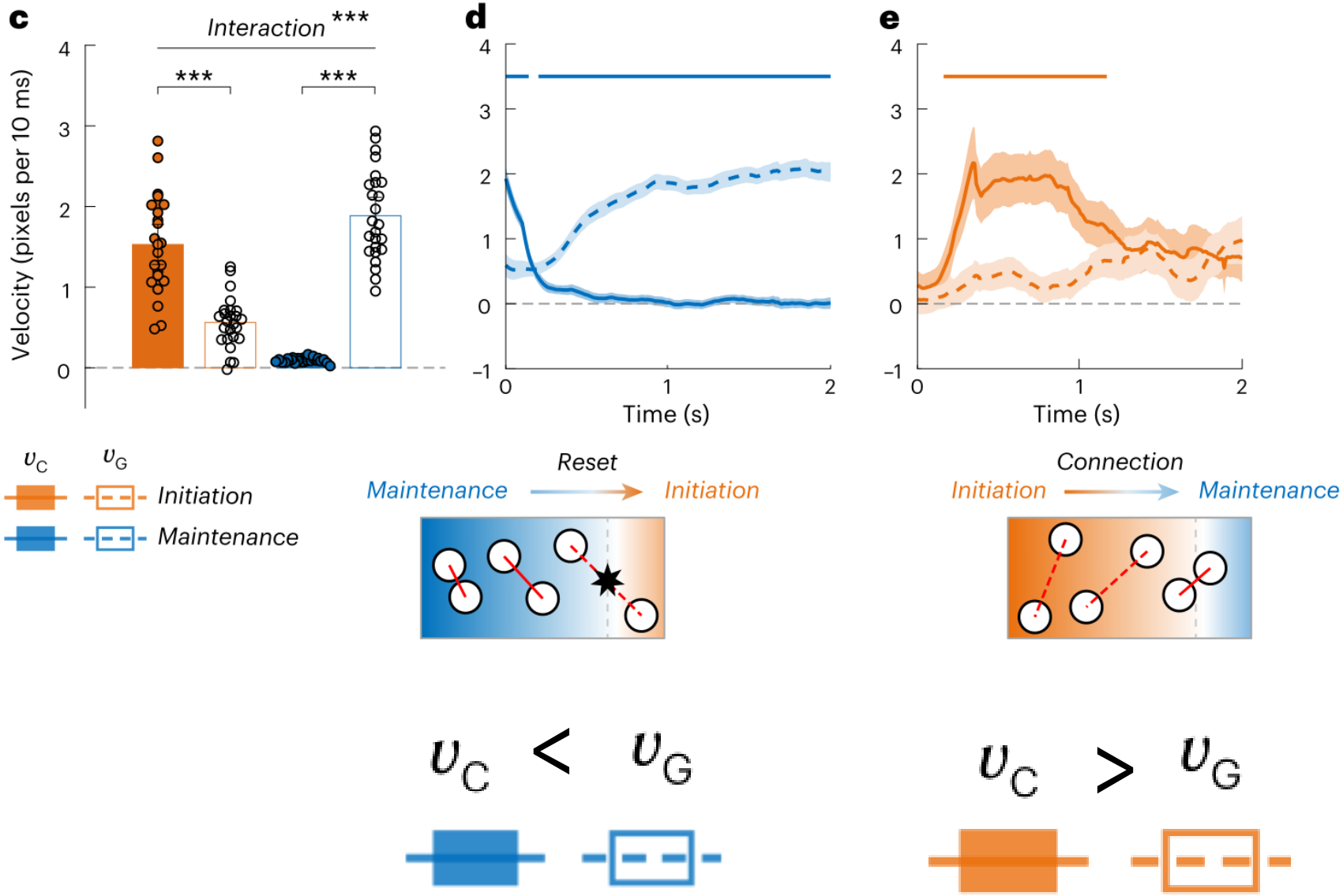

▲ Reset point
△ Connection point
1
2
3
4
5
Win
Distance (pixels)
698
140
0
Amygdala
TPJ


d
1
2
3
4
5

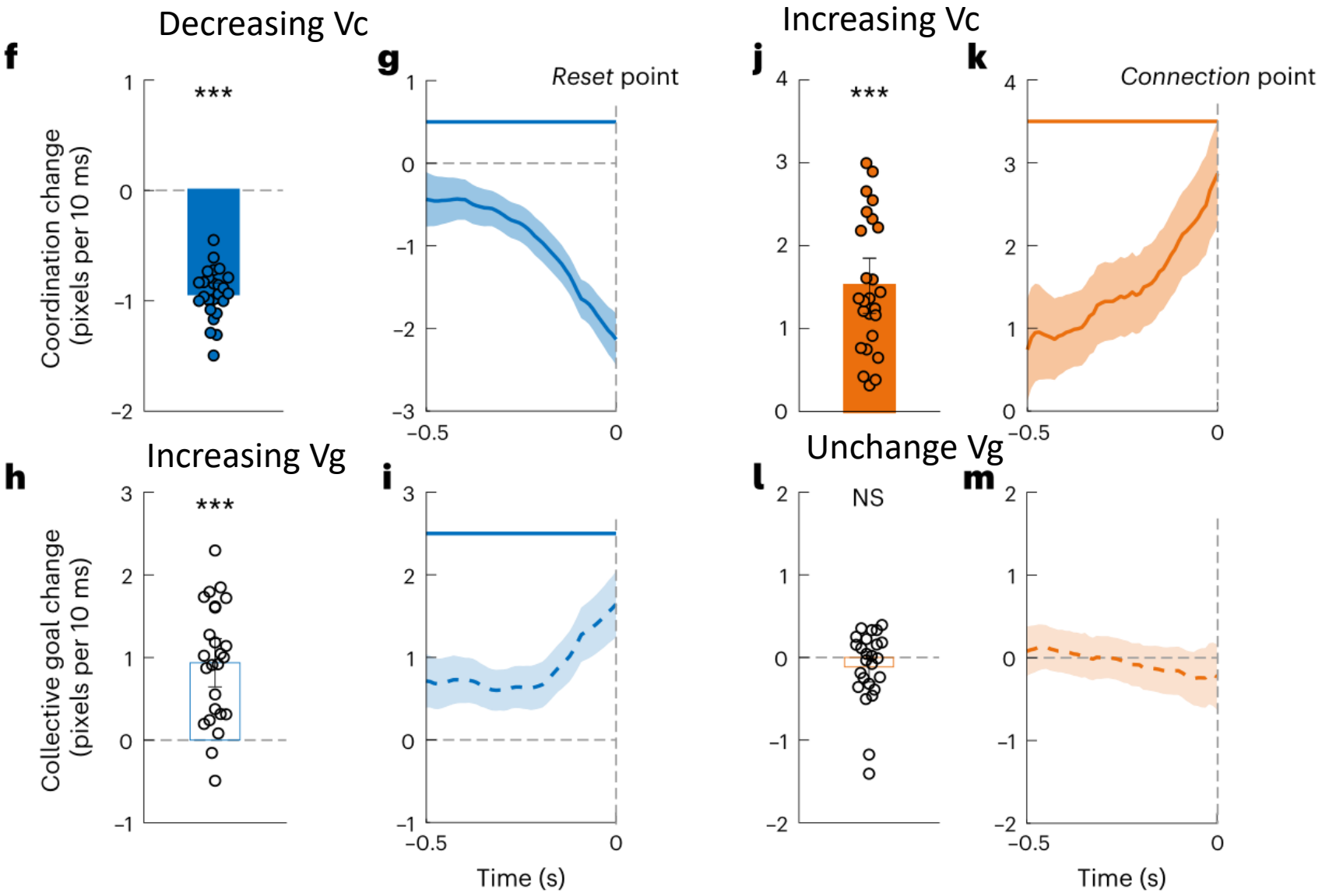
Result


a
Coordination
v_{C1}
v_1
v_{C2}
v_2
Finish line
$v_{C1} = \frac{\Delta D_{C1}}{\Delta t}$
t
ΔD_{C1}
$t + \Delta t$
b
Collective goal
v_{G2}
v_1
v_2
v_{G1}
Finish line
$v_{G1} = \frac{\Delta D_{G1}}{\Delta t}$
ΔD_{G1}
t
$t + \Delta t$
Avatar
Team center
Coordination
Collective goal

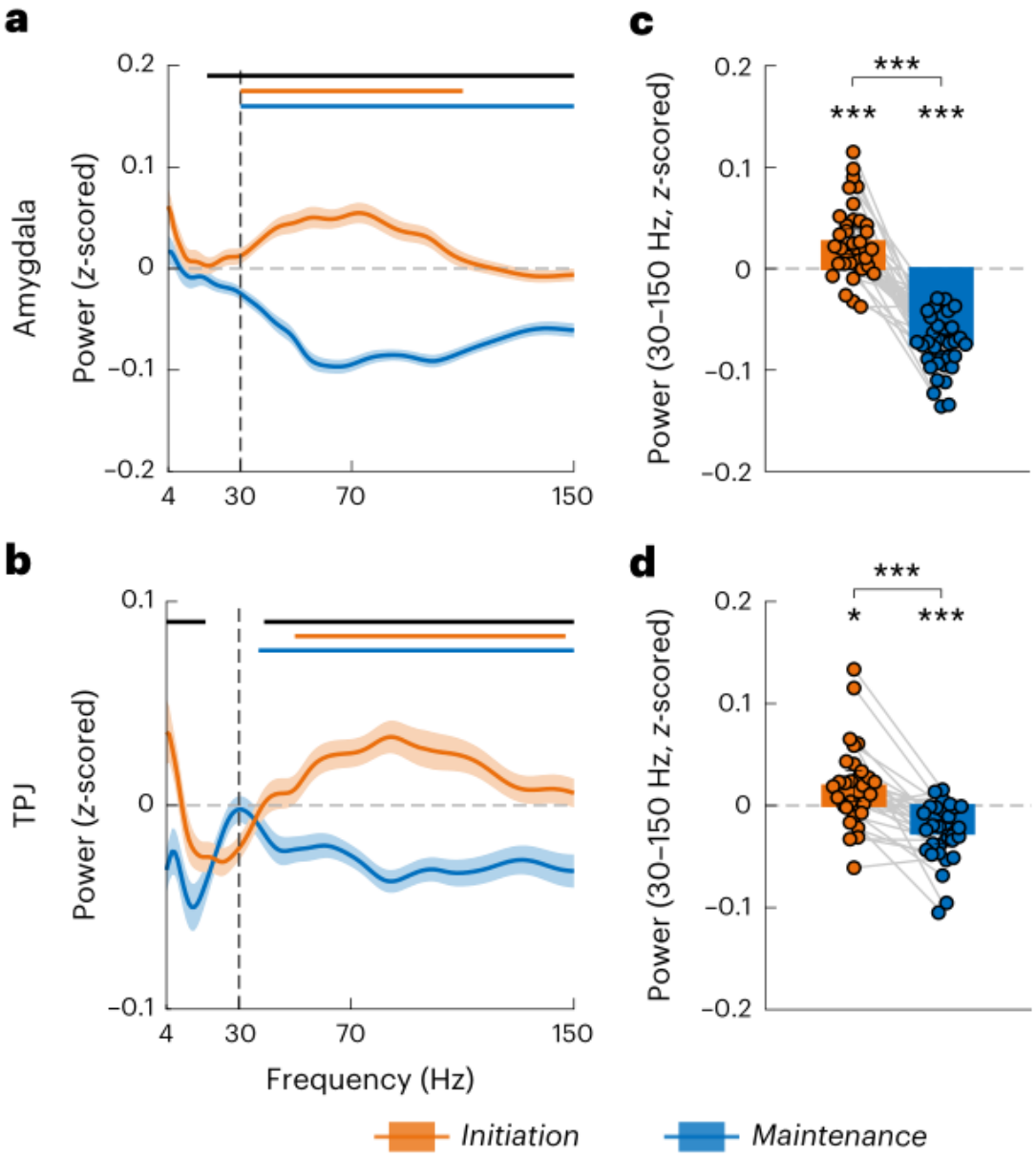
Result


c
Interaction ***
***
***
Velocity (pixels per 10 ms)
4
3
2
1
0
d
4
3
2
1
0
−1
0
1
2
Time (s)
e
4
3
2
1
0
−1
0
1
2
Time (s)
v_C
v_G
Initiation
Maintenance
Reset
Maintenance
Initiation
Connection
Initiation
Maintenance
$v_C < v_G$
$v_C > v_G$

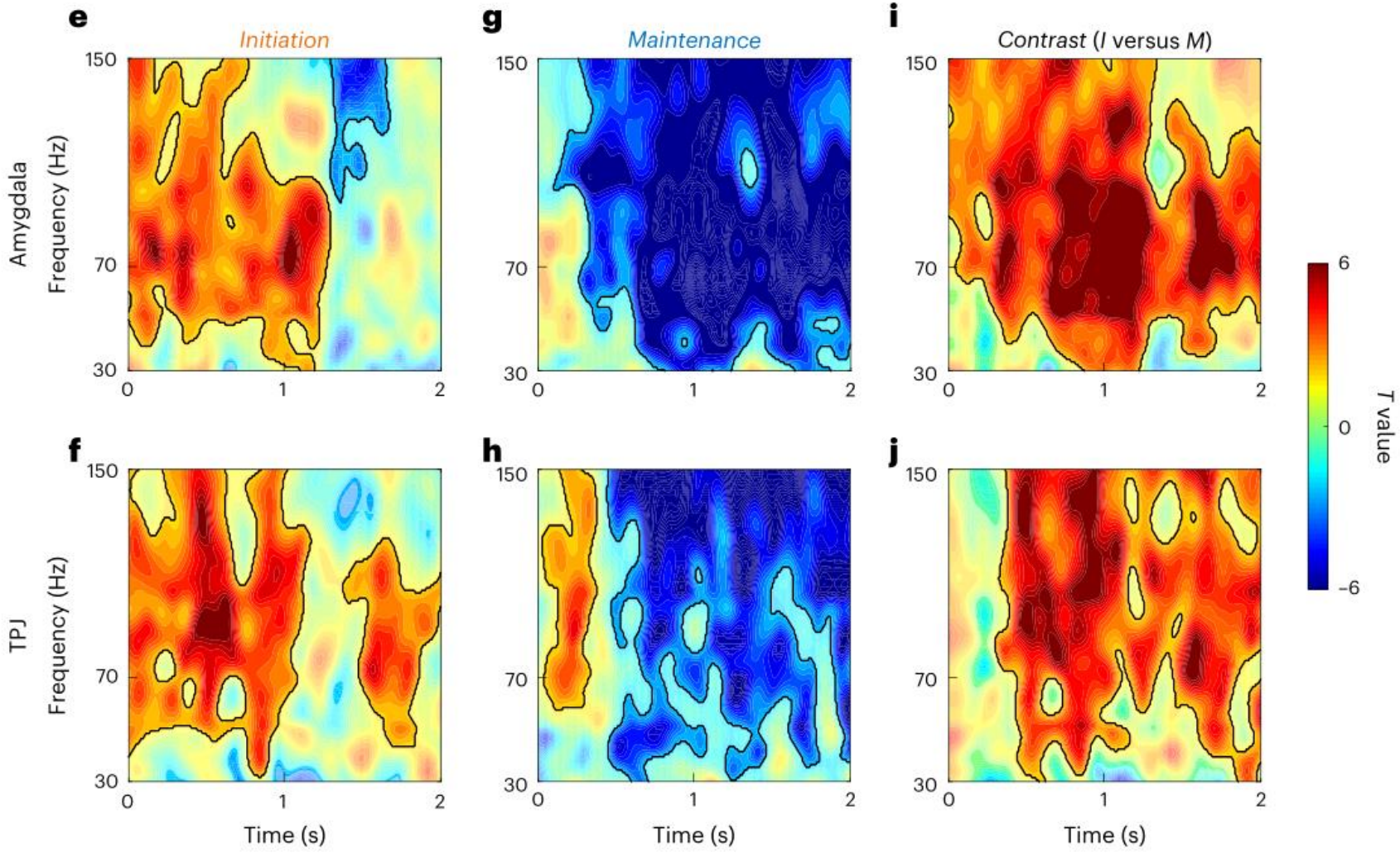
Result


Decreasing Vc
Increasing Vc
Increasing Vg
Unchange Vg
f
g
h
i
j
k
l
m
***
NS
Reset point
Connection point
Coordination change (pixels per 10 ms)
Collective goal change (pixels per 10 ms)
Time (s)

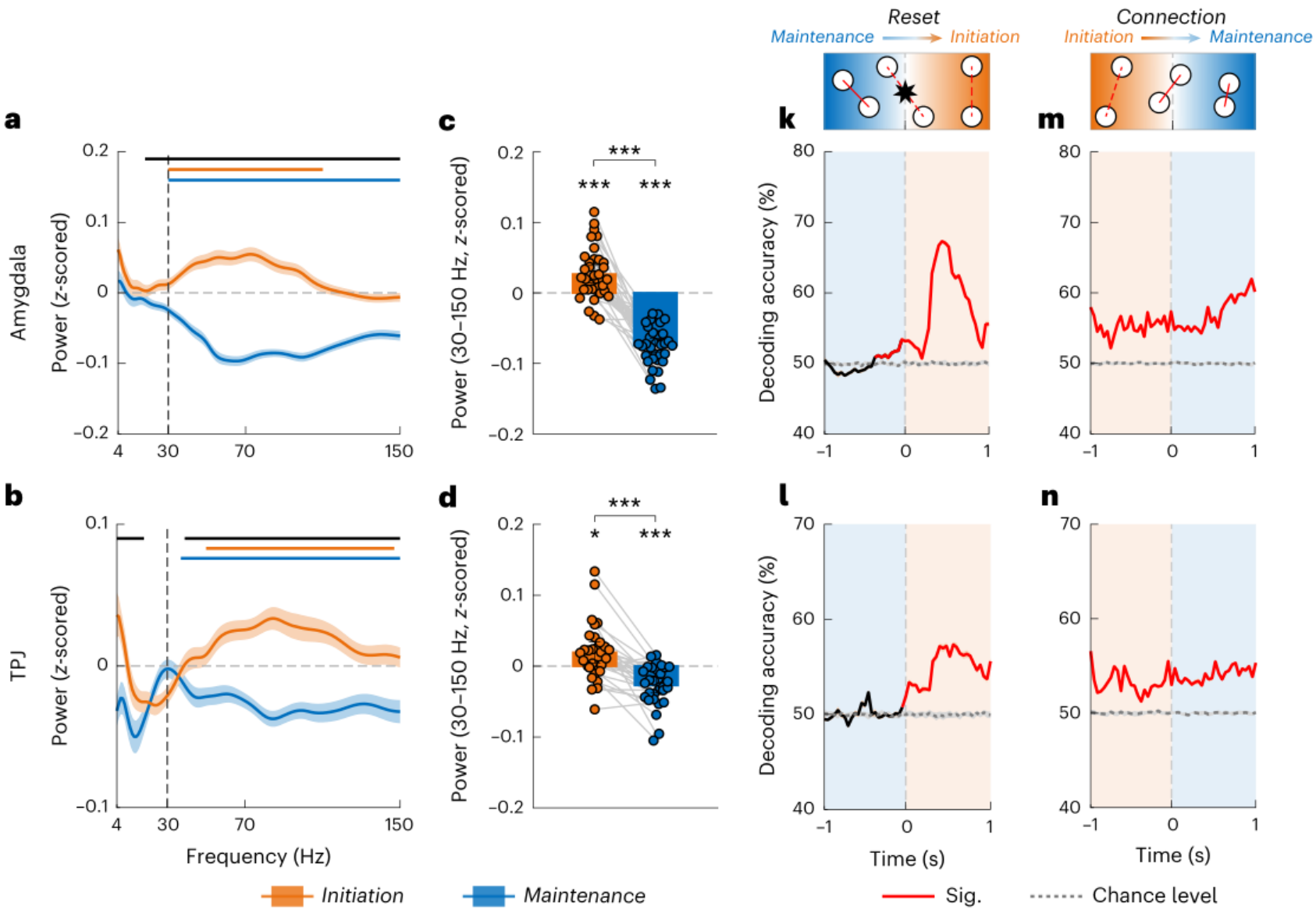
Result


a
Amygdala
Power (z-scored)
0.2
0.1
0
−0.1
−0.2
4
30
70
150
b
TPJ
Power (z-scored)
0.1
0
−0.1
4
30
70
150
Frequency (Hz)
c
Power (30–150 Hz, z-scored)
***
***
***
d
Power (30–150 Hz, z-scored)
***
*
***
Initiation
Maintenance

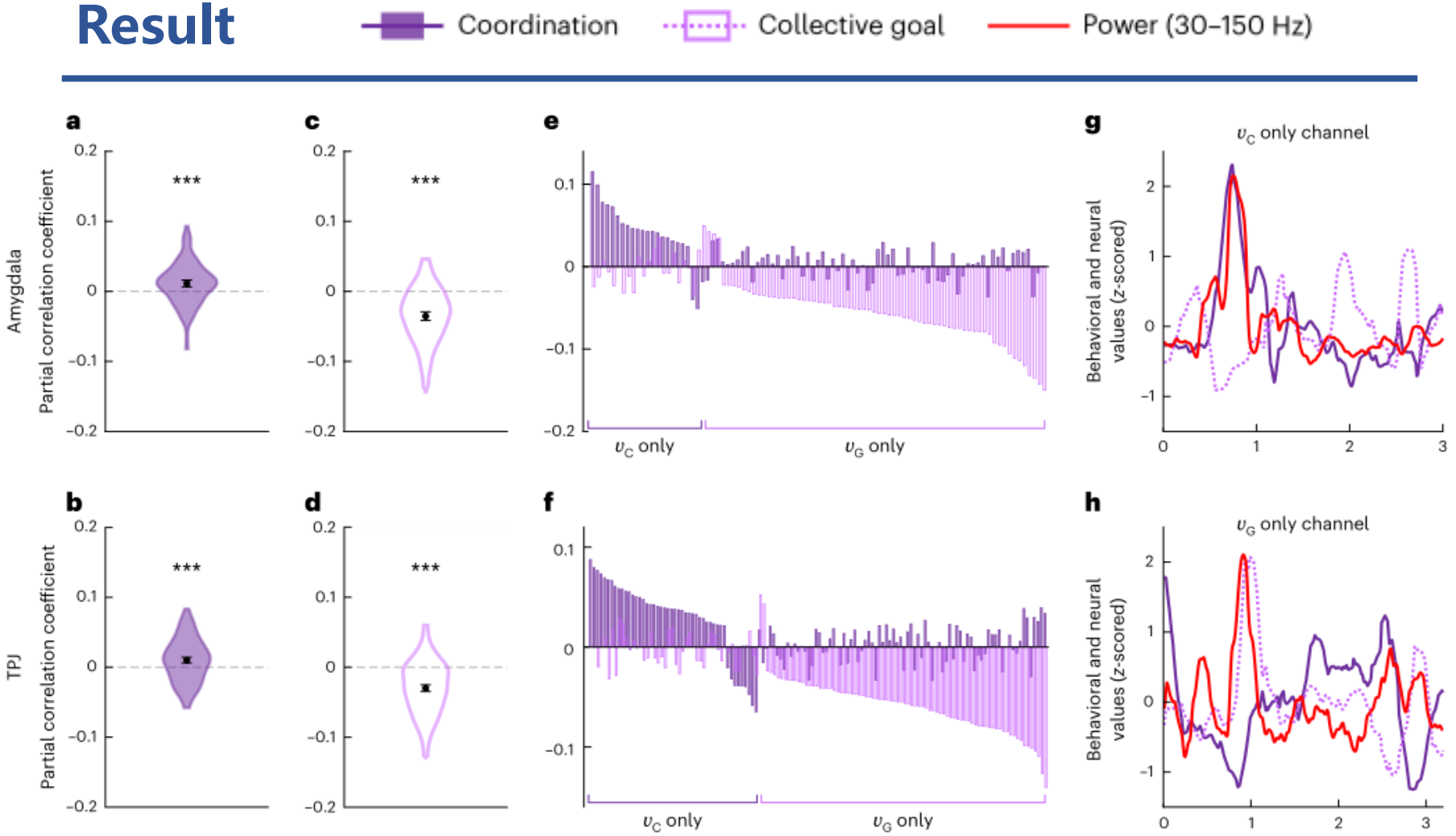
Result


e
Initiation
g
Maintenance
i
Contrast (I versus M)
f
h
j
Amygdala
TPJ
Frequency (Hz)
150
70
30
0
1
2
Time (s)
6
0
-6
T value

Result


a
Amygdala
Power (z-scored)
0.2
0.1
0
−0.1
−0.2
4
30
70
150
b
TPJ
Power (z-scored)
0.1
0
−0.1
4
30
70
150
Frequency (Hz)
c
Power (30–150 Hz, z-scored)
***
***
***
d
Power (30–150 Hz, z-scored)
***
*
***
Initiation
Maintenance
Reset
Maintenance
Initiation
Connection
Initiation
Maintenance
k
m
l
n
Decoding accuracy (%)
80
70
60
50
40
−1
0
1
Time (s)
Sig.
Chance level

Result

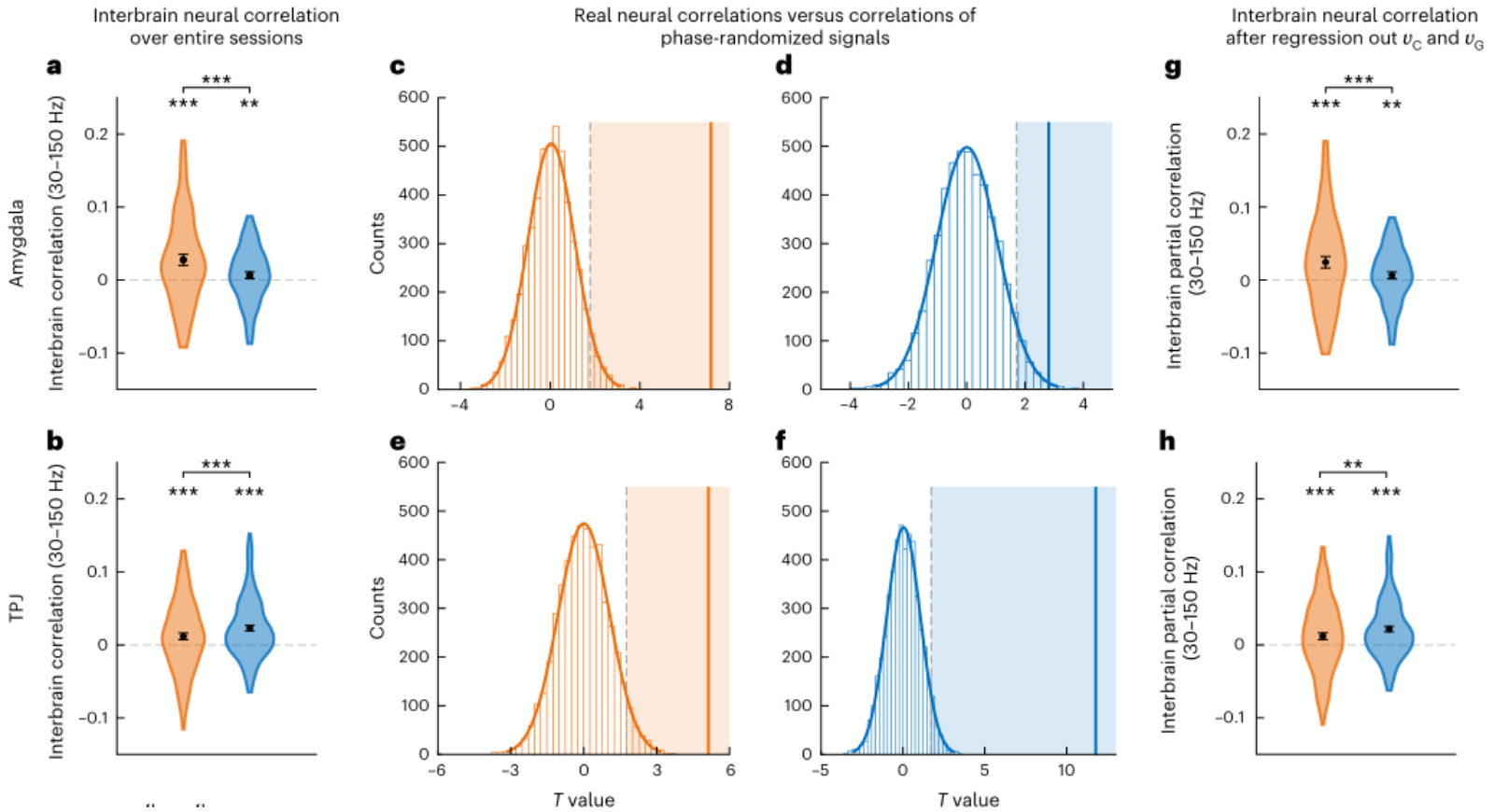


高频活动的增加正向预测了 vC，即越高的高频功率对应着越明显的朝向队友的运动；

高频活动的降低则与 vG 相关，意味着较低的高频功率与更快朝向终点的运动有关

TPJ的一部分是状态决定编码的

Result



- 在合作双方的杏仁核和TPJ中，高频活动均表现出显著的跨脑相关性；
- 而且这种相关性是状态依赖的：在杏仁核中，合作启动状态下的相关性显著高于维持状态；而在TPJ中，则是维持状态下的相关性更强；

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