Supplementary Materials for

Incorporation of a coding scheme based on neuronal firing patterns and distributions improves noninvasive brain control of robotic devices

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The PDF file includes the following:

Other Supplementary Materials for this manuscript include the following:

Fig. S1.

Fig. S1. Trajectories of all hit trials in the centre-out task for 26 participants. The title of each subgraph is the participant's initials.

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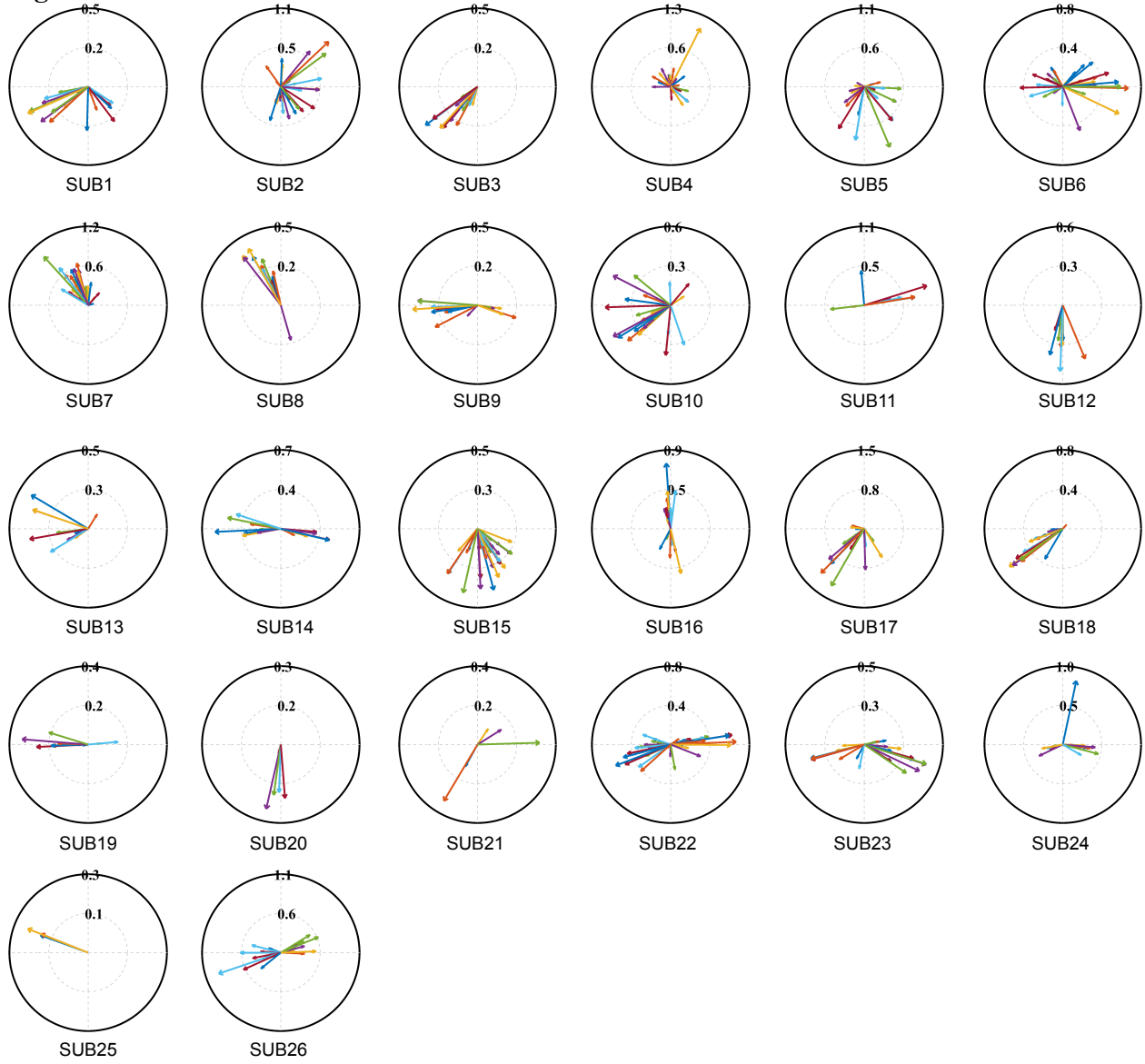
Fig. S2.

Fig. S2. Preferred direction vectors of channels with cosine tuning ($R^2_{cosine} > 0.8$) at representative time points for each participant.

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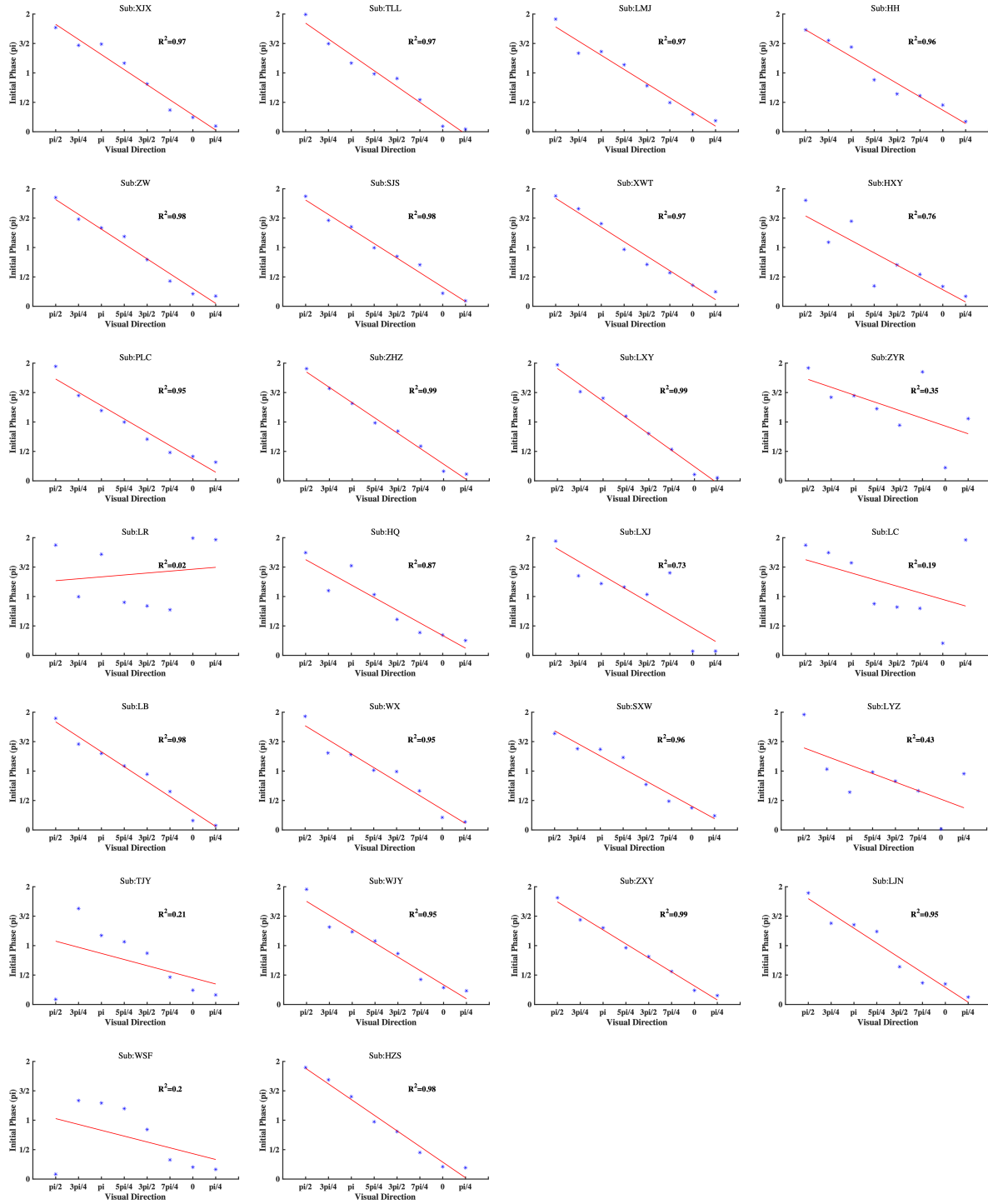
Fig. S3.

Fig. S3. The initial phase of the dominant frequency component within featured waves for all participants.

Fig. S4.

Statistical results of the questionnaire survey of 28 participants after the experiment.
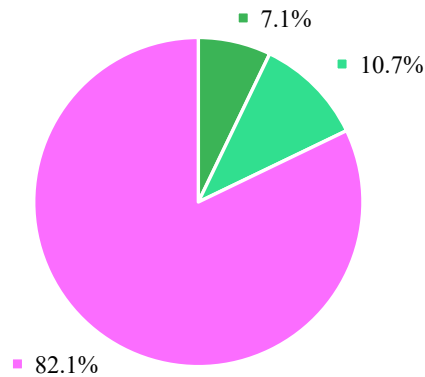
Q1: Prior to the online sessions, do the verbal instructions from the technician and your initial trials enable you to effectively comprehend how to guide the neural cursor to move towards the target direction?

- Highly disagree - Disagree - Neutrality - Agree - Higly agree

Q2: During the chasing and fleeing task, are you able to effectively observe the position and direction of the moving target?
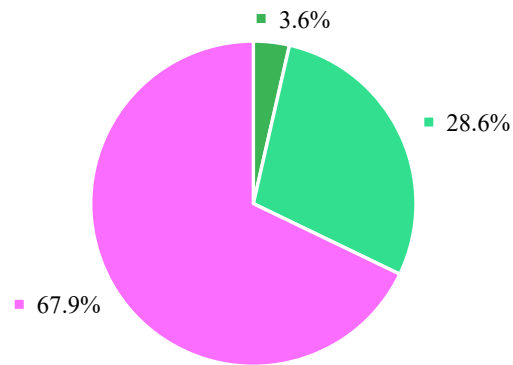
- Highly disagree - Disagree - Neutrality - Agree - Higly agree

Q3: Compared to traditional SSVEP-BCI experiments, did you perceive the visual stimulation intensity in this experiment as being more subtle? (If you have not participated in traditional SSVEP-BCI experiments, you may choose not to answer this question.)

3.8%   7.7%

19.2%

69.2%
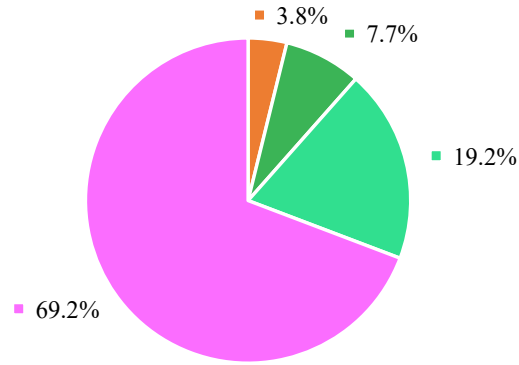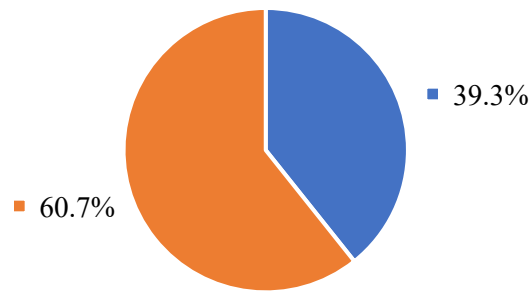
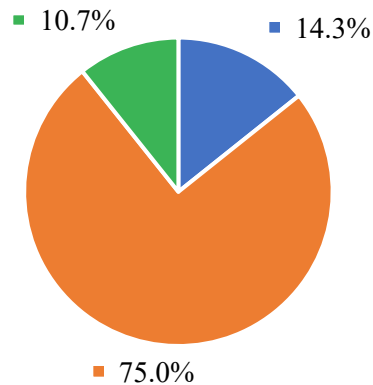■ Highly disagree   ■ Disagree   ■ Neutrality   ■ Agree   ■ Higly agree

Q4: During the online sessions, to direct the neural cursor towards the target direction, where was your gaze focused?

39.3%

60.7%

■ A:Gaze remained consistently fixated on the visual cue at the intended direction.

■ B:Gaze was generally oriented towards the intended direction, but it wasn't consistently fixed on the visual cue.
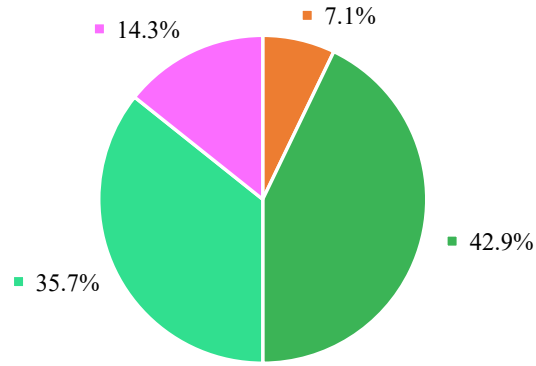
5   Q5: During the online sessions, do you feel panicked when the cursor failed to move in the intended direction?
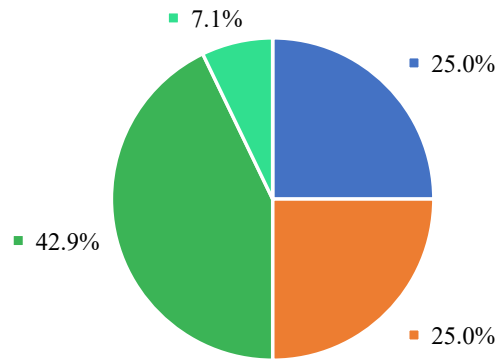

10.7%   14.3%

75.0%

■ A:Yes, I panic and don't know how to operate properly.

■ B:Rarely, I can calmly correct the mouse's movement direction.

■ C:Others

Q6: Did you perceive the cursor control tasks as considerably challenging?

- Highly disagree
- Disagree
- Neutrality
- Agree
- Higly agree

Q7: Did you perceive a sense of exhaustion upon completing the entire experiment?

- Highly disagree
- Disagree
- Neutrality
- Agree
- Higly agree

Q8: Do you believe that the current experiment represents the best control performance you can achieve?

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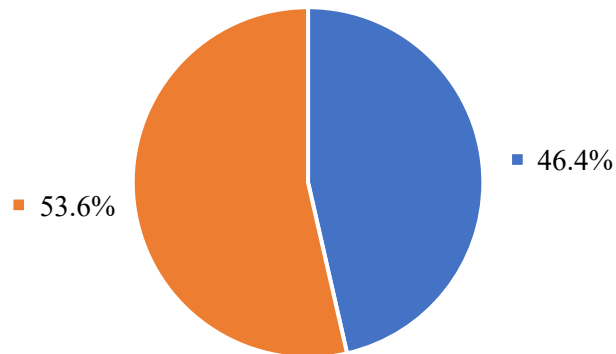
- A:I believe I can achieve even better control performance.
- B:Yes, I think it's difficult for me to achieve better performance.

Q9: Would you be open to participating in further research if the opportunity arises?

46.4%

50.0%

3.6%

■ A:Of course ■ B:If time allows, I can. ■ C:Disagree
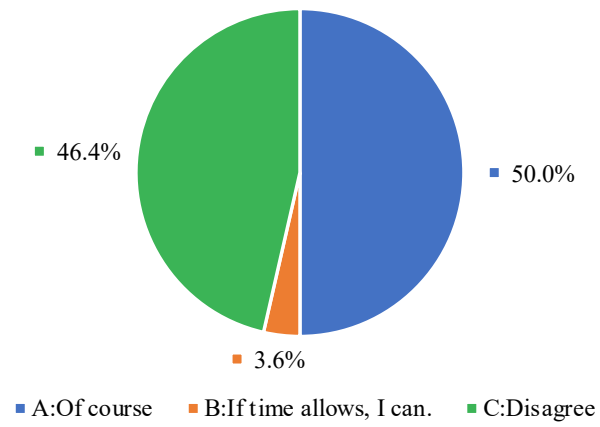
Movie S1.

Full task demonstration of BCI cursor control.

Movie S2.

Typical demonstration of unmanned vehicle control.

Movie S3.

Typical demonstration of quadcopter control.

Movie S4.

2D centre-out BCI cursor control example trials.

Movie S5.

1D vertical movement BCI cursor control example trials.

Movie S6.

1D horizontal movement BCI cursor control example trials.

Movie S7.

Tracking task example trials.

Movie S8.

Chasing and fleeing BCI cursor control example trials.

Movie S9.

Vehicle control task example trials.

Movie S10.

Quadcopter control task example trials.