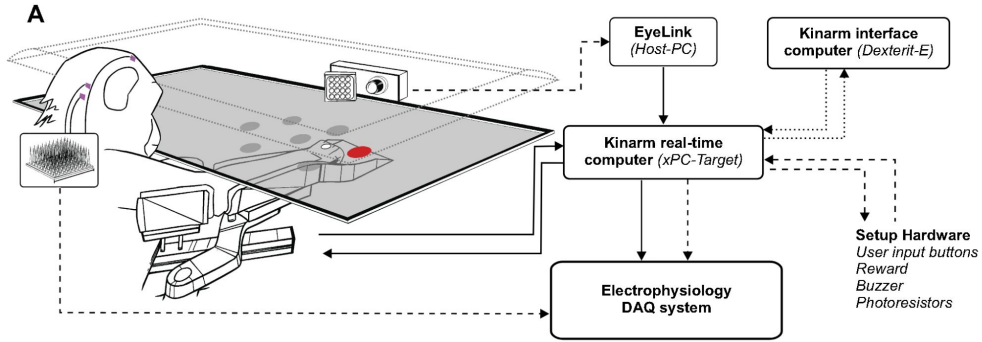
Vision for action



De Haan et al., *J Neurophysiol* (2018)

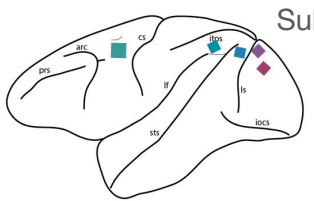
Lead author: Demetrio Ferro

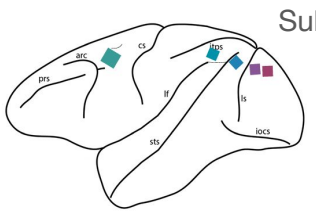
Center for Brain and Cognition, Universitat Pompeu Fabra,
Department for Engineering and Communication Technologies,
Carrer Ramon Trias Fargas, 25-27, 08003, Barcelona, ES.

demetrio.ferro@upf.edu, d-ferro.github.io, gin.g-node.org/56Fe, d-ferro.bsky.social

Universitat Pompeu Fabra Barcelona

Vision for action



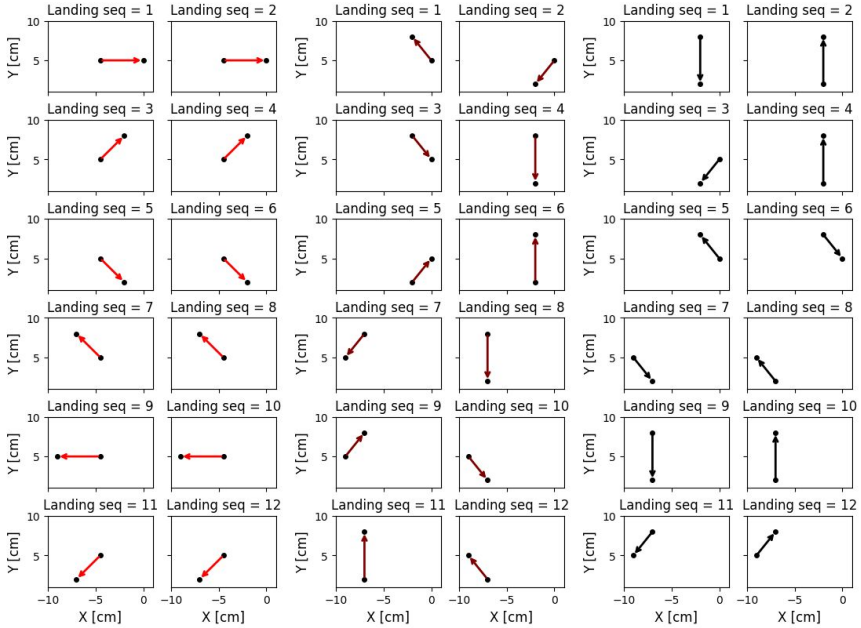


Subject	Task	V1/V2	V1/V2(s)	DP	DP(s)	7a	7a(s)	M1/PMd	M1/PMd(s)
→ E y180221	land002	4	4	14	10	24	15	113(A)	29(A)
→ E y180306	land001	8	5	22	17	22	15	101(A)	31(A)

(Data ready, not yet analyzed)

Hand Movement sequences

Land-001 vs Land-002



grouped by target_02

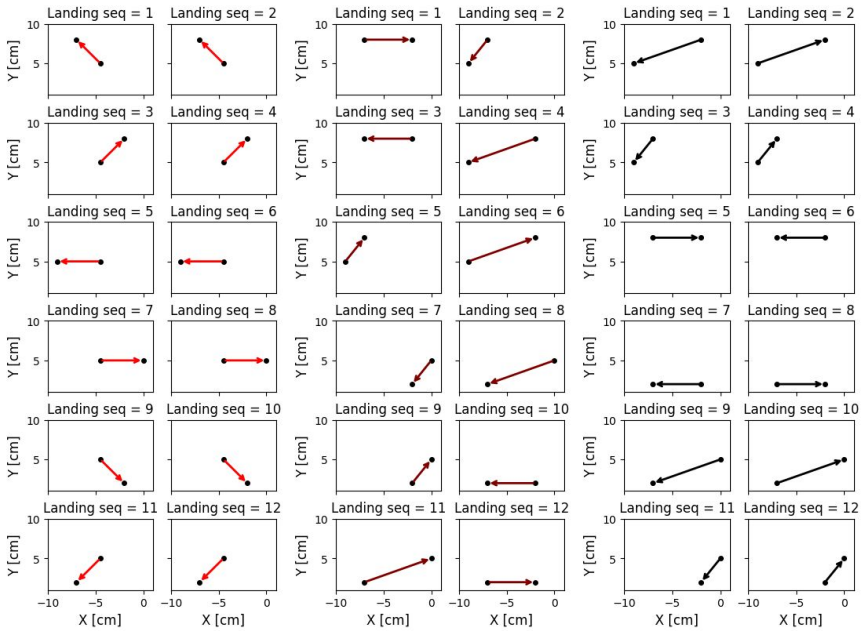
$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

grouped by target_03

$$x_i = \begin{bmatrix} ls = 1,6 \\ ls = 2,4 \\ ls = 3,5 \\ ls = 7,12 \\ ls = 8,10 \\ ls = 9,11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

grouped by target_04

$$x_i = \begin{bmatrix} ls = 1,3 \\ ls = 2,4,5 \\ ls = 6 \\ ls = 7,9 \\ ls = 8,11 \\ ls = 10,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$



grouped by target_02

$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

grouped by target_03

$$x_i = \begin{bmatrix} ls = 1,6 \\ ls = 2,4 \\ ls = 3,5 \\ ls = 7,12 \\ ls = 8,10 \\ ls = 9,11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

grouped by target_04

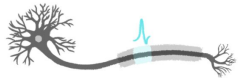
$$x_i = \begin{bmatrix} ls = 1,3 \\ ls = 2,5 \\ ls = 4,6 \\ ls = 7,9 \\ ls = 8,11 \\ ls = 10,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

Progress report:

- Extracted spikes by adding 500 ms pre-start time
- Selected all and only the time points that contained all trials
- Time-locked across trials at the end of each task epoch (not only at the start)
- Improved the Mutual Information analyses
- Implemented Classification of landing sequences
  - Using spike counts cell-by-cell (univariate)
  - Using spike counts at cell population level (multivariate)
- Explored time generalization properties of the classifiers

  (train at one epoch, test at subsequent epoch)

Firing rates



n=120 trials
n=36 cells

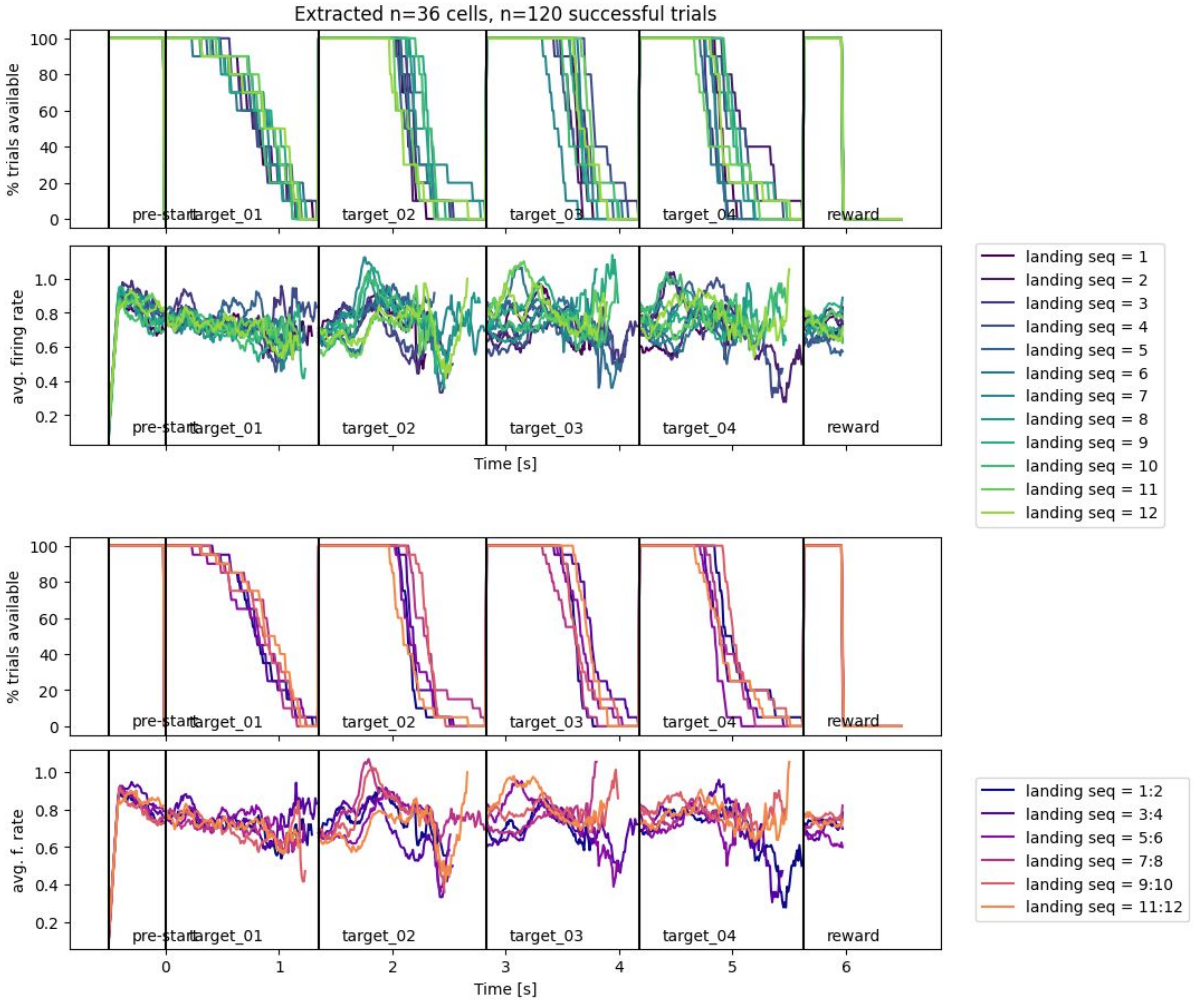
Extraction criteria:
SNR = 3
min firing = 1Hz

Spike count Boxcar:
T=100ms,
offset=10 ms.

Cells-averaged
Trials-averaged

Pooled with event start alignment

Stratified by landing sequence (land-001)



E y180306 land001

n=120 trials
n=36 cells

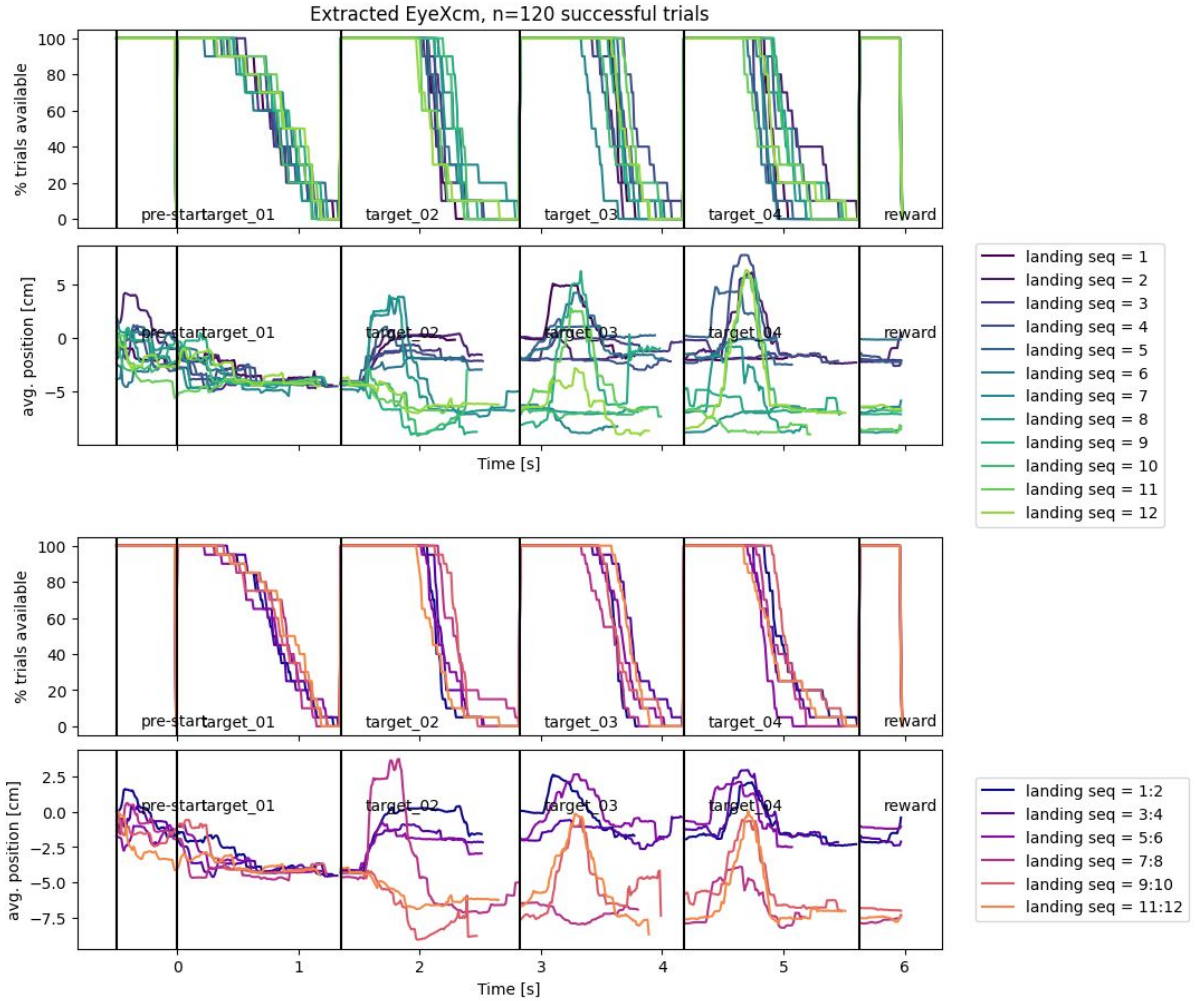
Extraction criteria:
SNR = 3
min firing = 1Hz

Spike count Boxcar:
T=100ms, offset=10 ms.

Cells-averaged
Trials-averaged

Pooled with event end alignment

Stratified by landing sequence (land-001)



Eye (horizontal)

n=120 trials
n=36 cells

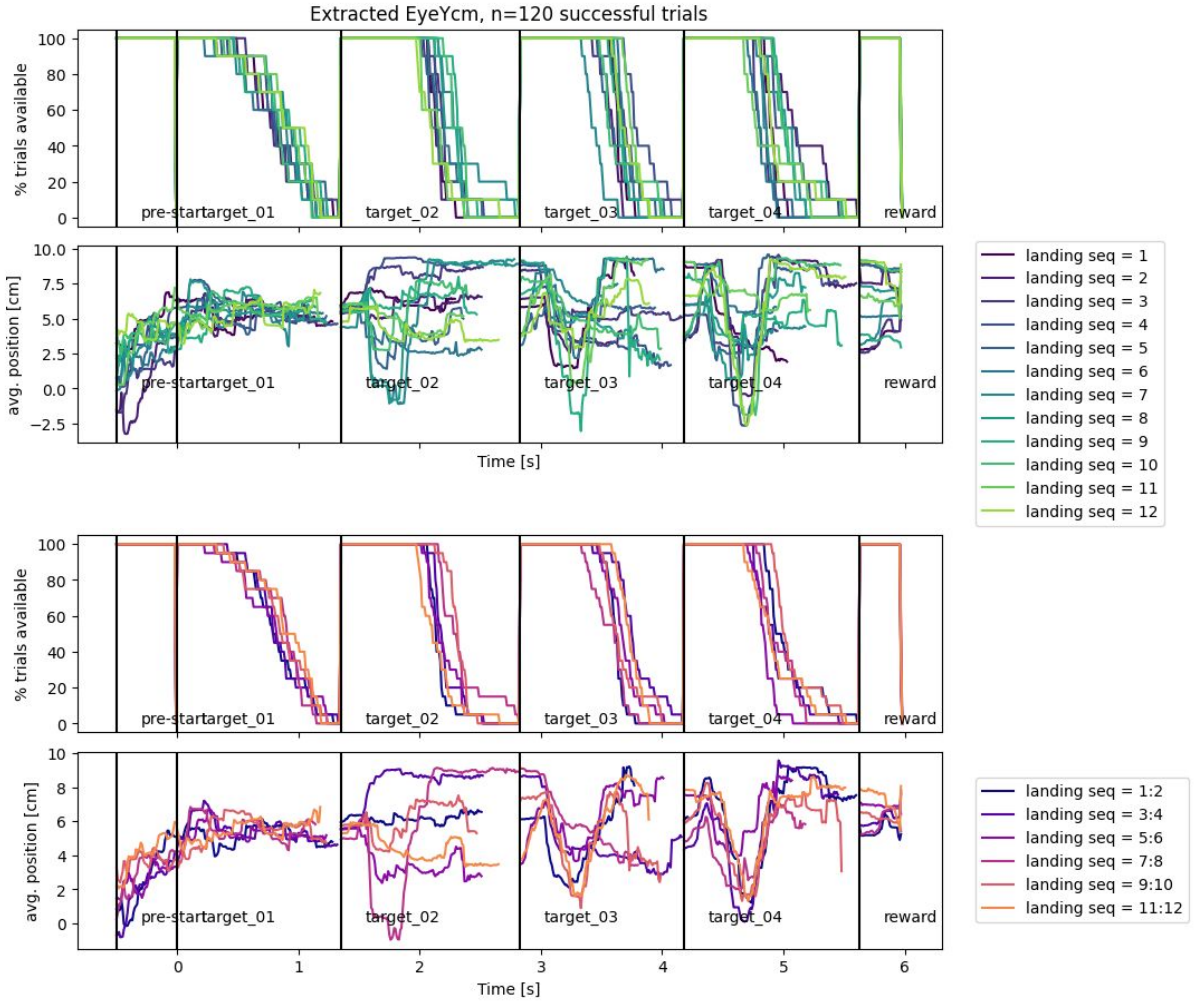
Extraction criteria:
SNR = 3
min firing = 1Hz

Spike count Boxcar:
T=100ms,
offset=10 ms.

Cells-averaged
Trials-averaged

Pooled with event end alignment

Stratified by landing sequence (land-001)



Eye (vertical)

n=120 trials
n=36 cells

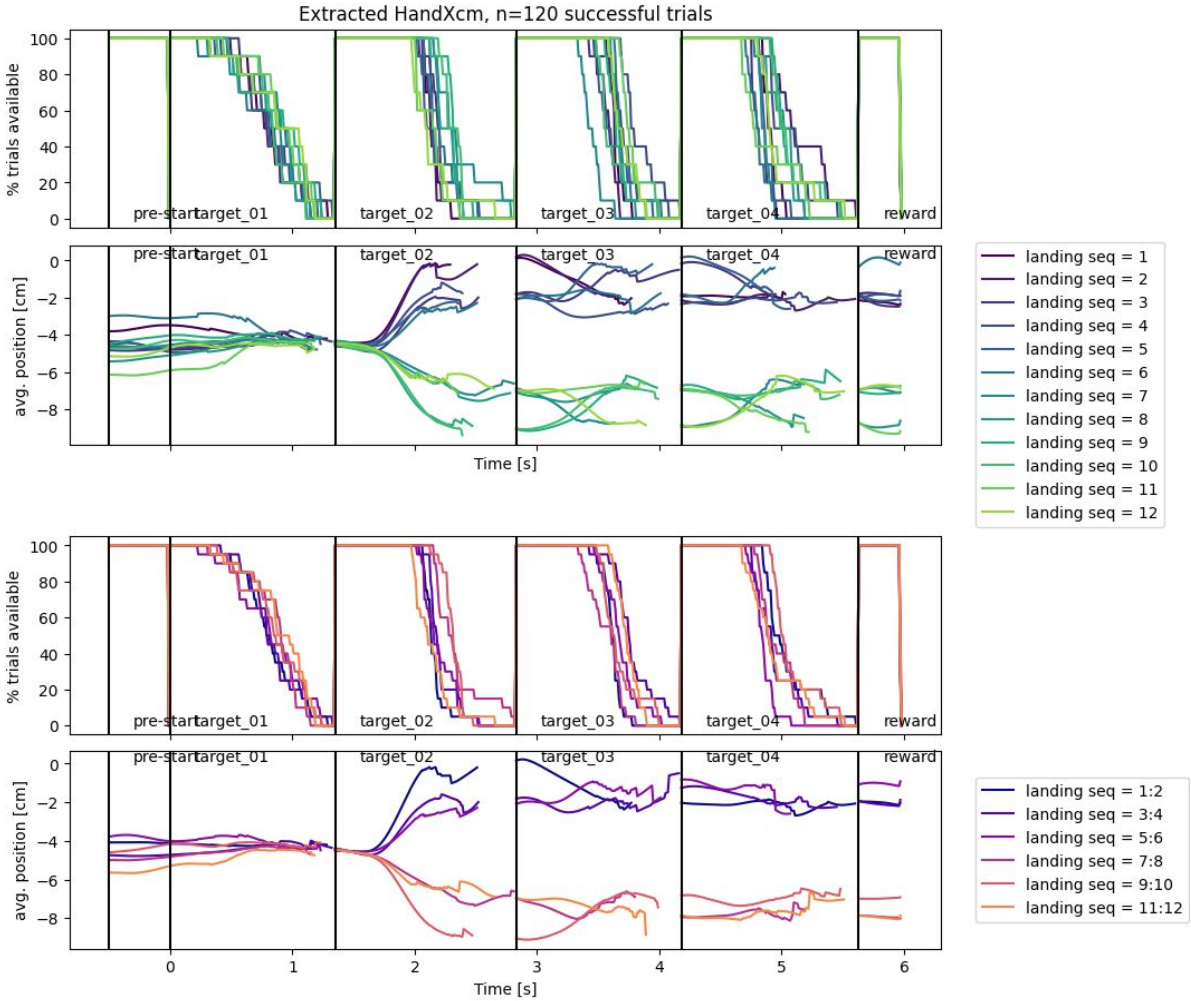
Extraction criteria:
SNR = 3
min firing = 1Hz

Spike count Boxcar:
T=100ms, offset=10 ms.

Cells-averaged
Trials-averaged

Pooled with event end alignment

Stratified by landing sequence (land-001)



Hand (horizontal)

n=120 trials
n=36 cells

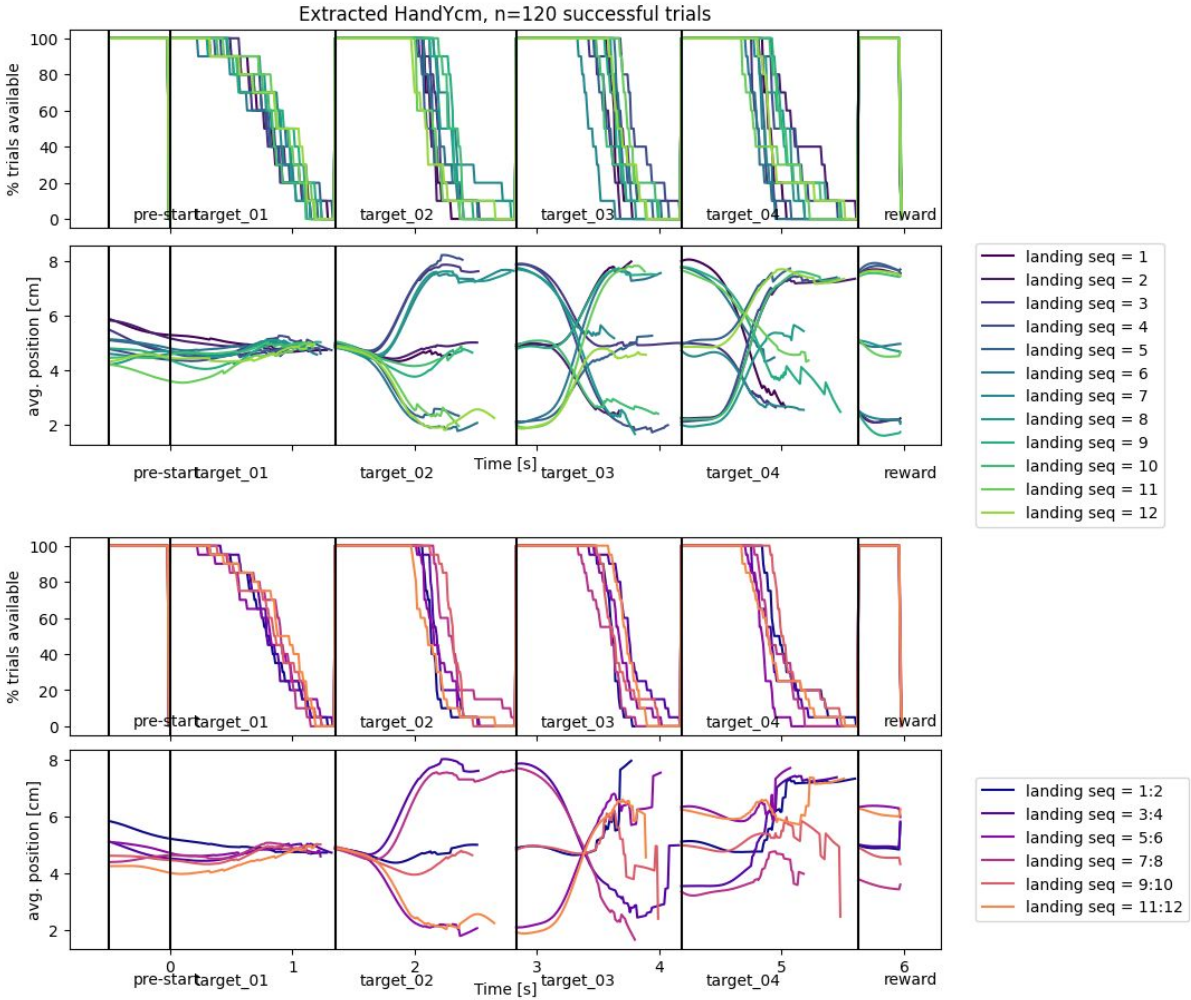
Extraction criteria:
SNR = 3
min firing = 1Hz

Spike count Boxcar:
T=100ms, offset=10 ms.

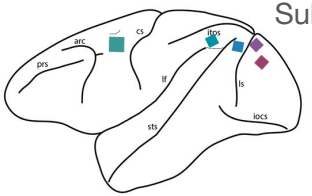
Cells-averaged
Trials-averaged

Pooled with event end alignment

Stratified by landing sequence (land-001)



Hand (vertical)

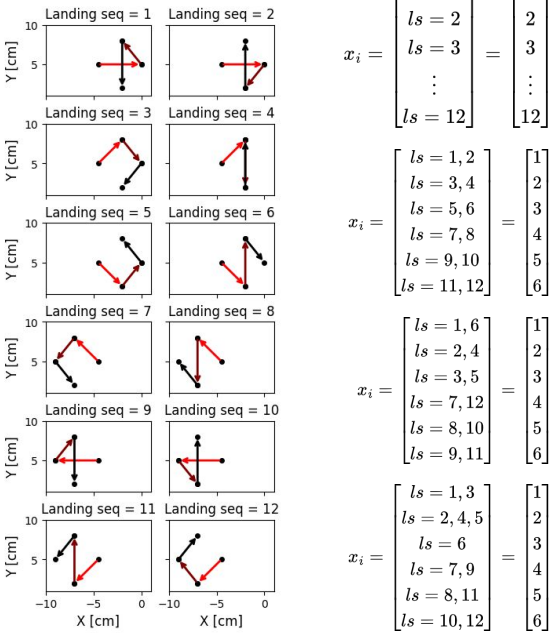


Subject	Task	V1/V2	V1/V2(s)	DP	DP(s)	7a	7a(s)	M1/PMd	M1/PMd(s)
E	y180306 land001	4(M4)	-	16(M4)	-	16(M4)	-		

Nearest-Neighbor classification: $y_{i,t}$ spike count, x_i landing sequence, trial i, time bin t.

Using $k = 12$ or $k = 6$ nearest neighbors, run over $cv = 4$ cross-validation folds.

The procedure is computed for each cell, then the average classification accuracy is shown



$$x_i = \begin{bmatrix} ls = 1 \\ ls = 2 \\ ls = 3 \\ \vdots \\ ls = 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$$

$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

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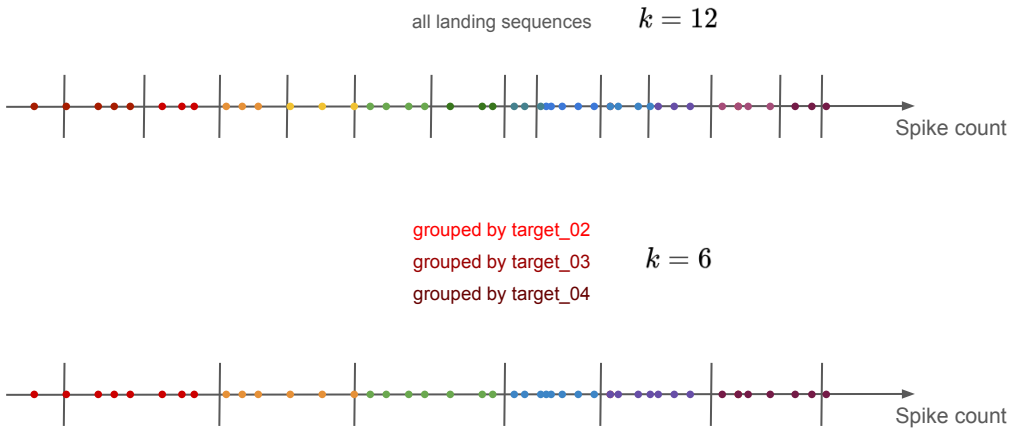
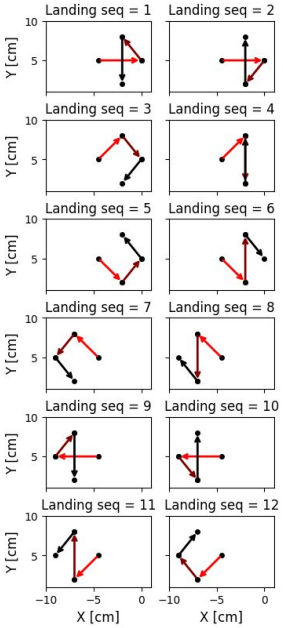
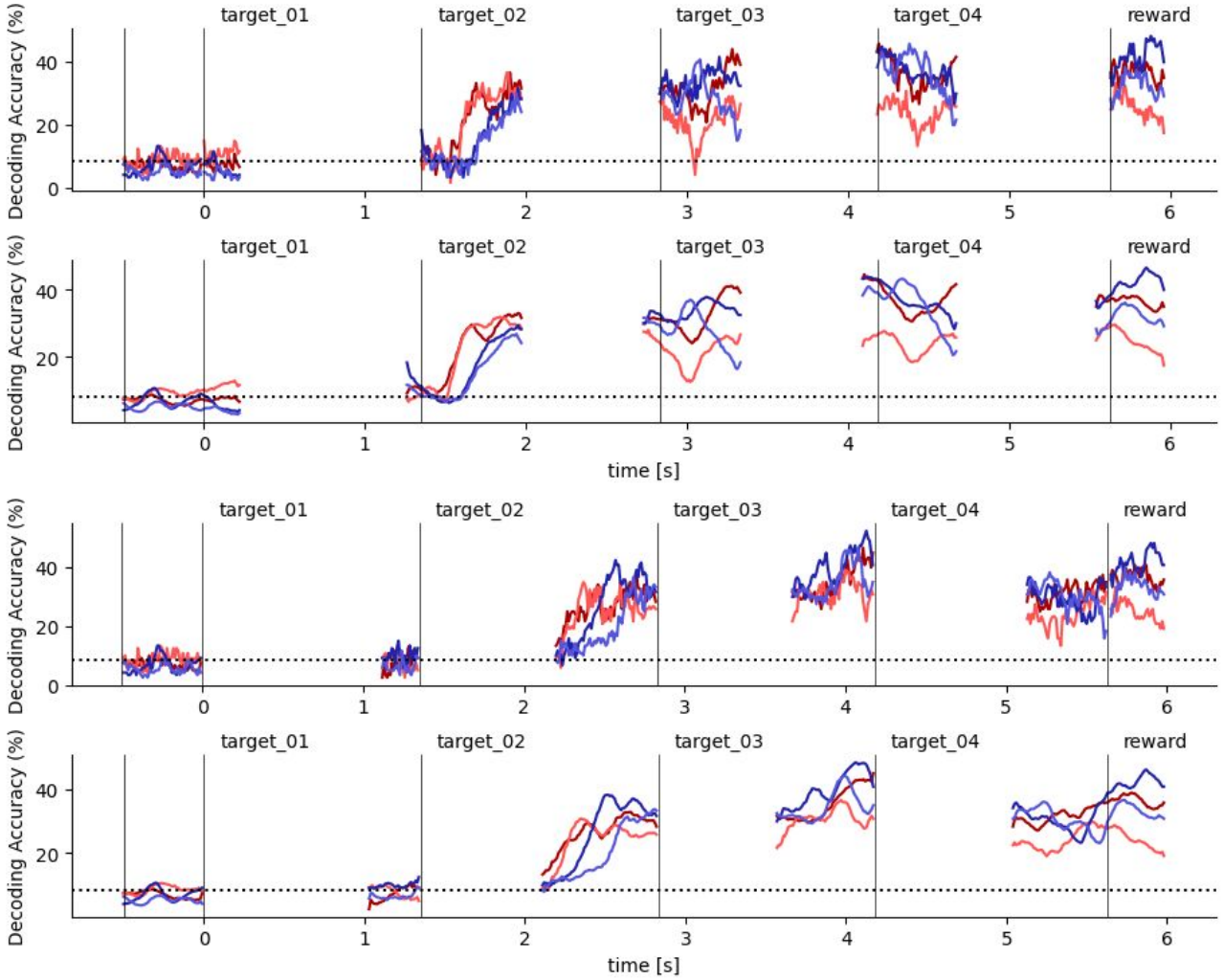


E y180306 land001

all landing sequences

$$x_i = \begin{bmatrix} ls = 1 \\ ls = 2 \\ ls = 3 \\ \vdots \\ ls = 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$$

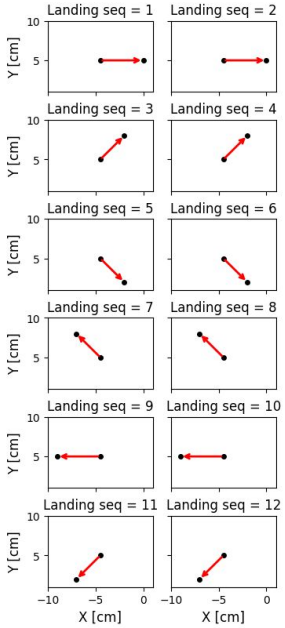


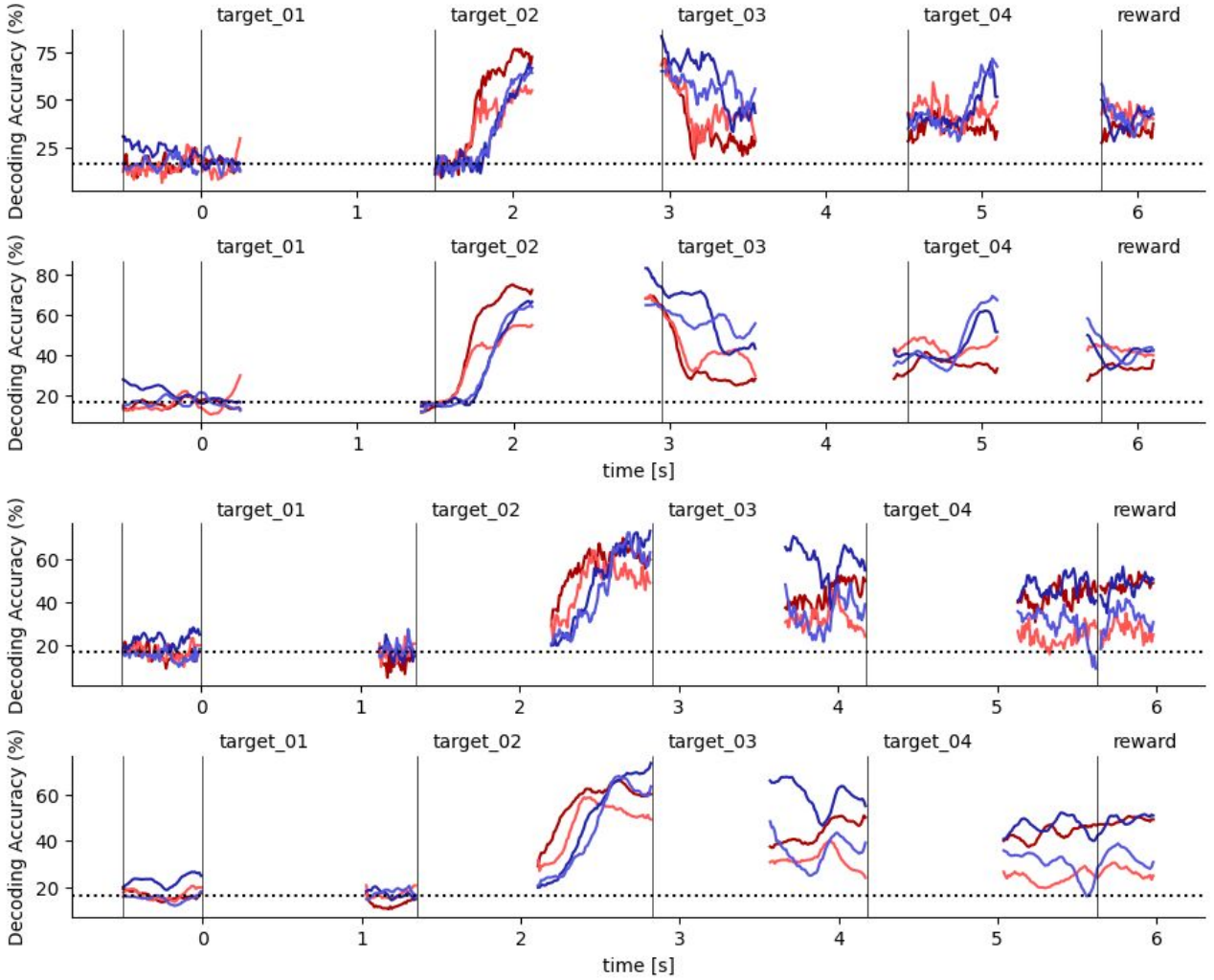


E y180306 land001

grouped by target_02

$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

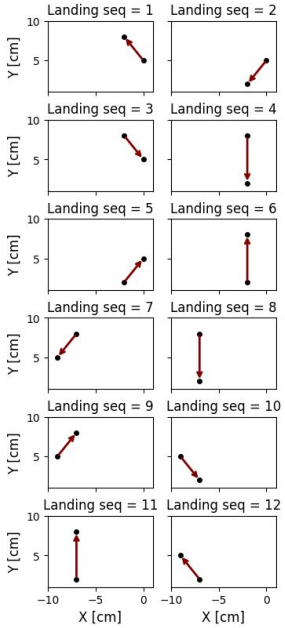


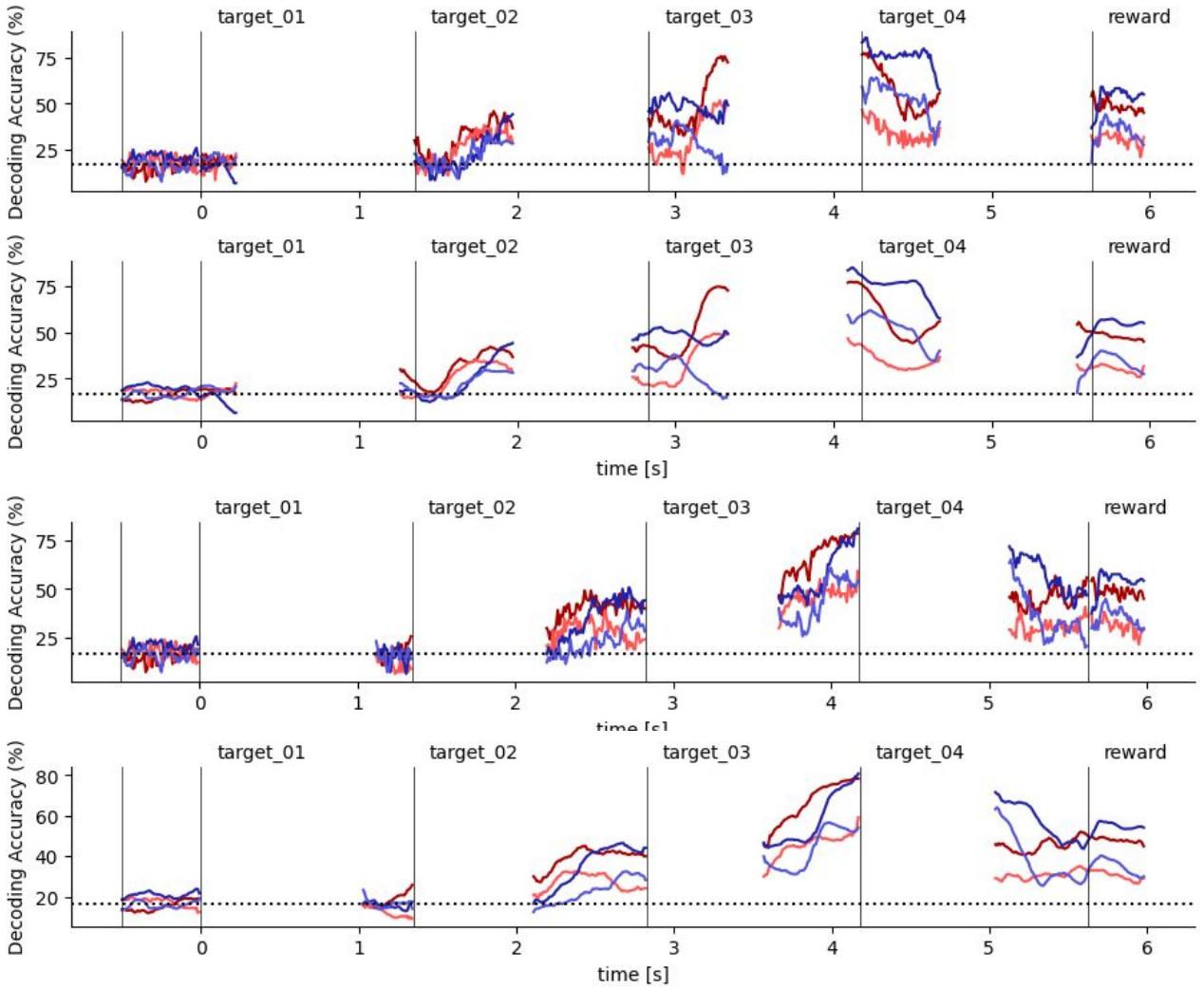


E y180306 land001

grouped by target_03

$$x_i = \begin{bmatrix} ls = 1, 6 \\ ls = 2, 4 \\ ls = 3, 5 \\ ls = 7, 12 \\ ls = 8, 10 \\ ls = 9, 11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

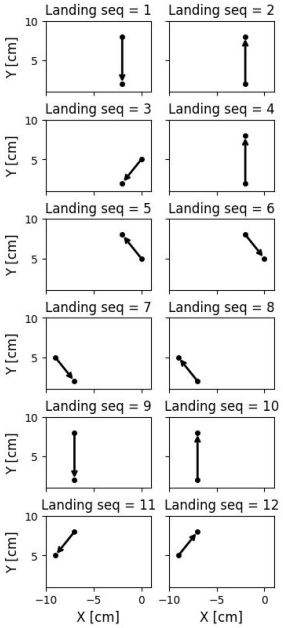


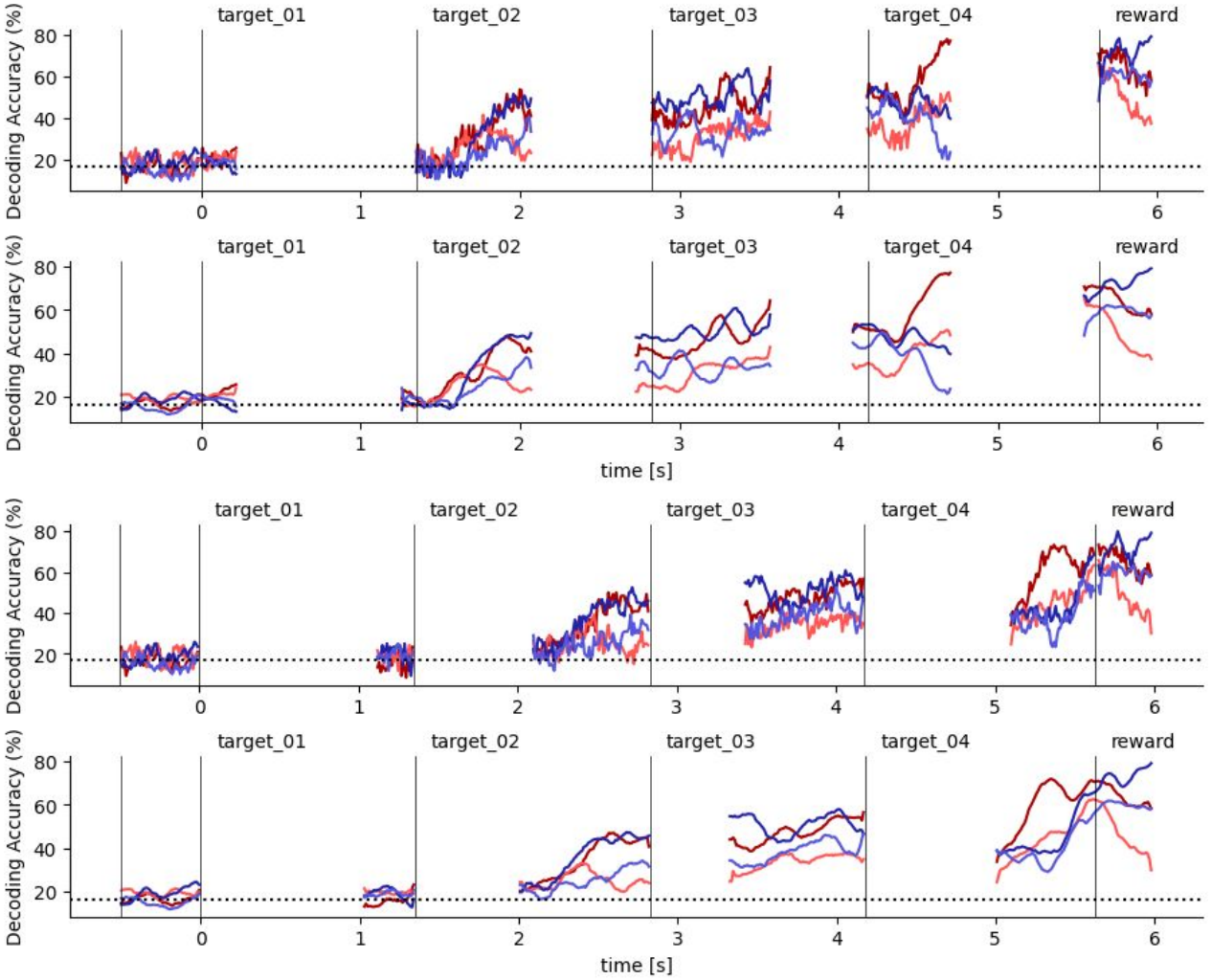


E y180306 land001

grouped by target_04

$$x_i = \begin{bmatrix} ls = 1,3 \\ ls = 2,4,5 \\ ls = 6 \\ ls = 7,9 \\ ls = 8,11 \\ ls = 10,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$





E y180306 land001

all landing sequences

$$x_i = \begin{bmatrix} ls = 1 \\ ls = 2 \\ ls = 3 \\ \vdots \\ ls = 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$$

grouped by target_02

$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

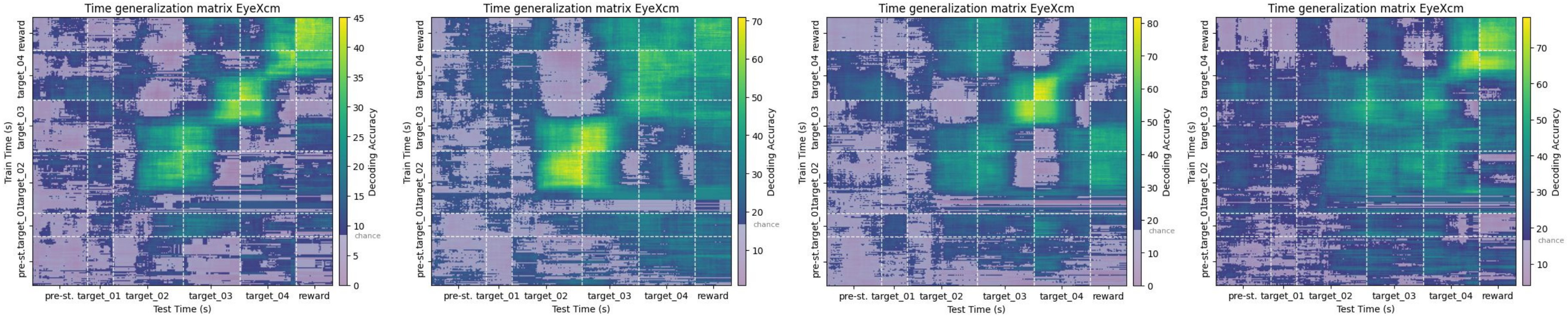
grouped by target_03

$$x_i = \begin{bmatrix} ls = 1,6 \\ ls = 2,4 \\ ls = 3,5 \\ ls = 7,12 \\ ls = 8,10 \\ ls = 9,11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

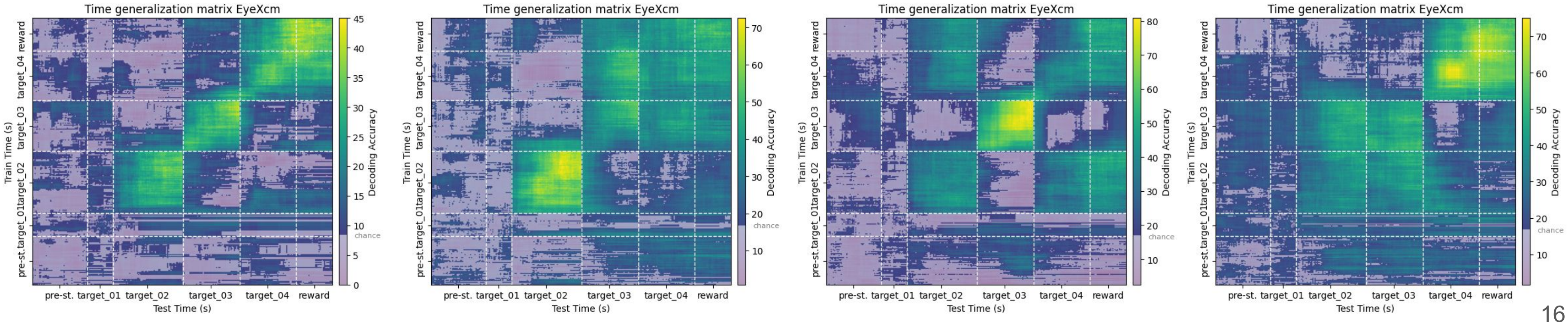
grouped by target_04

$$x_i = \begin{bmatrix} ls = 1,3 \\ ls = 2,4,5 \\ ls = 6 \\ ls = 7,9 \\ ls = 8,11 \\ ls = 10,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

Aligned to epoch start



Aligned to epoch end



E y180306 land001

all landing sequences

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grouped by target_02

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grouped by target_04

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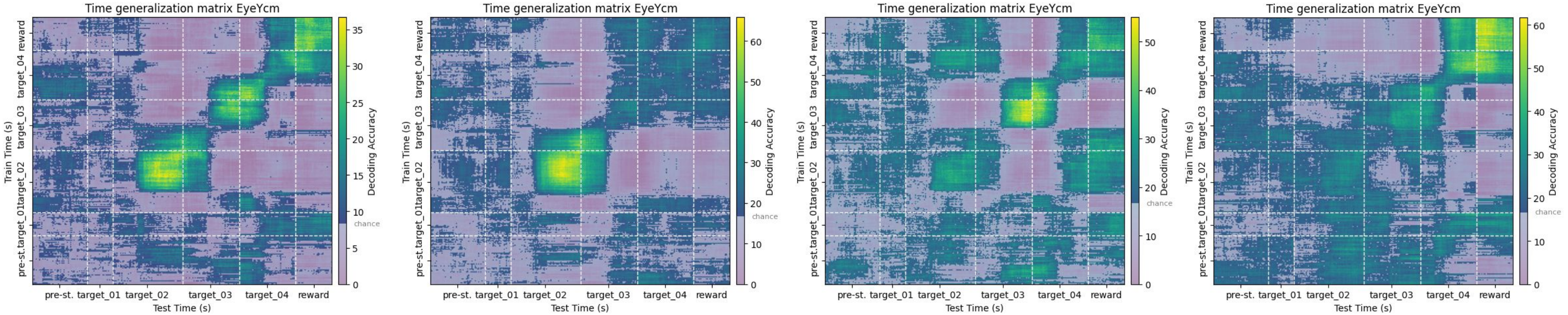
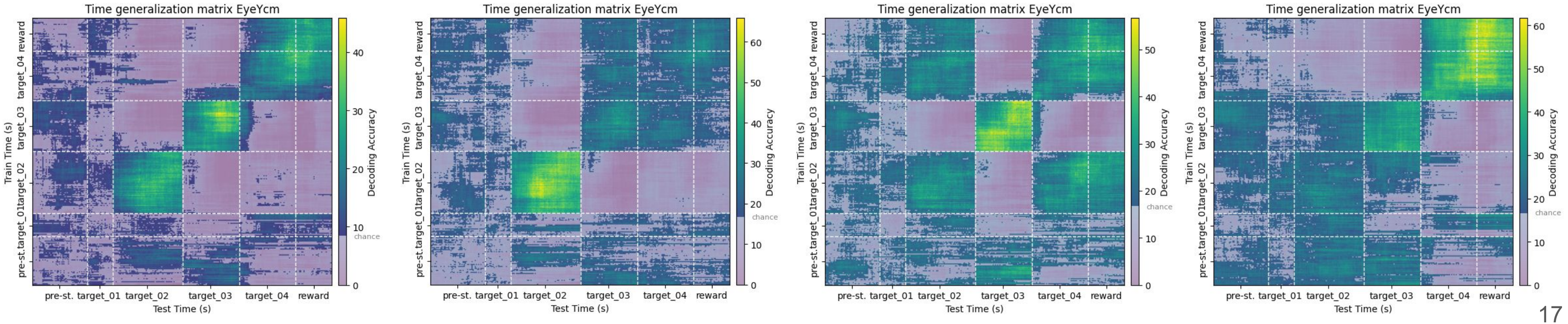
Aligned to epoch start



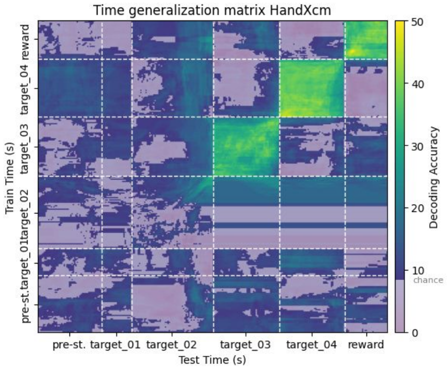
Aligned to epoch end

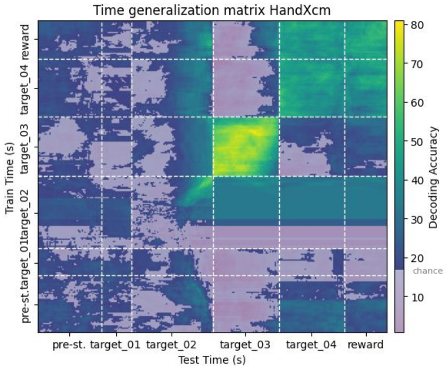


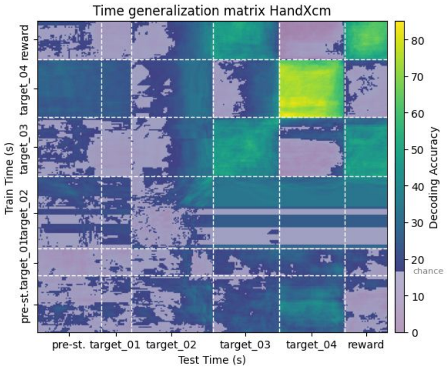
E y180306 land001

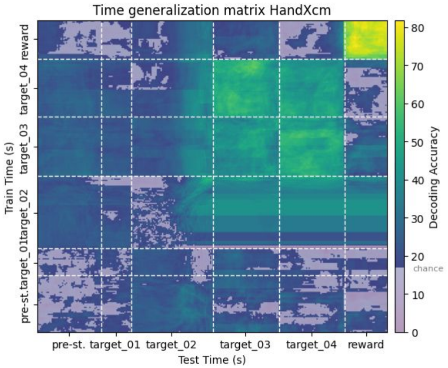
all landing sequences	grouped by target_02	grouped by target_03	grouped by target_04
$x_i = \begin{bmatrix} ls=1 \\ ls=2 \\ ls=3 \\ \vdots \\ ls=12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$	$x_i = \begin{bmatrix} ls=1,2 \\ ls=3,4 \\ ls=5,6 \\ ls=7,8 \\ ls=9,10 \\ ls=11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$	$x_i = \begin{bmatrix} ls=1,6 \\ ls=2,4 \\ ls=3,5 \\ ls=7,12 \\ ls=8,10 \\ ls=9,11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$	$x_i = \begin{bmatrix} ls=1,3 \\ ls=2,4,5 \\ ls=6 \\ ls=7,9 \\ ls=8,11 \\ ls=10,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$

Aligned to epoch start

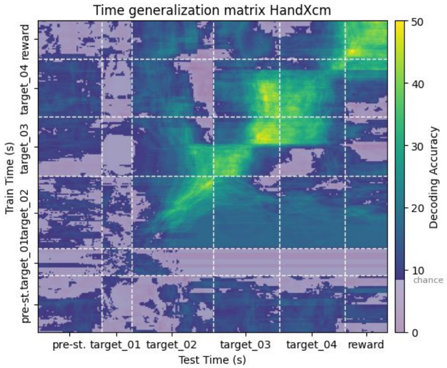


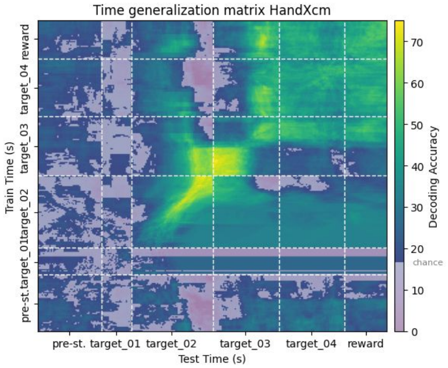


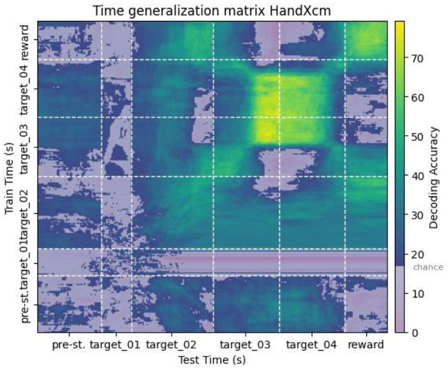


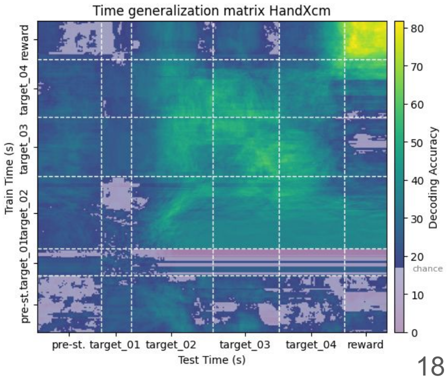


Aligned to epoch end









all landing sequences

$$x_i = \begin{bmatrix} ls = 1 \\ ls = 2 \\ ls = 3 \\ \vdots \\ ls = 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$$

grouped by target_02

$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

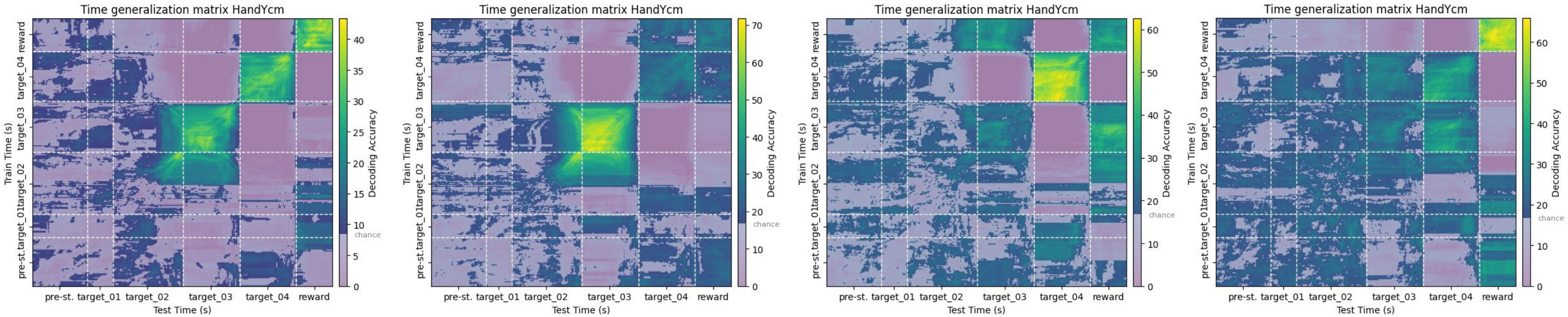
grouped by target_03

$$x_i = \begin{bmatrix} ls = 1,6 \\ ls = 2,4 \\ ls = 3,5 \\ ls = 7,12 \\ ls = 8,10 \\ ls = 9,11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

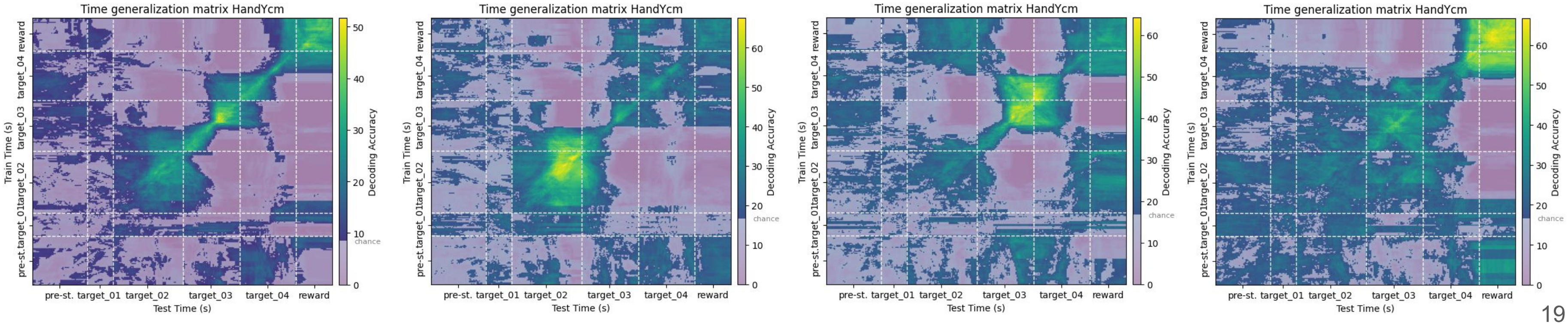
grouped by target_04

$$x_i = \begin{bmatrix} ls = 1,3 \\ ls = 2,4,5 \\ ls = 6 \\ ls = 7,9 \\ ls = 8,11 \\ ls = 10,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

Aligned to epoch start



Aligned to epoch end



E y180306 land001

all landing sequences

$$x_i = \begin{bmatrix} ls = 1 \\ ls = 2 \\ ls = 3 \\ \vdots \\ ls = 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$$

grouped by target_02

$$x_i = \begin{bmatrix} ls = 1,2 \\ ls = 3,4 \\ ls = 5,6 \\ ls = 7,8 \\ ls = 9,10 \\ ls = 11,12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

grouped by target_03

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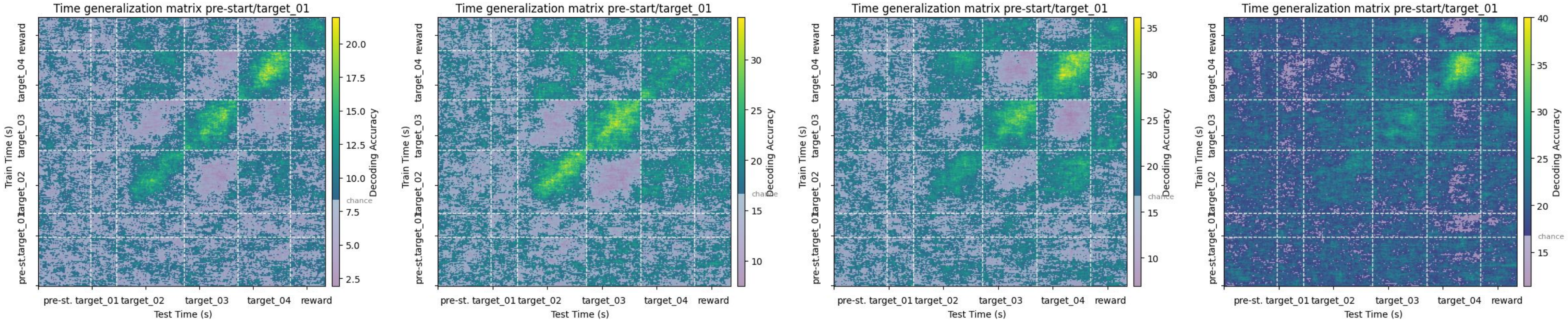
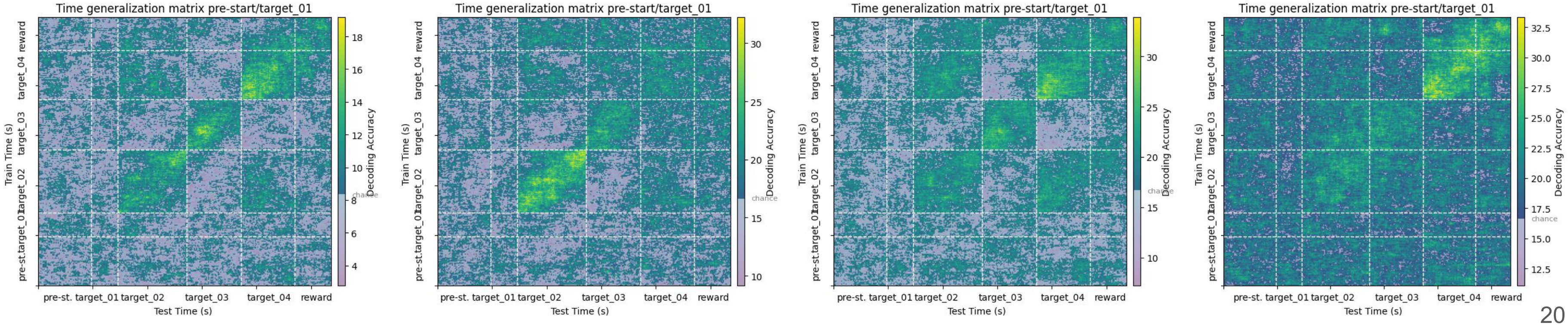
Aligned to epoch start



Aligned to epoch end



all landing sequences

$$x_i = \begin{bmatrix} ls = 1 \\ ls = 2 \\ ls = 3 \\ \vdots \\ ls = 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ \vdots \\ 12 \end{bmatrix}$$

grouped by target_02

$$x_i = \begin{bmatrix} ls = 1, 2 \\ ls = 3, 4 \\ ls = 5, 6 \\ ls = 7, 8 \\ ls = 9, 10 \\ ls = 11, 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

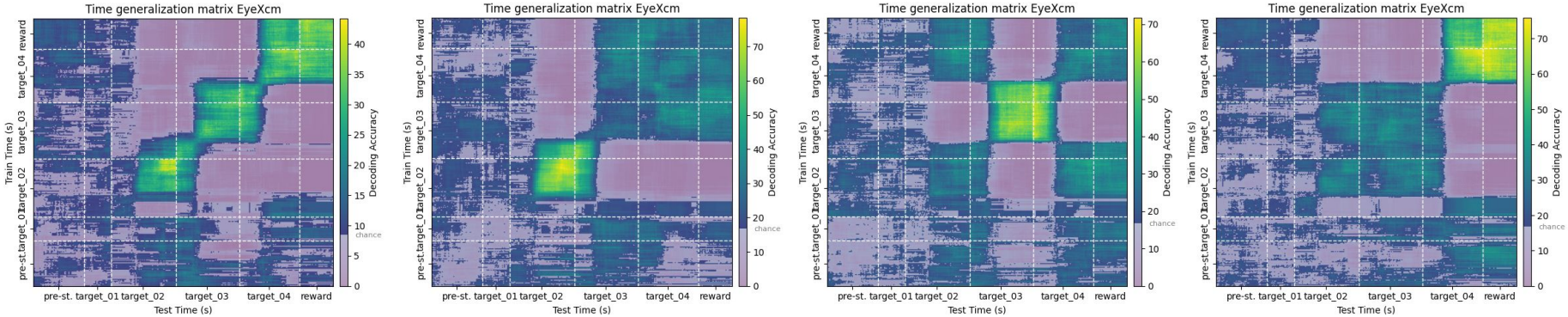
grouped by target_03

$$x_i = \begin{bmatrix} ls = 1, 6 \\ ls = 2, 4 \\ ls = 3, 5 \\ ls = 7, 12 \\ ls = 8, 10 \\ ls = 9, 11 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

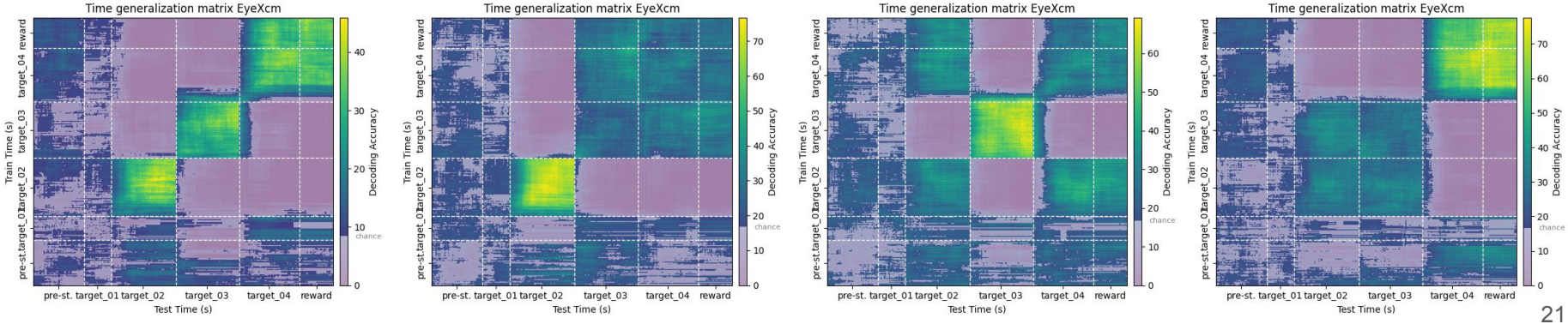
grouped by target_04

$$x_i = \begin{bmatrix} ls = 1, 3 \\ ls = 2, 5 \\ ls = 4, 6 \\ ls = 7, 9 \\ ls = 8, 11 \\ ls = 10, 12 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}$$

Aligned to epoch start



Aligned to epoch end



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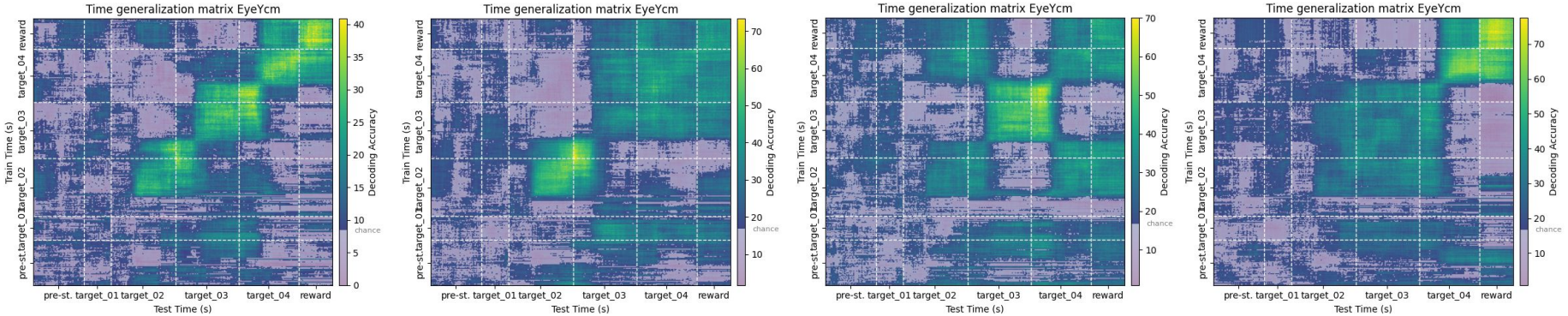
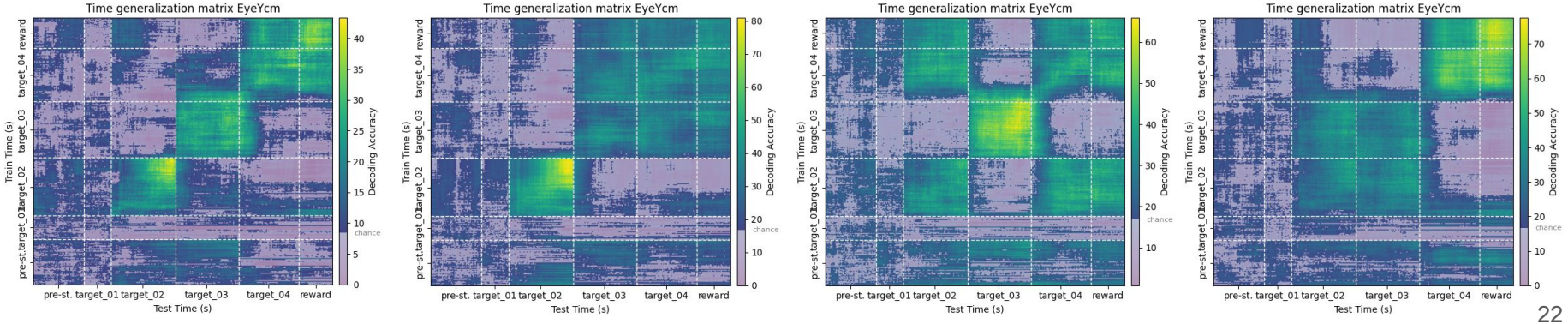
Aligned to epoch start



Aligned to epoch end



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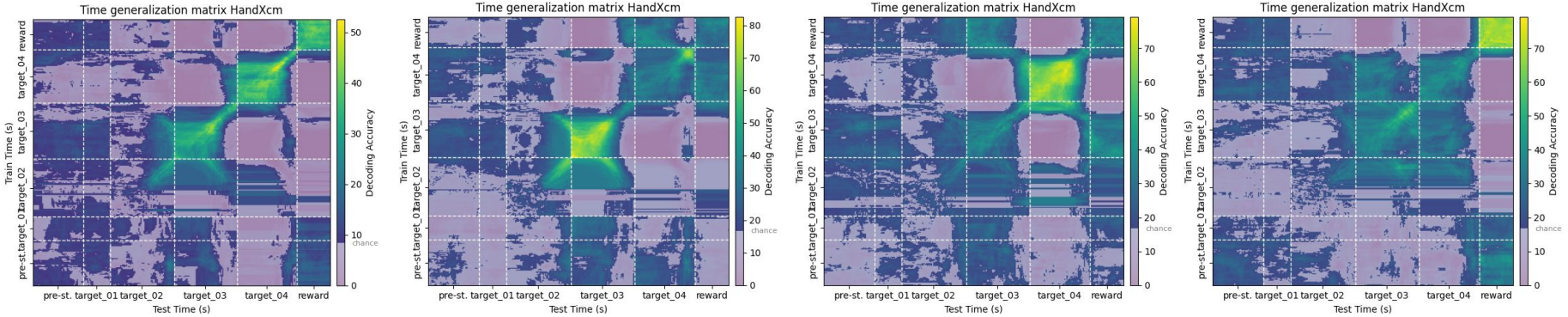
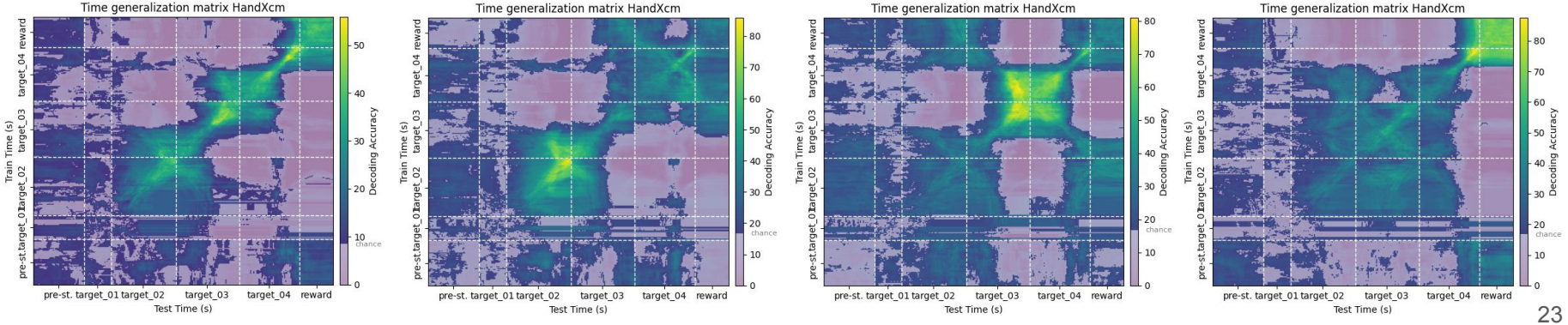
Aligned to epoch start



Aligned to epoch end



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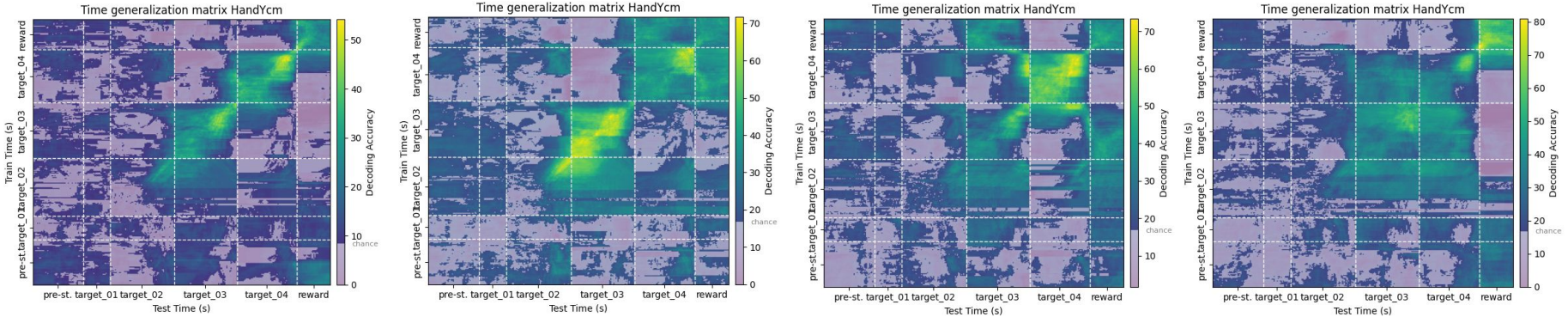
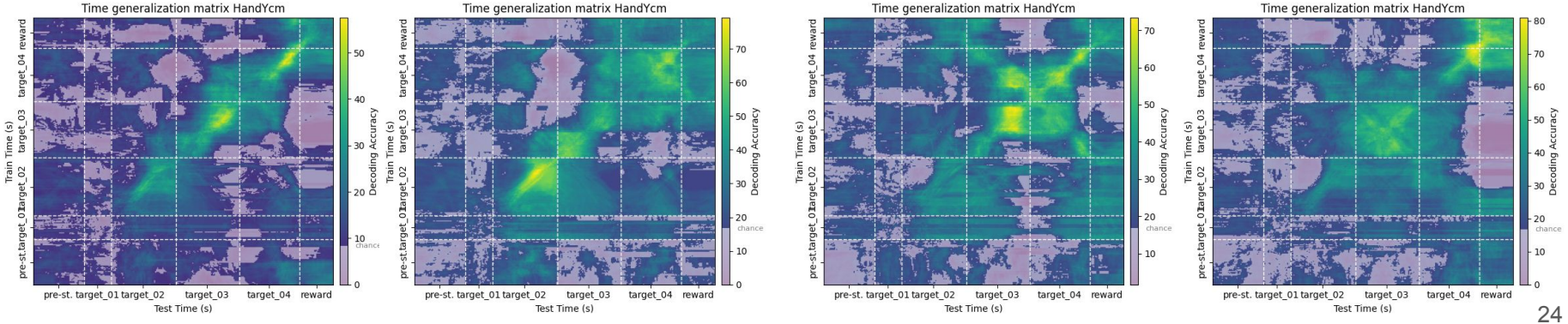
Aligned to epoch start



Aligned to epoch end



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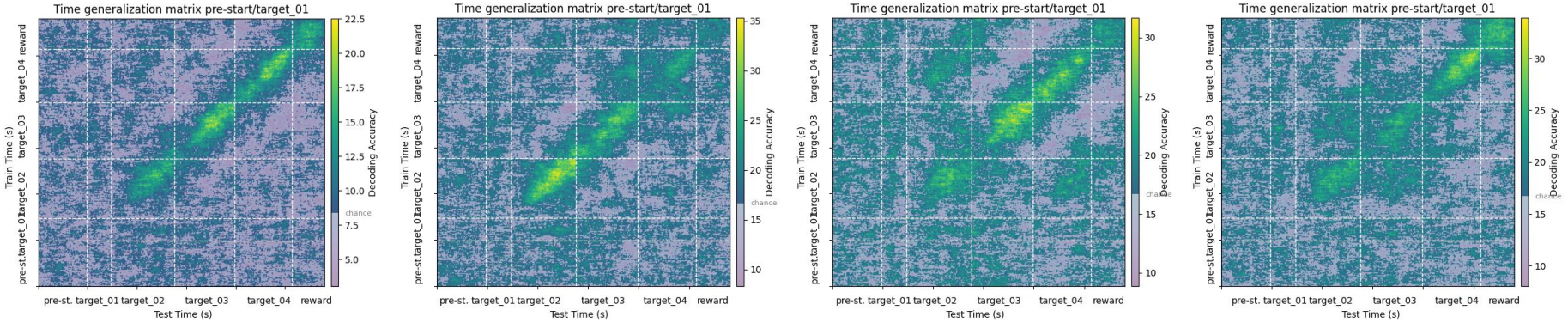
Aligned to epoch start



Aligned to epoch end