

Supplementary Material

“Non-binary m-sequences for more comfortable brain–computer interfaces based on c-VEPs”

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1. Unfolded accuracy results for each participant

As stated in the manuscript, unfolded results for each participant are available in the following Tables 1-5, indicating the reached accuracy, information transfer rate (ITR) and trial duration for each p -ary m-sequence.

2. Unfolded questionnaire results for each participant

Table 6 shows the unfolded questionnaire ratings for each participant, before normalizing and grouping them into relevant aspects of the study, as stated in the manuscript.

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Table 1: Online results for the GF(2^6) m-sequence

No. cycles		1	2	3	4	5	6	7	8	9	10
Accuracy (%)	U01	37.50	90.62	96.88	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U02	81.25	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U03	84.38	96.88	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U04	65.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U05	78.12	93.75	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U06	53.12	71.88	90.62	93.75	93.75	93.75	96.88	96.88	93.75	96.88
	U07	71.88	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U08	65.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U09	81.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U10	37.50	53.12	81.25	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U11	59.38	100.00	100.00	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U12	62.50	84.38	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U13	40.62	78.12	96.88	90.62	96.88	96.88	96.88	96.88	96.88	96.88
	U14	84.38	96.88	96.88	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U15	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U16	50.00	87.50	93.75	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	Mean	65.43	90.43	96.68	98.05	99.41	99.41	99.61	99.61	99.41	99.61
STD	17.38	12.67	4.75	2.68	1.65	1.65	1.03	1.03	1.65	1.03	
ITR (bpm)	U01	69.00	181.99	140.09	105.07	91.43	76.19	65.31	57.14	50.79	45.71
	U02	293.86	210.13	152.38	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U03	315.92	210.13	140.09	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U04	197.56	228.57	152.38	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U05	272.86	195.34	140.09	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U06	133.88	116.80	121.33	97.67	78.14	65.11	60.04	52.53	43.41	42.03
	U07	233.60	210.13	152.38	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U08	197.56	228.57	152.38	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U09	293.86	228.57	152.38	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U10	69.00	66.94	97.95	105.07	91.43	76.19	65.31	57.14	50.79	45.71
	U11	164.38	228.57	152.38	105.07	91.43	76.19	65.31	57.14	50.79	45.71
	U12	180.63	157.96	140.09	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U13	80.66	136.43	140.09	91.00	84.05	70.04	60.04	52.53	46.70	42.03
	U14	315.92	210.13	140.09	105.07	91.43	76.19	65.31	57.14	50.79	45.71
	U15	390.69	228.57	152.38	114.29	91.43	76.19	65.31	57.14	50.79	45.71
	U16	119.61	169.60	130.23	105.07	91.43	76.19	65.31	57.14	50.79	45.71
	Mean	208.06	188.03	141.04	108.91	90.14	75.11	64.65	56.57	50.08	45.25
STD	95.95	46.03	14.29	6.99	3.57	2.98	1.74	1.52	1.99	1.22	
Duration (s)		0.53	1.05	1.58	2.10	2.62	3.15	3.68	4.20	4.73	5.25

Table 2: Online results for the GF(3⁴) m-sequence

No. cycles	1	2	3	4	5	6	7	8	9	10
Accuracy (%)	U01	53.12	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U02	84.38	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U03	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U04	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U05	87.50	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U06	53.12	68.75	78.12	78.12	81.25	84.38	90.62	90.62	90.62
	U07	71.88	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U08	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U09	90.62	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U10	31.25	71.88	93.75	90.62	96.88	96.88	93.75	93.75	96.88
	U11	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U12	71.88	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U13	50.00	87.50	93.75	96.88	100.00	100.00	100.00	100.00	100.00
	U14	87.50	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U15	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U16	62.50	87.50	90.62	96.88	96.88	100.00	100.00	100.00	100.00
	Mean	75.78	92.77	97.27	97.66	98.44	98.83	99.02	99.02	99.22
	STD	19.53	9.61	5.73	5.58	4.56	3.81	2.64	2.64	2.34
ITR (bpm)	U01	105.43	143.32	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U02	248.79	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U03	286.64	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U04	330.96	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U05	267.13	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U06	105.43	84.74	71.62	53.72	46.28	41.46	40.95	35.83	31.85
	U07	183.96	153.83	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U08	307.67	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U09	286.64	165.48	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U10	37.62	91.98	102.56	71.66	66.19	55.16	43.95	38.46	34.19
	U11	286.64	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U12	183.96	143.32	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U13	94.19	133.56	102.56	82.74	72.00	60.00	51.43	45.00	40.00
	U14	267.13	165.48	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U15	330.96	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00
	U16	142.24	133.56	95.55	82.74	66.19	60.00	51.43	45.00	40.00
	Mean	216.59	154.70	113.27	85.68	69.67	58.54	50.31	44.02	39.13
	STD	91.75	30.31	13.28	9.55	6.33	4.56	3.02	2.64	2.35
Duration (s)	0.67	1.33	2.00	2.67	3.33	4.00	4.67	5.33	6.00	6.67

Table 3: Online results for the GF(5³) m-sequence

No. cycles	1	2	3	4	5	6	7	8	9	10
Accuracy (%)	U01	75.00	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U02	84.38	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U03	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U04	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U05	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U06	56.25	68.75	87.50	87.50	87.50	90.62	90.62	87.50	87.50
	U07	81.25	100.00	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U08	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U09	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U10	59.38	81.25	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U11	84.38	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U12	87.50	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U13	43.75	75.00	90.62	96.88	100.00	100.00	100.00	100.00	100.00
	U14	87.50	96.88	96.88	96.88	96.88	100.00	100.00	100.00	100.00
	U15	96.88	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U16	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mean	83.20	94.14	98.05	98.83	99.02	99.22	99.41	99.22	99.22
	STD	16.12	9.62	3.64	3.10	3.07	2.34	2.27	3.03	3.03
ITR (bpm)	U01	128.44	106.76	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U02	160.51	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U03	184.93	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U04	198.50	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U05	213.52	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U06	75.60	54.67	57.45	43.08	34.47	30.82	26.42	19.15	17.23
	U07	149.30	116.13	71.17	58.06	46.45	38.71	33.18	25.81	23.23
	U08	213.52	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U09	232.26	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U10	83.52	74.65	71.17	58.06	46.45	38.71	33.18	25.81	23.23
	U11	160.51	99.25	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U12	172.34	106.76	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U13	47.25	64.22	61.64	53.38	46.45	38.71	33.18	25.81	23.23
	U14	172.34	106.76	71.17	53.38	42.70	35.59	33.18	25.81	23.23
	U15	213.52	106.76	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	U16	213.52	116.13	77.42	58.06	46.45	38.71	33.18	25.81	23.23
	Mean	163.72	103.05	74.01	56.54	45.47	38.02	32.76	28.66	25.39
	STD	53.42	19.51	6.02	3.80	2.98	2.01	1.64	1.61	1.45
Duration (s)	1.03	2.07	3.10	4.13	5.17	6.20	7.23	8.27	9.30	10.33

Table 4: Online results for the GF(7²) m-sequence

No. cycles	1	2	3	4	5	6	7	8	9	10
Accuracy (%)	U01	43.75	75.00	93.75	93.75	96.88	96.88	96.88	96.88	96.88
	U02	56.25	78.12	93.75	100.00	100.00	100.00	100.00	100.00	100.00
	U03	53.12	84.38	93.75	100.00	100.00	100.00	100.00	100.00	100.00
	U04	62.50	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U05	37.50	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U06	18.75	40.62	59.38	71.88	71.88	68.75	75.00	71.88	78.12
	U07	56.25	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U08	50.00	78.12	93.75	100.00	100.00	100.00	100.00	100.00	100.00
	U09	81.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U10	40.62	62.50	84.38	90.62	93.75	96.88	96.88	93.75	96.88
	U11	46.88	93.75	96.88	96.88	100.00	100.00	100.00	100.00	100.00
	U12	34.38	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U13	25.00	62.50	81.25	87.50	100.00	100.00	100.00	100.00	100.00
	U14	78.12	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U15	62.50	90.62	100.00	96.88	96.88	96.88	100.00	100.00	100.00
	U16	50.00	90.62	96.88	96.88	96.88	100.00	100.00	100.00	100.00
	Mean	49.80	82.23	93.36	95.90	97.27	97.46	98.05	97.66	98.24
	STD	16.41	15.14	10.36	7.22	6.80	7.51	6.04	6.86	5.30
ITR (bpm)	U01	122.05	165.90	170.93	128.19	110.32	91.93	78.80	68.95	61.29
	U02	195.31	179.06	170.93	150.00	120.00	100.00	85.71	75.00	66.67
	U03	175.72	207.32	170.93	150.00	120.00	100.00	85.71	75.00	66.67
	U04	237.07	256.39	200.00	150.00	120.00	100.00	85.71	75.00	66.67
	U05	90.56	238.86	200.00	150.00	120.00	100.00	85.71	75.00	66.67
	U06	19.42	52.93	71.92	76.65	61.32	47.08	47.40	38.33	39.79
	U07	195.31	238.86	200.00	150.00	120.00	100.00	85.71	75.00	66.67
	U08	156.98	179.06	170.93	150.00	120.00	100.00	85.71	75.00	66.67
	U09	385.69	300.00	200.00	150.00	120.00	100.00	85.71	75.00	66.67
	U10	105.87	118.54	138.21	119.43	102.56	91.93	78.80	64.10	61.29
	U11	139.09	256.39	183.86	137.90	120.00	100.00	85.71	75.00	66.67
	U12	76.16	238.86	200.00	150.00	120.00	100.00	85.71	75.00	66.67
	U13	38.78	118.54	128.56	111.30	120.00	100.00	85.71	75.00	66.67
	U14	358.12	256.39	200.00	150.00	120.00	100.00	85.71	75.00	66.67
	U15	237.07	238.86	200.00	137.90	110.32	91.93	85.71	75.00	66.67
	U16	156.98	238.86	183.86	137.90	110.32	100.00	85.71	75.00	66.67
	Mean	168.14	205.30	174.38	137.45	113.43	95.18	82.46	71.65	64.31
	STD	98.39	63.07	34.21	19.70	14.44	12.81	9.33	9.09	6.57
Duration (s)	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00

Table 5: Online results for the GF(11²) m-sequence

No. cycles	1	2	3	4	5	6	7	8	9	10
Accuracy (%)	U01	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U02	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U03	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U04	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U05	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U06	71.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U07	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U08	84.38	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U09	93.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U10	62.50	84.38	90.62	96.88	100.00	100.00	100.00	100.00	100.00
	U11	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U12	90.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U13	68.75	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	U14	78.12	81.25	81.25	81.25	81.25	78.12	78.12	78.12	75.00
	U15	100.00	100.00	96.88	100.00	100.00	100.00	100.00	100.00	100.00
	U16	81.25	96.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mean	86.72	97.46	98.05	98.63	98.83	98.63	98.63	98.63	98.44
	STD	10.91	5.66	4.93	4.55	4.54	5.30	5.30	5.30	6.05
ITR (bpm)	U01	191.09	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U02	205.11	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U03	220.64	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U04	191.09	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U05	240.00	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U06	122.64	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U07	205.11	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U08	165.86	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U09	205.11	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U10	94.83	82.93	63.70	55.16	48.00	40.00	34.29	30.00	26.67
	U11	191.09	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U12	191.09	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U13	112.98	110.32	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	U14	143.25	77.14	51.42	38.57	30.85	23.87	20.46	17.91	15.92
	U15	240.00	120.00	73.55	60.00	48.00	40.00	34.29	30.00	26.67
	U16	154.27	110.32	80.00	60.00	48.00	40.00	34.29	30.00	26.67
	Mean	179.64	113.79	76.79	58.36	46.93	38.99	33.42	29.24	25.99
	STD	42.19	13.19	7.74	5.24	4.15	3.90	3.35	2.93	2.60
Duration (s)	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

Table 6: Raw questionnaire results

Statement	U01	U02	U03	U04	U05	U06	U07	U08	U09	U10	U11	U12	U13	U14	U15	U16
It has been interesting for me to know and use this BCI system	5	5	5	5	5	5	5	4	5	5	4	4	5	5	5	5
The system has been difficult for me to use	1	2	1	4	1	2	2	2	1	1	2	1	2	1	1	1
I imagine the use of this type of system in the daily life of people with motor disabilities	4	5	4	5	5	4	4	3	5	4	3	5	3	5	3	5
Sessions require too much concentration	3	4	2	5	4	3	3	3	3	3	2	2	4	4	1	1
The system responds with sufficient speed and fluidity	4	5	5	5	5	5	4	4	5	5	4	4	5	5	5	5
The duration of the session seemed excessive	4	4	3	4	2	3	2	4	1	4	3	3	4	1	2	4
I would be willing to participate in another study of these characteristics	4	5	4	5	5	4	5	5	5	3	4	4	4	5	5	4
Visual stimuli have caused eyestrain	3	4	4	5	4	3	4	4	2	4	1	2	4	3	4	2
The command selection paradigm is intuitive and easy to understand	5	5	4	4	5	5	4	4	5	5	5	5	5	5	5	5
I have found it difficult to select the desired commands	1	1	1	1	1	3	1	1	1	1	2	1	1	1	1	1