

Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eMETHODS: Time to HbO₂ Peak and Nadir

In order to explore the differences in temporal dynamics of HbO₂ concentration between Q1 and Q4 groups, the median time for HbO₂ concentration maxima following task onset (“time to peak”) and median time for HbO₂ minima (“time to nadir”) were compared between Q1 and Q4 using the Mann-Whitney U test. Additionally, for each group, time to HbO₂ peak was compared to time to HbO₂ nadir during each condition using the Wilcoxon Signed Rank test.

eRESULTS

Within-Group Comparisons of Time to HbO₂ Peak and Nadir

Time to HbO₂ peak (TTP) was shorter than time to HbO₂ nadir (TTN) for Q1 residents, especially under TP (eFigure 2 in the Supplement). However, for Q4 residents, TTP was significantly longer than the TTN (eFigure 2 in the Supplement).

Between-Group Comparisons of Time to HbO₂ Peak and Nadir

In both SP and TP conditions, HbO₂ concentration peaked earlier in Q1 than in Q4 in the bilateral VLPFC, left dorsomedial PFC and right DLPFC (eFigure 3a in the Supplement). In the SP condition, a trend towards shorter TTN was observed amongst Q4 compared to Q1 residents. Interestingly, this manifest more clearly under TP, in which TTN was significantly shorter in Q4 compared to Q1 residents in bilateral VLPFC, left dorsomedial PFC and right DLPFC channels (eFigure 3b in the Supplement).

Emitter	Detector	Channel	Gyrus	Prefrontal Subregion
1	1	1	Left Inferior Frontal (Pars Triangularis)	Left Mid-VLPFC
1	2	2	Left Superior Frontal	Left Dorsomedial PFC
2	1	3	Left Inferior Frontal (Pars Triangularis)	Left Mid-VLPFC
2	3	4	Left Inferior Frontal (Pars Triangularis)	Left Mid-VLPFC
3	1	5	Left Superior Frontal	Left Dorsomedial PFC
3	2	6	Left Inferior Frontal (Pars Triangularis)	Left Mid-VLPFC
3	3	7	Left Superior Frontal	Left Dorsomedial PFC
3	4	8	Left Inferior Frontal (Pars Triangularis)	Left Mid-VLPFC
4	2	9	Left Inferior Frontal (Pars Triangularis)	Left Mid-VLPFC
4	4	10	Left Superior Frontal	Left Dorsomedial PFC
5	3	11	Left Inferior Frontal (Pars Opercularis)	Left Posterior-VLPFC
5	4	12	Left Superior Frontal	Left Dorsomedial PFC
6	5	13	Right Inferior Frontal (Pars Triangularis)	Right Mid-VLPFC
6	6	14	Right Inferior Frontal (Pars Triangularis)	Right Mid-VLPFC
7	5	15	Right Middle Frontal	Right DLPFC
7	7	16	Right Inferior Frontal (Pars Triangularis)	Right Mid-VLPFC
8	5	17	Right Inferior Frontal (Pars Opercularis)	Right Posterior-VLPFC
8	6	18	Right Middle Frontal	Right DLPFC
8	7	19	Right Inferior Frontal (Pars Triangularis)	Right Mid-VLPFC
8	8	20	Right Middle Frontal	Right DLPFC
9	6	21	Right Inferior Frontal (Pars Triangularis)	Right Mid-VLPFC
9	8	22	Right Precentral	Right Primary Motor Cortex
10	7	23	Right Inferior Frontal (Pars Triangularis)	Right Mid-VLPFC
10	8	24	Right Inferior Frontal (Pars Opercularis)	Right Posterior-VLPFC

VLPFC: ventrolateral prefrontal cortex; DLPFC: dorsolateral prefrontal cortex

eTABLE 2. Changes in cortical haemodynamics in each channel in the self-paced condition among Q1 residents										
Channel	HbO ₂ Rest	HbO ₂ Task	ΔHbO ₂	Direction of HbO ₂ change	P-value ^a	HHbRest	HHbTask	ΔHHb	Direction of HHb change	P-value ^a
1	-0.15	0.07	0.22	↑	0.187	0.00	0.07	0.07	↑	0.404
2	-0.21	0.11	0.33	↑	0.120	-0.06	0.05	0.11	↑	0.145
3	-0.32	0.00	0.33	↑	0.134	-0.03	-0.03	0.00	↓	0.980
4	-0.26	0.06	0.32	↑	0.019	0.07	0.03	-0.04	↓	0.455
5	-0.10	0.06	0.16	↑	0.440	-0.16	0.02	0.17	↑	0.075
6	-0.61	0.00	0.61	↑	0.001	0.06	0.02	-0.04	↓	0.481
7	-0.18	0.04	0.22	↑	0.107	0.14	0.06	-0.08	↓	0.251
8	-0.41	0.08	0.49	↑	0.209	-0.06	-0.07	0.00	↓	0.997
9	-0.39	0.06	0.45	↑	<0.001	0.11	0.03	-0.08	↓	0.144
10	-0.22	0.08	0.30	↑	0.096	0.00	0.04	0.04	↑	0.643
11	-0.61	0.10	0.72	↑	<0.001	0.10	0.01	-0.09	↓	0.081
12	-0.66	0.12	0.78	↑	<0.001	0.10	-0.03	-0.13	↓	0.090
13	-0.20	-0.05	0.15	↑	0.311	-0.04	0.05	0.09	↑	0.128
14	-0.59	-0.10	0.49	↑	0.014	-0.02	0.05	0.08	↑	0.442
15	-0.09	0.10	0.19	↑	0.204	-0.10	0.00	0.09	↑	0.280
16	-0.56	-0.06	0.50	↑	0.001	0.11	0.12	0.01	↑	0.915
17	-0.57	-0.38	0.19	↑	0.531	0.07	-0.03	-0.10	↓	0.508
18	-0.29	0.06	0.35	↑	0.004	0.11	0.02	-0.09	↓	0.191
19	-0.95	-0.12	0.83	↑	<0.001	0.10	0.04	-0.05	↓	0.578
20	-0.28	0.04	0.32	↑	0.010	0.14	-0.03	-0.17	↓	0.040
21	-0.52	-0.01	0.51	↑	<0.001	0.10	0.03	-0.07	↓	0.086
22	-0.79	0.06	0.85	↑	0.002	0.11	-0.19	-0.29	↓	0.163
23	-0.27	-0.05	0.23	↑	0.053	0.18	-0.02	-0.19	↓	0.002
24	-0.74	0.03	0.77	↑	<0.001	0.10	-0.02	-0.11	↓	0.010

Oxygenated haemoglobin (HbO₂) and deoxygenated haemoglobin (HHb) concentrations are measured in micromoles and are averaged across subjects and across trials. Significant changes (p<0.05) in HbO₂ or HHb concentration from rest to task are highlighted in bold. ^aPaired samples t test

eTABLE 3. Changes in cortical haemodynamics in each channel in the time pressure condition among Q1 residents										
Channel	HbO ₂ Rest	HbO ₂ Task	ΔHbO ₂	Direction of HbO ₂ change	P-value ^a	HHbRest	HHbTask	ΔHHb	Direction of HHb change	P-value ^a
1	-0.06	0.10	0.16	↑	0.576	-0.08	0.01	0.09	↑	0.408
2	-0.63	0.08	0.71	↑	0.001	-0.12	0.17	0.30	↑	0.060
3	-0.42	0.30	0.72	↑	0.006	-0.03	0.02	0.05	↑	0.711
4	-0.39	-0.02	0.37	↑	0.052	-0.02	0.15	0.17	↑	0.080
5	-0.14	0.03	0.17	↑	0.560	-0.06	0.07	0.13	↑	0.446
6	-0.39	0.15	0.54	↑	0.001	-0.03	0.00	0.03	↑	0.775
7	-0.16	0.00	0.16	↑	0.327	0.12	0.05	-0.07	↓	0.534
8	-0.38	0.26	0.63	↑	0.014	0.13	-0.05	-0.17	↓	0.344
9	-0.15	0.03	0.18	↑	0.204	0.05	0.01	-0.03	↓	0.685
10	-0.12	0.16	0.28	↑	0.204	0.14	0.07	-0.07	↓	0.587
11	-0.32	0.13	0.45	↑	0.024	0.13	-0.02	-0.15	↓	0.057
12	-0.29	0.12	0.40	↑	0.003	0.05	-0.04	-0.09	↓	0.355
13	-0.21	0.11	0.31	↑	0.249	-0.08	0.09	0.17	↑	0.171
14	-0.62	0.06	0.68	↑	0.050	0.04	0.11	0.07	↑	0.535
15	-0.16	0.26	0.42	↑	0.189	0.05	0.09	0.04	↑	0.785
16	-0.30	0.11	0.41	↑	0.030	0.05	0.07	0.02	↑	0.790
17	-1.07	0.15	1.23	↑	0.022	0.50	0.15	-0.36	↓	0.098
18	-0.15	0.07	0.23	↑	0.293	0.09	0.04	-0.05	↓	0.610
19	-0.61	0.07	0.68	↑	0.002	0.08	-0.05	-0.13	↓	0.089
20	-0.03	-0.05	-0.02	↓	0.945	0.19	-0.03	-0.22	↓	0.085
21	-0.11	0.04	0.15	↑	0.234	0.00	0.03	0.03	↑	0.485
22	-0.62	0.07	0.69	↑	<0.001	0.05	0.03	-0.02	↓	0.835
23	-0.01	-0.03	-0.02	↓	0.889	0.08	-0.06	-0.13	↓	0.075
24	-0.43	0.10	0.53	↑	<0.001	0.15	0.04	-0.11	↓	0.073

Oxygenated haemoglobin (HbO₂) and deoxygenated haemoglobin (HHb) concentrations are measured in micromoles and are averaged across subjects and across trials. Significant changes (p<0.05) in HbO₂ or HHb concentration from rest to task are highlighted in bold. ^aPaired samples t test

eTABLE 4. Changes in cortical haemodynamics in each channel in the self-paced condition among Q4 residents										
Channel	HbO ₂ Rest	HbO ₂ Task	ΔHbO ₂	Direction of HbO ₂ change	P-value ^a	HHbRest	HHbTask	ΔHHb	Direction of HHb change	P-value ^a
1	0.28	-0.36	-0.64	↓	0.199	0.30	0.17	-0.14	↓	0.326
2	0.45	-0.13	-0.57	↓	0.192	0.10	0.12	0.02	↑	0.906
3	0.17	-0.45	-0.62	↓	0.172	0.25	0.30	0.05	↑	0.805
4	-0.02	-0.22	-0.20	↓	0.343	0.25	0.09	-0.17	↓	0.018
5	0.20	-0.09	-0.29	↓	0.359	0.07	0.14	0.07	↑	0.656
6	-0.44	-0.45	-0.01	↓	0.974	0.18	0.23	0.04	↑	0.772
7	-0.09	-0.20	-0.10	↓	0.717	0.12	0.09	-0.03	↓	0.817
8	-0.31	-0.21	0.10	↑	0.685	0.25	0.20	-0.05	↓	0.771
9	-0.05	-0.11	-0.05	↓	0.777	0.09	0.05	-0.04	↓	0.418
10	-0.16	0.00	0.16	↑	0.372	0.18	0.14	-0.04	↓	0.692
11	-0.10	-0.18	-0.08	↓	0.798	0.30	0.10	-0.20	↓	0.039
12	-0.11	-0.19	-0.07	↓	0.657	0.06	0.01	-0.05	↓	0.433
13	0.14	-0.23	-0.37	↓	0.160	0.25	0.11	-0.14	↓	0.113
14	-0.60	-0.29	0.31	↑	0.426	0.20	0.16	-0.04	↓	0.833
15	-0.11	-0.01	0.10	↑	0.613	0.21	0.14	-0.08	↓	0.473
16	-0.28	-0.29	-0.01	↓	0.980	0.21	0.12	-0.10	↓	0.195
17	-0.05	-0.13	-0.09	↓	0.839	0.35	0.38	0.03	↑	0.917
18	0.01	-0.09	-0.10	↓	0.708	0.22	0.05	-0.16	↓	0.003
19	0.10	-0.24	-0.34	↓	0.370	0.40	0.19	-0.21	↓	0.107
20	-0.27	-0.11	0.17	↑	0.282	0.13	0.04	-0.09	↓	0.090
21	0.23	-0.09	-0.33	↓	0.310	0.16	0.05	-0.11	↓	0.080
22	0.08	-0.02	-0.10	↓	0.727	0.42	0.17	-0.25	↓	0.137
23	0.01	-0.10	-0.11	↓	0.571	0.08	0.03	-0.05	↓	0.313
24	0.08	-0.21	-0.29	↓	0.494	0.35	0.06	-0.28	↓	0.007

Oxygenated haemoglobin (HbO₂) and deoxygenated haemoglobin (HHb) concentrations are measured in micromoles and are averaged across subjects and across trials. Significant changes (p<0.05) in HbO₂ or HHb concentration from rest to task are highlighted in bold. ^aPaired samples t test

eTABLE 5. Changes in cortical haemodynamics in each channel in the time pressure condition among Q4 residents										
Channel	HbO ₂ Rest	HbO ₂ Task	ΔHbO ₂	Direction of HbO ₂ change	P-value ^a	HHbRest	HHbTask	ΔHHb	Direction of HHb change	P-value ^a
1	-0.15	-0.55	-0.40	↓	0.220	-0.02	0.10	0.12	↑	0.538
2	0.20	-0.09	-0.29	↓	0.432	0.19	0.09	-0.09	↓	0.636
3	-0.96	-0.67	0.29	↑	0.481	0.33	0.52	0.19	↑	0.626
4	-0.03	-0.40	-0.37	↓	0.018	0.06	0.00	-0.06	↓	0.764
5	-0.20	-0.11	0.09	↑	0.815	-0.02	0.11	0.13	↑	0.657
6	-0.80	-0.46	0.34	↑	0.181	-0.01	0.33	0.34	↑	0.106
7	0.14	-0.18	-0.32	↓	0.226	0.13	0.02	-0.11	↓	0.542
8	-0.76	-0.03	0.73	↑	0.019	0.19	0.43	0.24	↑	0.324
9	-0.14	-0.35	-0.21	↓	0.255	-0.07	0.00	0.07	↑	0.440
10	-0.15	-0.19	-0.03	↓	0.931	0.20	0.05	-0.15	↓	0.527
11	0.35	-0.27	-0.62	↓	0.041	0.25	0.05	-0.21	↓	0.138
12	0.61	-0.21	-0.82	↓	0.016	0.13	-0.02	-0.15	↓	0.213
13	0.53	-0.11	-0.64	↓	0.048	0.04	0.14	0.10	↑	0.356
14	-0.20	-0.70	-0.50	↓	0.304	-0.07	0.31	0.37	↑	0.105
15	-0.09	-0.10	-0.01	↓	0.985	-0.22	0.24	0.46	↑	0.091
16	0.26	-0.37	-0.62	↓	0.019	0.05	0.11	0.06	↑	0.563
17	-0.69	-0.57	0.12	↑	0.778	-0.24	0.69	0.93	↑	0.020
18	-0.22	-0.19	0.02	↑	0.886	-0.11	0.06	0.18	↑	0.220
19	-0.35	-0.28	0.07	↑	0.704	0.09	0.24	0.15	↑	0.340
20	-0.07	-0.04	0.03	↑	0.874	0.03	0.10	0.07	↑	0.587
21	-0.01	-0.13	-0.12	↓	0.555	0.05	0.05	0.01	↑	0.948
22	-0.18	-0.24	-0.05	↓	0.838	0.18	0.23	0.06	↑	0.767
23	0.26	-0.13	-0.39	↓	0.118	0.02	0.04	0.02	↑	0.752
24	0.27	-0.21	-0.48	↓	0.140	0.26	-0.03	-0.29	↓	0.006

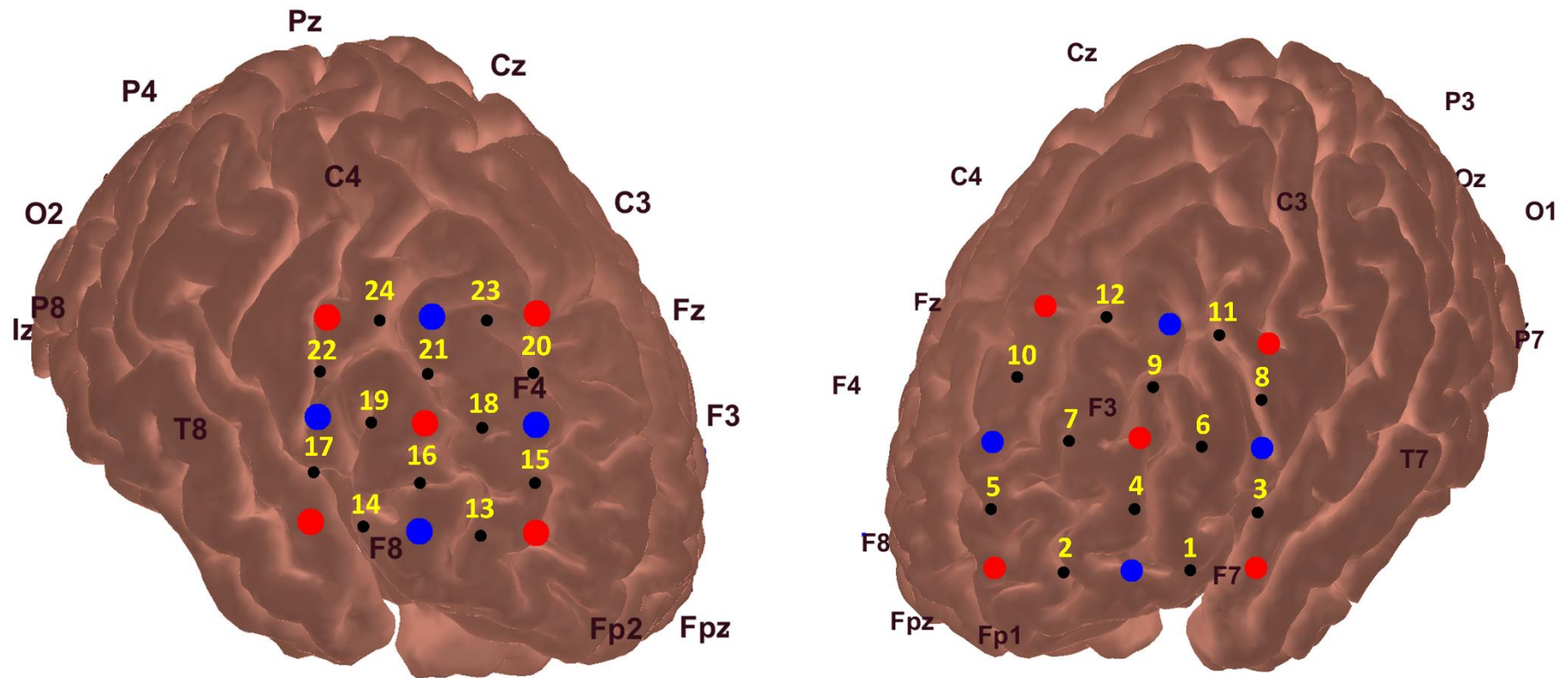
Oxygenated haemoglobin (HbO₂) and deoxygenated haemoglobin (HHb) concentrations are measured in micromoles and are averaged across subjects and across trials. Significant changes (p<0.05) in HbO₂ or HHb concentration from rest to task are highlighted in bold. ^aPaired samples t test

Channel	ΔHbO_2 (Self-Paced)	ΔHbO_2 (Time Pressure)	Change in ΔHbO_2	Direction of ΔHbO_2 change	P-value ^a
1	0.22	0.16	-0.06	↓	0.841
2	0.33	0.71	0.38	↑	0.118
3	0.33	0.72	0.39	↑	0.285
4	0.32	0.37	0.05	↑	0.835
5	0.16	0.17	0.01	↑	0.972
6	0.61	0.54	-0.06	↓	0.698
7	0.22	0.16	-0.07	↓	0.758
8	0.49	0.63	0.14	↑	0.780
9	0.45	0.18	-0.27	↓	0.068
10	0.30	0.28	-0.02	↓	0.946
11	0.72	0.45	-0.26	↓	0.136
12	0.78	0.40	-0.38	↓	0.060
13	0.15	0.31	0.17	↑	0.426
14	0.49	0.68	0.19	↑	0.591
15	0.19	0.42	0.23	↑	0.439
16	0.50	0.41	-0.09	↓	0.671
17	0.19	1.23	1.03	↑	0.097
18	0.35	0.23	-0.12	↓	0.570
19	0.95	0.68	-0.27	↓	0.165
20	0.26	-0.02	-0.27	↓	0.255
21	0.51	0.15	-0.36	↓	0.011
22	0.91	0.69	-0.23	↓	0.471
23	0.23	-0.02	-0.24	↓	0.151
24	0.77	0.53	-0.24	↓	0.046

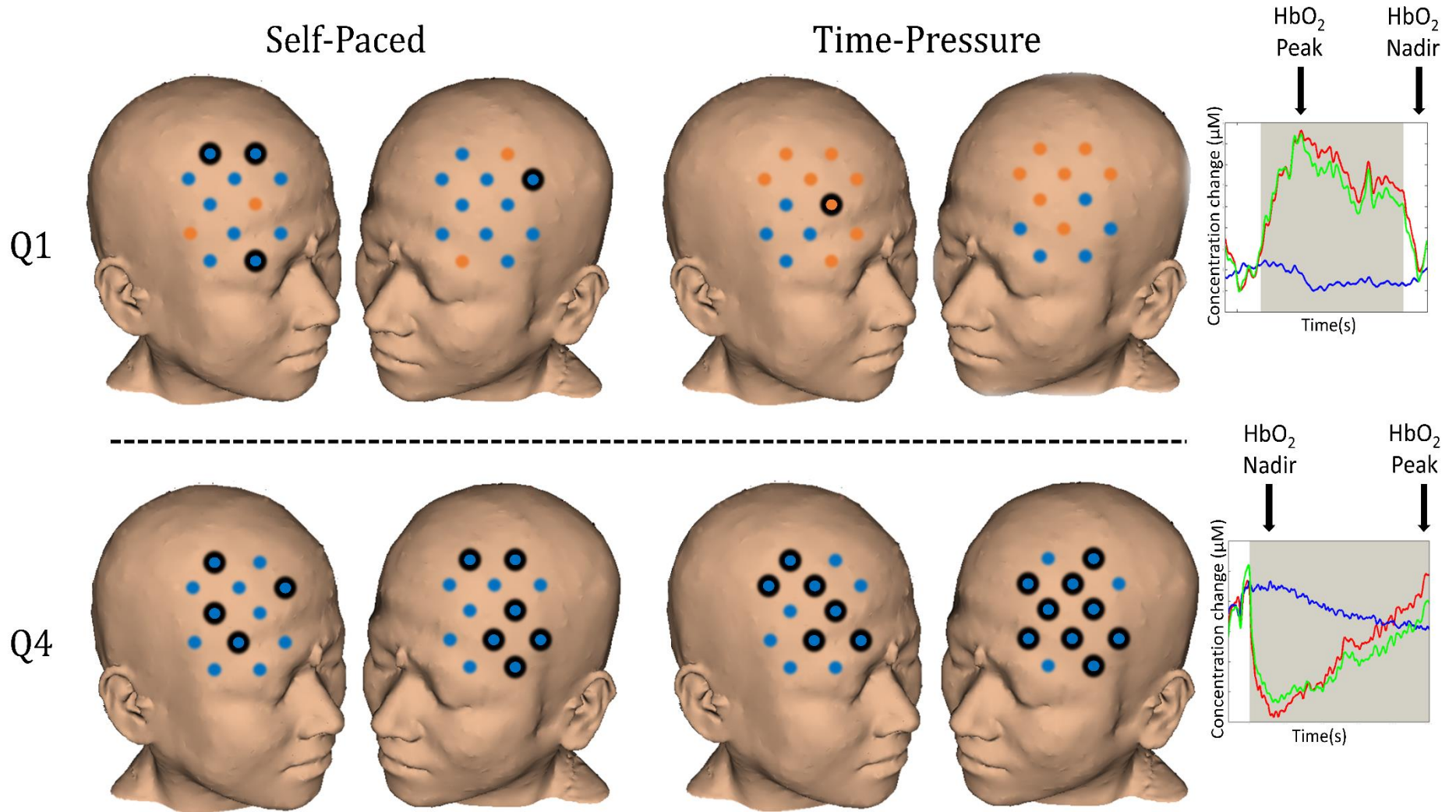
Change in oxygenated haemoglobin concentration (ΔHbO_2) is measured in micromoles and is averaged across subjects and across trials. Significant differences ($p < 0.05$) in ΔHbO_2 between conditions are highlighted in bold. ^aPaired samples t test

eTABLE 7. Differences in ΔHbO_2 between conditions in each channel among Q4 residents					
Channel	ΔHbO_2 (Self-Paced)	ΔHbO_2 (Time Pressure)	Change in ΔHbO_2	Direction of ΔHbO_2 change	P-value ^a
1	-0.64	-0.40	0.24	↑	0.613
2	-0.57	-0.35	0.22	↑	0.664
3	-0.62	0.38	1.01	↑	0.043
4	-0.20	-0.39	-0.19	↓	0.363
5	-0.29	0.04	0.33	↑	0.502
6	-0.01	0.35	0.36	↑	0.311
7	-0.10	-0.29	-0.19	↓	0.622
8	0.10	0.77	0.67	↑	0.092
9	-0.05	-0.20	-0.15	↓	0.525
10	0.16	0.07	-0.09	↓	0.823
11	-0.08	-0.56	-0.48	↓	0.142
12	-0.07	-0.73	-0.65	↓	0.053
13	-0.37	-0.65	-0.28	↓	0.434
14	0.31	-0.46	-0.77	↓	0.086
15	0.10	-0.02	-0.12	↓	0.740
16	-0.01	-0.62	-0.61	↓	0.056
17	-0.09	0.14	0.23	↑	0.626
18	-0.10	0.01	0.11	↑	0.635
19	-0.34	0.06	0.39	↑	0.219
20	0.17	0.05	-0.12	↓	0.582
21	-0.33	-0.11	0.22	↑	0.430
22	-0.10	0.01	0.11	↑	0.737
23	-0.11	-0.37	-0.26	↓	0.389
24	-0.29	-0.40	-0.11	↓	0.795

Change in oxygenated haemoglobin concentration (ΔHbO_2) is measured in micromoles and is averaged across subjects and across trials. Significant differences ($p < 0.05$) in ΔHbO_2 between conditions are highlighted in bold. ^aPaired samples t test

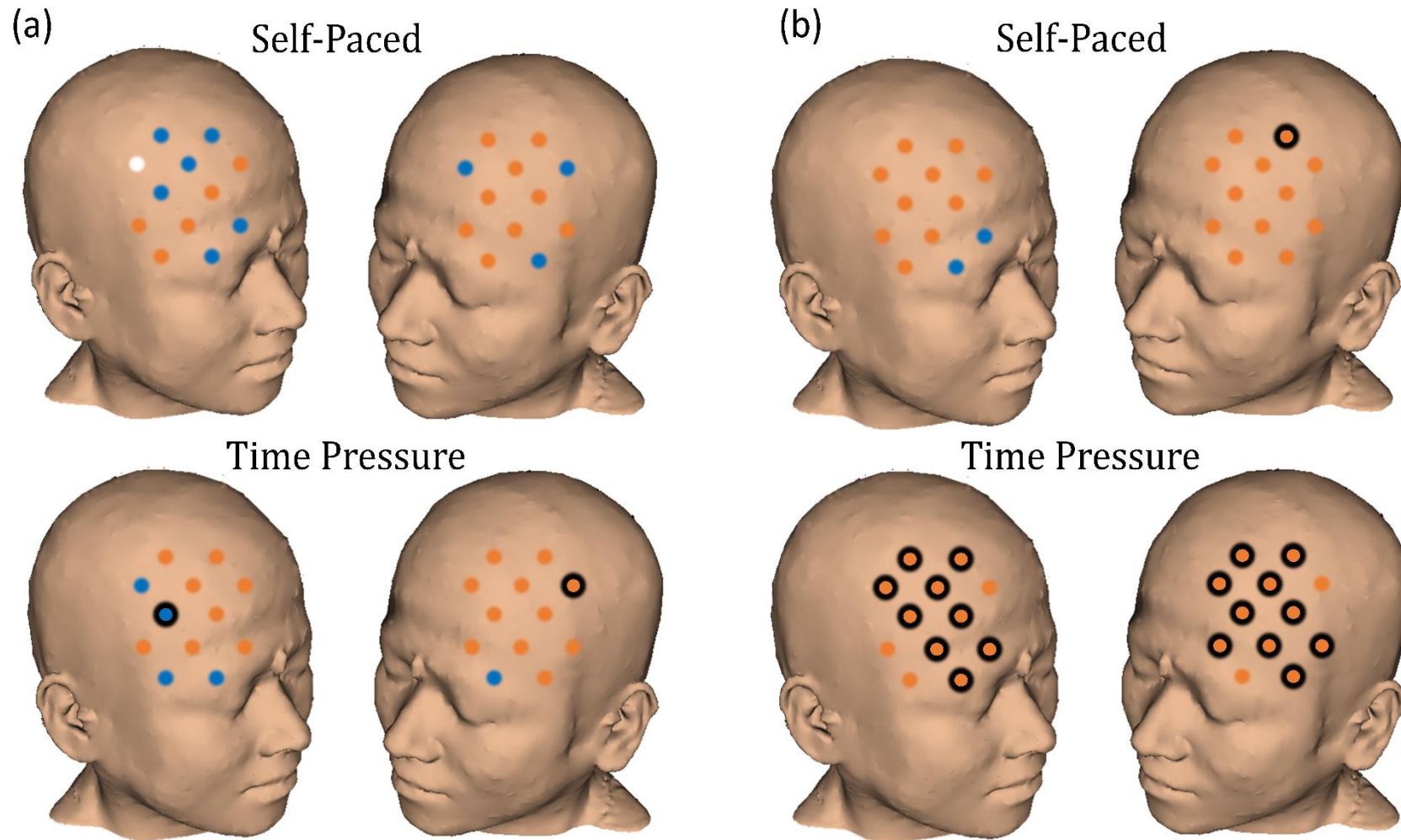


eFigure 1. Prefrontal Channel Positions. Near-infrared light emitter (red) and detector (blue) positions are aligned to the international 10-5 system of optode placement (reference points labelled in black). An emitter-detector pair constitutes a data collection 'channel' (black dots) and are labelled 1 to 24. Channel positional data were captured using a 3D electromagnetic probe-positioning digitizer (Polhemus, Hitachi Medical Corp., Japan) and projected onto a magnetic resonance image to visualise the cortical structures underlying each channel.



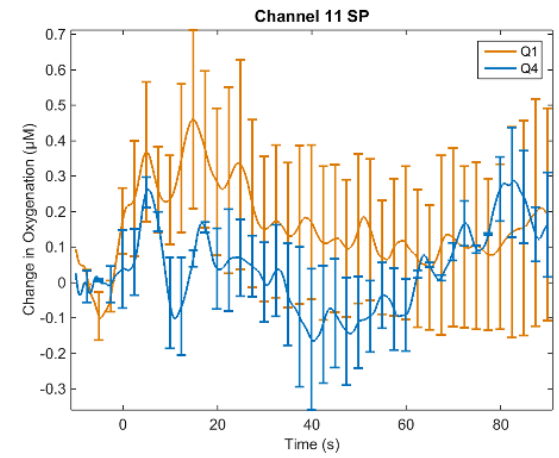
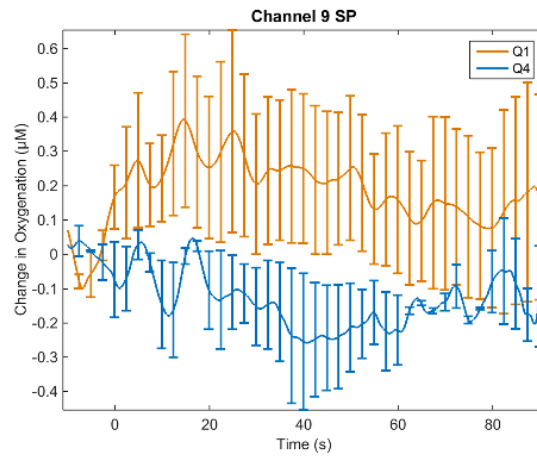
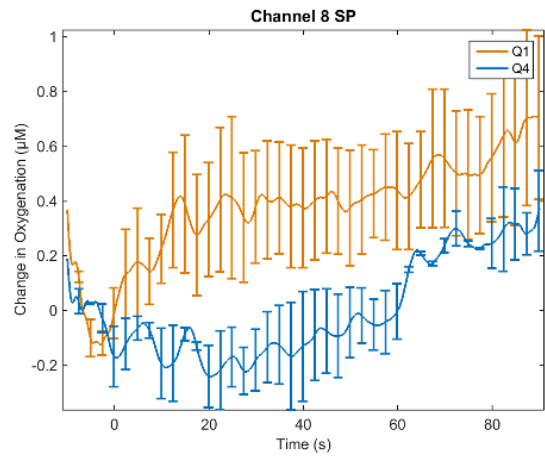
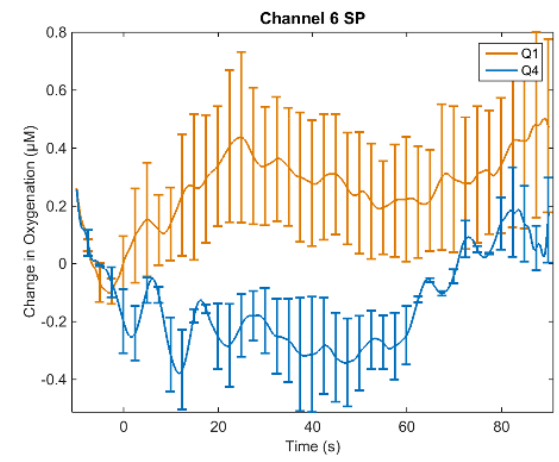
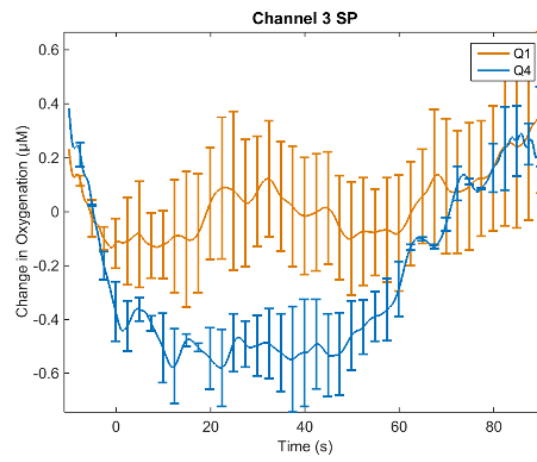
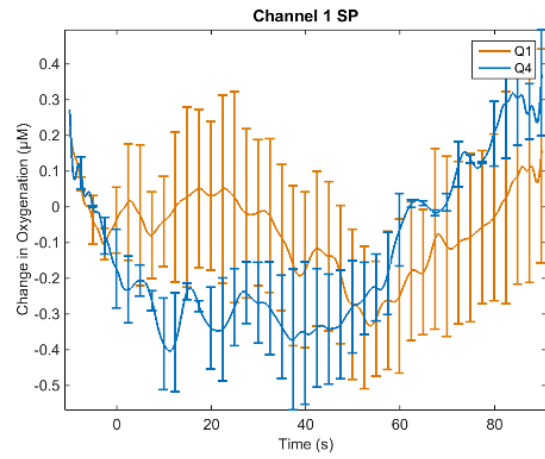
eFigure 2. Within-group comparison of time to HbO₂ concentration peak and time to HbO₂ concentration nadir. Channels in which HbO₂ concentration peaks before it reaches a nadir (i.e. an activation response) are shown in orange, and those in which HbO₂ concentration reaches its nadir earlier than its peak (i.e. a deactivation response) are shown in blue. Channels in which there was a significant difference ($p < 0.05$, Wilcoxon Signed Ranks test) between the time to peak and time to nadir are outlined (black circle). In the Q1 group, time to HbO₂ peak was shorter than the time to nadir (activation) in the bilateral VLPFC and right DLPFC during the time pressure condition. In the Q4 group, time to HbO₂ peak was longer

than the time to nadir (deactivation) in the bilateral VLPFC in the self-paced condition, and in the bilateral VLPFC and right DLPFC in the time pressure condition. Example time-courses from each group depicting the temporal relationship between HbO₂ peak and HbO₂ nadir are shown.

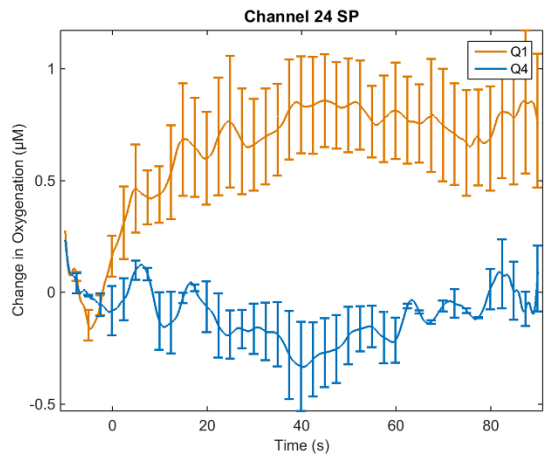
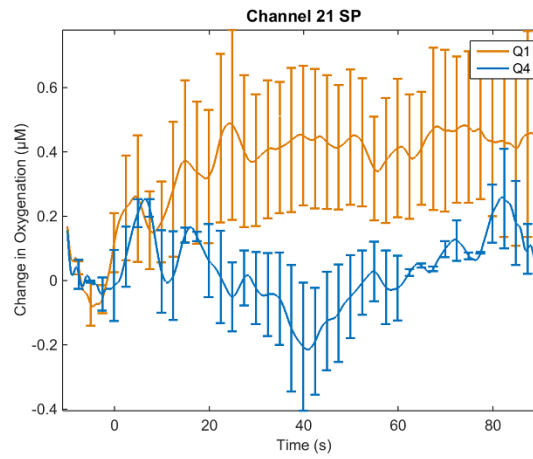
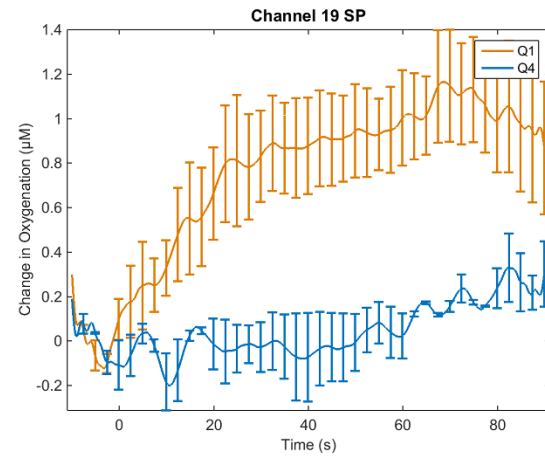
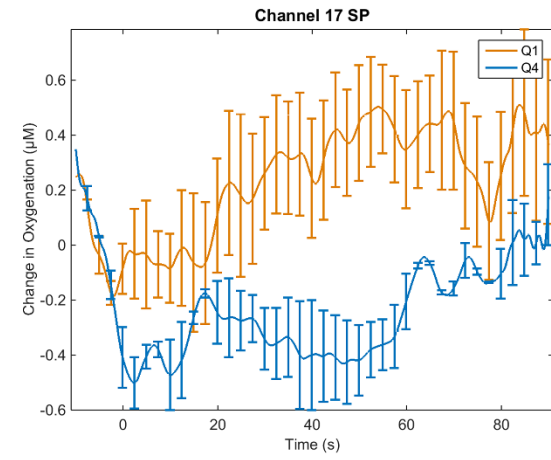
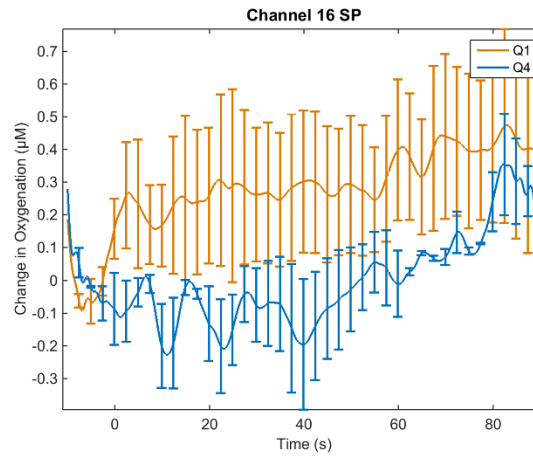
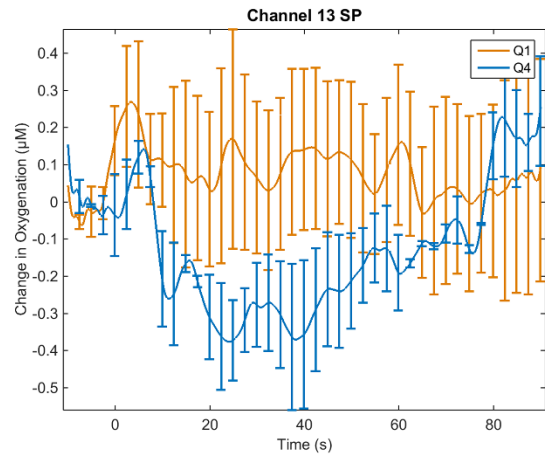


eFigure 3. Between-group comparison of time to HbO₂ concentration peak and time to HbO₂ concentration nadir. (a) Between-group comparisons of median time to HbO₂ peak. Channels in which HbO₂ concentration peaks earlier in Q1 than in Q4 are shown in orange, and those in which HbO₂ concentration peaks earlier in Q4 than in Q1 are shown in blue. Channels where time to peak is the same in both groups are coloured white. (b) Between-group comparisons of median time to HbO₂ nadir. Channels in which HbO₂ concentration reaches its nadir earlier in Q4 than in Q1 are shown in orange, and those in which HbO₂ concentration reaches a nadir earlier in Q1 than in Q4 are shown in blue. Channels where there are significant between-group differences in the time to peak or time to nadir are outlined (black circle).

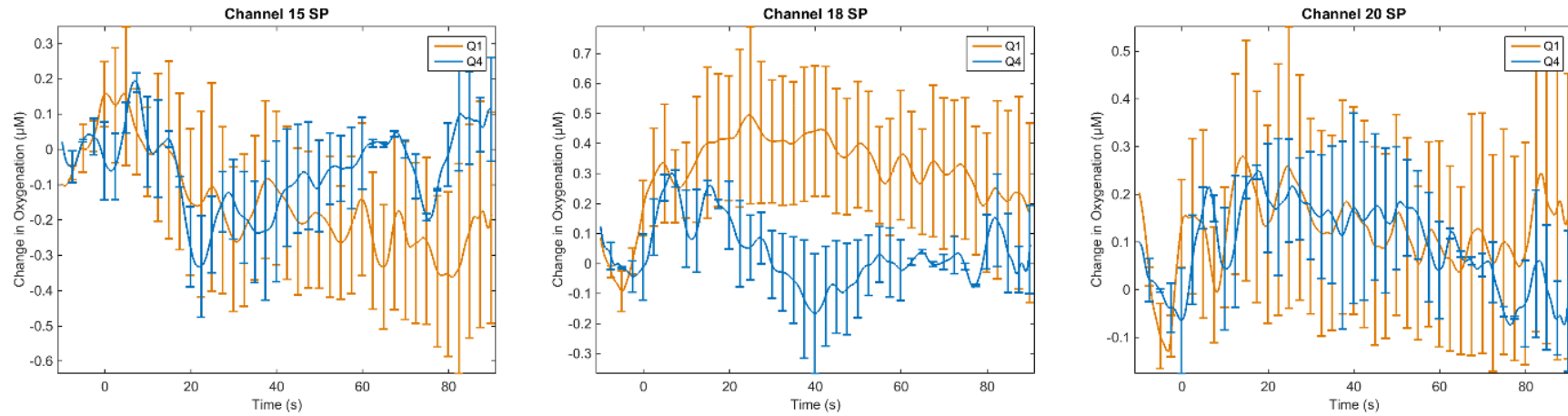
(a)



(b)

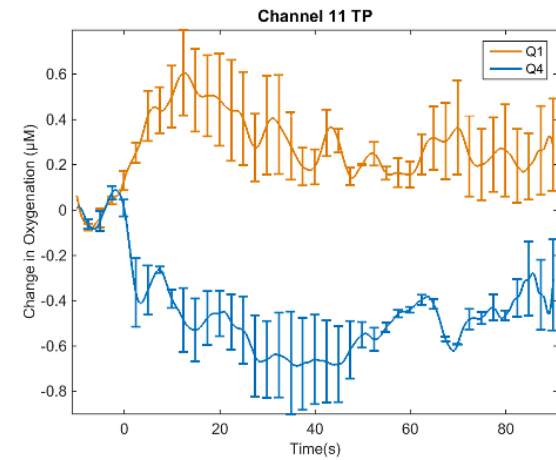
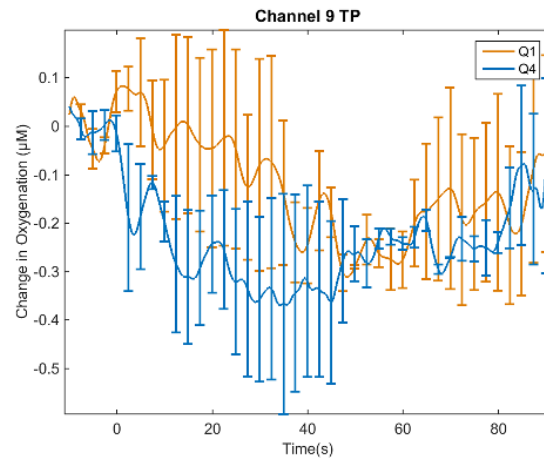
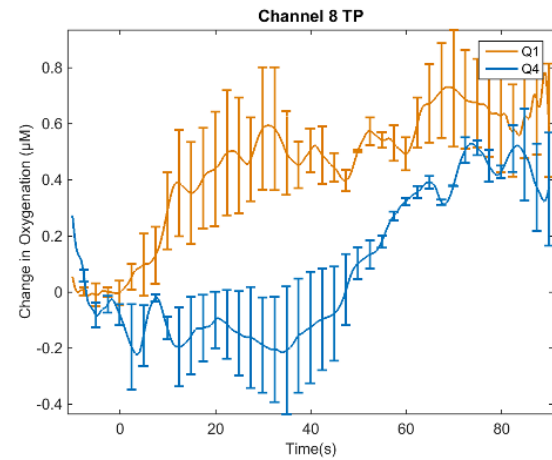
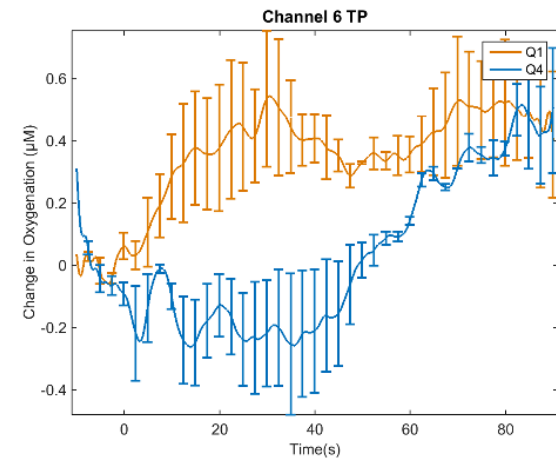
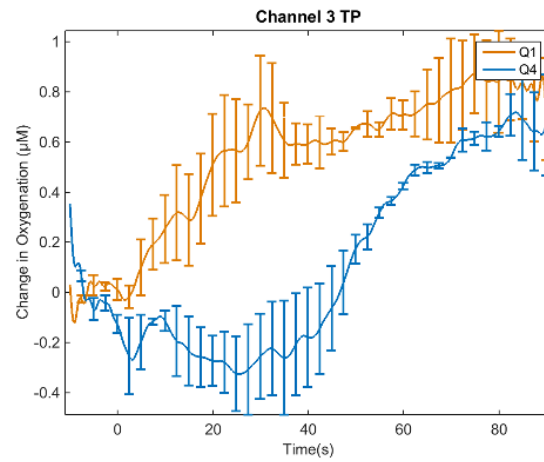
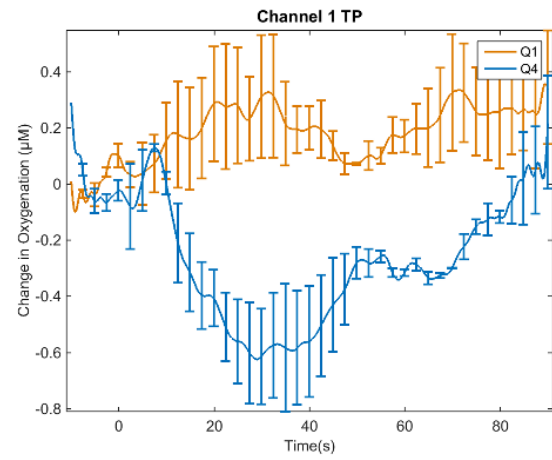


(c)

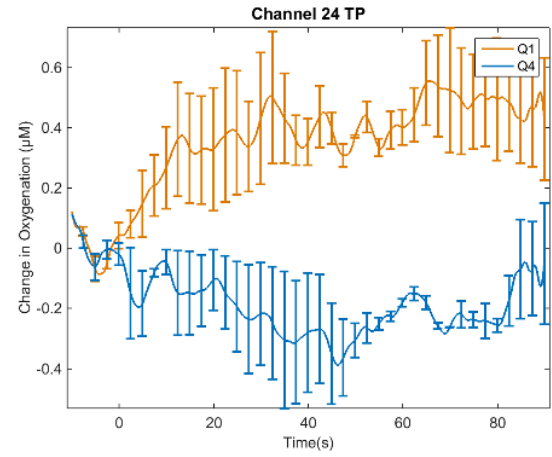
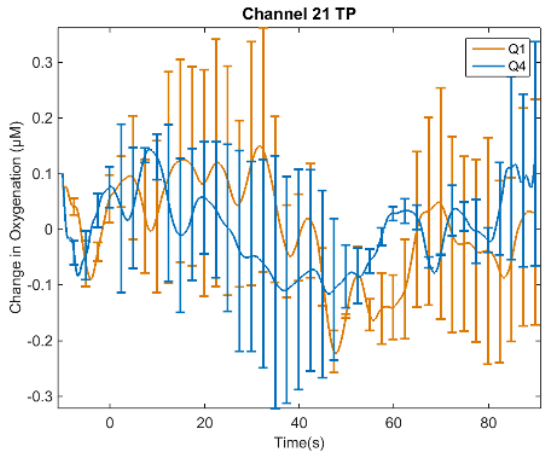
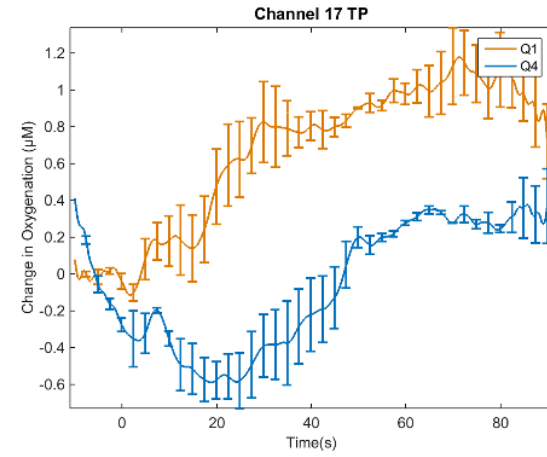
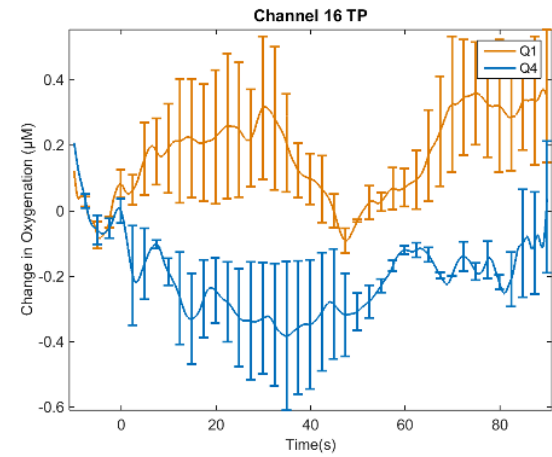
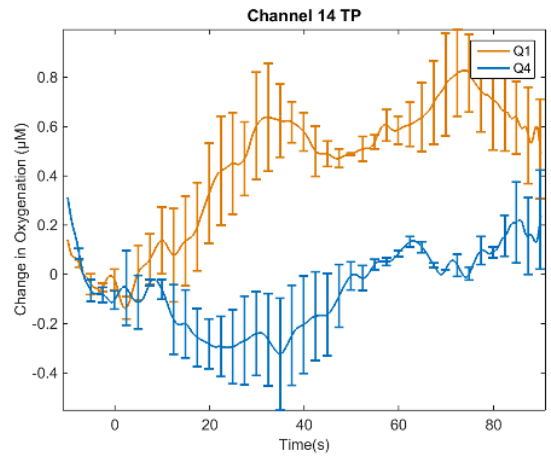
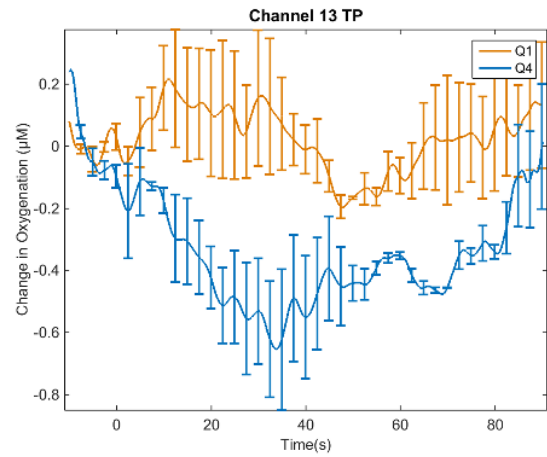


eFigure 4. Time courses demonstrating the change in oxygenated haemoglobin in individual channels in Q1 and Q4 residents during the self-paced condition. (a) left ventrolateral PFC, (b) right ventrolateral PFC, and (c) right dorsolateral PFC. Error bars represent standard deviations.

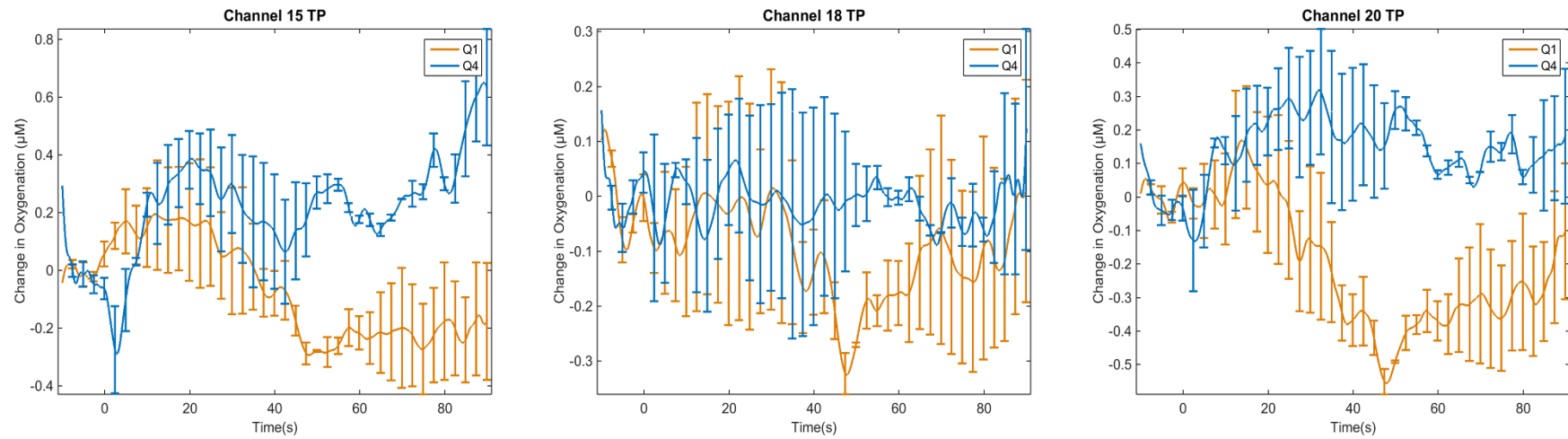
(a)



(b)



(c)



eFigure 5. Time courses demonstrating the change in oxygenated haemoglobin in individual channels in Q1 and Q4 residents during the time pressure condition. (a) left ventrolateral PFC, (b) right ventrolateral PFC, and (c) right dorsolateral PFC. Error bars represent standard deviations.