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Supplementary files

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Supplementary Figure

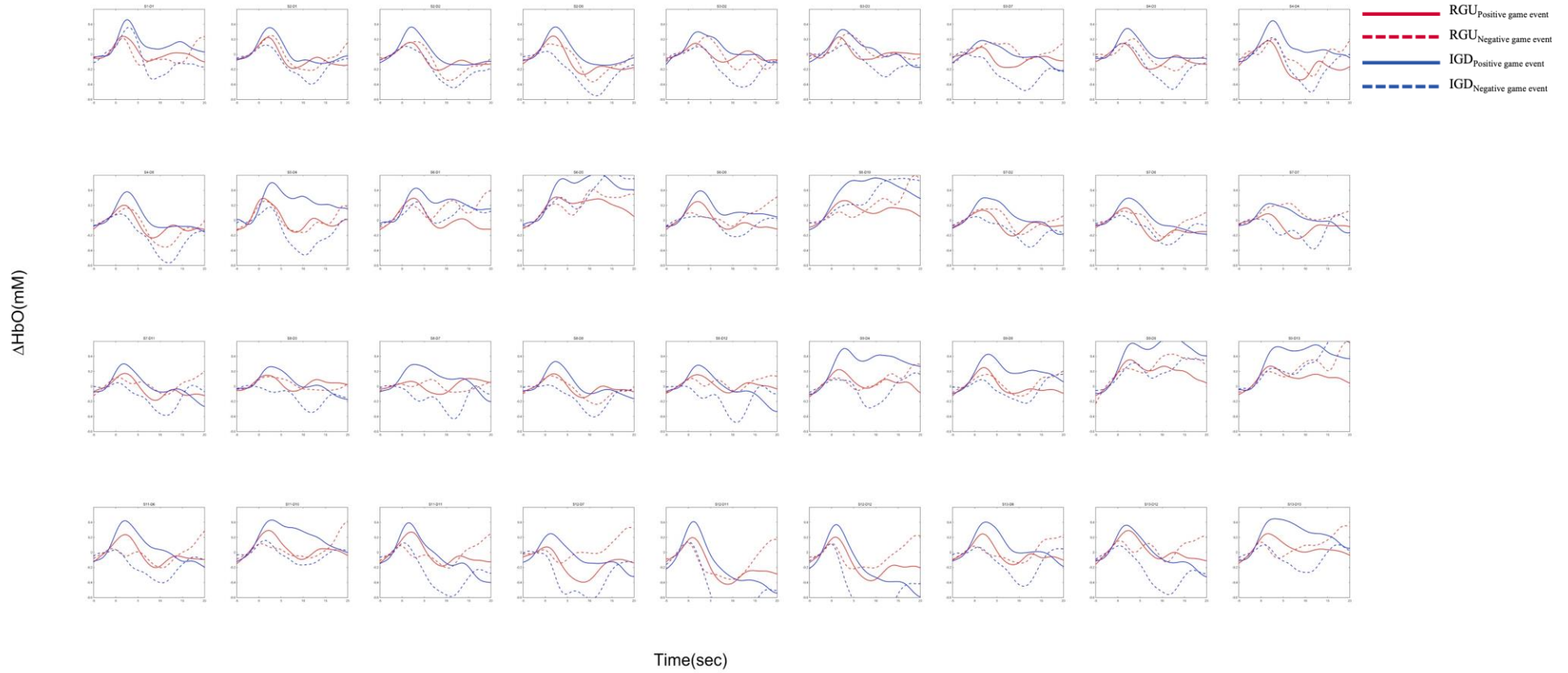


Figure S1. Average HbO response time series of each channel to positive and negative game events during solo gameplay.

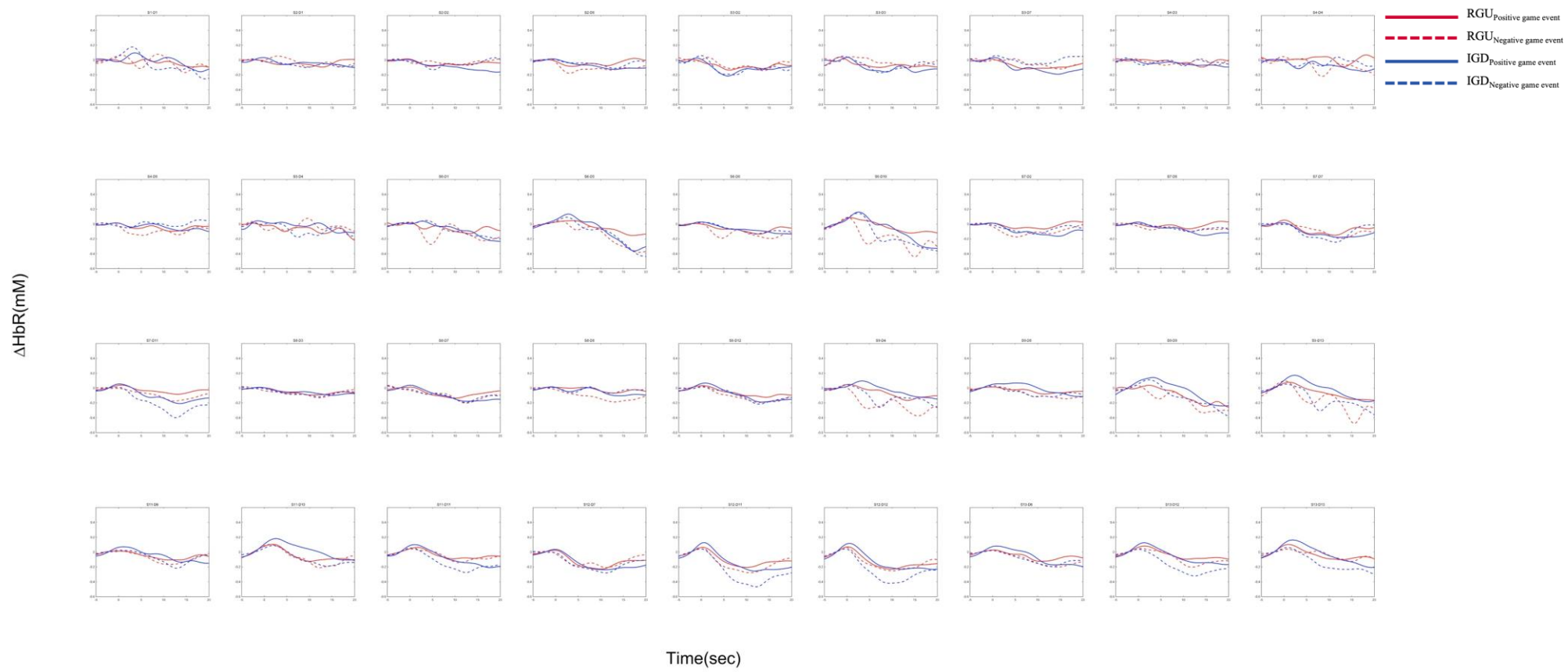


Figure S2. Average HbR response time series of each channel to positive and negative game events during solo gameplay.

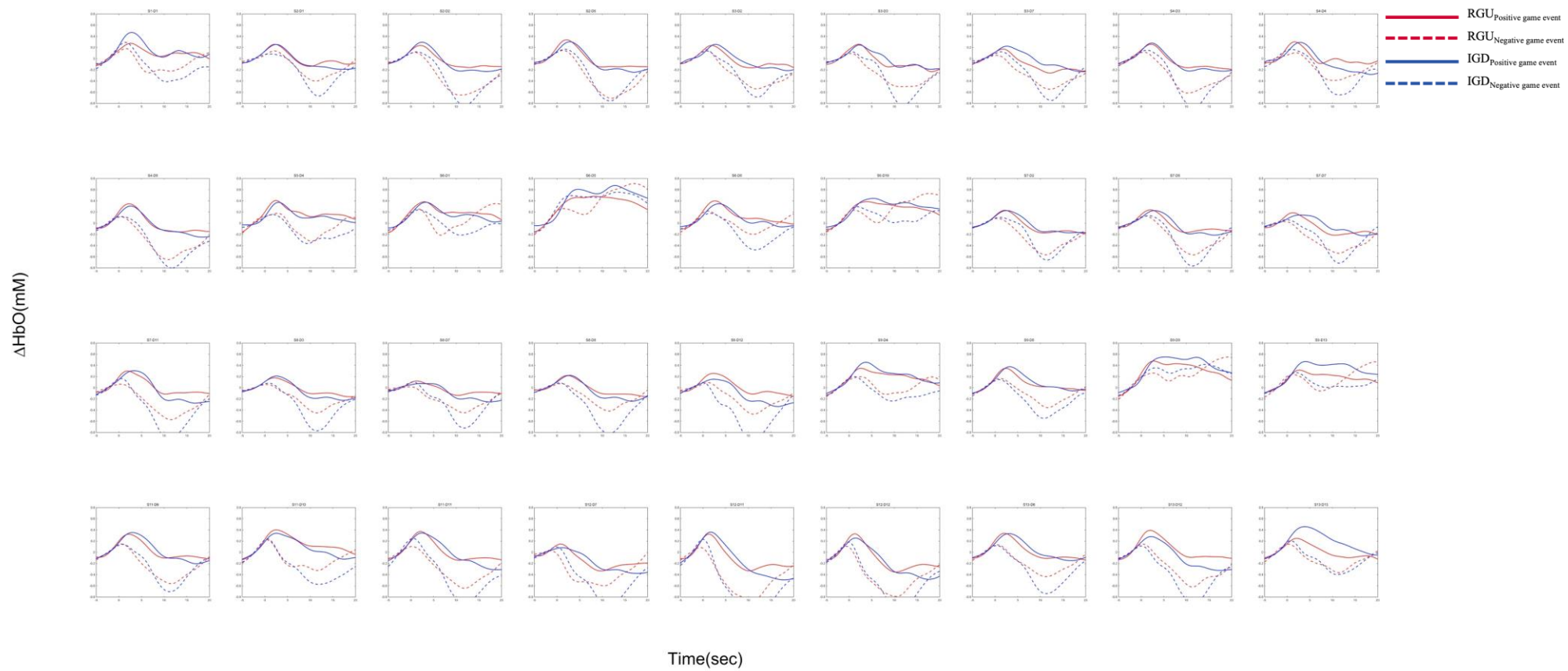


Figure S3. Average HbO response time series of each channel to positive and negative game events during multiplayer gameplay.

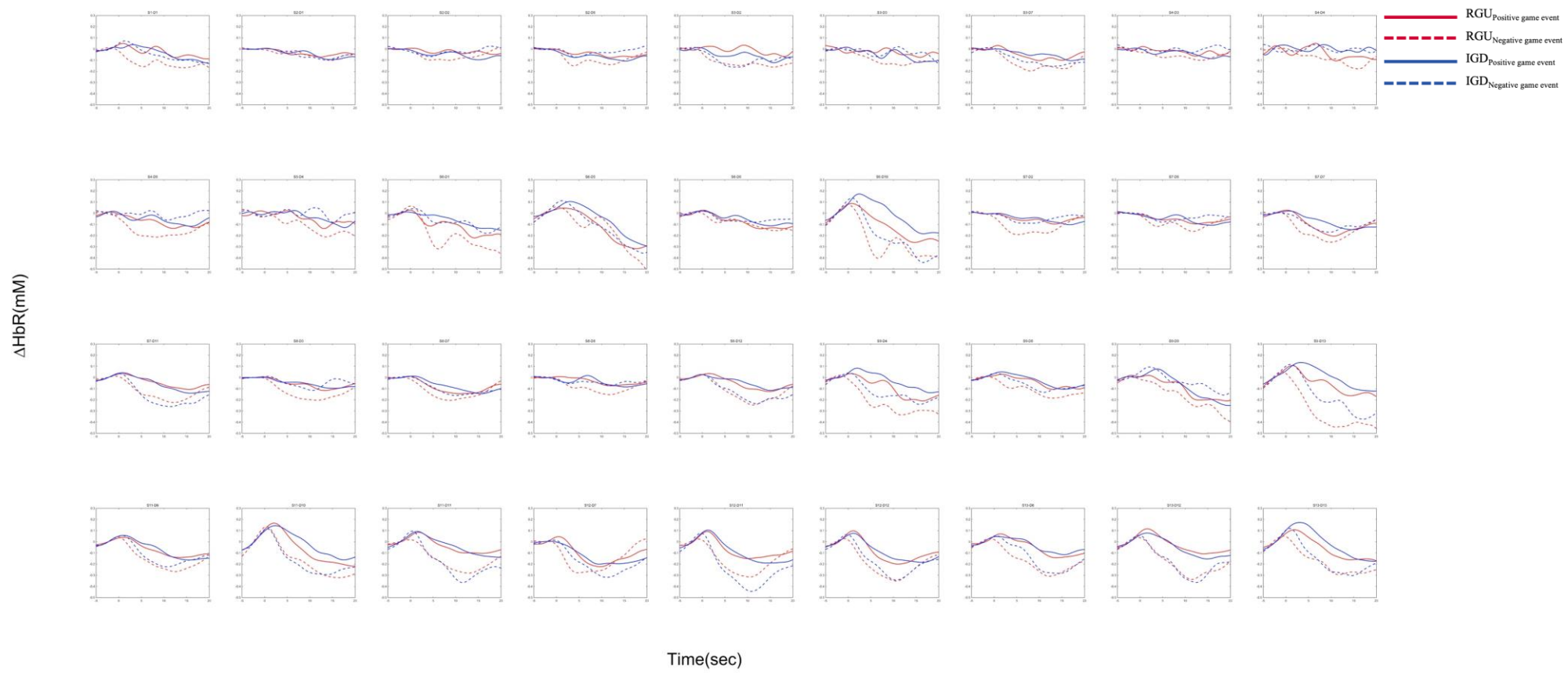


Figure S4. Average HbR response time series of each channel to positive and negative game events during multiplayer gameplay.

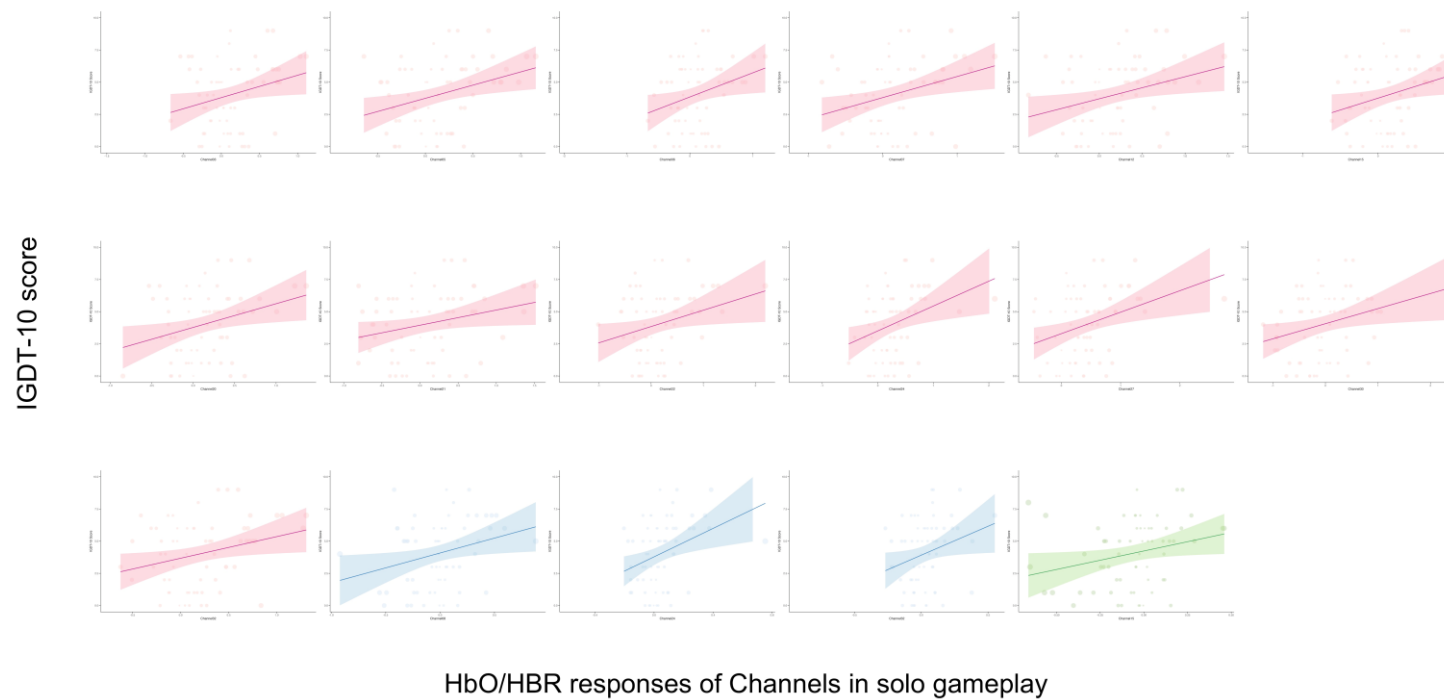


Figure S5. Linear regression between HbO/HbR responses and IGDT-10 scores during positive/negative game events in solo/multiplayer gameplay.

Note: the HbO positive responses in left dLPFC (channels 5/6/7/15/24), right dLPFC (channels 3/12), right vLPFC (channel 27), FPA (channels 20/21/22/30/32) and IGDT-10 scores during positive game events. the HbR inverse responses in left dLPFC (channel 24), left vLPFC (channel 8), FPA (channel 32) and IGDT-10 scores.

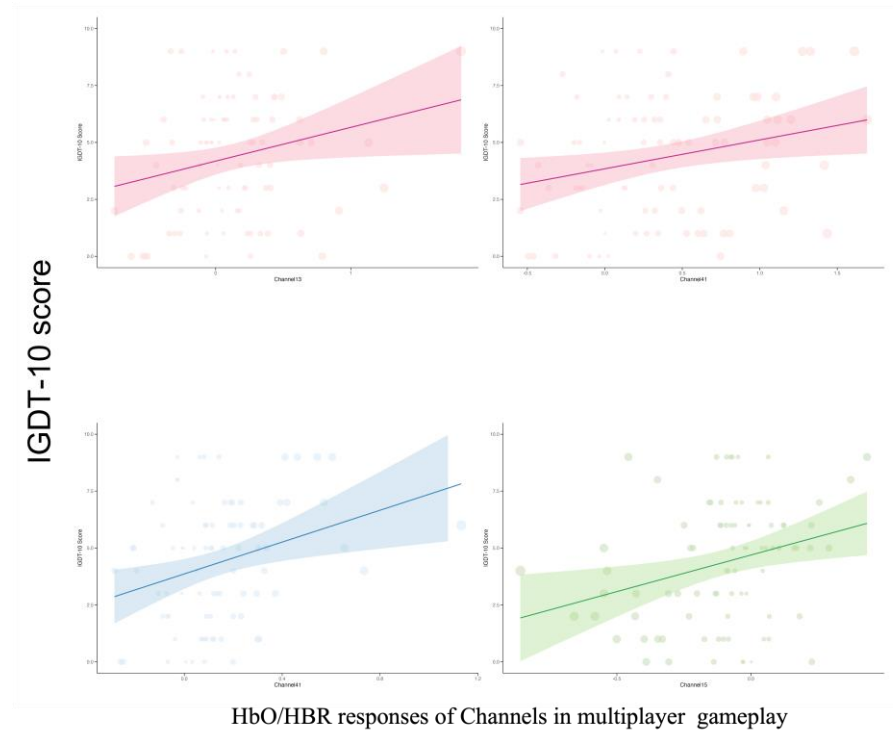


Figure S6. Linear regression between HbO/HbR responses and IGDT-10 scores during positive/negative game events in multiplayer gameplay.

Note: the HbO positive responses in channels left dLPFC (channel 41), FPA (channel 13) and IGDT-10 scores. the HbR inverse responses in left dLPFC (channel 41) and IGDT-10 scores.

Supplementary Table

Table S1. The MNI coordinate of channel locations

Channel	Cortex	MNI			Probability
		x	y	z	
01	Right ventrolateral prefrontal cortex	58	12	39	0.94
02	Right dorsolateral prefrontal cortex	45	37	40	0.65
03	Right dorsolateral prefrontal cortex	28	52	39	1
04	Right dorsolateral prefrontal cortex	13	59	39	1
05	Left dorsolateral prefrontal cortex	-10	59	40	0.84
06	Left dorsolateral prefrontal cortex	-24	52	39	1
07	Left dorsolateral prefrontal cortex	-43	36	39	0.61
08	Left ventrolateral prefrontal cortex	-56	12	36	0.99
09	Right ventrolateral prefrontal cortex	66	4	28	1
10	Right ventrolateral prefrontal cortex	53	33	30	0.97
11	Right dorsolateral prefrontal cortex	38	52	30	0.93
12	Right dorsolateral prefrontal cortex	20	63	30	0.40
13	frontopolar area	4	63	30	0.83
14	Left dorsolateral prefrontal cortex	-17	63	30	0.36
15	Left dorsolateral prefrontal cortex	-37	53	29	0.93
16	Left ventrolateral prefrontal cortex	-50	36	27	0.99
17	Left ventrolateral prefrontal cortex	-63	8	24	1
18	Right ventrolateral prefrontal cortex	61	25	20	1
19	Right dorsolateral prefrontal cortex	48	48	23	0.54
20	frontopolar area	31	63	22	0.60
21	frontopolar area	14	69	24	1
22	frontopolar area	-11	69	22	1
23	frontopolar area	-28	63	21	0.57
24	Left dorsolateral prefrontal cortex	-45	49	21	0.53
25	Left ventrolateral prefrontal cortex	-59	25	17	1
26	Right ventrolateral prefrontal cortex	64	7	6	1
27	Right ventrolateral prefrontal cortex	57	39	9	0.96
28	frontopolar area	42	60	11	0.51
29	frontopolar area	23	71	13	1.00
30	frontopolar area	2	68	13	1.00
31	frontopolar area	-20	71	12	1.00
32	frontopolar area	-39	60	10	0.59
33	Left ventrolateral prefrontal cortex	-53	42	4	0.72
34	Left ventrolateral prefrontal cortex	-60	9	0	1
35	Right ventrolateral prefrontal cortex	58	25	-1	1
36	Right dorsolateral prefrontal cortex	51	50	-1	0.92

37	orbitofrontal cortex	34	67	3	0.35
38	orbitofrontal cortex	14	74	5	0.09
39	orbitofrontal cortex	-13	74	4	0.13
40	orbitofrontal cortex	-34	65	0	0.34
41	Left dorsolateral prefrontal cortex	-49	50	-3	0.94
42	Left ventrolateral prefrontal cortex	-52	24	-8	1

Table S2. ANOVA results of HbO responses in solo gameplay

	Class main effect		Game event main effect		Interaction	
	<i>F</i>	<i>P</i> (FDR)	<i>F</i>	<i>p</i> (FDR)	<i>F</i>	<i>p</i> (FDR)
CH 01	0.97	0.965	0.16	0.753	0.09	0.770
CH 02	0.05	0.965	1.71	0.261	8.19	0.023
CH 03	0.42	0.965	0.53	0.565	6.80	0.028
CH 04	0.00	0.965	0.28	0.699	10.90	0.012
CH 05	0.15	0.965	0.02	0.883	11.81	0.010
CH 06	0.55	0.965	0.24	0.701	6.82	0.028
CH 07	2.60	0.965	1.70	0.261	6.10	0.036
CH 08	0.08	0.965	10.83	0.012	7.18	0.028
CH 10	0.70	0.965	3.05	0.135	0.68	0.435
CH 11	0.13	0.965	4.14	0.092	7.68	0.027
CH 12	0.15	0.965	1.51	0.281	10.10	0.014
CH 13	0.29	0.965	0.07	0.814	14.51	0.005
CH 14	0.03	0.965	2.35	0.196	4.78	0.054
CH 15	0.03	0.965	3.74	0.104	7.50	0.027
CH 16	1.90	0.965	9.80	0.012	3.20	0.109
CH 18	1.92	0.965	5.58	0.050	0.57	0.467
CH 19	0.41	0.965	4.85	0.070	1.62	0.240
CH 20	0.19	0.965	1.49	0.281	6.33	0.034
CH 21	0.14	0.965	0.10	0.799	14.00	0.005
CH 22	0.03	0.965	4.31	0.089	9.50	0.016
CH 23	0.00	0.965	3.32	0.125	5.58	0.038
CH 24	0.27	0.965	9.12	0.014	9.05	0.017
CH 25	1.45	0.965	6.21	0.041	0.97	0.359
CH 27	4.00	0.965	10.00	0.012	1.00	0.359
CH 28	0.03	0.965	10.88	0.012	6.08	0.036
CH 29	0.04	0.965	2.04	0.229	3.82	0.086
CH 30	0.01	0.965	6.16	0.041	15.64	0.005
CH 31	0.21	0.965	3.07	0.135	2.17	0.184
CH 32	0.24	0.965	11.29	0.012	5.93	0.036
CH 33	1.70	0.965	4.00	0.097	2.10	0.184
CH 36	0.02	0.965	8.57	0.016	3.21	0.109
CH 37	0.63	0.965	8.93	0.014	2.98	0.119
CH 38	0.24	0.965	9.76	0.012	5.05	0.048
CH 39	0.04	0.965	10.62	0.012	5.70	0.038
CH 40	1.30	0.965	6.80	0.033	2.10	0.184
CH 41	0.37	0.965	15.36	0.008	3.61	0.093

Note: *p* (FDR) is the *p* corrected by FDR. The Class main effect refers to the main effect comparing differences between groups (IGD group vs. RGU group). The Game event main effect refers to the main effect comparing differences between game events (positive vs. negative events). The Interaction represents the interaction effect between class and game event. As below.

Table S3. Post-test results in ANOVA of HbO responses in solo gameplay.

	<i>M (SE)</i> Positive game events		<i>M (SE)</i> Negative game events		Positive game events		Negative game events	
	IGD	RGU	IGD	RGU	<i>t</i>	Cohen's d	<i>t</i>	Cohen's d
CH02	0.25(0.06)	0.03(0.06)	-0.04(0.09)	0.14(0.09)	-2.69**	-0.39	1.39	0.33
CH03	0.27(0.07)	0.01(0.07)	0.02(0.11)	0.15(0.11)	-2.80**	-0.44	0.82	0.22
CH04	0.31(0.07)	0.03(0.07)	-0.01(0.11)	0.26(0.11)	-2.64*	-0.42	1.74	0.41
CH05	0.28(0.06)	0.01(0.07)	0.04(0.10)	0.23(0.11)	-2.84**	-0.51	1.30	0.36
CH06	0.23(0.06)	-0.03(0.06)	0.00(0.10)	0.13(0.10)	-2.91**	-0.45	0.87	0.21
CH07	0.34(0.08)	-0.05(0.08)	0.04(0.11)	0.04(0.11)	-3.28**	-0.61	0.05	0.01
CH12	0.34(0.07)	0.05(0.08)	-0.01(0.10)	0.20(0.10)	-2.75**	-0.46	1.46	0.34
CH13	0.18(0.07)	-0.07(0.08)	-0.15(0.10)	0.21(0.10)	-2.35*	-0.40	2.54*	0.56
CH15	0.27(0.06)	0.04(0.07)	-0.09(0.1)	0.10(0.11)	-2.47*	-0.37	1.32	0.32
CH20	0.27(0.07)	0.02(0.07)	-0.04(0.11)	0.12(0.11)	-2.52*	-0.39	1.01	0.25
CH21	0.24(0.09)	-0.08(0.10)	-0.16(0.14)	0.26(0.15)	-2.33*	-0.40	2.02*	0.54
CH22	0.31(0.09)	0.00(0.1)	-0.18(0.13)	0.09(0.14)	-2.39*	-0.42	1.40	0.36
CH24	0.42(0.07)	0.13(0.07)	-0.05(0.11)	0.13(0.11)	-2.80**	-0.47	1.17	0.29
CH30	0.17(0.10)	-0.23(0.11)	-0.51(0.16)	-0.07(0.16)	-2.84**	-0.48	1.95	0.51
CH32	0.35(0.07)	0.09(0.07)	-0.15(0.11)	0.01(0.12)	-2.56*	-0.39	0.94	0.23
CH38	0.19(0.10)	-0.13(0.11)	-0.40(0.16)	-0.23(0.16)	-2.15*	-0.37	0.77	0.20

Note: ** $p < 0.01$, * $p < 0.05$. Table S3 showed the post-hoc tests for channels with significant interaction effects between class and game event during solo gameplay. Since this study primarily focuses on the differences between the IGD and RGU groups under different game events, the game event was held constant.

Table S4. ANOVA results of HbR responses in solo gameplay.

	Class main effect		Game event main effect		Interaction	
	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
CH01	0.68	0.410	0.27	0.610	0.00	0.950
CH02	1.20	0.277	1.30	0.251	4.10	0.048
CH03	1.84	0.180	0.01	0.941	2.91	0.093
CH04	1.04	0.310	0.12	0.730	0.04	0.840
CH05	1.36	0.250	1.98	0.160	0.03	0.870
CH06	0.00	0.960	0.05	0.820	0.21	0.650
CH07	0.49	0.490	0.02	0.880	0.02	0.890
CH08	1.52	0.220	0.38	0.540	0.53	0.470
CH10	5.70	0.021	1.40	0.248	2.70	0.106
CH11	1.63	0.210	0.22	0.640	0.74	0.390
CH12	0.08	0.770	2.04	0.160	2.61	0.110
CH13	3.71	0.059	1.20	0.277	0.34	0.563
CH14	0.01	0.910	0.93	0.340	0.19	0.670
CH15	7.40	0.008	1.80	0.189	2.80	0.097
CH16	2.16	0.146	7.90	0.007	0.35	0.559
CH18	0.56	0.460	1.83	0.180	0.05	0.820
CH19	3.80	0.056	1.20	0.273	1.40	0.242
CH20	0.01	0.920	0.32	0.580	0.47	0.490
CH21	1.38	0.250	0.00	0.980	1.23	0.270
CH22	0.08	0.780	0.59	0.450	0.32	0.580
CH23	0.30	0.586	7.60	0.008	3.30	0.074
CH24	2.00	0.162	3.80	0.055	2.80	0.099
CH25	4.41	0.040	2.64	0.110	0.07	0.790
CH27	2.50	0.120	4.80	0.032	2.00	0.163
CH28	0.86	0.360	0.37	0.540	0.33	0.570
CH29	1.12	0.294	4.46	0.039	0.53	0.467
CH30	0.12	0.730	1.48	0.230	0.83	0.370
CH31	1.26	0.270	2.45	0.120	0.46	0.500
CH32	0.51	0.480	4.69	0.034	1.68	0.199
CH33	1.17	0.283	6.55	0.013	0.10	0.754
CH36	0.59	0.446	3.04	0.086	1.75	0.190
CH37	0.55	0.460	1.15	0.290	4.00	0.050
CH38	0.25	0.618	8.55	0.005	1.89	0.174
CH39	0.00	0.992	8.36	0.005	4.04	0.049
CH40	0.67	0.417	4.67	0.035	3.76	0.057
CH41	0.05	0.829	6.26	0.015	2.49	0.120

Note: the *p* value after FDR correction is not significant ($p(\text{FDR}) > 0.05$), only the uncorrected *p* value is reported.

Table S5. ANOVA results of HbO responses in multiplayer gameplay.

	Class main effect		Game event main effect		Interaction	
	<i>F</i>	<i>p</i> (FDR)	<i>F</i>	<i>p</i> (FDR)	<i>F</i>	<i>p</i> (FDR)
CH01	2.03	0.804	17.83	<0.001	0.01	0.960
CH02	0.23	0.850	5.81	0.02	0.01	0.960
CH03	2.26	0.804	14.58	0.001	0.29	0.954
CH04	1.12	0.804	12.98	0.001	0.21	0.954
CH05	2.00	0.804	8.50	0.006	0.19	0.954
CH06	1.03	0.804	8.93	0.005	0.85	0.954
CH07	1.87	0.804	3.19	0.083	0.12	0.954
CH08	0.08	0.850	5.83	0.02	0.07	0.954
CH10	0.17	0.850	11.77	0.002	0.51	0.954
CH11	0.77	0.850	13.86	0.001	0.61	0.954
CH12	2.35	0.804	11.61	0.002	0.62	0.954
CH13	2.68	0.804	10.51	0.002	0.19	0.954
CH14	0.00	0.980	12.22	0.001	0.16	0.954
CH15	0.25	0.850	20.97	<0.001	0.35	0.954
CH16	0.11	0.850	11.04	0.002	0.28	0.954
CH18	1.35	0.804	3.04	0.087	0.59	0.954
CH19	0.22	0.850	11.14	0.002	0.14	0.954
CH20	0.95	0.804	9.29	0.004	0.04	0.960
CH21	1.55	0.804	14.77	0.001	0.29	0.954
CH22	0.40	0.850	14.84	0.001	0.08	0.954
CH23	0.09	0.850	16.98	<0.001	0.52	0.954
CH24	0.00	0.980	21.00	<0.001	2.20	0.954
CH25	0.65	0.850	2.47	0.120	0.11	0.954
CH27	0.16	0.850	7.69	0.008	0.07	0.954
CH28	1.08	0.804	26.17	<0.001	0.01	0.960
CH29	0.12	0.850	24.76	<0.001	0.13	0.954
CH30	0.43	0.850	28.08	<0.001	0.79	0.954
CH31	1.45	0.804	20.04	<0.001	0.39	0.954
CH32	0.17	0.850	27.57	<0.001	0.21	0.954
CH33	0.94	0.804	5.68	0.021	0.69	0.954
CH36	0.02	0.953	30.74	<0.001	0.63	0.954
CH37	0.24	0.850	24.67	<0.001	0.02	0.960
CH38	0.17	0.850	34.06	<0.001	0.39	0.954
CH39	0.32	0.850	34.83	<0.001	0.34	0.954
CH40	0.64	0.850	28.08	<0.001	0.00	0.960
CH41	1.90	0.804	24.60	<0.001	1.30	0.954

Note: *p*(FDR) is the *p* corrected by FDR.

Table S6. ANOVA results of HbR responses in multiplayer gameplay.

	Class main effect		Game event main effect		Interaction	
	<i>F</i>	<i>p</i> (FDR)	<i>F</i>	<i>p</i> (FDR)	<i>F</i>	<i>p</i> (FDR)
CH01	5.45	0.132	2.75	0.130	0.94	0.859
CH02	0.22	0.922	0.09	0.770	0.10	0.871
CH03	0.00	0.998	3.20	0.109	0.98	0.859
CH04	0.52	0.785	8.93	0.009	0.04	0.890
CH05	0.50	0.785	0.93	0.371	0.00	0.990
CH06	0.43	0.803	2.79	0.130	1.32	0.839
CH07	0.04	0.927	2.53	0.149	0.71	0.871
CH08	0.96	0.625	2.04	0.192	2.37	0.834
CH10	10.40	0.032	4.20	0.072	1.20	0.839
CH11	0.15	0.927	3.30	0.105	3.81	0.816
CH12	5.50	0.132	12.80	0.002	2.80	0.834
CH13	1.30	0.555	3.60	0.096	1.20	0.839
CH14	2.10	0.384	3.50	0.096	2.20	0.834
CH15	14.30	0.011	6.60	0.023	9.10	0.119
CH16	5.05	0.141	15.72	0.001	0.21	0.871
CH18	2.00	0.384	1.70	0.221	0.20	0.871
CH19	0.16	0.927	0.36	0.566	0.30	0.871
CH20	0.27	0.915	1.33	0.281	0.15	0.871
CH21	3.21	0.276	8.40	0.011	0.65	0.871
CH22	2.45	0.338	4.67	0.058	0.37	0.871
CH23	0.11	0.927	5.81	0.032	1.35	0.839
CH24	2.85	0.312	7.13	0.018	0.45	0.871
CH25	2.55	0.330	0.73	0.413	0.28	0.871
CH27	9.07	0.041	27.23	<0.001	0.19	0.871
CH28	0.63	0.772	11.03	0.003	0.03	0.890
CH29	0.00	0.977	17.97	<0.001	0.11	0.871
CH30	1.00	0.625	13.70	0.001	3.40	0.816
CH31	0.00	0.977	8.28	0.011	0.08	0.871
CH32	3.50	0.258	11.10	0.003	1.70	0.839
CH33	6.20	0.132	12.90	0.002	0.30	0.871
CH36	0.04	0.927	22.56	<0.001	0.42	0.871
CH37	0.10	0.927	19.16	<0.001	0.04	0.890
CH38	0.07	0.927	22.99	<0.001	0.47	0.871
CH39	1.50	0.495	21.20	<0.001	1.60	0.839
CH40	0.04	0.927	19.87	<0.001	0.14	0.871
CH41	3.87	0.234	21.28	<0.001	0.48	0.871

Note: *p* (FDR) is the *p* corrected by FDR.

Table S7. Regression analysis of HbO/HbR responses and IGDT-10 score in solo gameplay.

	<i>b</i>	<i>SD</i>	<i>t</i>	<i>r</i> ²
HbO responses during positive game events				
CH03	1.74	0.81	2.14*	0.07
CH05	2.21	0.77	2.88*	0.12
CH06	2.00	0.83	2.43*	0.09
CH07	1.71	0.63	2.73*	0.11
CH12	1.78	0.72	2.48*	0.09
CH15	1.90	0.83	2.27*	0.08
CH20	1.92	0.77	2.48*	0.09
CH21	1.24	0.58	2.13*	0.07
CH22	1.32	0.58	2.27*	0.08
CH24	1.97	0.72	2.72*	0.11
CH27	1.72	0.59	2.90*	0.12
CH30	1.17	0.51	2.29*	0.08
CH32	1.80	0.75	2.41*	0.09
HbR responses during positive game events				
CH08	2.36	1.03	2.30*	0.08
CH24	5.74	1.97	2.91*	0.12
CH32	4.72	2.13	2.22*	0.07
HbR responses during negative game events				
CH15	2.89	1.38	2.10*	0.07

Note: * $p < 0.05$. Table S7 presents only the results where HbO and HbR were significantly associated with IGDT-10 scores during positive/negative game events in solo gameplay.

Table S8. Regression analysis of HbO/HbR responses and IGDT-10 scores in multiplayer gameplay.

	<i>b</i>	<i>SD</i>	<i>t</i>	<i>r</i> ²
HbO responses during positive game events				
CH13	1.49	0.69	2.15*	0.05
CH41	1.31	0.54	2.41*	0.07
HbR responses during positive game events				
CH41	3.52	1.24	2.84*	0.09
HbR responses during negative game events				
CH12	3.24	1.39	2.33*	0.06
CH15	3.45	1.22	2.83*	0.09

Note: * $p < 0.05$. Table S8 presents only the results where HbO and HbR were significantly associated with IGDT-10 scores during positive/negative game events in multiplayer gameplay.

Supplementary data

Comparative analysis of solo and multiplayer gameplay experiences

This study further compared the subjective evaluations of 403 Honor of Kings players regarding different aspects of gameplay modes (solo vs. multiplayer), including frequency of gameplay, level of complexity, degree of preference, level of enjoyment, and level of excitement. The results indicated that the ratio of players who primarily chose solo gameplay to those who selected multiplayer gameplay was 1:25.87. Across all evaluated dimensions—frequency of gameplay, complexity, preference, enjoyment, and excitement—the multiplayer mode was rated significantly higher than the solo mode (see Table S9). Please contact the corresponding author for relevant data.

Table S9. Comparison of gameplay experiences between solo and multiplayer modes

	solo gameplay	multiplayer gameplay			
	<i>M(SD)</i>	<i>M(SD)</i>	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
Frequency of gameplay	2.45(1.10)	3.57(1.01)	-17.75	<0.001	-0.88
Level of complexity	1.94(1.04)	2.96(1.04)	-16.90	<0.001	-0.84
Degree of preference	2.75(1.15)	3.53(0.97)	-12.02	<0.001	-0.60
Level of enjoyment	2.98(1.10)	3.59(0.95)	-9.21	<0.001	-0.46
Level of excitement	2.77(1.17)	3.54(0.98)	-12.55	<0.001	-0.63

Note: N= 403; Frequency of gameplay: For the solo/multiplayer mode, how often do you play this mode? (1=Never, 2=Rarely, 3=Occasionally, 4=Sometimes, 5=Always); Level of complexity: For the solo/multiplayer mode, how complex do you find this mode? (1=Very Simple, 2=Generally Simple, 3=Moderate, 4=Generally Complex, 5=Very Complex); Degree of preference: For the solo/multiplayer mode, how much do you like this mode? (1=Strongly Dislike, 2=Generally Dislike, 3=Neutral, 4=Generally Like, 5=Strongly Like); Level of enjoyment: For the solo/multiplayer mode, how enjoyable do you find the game process in this mode? (1=Very Unenjoyable, 2=Generally Unenjoyable, 3=Moderate, 4=Generally Enjoyable, 5=Very Enjoyable); Level of excitement: For the solo/multiplayer mode, how exciting do you find the game process in this mode? (1=Not Exciting at All, 2=Generally Not Exciting, 3=Moderate, 4=Generally Exciting, 5=Very Exciting).