**Supplementary information**

**Associations among brain size and social-modulating hormones with aggression and cognitive performance in a monogamous cichlid fish**

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Table legends:

|  |  |  |  |
| --- | --- | --- | --- |
| cortisol | = Cortisol (ng/ml) | trials\_learn | = # trials to learn |
| testosterone | = T (ng/ml) | time\_glass | = Time on glass (s) |
| 11KT | = 11KT (ng/ml) | latency\_detour | = Latency to detour (s) |
| ratio.kt/t | = 11KT/T | %correct | = % correct responses |
| attacks | = Attacks (frequency) | vol\_tl/sl | = Volume tl (μm3) per individual standard length |
| displays | = Displays (frequency) | vol\_di/sl | = Volume di (μm3) per individual standard length |
| latency\_attack | = Latency to attack (s) | vol\_ot/sl | = Volume ot (μm3) per individual standard length |
| female\_id | = females’ identification | vol\_bs/sl | = Volume bs (μm3) per individual standard length |
| male\_id | = males’ identification | vol\_cb/sl | = Volume cb (μm3) per individual standard length |

**Linear Models – comparison between females and males**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| sex | cortisol | testosterone | 11KT | ratio.kt/t | attacks | displays | latency\_attack | trials\_learn | time\_glass | latency\_detour | %correct | vol\_tl/sl | vol\_di/sl | vol\_ot/sl | vol\_bs/sl | vol\_cb/sl |
| male | 198.267 | 0.177 | 0.104 | 0.588 | 75 | 13.7 | 58.2 | 4 | 10.132 | 25.227 | 25 | 1.999 | 1.687 | 5.123 | 0.407 | 1.517 |
| male | 177.952 | 1.165 | 0.270 | 0.232 | 1 | 4.3 | 124 | 9 | 3.960 | 187.999 | 55 | 1.588 | 1.088 | 4.235 | 0.562 | 1.184 |
| male | 119.963 |  |  |  | 5 | 1 | 338 | 9 | 4.906 | 43.245 | 70 | 2.680 | 1.320 | 8.569 | 0.522 | 1.148 |
| male | 82.422 | 0.926 | 0.532 | 0.574 | 13.3 | 6 | 216 | 5 | 20.350 | 44.881 | 30 | 1.364 | 1.125 | 5.260 | 0.572 | 1.461 |
| male | 83.734 | 0.847 | 0.418 | 0.493 | 20.7 | 4.7 | 241.2 | 15 | 5.975 | 194.068 | 35 | 1.354 | 1.797 | 4.232 | 0.287 | 0.648 |
| male | 156.482 | 0.353 | 0.288 | 0.816 |  |  |  |  |  |  |  | 1.917 | 1.112 | 4.059 |  | 1.740 |
| male | 204.708 | 0.309 | 0.300 | 0.973 |  |  |  | 10 | 10.675 | 45.779 | 30 | 1.448 | 1.323 | 3.344 |  | 1.341 |
| male | 122.897 | 0.354 | 0.179 | 0.505 |  |  |  | 10 | 13.019 | 32.973 | 25 | 1.869 |  | 3.700 |  | 1.342 |
| male | 133.343 | 0.504 | 0.331 | 0.657 | 50 | 7.7 | 282.2 | 10 | 22.841 | 38.524 | 30 | 2.129 | 1.343 | 4.452 | 0.725 | 1.472 |
| male | 86.477 | 0.738 | 0.227 | 0.307 | 3 | 0.7 | 571 | 9 | 9.178 | 19.638 | 10 | 2.383 | 1.600 | 4.672 |  | 1.435 |
| male | 147.177 | 0.834 | 0.311 | 0.373 | 15.3 | 8 | 107.4 | 10 | 9.521 | 26.066 | 55 | 2.106 | 1.311 | 3.982 | 0.533 | 1.641 |
| male | 189.690 |  |  |  | 1.3 | 1.7 | 153 | 9 | 10.178 | 28.326 | 55 | 2.122 | 1.324 | 4.783 | 0.522 | 1.075 |
| male | 62.230 | 0.569 | 0.334 | 0.588 | 112.3 | 11 | 55.1 | 9 | 13.090 | 26.299 | 20 | 1.591 | 1.000 | 3.450 | 0.322 | 1.292 |
| male | 101.774 | 0.433 | 0.191 | 0.442 |  |  |  | 9 | 17.018 | 50.838 | 40 | 2.382 |  | 3.772 | 0.373 | 1.161 |
| male | 144.477 | 0.739 | 0.309 | 0.418 | 64.7 | 34.7 | 111.4 | 10 | 5.825 | 29.228 | 55 | 1.822 | 1.762 | 1.539 | 0.736 | 1.037 |
| male |  | 0.514 |  |  |  |  |  |  |  |  |  | 1.855 | 1.121 | 3.682 | 0.423 | 1.472 |
| male |  | 0.663 | 0.433 | 0.654 |  |  |  | 14 | 9.664 | 48.657 | 45 | 1.951 | 1.334 | 3.372 |  | 1.672 |
| male | 68.417 | 0.494 | 0.212 | 0.429 | 2.3 | 0.3 | 335.7 | 5 | 0.149 | 16.436 | 95 | 1.956 |  | 4.875 |  | 1.315 |
| male | 225.689 | 0.804 | 0.285 | 0.354 |  | 0.3 | 583 | 9 | 7.157 | 22.066 | 35 | 1.196 | 0.813 | 3.439 | 0.198 | 0.910 |
| female | 103.315 | 0.397 | 0.014 | 0.035 |  |  |  | 19 | 6.881 | 155.770 | 25 | 1.700 | 0.876 | 4.650 | 0.411 | 1.081 |
| female | 137.433 | 0.533 | 0.016 | 0.029 |  |  |  | 9 | 7.472 | 66.629 | 35 | 1.644 | 1.069 | 4.587 | 0.294 | 1.117 |
| female | 178.171 | 1.637 | 0.126 | 0.077 | 13 | 3 | 141.3 | 4 | 7.472 | 66.629 | 35 | 2.299 | 1.529 | 5.058 | 0.611 | 1.263 |
| female | 171.155 | 0.663 | 0.208 | 0.313 | 3.7 | 5.7 | 179 | 4 | 17.446 | 31.894 | 0 | 2.395 | 1.540 | 4.762 | 0.435 | 1.119 |
| female | 153.114 | 0.275 | 0.012 | 0.044 | 25.3 | 7.7 | 94.8 | 9 | 6.568 | 26.107 | 15 | 2.738 | 1.209 | 5.669 | 0.388 | 1.476 |
| female | 224.420 | 0.593 | 0.017 | 0.028 | 21.7 | 4.7 | 156.7 | 4 | 10.584 | 27.094 | 10 | 2.085 | 1.973 | 4.290 | 0.697 | 1.152 |
| female | 170.006 | 0.849 | 0.030 | 0.035 | 9.7 | 4.7 | 70.6 | 4 | 8.081 | 21.344 | 40 | 2.489 | 1.777 | 5.729 | 0.771 | 1.310 |
| female | 164.503 | 0.544 | 0.016 | 0.028 | 13.7 | 1.7 | 50.7 | 9 | 12.163 | 30.500 | 35 | 2.605 | 0.777 | 4.696 | 0.539 | 1.457 |
| female | 73.508 | 2.135 | 0.378 | 0.177 | 9 | 10 | 82.9 | 4 | 15.455 | 40.199 | 25 | 1.903 | 1.062 | 4.628 | 0.432 | 1.381 |
| female | 111.730 | 0.682 | 0.391 | 0.574 | 71.7 | 8 | 201.1 | 14 | 2.791 | 21.834 | 70 | 1.611 | 1.151 | 3.741 | 0.285 | 0.534 |
| female | 53.858 | 0.388 | 0.100 | 0.256 | 1.3 | 0.7 | 455.2 | 5 | 16.841 | 37.269 | 5 | 2.003 | 0.949 | 3.772 | 0.448 | 1.189 |
| female | 84.111 | 0.434 | 0.176 | 0.405 | 78 | 4.7 | 390.3 | 10 | 19.615 | 35.369 | 40 | 2.210 | 0.922 | 5.730 | 0.372 | 1.863 |
| female | 56.120 | 1.469 | 0.057 | 0.039 | 3 | 2.7 | 196.1 | 19 | 22.405 | 54.849 | 30 | 2.081 | 1.253 | 3.543 | 0.536 | 1.284 |
| female | 99.098 | 0.766 | 0.088 | 0.114 | 189.3 | 4.3 | 216.7 | 10 | 7.595 | 20.079 | 50 | 1.526 | 0.843 | 3.914 | 0.358 | 1.297 |
| female | 65.907 | 0.533 | 0.019 | 0.036 |  |  |  | 15 | 8.652 | 22.207 | 35 | 2.007 |  | 4.107 |  | 1.293 |
| female | 62.379 | 0.726 | 0.366 | 0.505 | 3 | 2 | 73.3 | 5 | 15.363 | 29.310 | 45 | 2.061 |  | 3.155 | 0.311 | 0.899 |
| female | 60.130 | 0.899 | 0.118 | 0.131 |  | 1 | 194.3 | 20 | 21.534 | 40.920 | 25 | 1.578 | 0.865 | 3.262 | 0.636 | 1.471 |
| female | 147.034 | 0.315 | 0.013 | 0.041 | 43.3 | 4.3 | 241.2 | 5 | 11.857 | 18.056 | 40 | 1.914 | 0.977 | 3.876 |  | 0.595 |
| female | 203.522 | 1.595 | 0.139 | 0.087 | 5.3 | 1 | 476 | 9 | 4.949 | 15.302 | 40 | 2.908 | 1.031 | 3.388 | 0.205 | 1.004 |

**Spearman’s correlation**

Females

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| female\_id | cortisol | testosterone | 11KT | ratio.kt/t | attacks | displays | latency\_attack | trials\_learn | time\_glass | latency\_detour | %correct | vol\_tl/sl | vol\_di/sl | vol\_ot/sl | vol\_bs/sl | vol\_cb/sl |
| GB1 | 103.315 | 0.397 | 0.014 | 0.035 |  |  |  | 19 | 6.881 | 155.770 | 25 | 1.700 | 0.876 | 4.650 | 0.411 | 1.081 |
| GB2 | 137.433 | 0.533 | 0.016 | 0.029 |  |  |  | 9 | 7.472 | 66.629 | 35 | 1.644 | 1.069 | 4.587 | 0.294 | 1.117 |
| GB3 | 178.171 | 1.637 | 0.126 | 0.077 | 13 | 3 | 141.3 | 4 | 7.472 | 66.629 | 35 | 2.299 | 1.529 | 5.058 | 0.611 | 1.263 |
| GB4 | 171.155 | 0.663 | 0.208 | 0.313 | 3.7 | 5.7 | 179 | 4 | 17.446 | 31.894 | 0 | 2.395 | 1.540 | 4.762 | 0.435 | 1.119 |
| GB5 | 153.114 | 0.275 | 0.012 | 0.044 | 25.3 | 7.7 | 94.8 | 9 | 6.568 | 26.107 | 15 | 2.738 | 1.209 | 5.669 | 0.388 | 1.476 |
| GB6 | 224.420 | 0.593 | 0.017 | 0.028 | 21.7 | 4.7 | 156.7 | 4 | 10.584 | 27.094 | 10 | 2.085 | 1.973 | 4.290 | 0.697 | 1.152 |
| GB7 | 170.006 | 0.849 | 0.030 | 0.035 | 9.7 | 4.7 | 70.6 | 4 | 8.081 | 21.344 | 40 | 2.489 | 1.777 | 5.729 | 0.771 | 1.310 |
| GB11 | 164.503 | 0.544 | 0.016 | 0.028 | 13.7 | 1.7 | 50.7 | 9 | 12.163 | 30.500 | 35 | 2.605 | 0.777 | 4.696 | 0.539 | 1.457 |
| GB13 | 73.508 | 2.135 | 0.378 | 0.177 | 9 | 10 | 82.9 | 4 | 15.455 | 40.199 | 25 | 1.903 | 1.062 | 4.628 | 0.432 | 1.381 |
| GB14 | 111.730 | 0.682 | 0.391 | 0.574 | 71.7 | 8 | 201.1 | 14 | 2.791 | 21.834 | 70 | 1.611 | 1.151 | 3.741 | 0.285 | 0.534 |
| GB21 | 53.858 | 0.388 | 0.100 | 0.256 | 1.3 | 0.7 | 455.2 | 5 | 16.841 | 37.269 | 5 | 2.003 | 0.949 | 3.772 | 0.448 | 1.189 |
| GB22 | 84.111 | 0.434 | 0.176 | 0.405 | 78 | 4.7 | 390.3 | 10 | 19.615 | 35.369 | 40 | 2.210 | 0.922 | 5.730 | 0.372 | 1.863 |
| GB25 | 56.120 | 1.469 | 0.057 | 0.039 | 3 | 2.7 | 196.1 | 19 | 22.405 | 54.849 | 30 | 2.081 | 1.253 | 3.543 | 0.536 | 1.284 |
| GB26 | 99.098 | 0.766 | 0.088 | 0.114 | 189.3 | 4.3 | 216.7 | 10 | 7.595 | 20.079 | 50 | 1.526 | 0.843 | 3.914 | 0.358 | 1.297 |
| GB31 | 65.907 | 0.533 | 0.019 | 0.036 |  |  |  | 15 | 8.652 | 22.207 | 35 | 2.007 |  | 4.107 |  | 1.293 |
| GB32 | 62.379 | 0.726 | 0.366 | 0.505 | 3 | 2 | 73.3 | 5 | 15.363 | 29.310 | 45 | 2.061 |  | 3.155 | 0.311 | 0.899 |
| GB33 | 60.130 | 0.899 | 0.118 | 0.131 | 0 | 1 | 194.3 | 20 | 21.534 | 40.920 | 25 | 1.578 | 0.865 | 3.262 | 0.636 | 1.471 |
| GB34 | 147.034 | 0.315 | 0.013 | 0.041 | 43.3 | 4.3 | 241.2 | 5 | 11.857 | 18.056 | 40 | 1.914 | 0.977 | 3.876 |  | 0.595 |
| GB35 | 203.522 | 1.595 | 0.139 | 0.087 | 5.3 | 1 | 476 | 9 | 4.949 | 15.302 | 40 | 2.908 | 1.031 | 3.388 | 0.205 | 1.004 |

Males

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| male\_id | cortisol | testosterone | 11KT | ratio.kt/t | attacks | displays | latency\_attack | trials\_learn | time\_glass | latency\_detour | %correct | vol\_tl/sl | vol\_di/sl | vol\_ot/sl | vol\_bs/sl | vol\_cb/sl |
| GB8 | 198.267 | 0.177 | 0.104 | 0.588 | 75 | 13.7 | 58.2 | 4 | 10.132 | 25.227 | 25 | 1.999 | 1.687 | 5.123 | 0.407 | 1.517 |
| GB9 | 177.952 | 1.165 | 0.270 | 0.232 | 1 | 4.3 | 124 | 9 | 3.96 | 187.999 | 55 | 1.588 | 1.088 | 4.235 | 0.562 | 1.184 |
| GB12 | 119.963 |  |  |  | 5 | 1 | 338 | 9 | 4.906 | 43.245 | 70 | 2.680 | 1.320 | 8.569 | 0.522 | 1.148 |
| GB15 | 82.422 | 0.926 | 0.532 | 0.574 | 13.3 | 6 | 216 | 5 | 20.35 | 44.881 | 30 | 1.364 | 1.125 | 5.260 | 0.572 | 1.461 |
| GB16 | 83.734 | 0.847 | 0.418 | 0.493 | 20.7 | 4.7 | 241.2 | 15 | 5.975 | 194.068 | 35 | 1.354 | 1.797 | 4.232 | 0.287 | 0.648 |
| GB17 | 156.482 | 0.353 | 0.288 | 0.816 |  |  |  |  |  |  |  | 1.917 | 1.112 | 4.059 |  | 1.740 |
| GB18 | 204.708 | 0.309 | 0.300 | 0.973 |  |  |  | 10 | 10.675 | 45.779 | 30 | 1.448 | 1.323 | 3.344 |  | 1.341 |
| GB19 | 122.897 | 0.354 | 0.179 | 0.505 |  |  |  | 10 | 13.019 | 32.973 | 25 | 1.869 |  | 3.700 |  | 1.342 |
| GB20 | 133.343 | 0.504 | 0.331 | 0.657 | 50 | 7.7 | 282.2 | 10 | 22.841 | 38.524 | 30 | 2.129 | 1.343 | 4.452 | 0.725 | 1.472 |
| GB23 | 86.477 | 0.738 | 0.227 | 0.307 | 3 | 0.7 | 571 | 9 | 9.178 | 19.638 | 10 | 2.383 | 1.600 | 4.672 |  | 1.435 |
| GB24 | 147.177 | 0.834 | 0.311 | 0.373 | 15.3 | 8 | 107.4 | 10 | 9.521 | 26.066 | 55 | 2.106 | 1.311 | 3.982 | 0.533 | 1.641 |
| GB27 | 189.690 |  |  |  | 1.3 | 1.7 | 153 | 9 | 10.178 | 28.326 | 55 | 2.122 | 1.324 | 4.783 | 0.522 | 1.075 |
| GB29 | 62.230 | 0.569 | 0.334 | 0.588 | 112.3 | 11 | 55.1 | 9 | 13.09 | 26.299 | 20 | 1.591 | 1.000 | 3.450 | 0.322 | 1.292 |
| GB30 | 101.774 | 0.433 | 0.191 | 0.442 |  |  |  | 9 | 17.018 | 50.838 | 40 | 2.382 |  | 3.772 | 0.373 | 1.161 |
| GB36 | 144.477 | 0.739 | 0.309 | 0.418 | 64.7 | 34.7 | 111.4 | 10 | 5.825 | 29.228 | 55 | 1.822 | 1.762 | 1.539 | 0.736 | 1.037 |
| GB37 |  | 0.514 |  |  |  |  |  |  |  |  |  | 1.855 | 1.121 | 3.682 | 0.423 | 1.472 |
| GB38 |  | 0.663 | 0.433 | 0.654 |  |  |  | 14 | 9.664 | 48.657 | 45 | 1.951 | 1.334 | 3.372 |  | 1.672 |
| GB39 | 68.417 | 0.494 | 0.212 | 0.429 | 2.3 | 0.3 | 335.7 | 5 | 0.149 | 16.436 | 95 | 1.956 |  | 4.875 |  | 1.315 |
| GB40 | 225.689 | 0.804 | 0.285 | 0.354 |  | 0.3 | 583 | 9 | 7.157 | 22.066 | 35 | 1.196 | 0.813 | 3.439 | 0.198 | 0.910 |