Dietary l-tryptophan leaves a lasting impression on the brain and the stress response

Comparative models suggest that effects of dietary tryptophan (Trp) on brain serotonin (5-hydroxytryptamine; 5-HT) neurochemistry and stress responsiveness are present throughout the vertebrate lineage. Moreover, hypothalamic 5-HT seems to play a central role in control of the neuroendocrine stress axis in all vertebrates. Still, recent fish studies suggest long-term effects of dietary Trp on stress responsiveness, which are independent of hypothalamic 5-HT. Here, we investigated if dietary Trp treatment may result in long-lasting effects on stress responsiveness, including changes in plasma cortisol levels and 5-HT neurochemistry in the telencephalon and hypothalamus of Atlantic salmon. Fish were fed diets containing one, two or three times the Trp content in normal feed for 1 week. Subsequently, fish were reintroduced to control feed and were exposed to acute crowding stress for 1 h, 8 and 21 d post Trp treatment. Generally, acute crowding resulted in lower plasma cortisol levels in fish treated with 3×Trp compared with 1×Trp- and 2×Trp-treated fish. The same general pattern was reflected in telencephalic 5-HTergic turnover, for which 3×Trp-treated fish showed decreased values compared with 2×Trp-treated fish. These long-term effects on post-stress plasma cortisol levels and concomitant 5-HT turnover in the telencephalon lends further support to the fact that the extrahypothalamic control of the neuroendocrine stress response is conserved within the vertebrate lineage. Moreover, they indicate that trophic/structural effects in the brain underlie the effects of dietary Trp treatment on stress reactivity.
Cognitive appraisal of aversive stimulus differs between individuals with contrasting stress coping styles; evidences from selected rainbow trout (Oncorhynchus mykiss) strains

Original language: English

L-Tryptophan, 5-HIAA 5-hydroxyindoleacetic acid, 5-HT 5-hydroxytryptamine (serotonin), HPI hypothalamic–pituitary–interrenal, SSRI supplementation and serotonin reuptake inhibitors, Trp tryptophan, Long-term effects, Monoamines

Electronic versions:
- Publishers version
- DOIs: 10.1017/S0007114517001428
- Source: FindIt
- Source-ID: 2371600705
- Publication: Research - peer-review › Journal article – Annual report year: 2017
Effects of acute and chronic stress on telencephalic neurochemistry and gene expression in rainbow trout (Oncorhynchus mykiss)
By filtering relevant sensory inputs and initiating stress responses, the brain is an essential organ in stress coping and adaptation. However, exposure to chronic or repeated stress can lead to allostatic overload, where neuroendocrinial and behavioral reactions to stress become maladaptive. This work examines forebrain mechanisms involved in allostatic processes in teleost fishes. Plasma cortisol, forebrain serotonergic (5-HTergic) neurochemistry, and mRNA levels of corticotropin-releasing factor (CRF), CRF-binding protein (CRFBP), CRF receptors (CRFR1 and CRFR2), mineralocorticoid receptor (MR), glucocorticoid receptors (GR1 and GR2) and serotonin type 1A (5-HT1A) receptors (5-HT1Aα and 5-HT1Aβ) were investigated at 1 h before and 0, 1 and 4 h after acute stress, in two groups of rainbow trout held in densities of 25 and 140 kg m⁻³ for 28 days. Generally, being held at 140 kg m⁻³ resulted in a less pronounced cortisol response. This effect was also reflected in lower forebrain 5-HTergic turnover, but not in mRNA levels in any of the investigated genes. This lends further support to reports that allostatic load causes fish to be incapable of mounting a proper cortisol response to an acute stressor, and suggests that changes in forebrain 5-HT metabolism are involved in allostatic processes in fish. Independent of rearing densities, mRNA levels of 5-HT1Aα and MR were downregulated 4 h post-stress compared with values 1 h post-stress, suggesting that these receptors are under feedback control and take part in the downregulation of the hypothalamic-pituitary-interrenal (HPI) axis after exposure to an acute stressor.

**General information**

**State:** Published  
**Organisations:** National Institute of Aquatic Resources, Section for Aquaculture, University of Copenhagen, Uppsala University, Lund University, Norwegian Institute for Water Research  
**Authors:** Moltesen, M. (Intern), Laursen, D. C. (Intern), Thörnqvist, P. O. (Ekstern), Åberg Andersson, M. (Intern), Winberg, S. (Ekstern), Höglund, E. (Intern)  
**Pages:** 3907-3914  
**Publication date:** 2016  
**Main Research Area:** Technical/natural sciences

**Publication information**  
**Journal:** Journal of Experimental Biology  
**Volume:** 219  
**Issue number:** 24  
**ISSN (Print):** 0022-0949

**Ratings:**  
BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 2.62 SJR 1.722 SNIP 1.279  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 1.812 SNIP 1.222 CiteScore 2.4  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 1.722 SNIP 1.331 CiteScore 2.51  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 1.719 SNIP 1.323 CiteScore 2.75  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 1.612 SNIP 1.395 CiteScore 2.91  
ISI indexed (2012): ISI indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 1.534 SNIP 1.315 CiteScore 2.77  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 1.474 SNIP 1.341  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2
Brain activation and appraisal of hypoxia in two strains of rainbow trout (Oncorhynchus mykiss) displaying divergent stress coping styles

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquaculture, Uni Research AS, Uppsala University
Authors: Moltesen, M. (Intern), Winberg, S. (Ekstern), Ebbesson, L. (Ekstern), Höglund, E. (Intern)
Publication date: 2012
Event: Poster session presented at Society for Neuroscience, New Orleans, United States.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2017

Projects:

Fish welfare aspects of individual variation in cognition, physiology and behavior

National Institute of Aquatic Resources
Period: 01/11/2011 → 01/05/2015
Number of participants: 2
Phd Student:
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Financing sources
Fish welfare aspects of individual variation in cognition, physiology and behaviour (Cope Well) (38813)
The project targeted welfare aspects of individual variability fish. Such differences include both behavioural and physiological traits, which are often clustered in separate stress coping styles. These stress coping styles seem to be coupled to fundamental differences in how information is processed. The aim of this project was to develop methods for separating fish with respect to stress coping styles, and investigate how fish with contrasting stress coping styles differs in cognitive evaluation of challenges. Moreover, the neural mechanism separating fish with contrasting stress coping styles was investigated. The project was part of a large scale collaborative project, funded by the European Commission FP 7 (Cope Well), aiming to establish, evaluate, and further develop, a new scientific framework for the understanding and application of the concept of animal welfare in farmed fish.

The project was coordinated by Havforskningsinstituttet (IMR), Norway.

The project was funded by EU, Framework Programme 7.

National Institute of Aquatic Resources
Section for Aquaculture
Havforskningsinstituttet
Uni Research AS
Partnership Transnational Consulting Partnership
Instituto Superior de Psicologia Aplicada
University of Stirling
University of Patras
University of Crete
Katholieke Universiteit
NOFIMA
Centro de Ciências do Mar do Algarve
Universidad Autonoma de Barcelona
University of Oslo
Stichting Dienst Landbouwkundig Onderzoek
Uppsala University
IFREMER
Period: 01/01/2011 → 31/12/2015
Number of participants: 2
Research area: Aquaculture
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