

About Niels Chr. Hansen

Niels Chr. Hansen holds a BA in classical piano, an MMus in music theory, and an MSc in the cognitive neuroscience of music. He completed his PhD dissertation at the Center for Music in the Brain, Aarhus University & The Royal Academy of Music Aarhus/Aalborg under the supervision of Peter Vuust and Marcus Pearce. In 2014 he was awarded an EliteForsk Travel Scholarship for his cross-disciplinary work.

Time and place for the defence

Friday 15 April 2016 at 1 pm to 4 pm
DNC-auditorium, Building 10G, Nørrebrogade 44, 8000 Århus C.

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PREDICTIVE CODING OF MUSICAL EXPERTISE

PhD Dissertation by Niels Chr. Hansen



AARHUS UNIVERSITET

PREDICTIVE CODING OF MUSICAL EXPERTISE

This PhD dissertation presents and tests a novel framework for scientific studies of musical expertise based on predictive coding theory. Using computational modelling, psychological experiments, and neuroimaging, the origin of expertise, its cognitive representation, neural correlates, availability to consciousness, and influence on predictive uncertainty and flexibility are investigated.

Musical expertise fascinates us

The fascinating powers of musical expertise make it a natural object of scientific enquiry. Previous research, however, has been underpinned by romanticised concepts of genius regarding experts as blessed with skills that are elusive, innate, all-or-nothing, beneficial, and creative. This work, in contrast, casts musical expertise as empirically investigable, acquired, continuous and multidimensional, adaptive as well as maladaptive, and relevant to both production and perception of music. This view was implemented in four studies.

Musicians make predictions with greater certainty

Study 1 found that predictive uncertainty of melodic pitch expectations correspond to the Shannon entropy of conditional probability distributions acquired through statistical learning of music. The fit between expectations and musical structure increased linearly with experi-

ence, leading musicians to predict with lower uncertainty in general and experience greater prediction error than non-musicians specifically when decodable probabilistic structure was abundant.

Stylistic specialisation causes more conscious processing

Study 2 found that expert jazz musicians had better access to conscious introspection of their uncertainty about the continuation of improvised solos by Charlie Parker. Professional jazz and classical musicians did, on other hand, not differ as regards retrospective expectedness processing. Moreover, classical and non-musicians refrained from misapplying their knowledge of general tonal music in stylistically irrelevant contexts. This supports theories of cognitive firewalls restricting the scope of predictive processing.

Musical training sharpens musical expectations

Study 3 found that statistical learning of music can be modelled as minimisation of the relative entropy between listener expectations and the probabilistic structure of music. Consistent with predictive coding theory, this process took place across timescales and stimuli and was unaffected by prior musical experience.

More sophisticated auditory processing in expert musicians

Study 4 used magnetoencephalography (MEG) to show greater under-additivity of the mismatch response in musicians compared to non-musicians, specifically for the pitch component when sounds were presented in a musical context. This may be interpreted as training-induced plasticity of the neural mechanisms for auditory feature processing.

Conclusions

Musical expertise

- emerges from statistical learning
- leads to sophistication of cognitive representations, minimisation of the uncertainty of musical predictions, development of specialised contextual knowledge, and enhanced conscious access to this knowledge
- not only captivates the audience, but also shapes the brains of the experts themselves