Generalisation of action sequences in RNNPB networks with mirror properties

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Introduction
It is still unclear how the human mirror neuron system (MNS) could learn to recognise a large variety of action sequences. Here we investigated a neural network with mirror properties. The Recurrent Neural Network with Parametric Bias (RNNPB) is capable of learning and reproducing different spatio-temporal patterns such as joint angles of action sequences [1].

Question and Method
How many spatiotemporal patterns can be stored in an RNNPB network? As an initial step we investigate how robust the learnt patterns are against noise. Next, we look how the network generalises to parametric variations of the learnt examples.

Network architecture
Our RNNPB network consists of 1 input, 5 hidden, 1 output, 2 context and 2 PB nodes. Network connection weights are updated using backpropagation through time (BPTT).

Training
Open loop. All weights are updated.

Reproduction
Closed loop with no updating and the PB vector is fixed to the learnt values

Recognition
Open loop. Only the PB vector is updated

Results
Reproducing learnt examples
The RNNPB network successfully reproduces 3 simultaneously learnt patterns. However, the decay rate and amplitude of the aperiodic pattern still deviate from the learning pattern.

Robust recognition
During recognition the PB vector converges to the learnt value: the distance is zero. When adding white noise the correct pattern is recognised up to a noise level of $\sigma=0.2$ (20% of amplitude).

Generalising from learnt examples
The PB vector smoothly varies with variations in frequency of the pattern to be recognised [2]. The same applies to variations in amplitude, but the generalisation is degenerate for the high frequency pattern.

Discussion and Conclusions
We have shown that the RNNPB architecture is capable of robust recognition of learnt patterns and it can generalise across them [2]. How to choose these learning examples to optimize the network’s performance is still an open issue.

References