Robust alignment of cross-session recordings of neural population activity by behaviour via unsupervised domain adaptation

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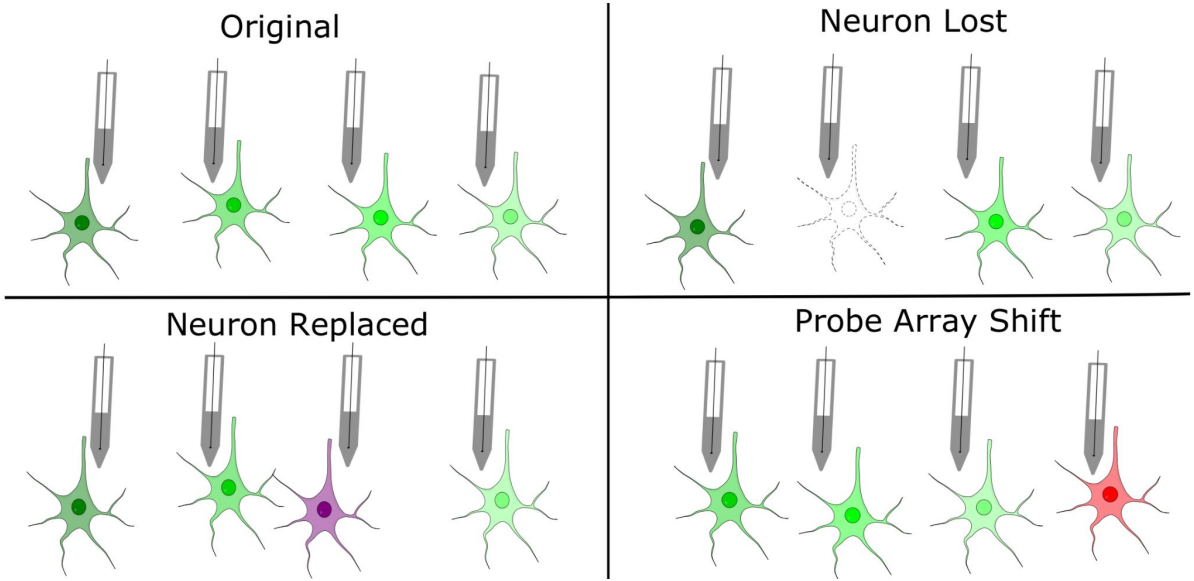
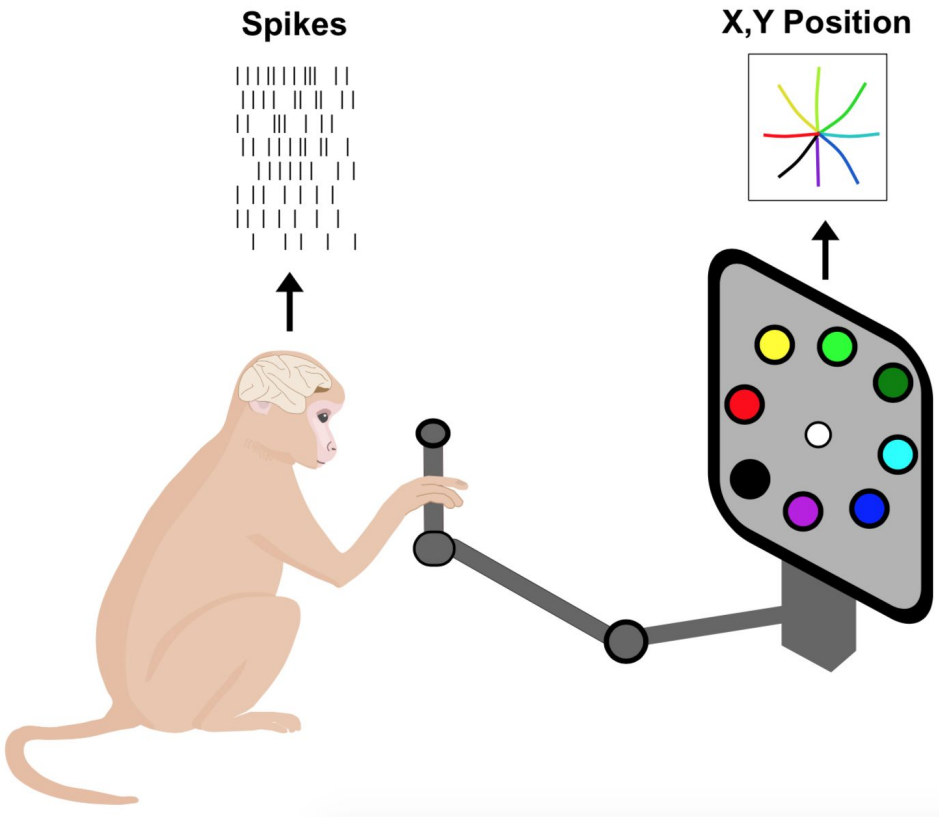
Cross-session neural variability

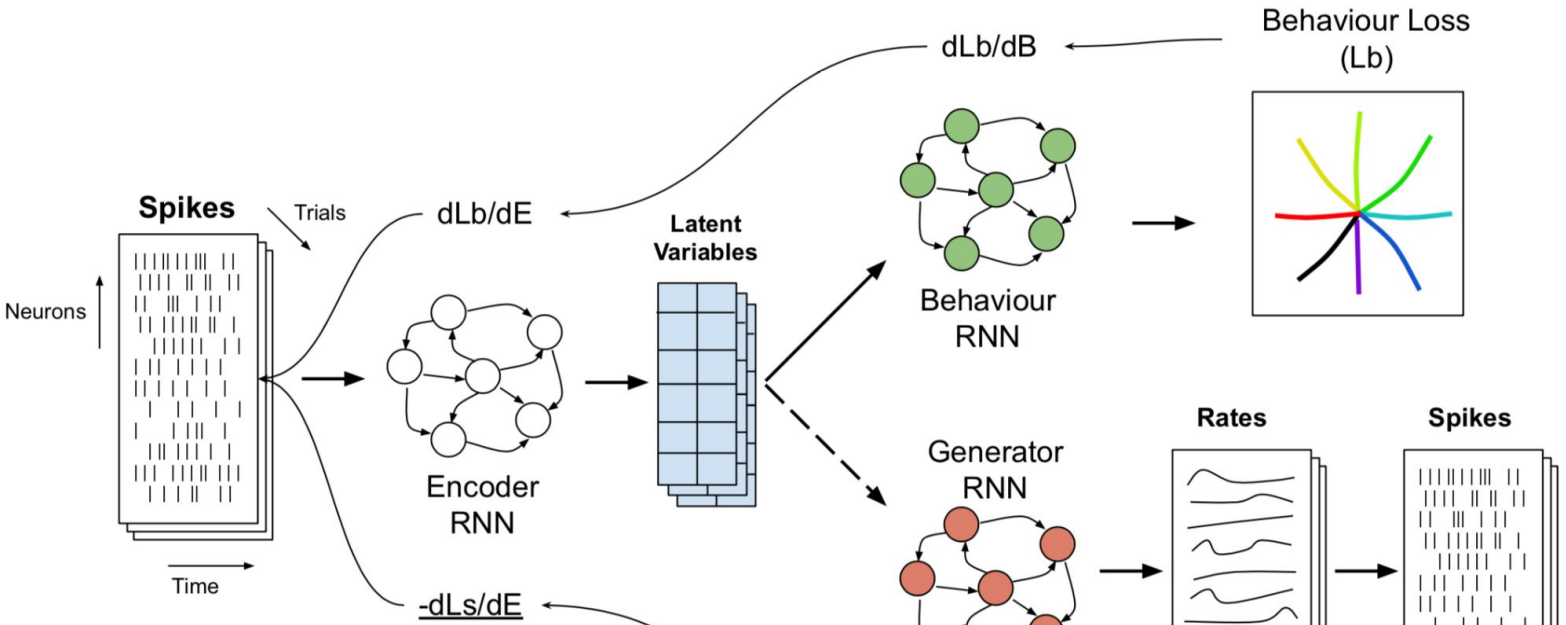
- Neural population activity is hypothesised to be inherently low-dimensional and stable over recording sessions.
- However, gradual changes to recorded neurons over time due to turnover and electrode movement leads to instability.



Data: Recordings from M1 during reach task



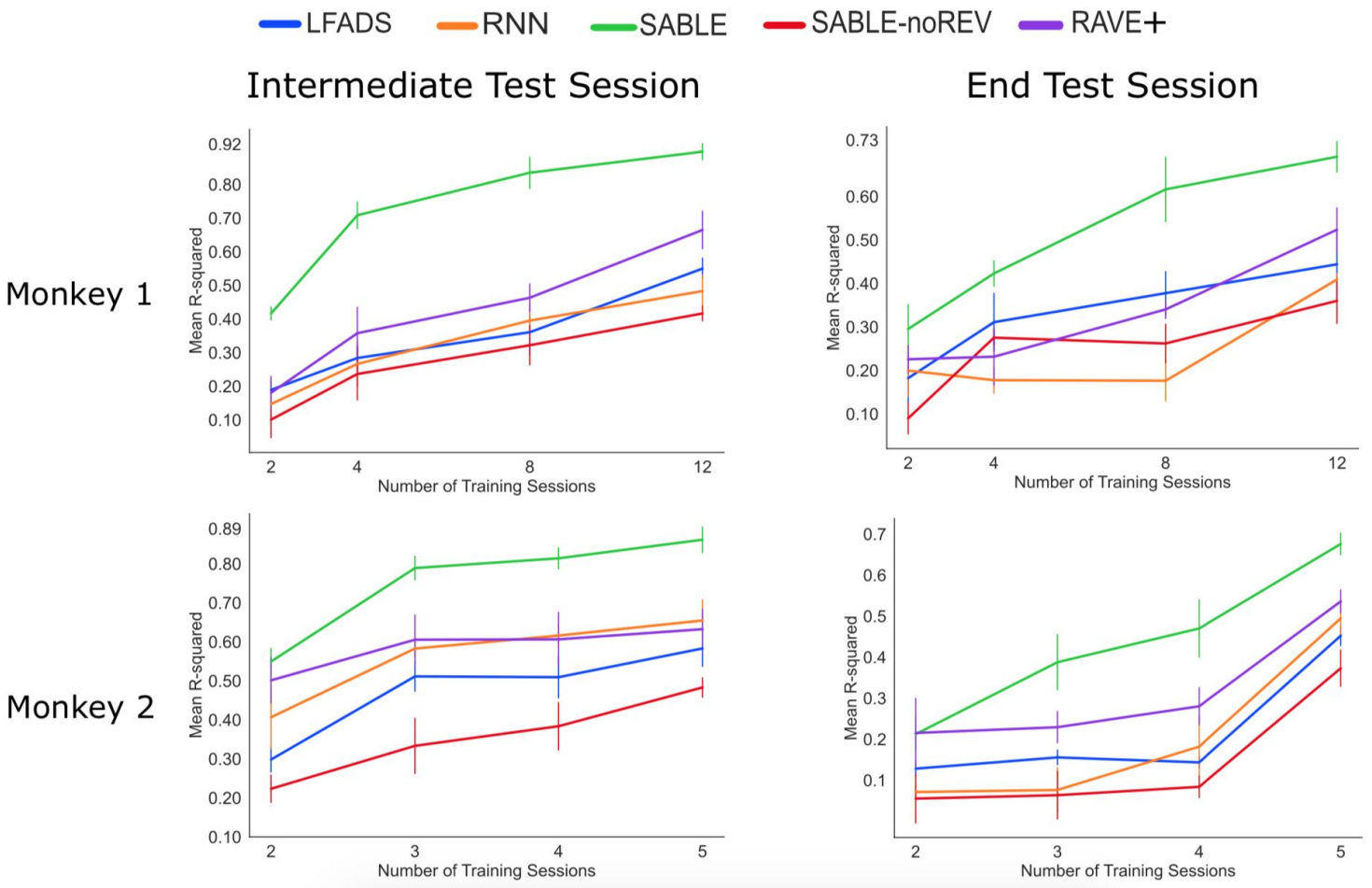
Model: **SABLE** - learns variability between sessions.



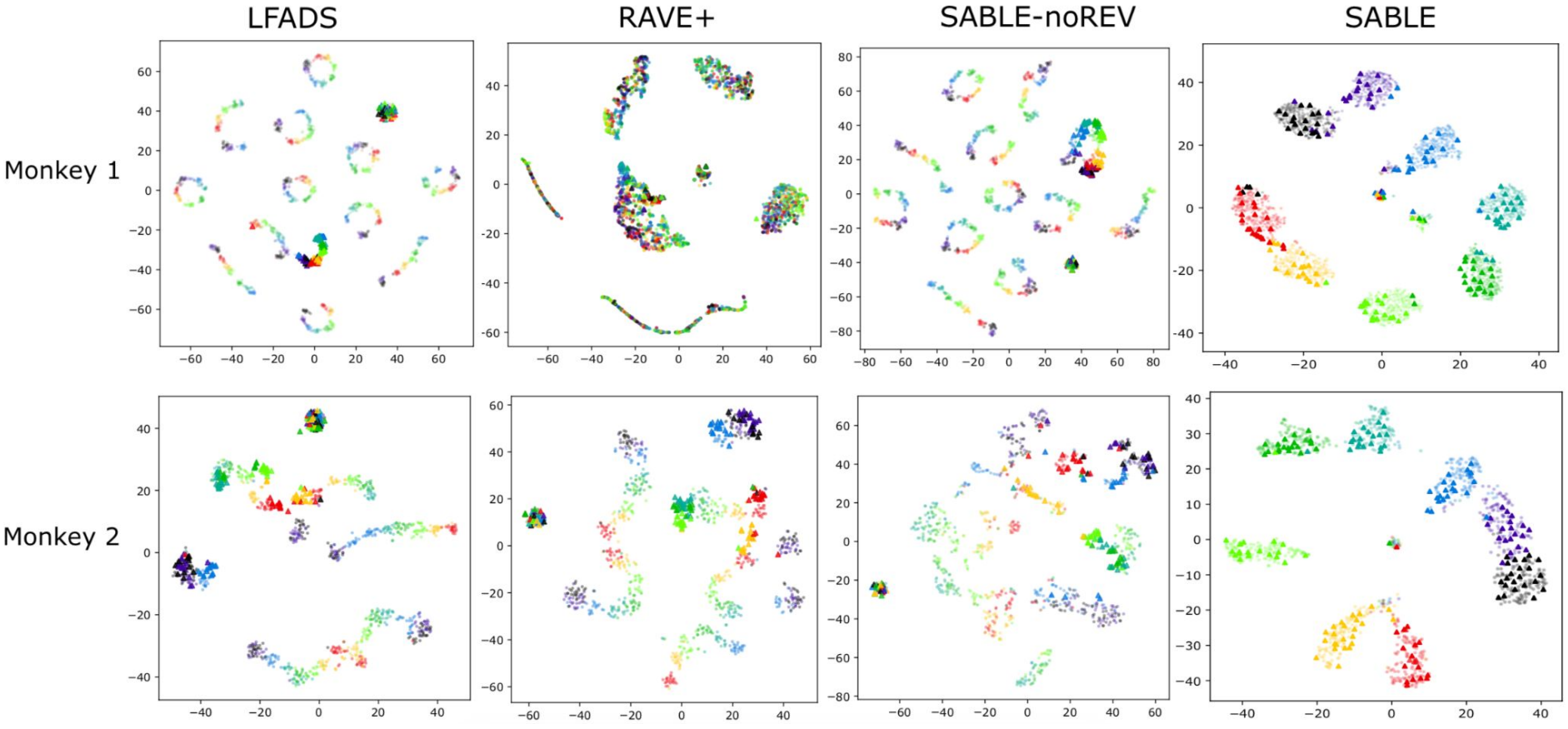
Backpropagation derivatives:

dLb/dB - behaviour loss w.r.t Behaviour RNN
dLs/dG - spike autoencoding loss w.r.t Generator RNN
dLb/dE - behaviour loss w.r.t Encoder RNN
-dLs/dE - **negative** spike autoencoding loss w.r.t Encoder RNN

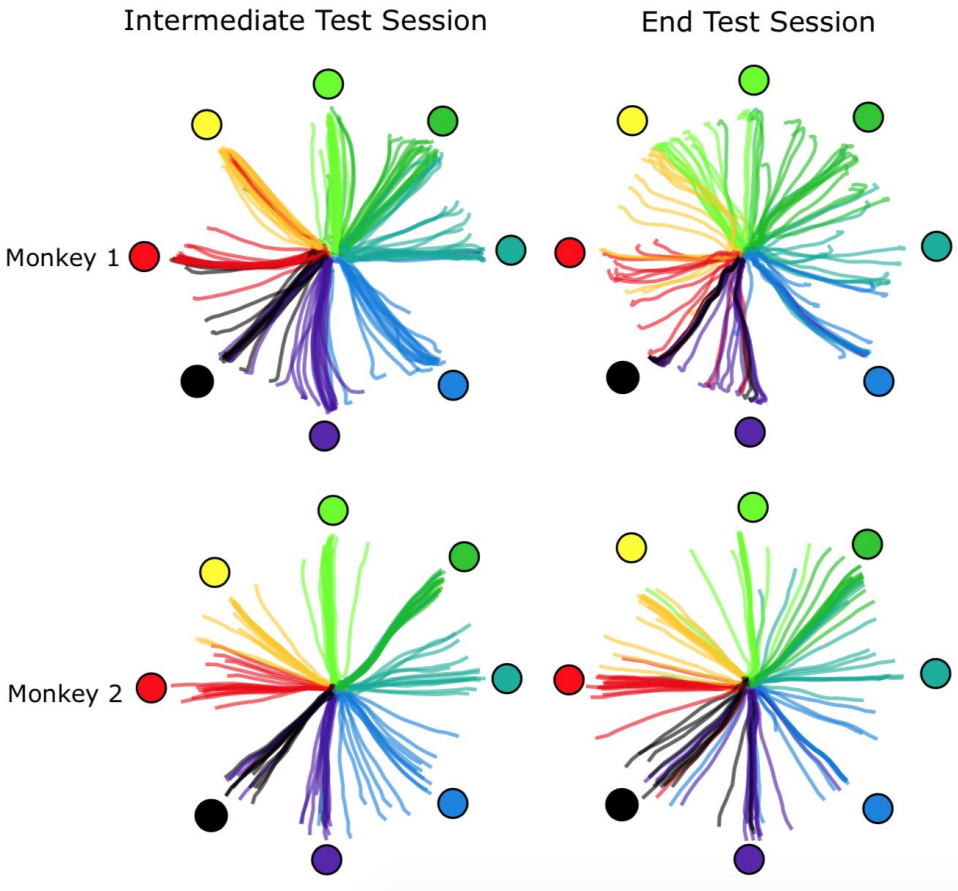
Results: Behaviour decoding accuracy on unseen sessions



Results: T-SNE plots of latent spaces



Results: SABLE behaviour reconstruction



Summary

- Approach: Sequential variational autoencoder combined with unsupervised domain adaptation.
- Trained on several recording sessions this model can achieve state-of-the-art generalization when predicting behaviour on unseen sessions of recording.
- Negative gradient leads to the encoder maximising the reconstruction loss, encouraged to generate latent variables which are not separated by session.
- Simultaneously, behaviour decoder forces the encoder to generate latent variables which are differentiated by behaviour.