Acknowledgements

The manuscript in front of you is the culmination of over four years of work. Naturally, there are many people that supported me over these years and who I wish to thank.

First, I would like to thank my wife María who has been an incredible support over the years. Through the dark Scottish winter months you have been my ray of sunlight. I do not know a single person as strong as you and I am grateful to have you by my side.

I thank my family, especially my parents Verena and Michael Kolibius for their unwavering support over my entire life and for being a permanent reference point in an otherwise chaotic world. I could not have done this without you. One day I hope to be such a good parent to my children.

At the very beginning of my PhD Simon Hanslmayr and Bernhard Staresina invited me to a meeting discussing which dataset should be used to investigate “Index Neurons”. I was unrecoverably lost which found its peak when Bernhard understood some implications before Simon finished his sentence. That was the only time I doubted myself.

I soon recovered my excitement for research although often stumbled on unseen ground. I am very grateful to Simon, my *Doktorvater* for his guidance and his trust in me even when I was hard stuck on a particular problem for weeks or head over heels down a rabbit hole. For me, Simon embodies coolness and a keen mind in equal parts. I would also like to thank my second supervisor Howard Bowman. I find your intuitive grasp on mathematics inspiring and thoroughly enjoy our long conversations about neuroscience and all other things.

I thank the sharp minds that have accompanied me in this journey and had so many valuable conversations, especially Sander van Bree, Mircea van der Plas, Marit Petzka, Chris Postzrich. Thank you for listening to my premature ecstatic outbursts on ideas that are often little more than conjecture (but sometimes turn out to be useful!).

Include a figure showing the LFP with AP

Episodic memories:

Tulving & markowitch 1998)

Nadel & Moscovitch 1997: even highly overlapping episodes are all unique.

We use the hilbert transform which assumes sinusoidality of the signal.

Other methods (e.g., linear interpolation methods: doi.org/10.1152/jn.00273.2019; empirical mode decomposition) do not have that assumption and might be more adequate.

During a spatial navigation task neural spiking locked to oscillations in the LFP of the microwire at which they were recorded, particularly at theta and gamma (josh 2007 paper). Locked to various phases in the theta range

Single neuron firing has been known to lock to the ongoing phase of theta (Josh 2007 paper xx). This spike-field code has been used to decode the position of an animal in relation to specific locations (okeefe place cell/phase precession) and stronger spike-field coupling has been shown to predict successful memory (rutishauser nature 2010).

Notes

you can look at HFA&Theta coupling (there is a bunch of literature on gamma&theta coupling although HFA is not gamma; HFA is likely aperiodic, mention the correlation between HFA and spikes but spike&theta coupling if there is something interesting

3B (HFP): time resolved HFP. Also look at misses adjusted for fewer number.

For intro:  
There are other notable mentions that produced major breakthroughs/milestones, such as Ramon y Cajal (...), Hans Berger (...). I will keep it at this restrictive list / But I will not attempt to provide an extensive list of ... here, nor do I deem an exaggerated focus on renowned scientists constructive/productive

read roux

read Shapiro (Behrens mentioned she proposes semanziation in CA1). Perhaps include his idea that semanzicied regularities in the cortex (or hippocampus) can be used as new inputs /elements into the hippocampus creating more complex combinations in each iteration.

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Once you can create ESN on demand you can check whether their firing rate follow the probability of the presentation of stimuli. A la polish paper with CN in a pyramid that I sent to Turk-Browne

Include Ison in the discussion about engram allocation, because it lines up (then also introduce quickly in intro)

Idea is this experiment:

A+B = C

A+D = E

A+F = G and stimulate each time. Do CN tuned to D fire to A and E?

Do they fire to B&C and F&G? IF so, in line with repetitions? Let's say A+B=C is more common then another trl is tun/reflected in re-tun?

Do we get a stimulus A CN? Does this change throughout the day/nights/experiment?

Do we have a ESN first? So for A+B=C?

Without stimulation (?) a+b=c

a+d=e

ESN for one overlap?

How are ESNs over repetitions? How does tuning response change? Repetition on next day as well? Pattern completion?

When associated with another image Concpet Neurons can change their tuning to the associate image. XX extended this work by first identifying Concept Neurons and then presenting their respective tuned images according to an implicit pattern. After several learning blocks, they could show that the implicit pattern was reflected in a change of firing rate. These line up nicely with rodent literature finding recently active neurons more excitable and more likely to be allocated to an event.

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