Notes of all papers read so far

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What this book is about

This book is a compilation of all the notes I will be making for the papers that I read from now. I've been realising my paper notes are scattered everywhere, across multiple folders and multiple computers, this is my attempt at trying to unify everything into one place.

Chapter 1

Toledo et al. 2020, Science

Cognitive map–based navigation in wild bats revealed by a new high-throughput tracking system. (Toledo et al., 2020)

- *notes taken on 2020-07-14*

1.1 Introduction

- map based navigation goes beyond just simple modes eg. beacon following or landmark based navigation.
- bats are known to return to their normal sites even after displacement, which suggests 'map-and-compass' navigation style
- Authors' previous results showed that fruit bats flew straight paths, but this was limited to a few nights of data.
- In this study, authors managed to study 172 bats over a cumulative of 3449 nights.

1.2 Methods

- *ATLAS* - a reverse GPS system, where the animal wears a tag that emits a signal which is received by multiple ground stations - and thus using TOADs, the animal can be detected.
- ATLAS coverage region is ~88,200 hectares (or an area that's 29X29km big!!)
- bats tagged, and all fruit trees within a given region recorded.
- Also performed translocation experiments. Each bat was translocated to the periphery of its normal foraging area, but within detection range of their foraging area

- Also performed time-lag embedding to understand how complex the navigational mechanism is

1.3 Results

- Bats exhibited straight tracks, which is indicative of goal-directed behabiou

- Each bat had its favourite tree, and visited it every night, and even visited it from multiple directions of arrival

- Solid evidence for a cognitive map is when an animal moves between two points that can't be detected/seen/observed from each other (ie. it requires a kind of 'rigorous' mapping)

- 4.3% of all tracks,and 70/172 bats actually showed such shortcuts

- There was no difference in the rate at which shortcuts happened between the age groups of bats tagged

- *following a conspecific* – they talk about it by saying that in their dataset, they didn't see individuals flying close together - but they only tagged 172 bats of ??? thousand in the whole population

- Translocated bats were able to return to their normal foraging area

- Time-lag embedding showed a high-dimensional correlation (?) indicating there must be many difference navigational factors

    - If bats were following a simple navigational route, they might always arrive and depart from the same direction - but the authors don't see this.

    - Authors don't seem convinced about the idea of an olfactory map

    - Authors also rule out the idea of pure path integration because they show that many bats returned to a different cave than the one they started out the evening from

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1.3.1 Comments

- Fig 2E: why would you use the p-value to show the *absence* of an effect? The p-value per se is hinged on so many other factors (eg.power, effect size, sample size), why not just report the raw data

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Chapter 2

Harten et al. 2020, Science

The ontogeny of a mammalian cognitive map in the real world (Harten et al., 2020)

- *notes taken on 2020-07-16*

2.1 Introduction, Methods, Results

- Whether animals navigate using 'maps'or not remains a question. The ability to take shortcuts, or direct routes between two points is a hallmark of map based navigation.

- The main problem with studying animal namvigation in the wild is that we can never be sure that the animal has not taken an apparent 'shortcut' before.

- authors were able to GPS track 22 young Egyptian Fruit Bats (*Rousettus aegeyptiacus*) from their first flight out of the roost

- Young bats increased their home range over the course of ~70 nights, by which they had the same home range size as an adult.

- Individuals showed two types of broad flight behaviour over a night, 'exploratory', where they explored for new trees, and nights where they visited prviously visted trees.

- Evidence to support the fact that the shortcuts were intentional:
  - shortcut were as straight as familiar routes ('commutes')
  - individuals seem to head in the direction of their target from the start of the 'shortcut'

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- – the 'shortcuts' could not be replicated by a random correlated walk (*this seems like a bit of a straw man null model (link), especially since the data is clearly so directional. The authors also specifically mention 'but without any navigational goal'*)

- *Bats performed both shortcuts and long-cuts from their first day outside,* - this is pretty impressive, but this also makes me think that the bats may actually be relying on a kind of path integration. Is their apatial memory so good that they can start mapping things over the course of one night? Is it possible that the bats may actually be using a beacon-type stategy to find their way around?

- Authors rule out olfaction and sound based cues by comparing wind direction and actual recordings made on the backpack tags. Both don't show support.

- *'Bats that were closer to the translocation release point before the translocation night did not necessarily navigate home better, once again contradicting the template-matching hypothesis'* , the authors also go on to follow and say that bats that flew higher were better able to find their way back. This actually doesn't rule out the template matching hypothesis either, because it might just mean that bats that flew higher had larger access to the area below, to form a 'higher SNR' template perhaps...

- The authors do also admit that the navigation behaviou they observed may be a result of multiple navigation strategies: *'..., navigation is a complex behavior that probably does not always rely on a single strategy'*

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2.1.1   Comments

- 'How animals navigate over large-scale environments remains a riddle', first line of the abstract starts with a rather bold statement. Is this statement really true for all animals, am under the impression that there is a large body of work for at least some animals.

- '*We documented how young pupsdeveloped their visual-based map*' - interesting, does this mean, echolocation develops later, or that the bats are known to use primarily vision for their navigation?

- Remember listening to a talk by Lee Harten in Konstanz ASAB, where she also presented work on the flight behaviour of the mother, who carried her pups around, and how the mother used to leave the pup in one tree, and so on. Do the authors discuss the implications of this type of memory on the shortcut taking ability of the young bats? *Yes, the authors have taken care of this, in the SI, they clearly state the mother and the pups*

were brought into an indoor facility, and the pups were kept indoors until they could fly

- *What about bats flying together?*, or encountering each other? Their in-hourse colony data kind of excludes this idea because the individual bats arrive alone, and are spaced b a few minutes. This is not the most rigorous evidence, but is still pretty indicatibe, eg. even in Orlova Chuka (and other caves), you can see the bats arrive alone in the morning. Howeer, this still doesn't really exclude the fact that bats may be encountering each other at some point over the course of the night.

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Chapter 3

Wikelski et al. 2020

Potential short-term eathquake forecasting by farm animal monitoring (Wikelski et al., 2020)

- weird animal behaviour just before earthquakes habe been reported, including dramatic cases where snakes and rats came out of their winter burrows during the winter in the 1975 Haicheng earthquake

- finding reliable changes in animal behaviour is tough because animal the animal behaviour needs to be monitored before and during the earthquake.

- Authors were able to overcome some of the limitations in the data this time by tagging multiple farm animals with high-resolution GPS tags that were equipped with many types of sensors

- Authors measured the behaviour of animals at the M6.6 Norcia earthquake that happened on 2016

3.1 Methods

- Animals chosen from a farm based on which ones the animals thought were most sensitive to the earthquakes.

- Two tagging periods, once before + during the earthquake, once after

3.2 Data description

- *Between ..., the animals experienced a total of 5,304 earthquakes with M > 0.4 ...and from ... a total of 12,948 ... didn't realise that earthquakes were so frequent in some areas.*

- The 'hypocenters' of the earthquakes were anywhere between 5-28 km from the farm *–all relatively close by!*

3.2.1   Results

- Find a negative correlation between time of increased animal activity and earthquake intensity. For earthquakes ≥ 4 M, the animals responded earlier to quakes that were closer to the farm, and later to those that were further away from the farm.

- "Warning times" ranged from 1-15 hours

- Animals seemed to be more sensitive to earthquakes in closed buildings - but there may be a seasonal factor in the observations too

- What are the possible cues the animals are using to detect/respond to these earthquakes

    - The inverse relation hints at a diffusive type process. "air ionization at pressurised rock surfaces" – diffusing into the air, to which the animals may be responding to.

3.2.2   Overall thoughts

- very intersting paper, which quantifies something which has been known but has now been studied in greater detail through this new technology.

- authors also suggest a future experimental setup where a series of animal moinorting stations could be used to predict the position and time of arrival of an earthquake.

Chapter 4

Ratcliffe et al. 2004, Can. J. Zool.

Conspecifics influence call design in the Brazilian free-tailed bat, Tadarida brasiliensis (Ratcliffe et al., 2004)

- *notes taken on 2020-07-21*

4.1 Introduction

- echolocation is pretty flexible and the emitted calls vary a lot based on the type of prey being caught, and the presence of conspecifics
- This paper is a kind of offspring of another (Avila-Flores 2003), where the authors saw that there was more call variation when bats flew together than when alone.
- Authors try to estimate this variation by comparing observed pairs of bat calls and 'virtual' pairs of bat calls.

4.2 Methods

- Free flying *Tadarida brasiliensis* recorded in three locations in Mexico City, of bats flying over a lake, and two others in open areas (park and city square)
- 30 sequences from each location obtained (15 single bat passes + 15 paired passes).
- Authors specifically chose call sequences with no overlap of bat calls.

4.3   Analysis

- To compare the single vs paired call behaviour, the difference in the mean values was used
- The difference in the mean, Δ_{mean} was used to compare if a bat showed alterations to its echolocation when alone vs. when with another bats.
- To understand if bats actually altered their call parameters when flying in groups the authors calculated the pair difference $bat1_{measurement} - bat2_{measurement}$ for actual observed pairs of bat call sequences, and those of virtual pairs.
- The pair difference was calculated by subtracting the means of the $bat1_{measurement}$ and $bat2_{measurement}$

4.4   Results

- Authors didn't find any statistical difference in call parameters across locations and so decided to pool them all together (and thus used single bat call sequences from multiple locations while making virtual pairs). (*See comments*)
- Authors found no inter-individual call differences across observed and virtual pairs for the parameters 1) call duration 2) bandwidth , and found differences in the peak frequency. (*See comments*)
- The authors also saw social calls in paired audio files.
- The authors are indeed careful while ending '*To be even-handed….changes in peak frequency which we found…are neither jamming avoidance nor air traffic control, but serve another and as yet undetermined communicative function*'

4.4.1   Comments

- authors state '*Although referred to as jamming avoidance.., support for this interpretation is not as strong as that for the jamming avoidance response in electric fish*'. They also go on to state that labortatory studies seem to have 'met with some success'. In general, does this support the fact that bats in the field may actually not be showing dramatic changes in calls at all - it's only when they're put into a quiet unusual lab context that they begin to show changes. Perhaps, this strong response is seen because the animals have gotten used to flying under quiest conditions, and are now suddenly challenged?

- how do the authors actually know that the two bats in a paired call sequence were flying together/in close proximity? '*We assinged each recorded seequence to one of two situations…..and two bats flying close proximity*'

- this is a rather vague definition. With a single bat detector, it is not possible to track the bats in 3d, at most one can check if the waveforms of the two bat calls are similar, but here too it only means that the two bats were flying in the same radius from the bat detector. It is somewhat crude, though admittedly, the best possible criteria given the current instrument.

- Authors actually pooled call sequences from multiple locations and made virtual call pairs from this pool. This will actually have the effect of *increasing* the diversity of the observed data? Also, it is known from tracking studies that individual bats tend of have favourit foraging sites - and so in some sense, it is expected that there will be a 'local' flavour to the data. It would have been nice to see the authors perform the same analysis without pooling across locations.

- The authors find differences in peak frequency between real and virtual pairs. This could really be an effect of where the bats were flying while in pairs vs when they were alone. The simplest explanation is that the bats may be flying further away from the microphone, thus leading to different SNRs at recording - which then leads to different peak frequencies. The difference in the peak frequency could really be an artifact and not a real effect. Moreover, given the authors state that they do see social calls, the line between social call and echolocation call is a thin one, which means, perhaps the authors are seeing this effect? The authors state this themselves *'Our recordings suggest a continuum in call features between echolocation and social calls…'*

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Chapter 5

Benediktova et al. 2020

Magnetic alignment enhances homing efficiency of hunting dogs (Benediktová et al., 2020) - 'homing' behaviour has been shown in many animals, and could be driven by multiple cues. Homing behaviour in non-migratory species still needs to be excplored more. - Reports of dogs that found their way back even when displaced beyond their usual home range, and without access to familar visual cues. - Hunting dogs have been bred by humans to chase game and then return to the start point if not followed by the hunter. These 'hunts' can ve a few hundreds to thousands of meter long. - These dogs may find their way back either using their own scent trail - which the authors called 'tracking' or, by actually navigating using the landmarks or information gained during the onward travel, which the authors call 'scouting'

5.1 Methods

- The hunting dogs were left to innately follow the olfactory tracks of game animals in the wildlife reserve
- Small dogs were used, and so there was no 'physical thresat' to wild animals
- All dogs were tagged with GPS collars, and some of the trials with dogs also had a camera involved.
- Trials were performed with single dogs, and in areas free of high voltage power lines, roads or buildings and across the day and season (across the year)
- There needs to be some more clarity in terms of when a trial started (see *Comments*)
- Owners hid behind a tree to reduce visual beaconing
- Only excursions >200 metres were considered for this study

- Authors split all excursions into 10 equal parts, and assigned phases to them based on the average speed of the part.

5.1.1   Return strategies

- Dog return strategies could be categorised into two classes
  - tracking: the inbound and outbound trajectory are the same , and the inbound-outbound trajectories were <30 m apart
  - scouting: a new woute was taken, and the inbound-outbound trajectories were >30 m apart

5.1.2   Results

- in ~59% of all trials, dogs ended up tracking their way back, while in 33% of the trials, dogs ended up scouting their way back, and in 8% of the trials, dogs used a mic of scouting and tracking
- Scouting dogs showed a higher average speed while returning (because they tended to take shorter routes)
- Trials bbegan and ended with no particular bias in the compass directions, though trials which were in the north-south axis, showed more efficient homing runs
- wind direction and sun location didn't seem to make a difference
- dogs returning with a scouting strategy seemed to begin by first travelling along the north-south axis, irrespective of the actual locationg ot he destination ### Discussion
- Authors convincingly rule out the possibility of multiple cues begin used(vision, olfaction, celestial cues). Thedogs are too short to see far, and the forest is pretty opaque. Olfactory cues are likely to change a lot, though one can't rule it out completely
- The sun's location/polarised light – this they haven't been fully able to elimination - but they indicate that there were trials where the sun wa blocked by clouds - which would reduce the strength of polarised light 'map'
- Authors do highlight the fact that path integration is definitely one possible mechanism by which the dogs in this tudy may be finding their way back, but the question of the north-south run still remains - and it may in fact serve as a kind of recalibration run, over which the errors accumulated over path integration can somehow be 'corrected'?

5.1.3   Overall thoughts / Comments

- Really smoth introduction - easy to follow

- It's not entirely clear how the trial exactly proceeded. The dogs were brought to a site, and then left to roam free.
  - *The handheld GPS device was programmed to indicate when the dog had travelled 100 m from the position of the owner. At this moment (designated as 'excursion start') the owners stopped walking...*. This is the confusing part, because, what was the owner doing before that? Were the dog and the owner walking together (unleashed dog) on a trail, and then when the dog roamed far away enough, the trial was considered started. But this still elaves some room for error in terms, of wehere the dog left the 'main trail' and where the owner was when the trial started.....confusing
- In figure 4, bottom plot - authors plot the *log* of the inbound track length against the raw beeline difference. This is a bit misleading perhaps? In general, yes, the log-transform will tend to show lesser variation - but in general, there will always be a linear correlation between te distance the animal travelled and the beeline distance ...especially if there is some kind of navigation in place... - am I being over-cautious here or not - can't make out.
- Pretty cool study, this study ads to the general observation of so many magnetically related behaviours (dogs peeing/pooping facing one direction (where did i read this), arctic foxes always facing one stereotyped direction before ponching onto their prey underneath the snow, and cows facing in one direction while grazing)

Chapter 6

Final Words

We have finished a nice book.

Bibliography

Benediktová, K., Adámková, J., Svoboda, J., Painter, M. S., Bartoš, L., Nováková, P., Vynikalová, L., Hart, V., Phillips, J., and Burda, H. (2020). Magnetic alignment enhances homing efficiency of hunting dogs. *Elife*, 9:e55080.

Harten, L., Katz, A., Goldshtein, A., Handel, M., and Yovel, Y. (2020). The ontogeny of a mammalian cognitive map in the real world. *Science*, 369(6500):194–197.

Ratcliffe, J. M., Hofstede, H. M. t., Avila-Flores, R., Fenton, M. B., McCracken, G. F., Biscardi, S., Blasko, J., Gillam, E., Orprecio, J., and Spanjer, G. (2004). Conspecifics influence call design in the brazilian free-tailed bat, tadarida brasiliensis. *Canadian Journal of Zoology*, 82(6):966–971.

Toledo, S., Shohami, D., Schiffner, I., Lourie, E., Orchan, Y., Bartan, Y., and Nathan, R. (2020). Cognitive map–based navigation in wild bats revealed by a new high-throughput tracking system. *Science*, 369(6500):188–193.

Wikelski, M., Mueller, U., Scocco, P., Catorci, A., Desinov, L. V., Belyaev, M. Y., Keim, D., Pohlmeier, W., Fechteler, G., and Martin Mai, P. (2020). Potential short-term earthquake forecasting by farm animal monitoring. *Ethology*, n/a(n/a).