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Main figure

Rest supplementary

Summary 250 words

How organisms interact with the world is fundamental to how evolution shapes the sensory systems that allow them to perceive it. One aspect of perception shared across living organisms is the scale at which it can perceive events in its environment. The rate at which a organisms can perceive events is highly variable across the Animal Kingdom ranging from the high temporal abilities of pied fly catchers and dragon flies to the extremely slow paced visual perception of the deep sea escolar. This variation in temporal perception is predicted to be primarily driven by evolutionary selection based on the ecological pace of a species, with species with fast moving ecologies expected to evolve fast paced temporal perception abilities. However, the link between a species temporal perceptive abilities and the pace of its ecology has only been tested within particular species or limited to certain taxa, with few large scale tests of this hypothesis. Here, we use critical flicker fusion, a measure of visual temporal perception, data across over 100 animal species spread across xx Phyla, to test whether ecological pace is linked to temporal perceptual abilities. We show smaller species which can fly along with pursit predators have the highest critical flicker fusion rates. We also show that while marine ballistic predators, which generally employ sit and wait strategies, have higher temporal perceptive abilities compared to foraging predators, terrestrial ballist predators do not. This difference between marine and terrestrial envnments is likey liked to dfferences in the abilty to acts on information, further highlighting how enviornmetns affect temporal perception. These results are important because.

Intro

Results

Discussion

STAR Methods

Intro paragraph

Our ability to interact with the environment is fundamentally linked with our ability to perceive it. The ability to perceive separate objects spatially can be an important trait in species which require pinpoint accurate spatial information, such as found in many birds of prey (ref), while the ability to perceive different wavelengths can determine whether a species see’s a potential mate or a warning (ref example). However, a potentially more fundamental aspect of perception is the ability to perveance the rate of events in time, or temporal perception.

Temporal perception has a long history of research. Classical measures, such as the critical flicker fusions rate of a species visual systems were developed over 100 years ago but are still the standard measure of temporal perception. This approach which does x y and z has been applied across a wide range of species. Species such as dragon flies and blow flies can perceive flicker at over 300 Hz, while the visual system of Starfish is restricted to below 0.7Hz. Within vertebrates, temporal perception ranges from 5hz in the slow moving artic fish the escolar, to 144Hz in the aerial predator the pied fly catcher. However, dispite its long history of use and the wide taxonomic range of animals it has ben measure for (ref), little is known regarding the drivers of temporal perception in animal.

Autrum’s hypothesis (1950) was one of the earliest attempts to explain variation in temporal variation through linking it with visual ecology. This hypothesis posited that fast paced visual ecologies would create selection pressures for higher temporal perceptual abilities in a trade off with the metabolic costs required for such increased information processing (ref). Supported for this has typically been found in case studies of taxonomic groups with extreme visual ecologies such as associated with volant predators or deep sea scavenging. For example, studies of blue tits, pied fly catchers and xxx have shown that birds which are more associated with aerial capture of prey had the highest cff values. Conversely, studies of deep sea scavenging species have found xxxx.

While these studies demonstrate the likely wide application of Autrium hypotheses they are typically restricted to specific taxonomical groups or species. We use the standardised and historic use of critical flicker fusion measures of temporal perception to test the universality of Atriums hypothesis and allow a more nuanced understanding of the selection pressures of temporal perception.

Across xxx species ranging from xx to xxx (phylogeny figure), we find that, as expected according to Autrium’s hypothesis that volant species, species in high light environments and species smaller species have the highest cff values. Volant species are typically expected to require higher temporal perception due to the requirements of high manoeuvrability in flight. This increased cff extends to volant species in low light environments with the highest xx cff values in low light environments found in volant species. Similarly, lower cff values in lower light environments are expected given the trade off between temporal perception andacuaty in relation to the visual system. Several studies have demonstrated that species adapted to lower light environments trade-off temporal perception (studies). This is perhaps best demonstrated by the difference between deep sea speices such as xxx, which have some of the lowest cff values, compared to shallow species, including the xxx which has the highest recorded cff value in a marine species.

Supporting both Autrium’s hypothesis and previous studies we also found smaller species where associated with higher cff values, but only in higher light environments. Smaller species are expected to be generally more manoeuvrable and hence can act on high temporal information. Within the species in our dataset this is further demonstrated by the higher temporal perception in smaller volant species compared to larger species, such as between blowflies and larger moths. Interestingly, we only find this association with high light environments likely due to the temporal perception cap imposed by the physics of low light environment. The highest cff value in nocturnal volant species was xxx likely highlighting that selection above this value is severaly restricted dues to the trade-off.

We also find an unexpected context specific link between tropic ecologicly and temporal perceptual abilities. In marine environments we find support for higher cff values in both pursuit predators and for ballistic predators (sit and wait predators) when compared to foraging species (scavengers and herbivores). This link between tropic ecology and visual ecology is expcted as species invovolved with fast paced predator-prey interactions are expected to be selected. Specific adatpataions are also observed in species such as sword fishm which have the abilty to speed up their eyes.

However, in terrestrial environments we found no link between predator foraging type and temporal perception. While we lack the data for non-volant terrestrial pursuit predators our dataset indicates that the mean cff of the xxx terrestrial ballistc predators in our dataset is xx lower compared to foraging species. This difference between aquatic and terrestrial envionrments may stem from the difference in manuverabilty between these habitats and also the abilty of prey to escape. Aquatic enviormetns provides a mediaum on which orgaisims can instatanously act upon, In contrats, many sit and wait ballists predators in terrestrial enviorments are several restricted in their manouvrabilty once they engage with prey itesms,. For example, one a jumping spider jumps there is no last minutes changes. Furthermore, marine envionrments may also allow for higher escape rates for prey due to the 3D (). This is perhaps demonstrated by tiger beetle which do xxx.

Our results demonstrate both the general nature of Autrium hypothsis with regards to body size, light conditions and volance. However, our results also demonstrate the important context specific nature of different environments. While our analysis test tropic intercations temporal perception is also clearly driven by more nuanced factors such as desmotrated level of residual