Theoretical and empirical framework

The natural setting for food-seeking behavior

Foraging comprises the complete set of activities and behaviors related to obtaining food in a wild environment. Food-seeking behavior is a particular element of such set, which includes all re-orientation and locomotion activity related to the obtention of food. Thus, food-seeking behavior stops when a given food-resource is found, whereas foraging behavior is still present in future utilization of acquired energy, including feeding or possibly hoarding (Kramer 2001).

The food-seeking phase of foraging must ensure an optimal way to aquire food using the least amount of resource and reducing exposure to potential predators. If food-resources location where to be static, food-seeking behavior only necesary input would be an initial sampling of the environment, and then matching landscape cues, this is not the case. Animals do not necessarily follow landscape cue (Bartumeus et al. 2016), or even develop search strategies based on them (Kölzsch et al. 2015). Moreover, animals are subject to incomplete knowledge about resources location, quality and probability of obtention (Pyke 1984). Thus a foraging animal must determine its food-seeking behavior considering an inherently stochastic environment with only partial knowledge.

In a stochastic environment, in order to to establish optimal food-seeking strategies, animals should consider the overall statistical properties of the environment, otherwise, local environment volatility could lead to the misguided preference for lower mean quality food resources with high variability, which could lead to starvation in the long run. Empirical evidence has shown that multiple animal species, including humans, perform search in a Lévy-walk fashion (Garg and Kello 2021; A. Reynolds et al. 2018; Viswanathan et al. 1996; Kölzsch et al. 2015). Lévy-walks are random walks with a Lévy which produces heavy-tails, and describes multiple concentrated movements with sharp turning angles, followed by few ballistic displacements, such pattern produces optimal searches in a wide variety of environments were resources are dispersed in a patchy-fashion (Wosniack et al. 2017), although its generative mechanism is not clear (A. Reynolds et al. 2018) there is evidence that this mechanism is partially independent of sensory information (Humphries and Sims 2014; Sims et al. 2019), probably selected through evolution as it optimizes food searching with partial or complete lack of knowledge (Wosniack et al. 2017).

Given that this food-seeking strategies are present without sensory information, and are ubiquitous in animals, food-seeking behavior probably evolved to deal with partial knowledge in uncertain environment. While, Lévy-walks provide a 'basal' strategy when there is partial or no knowledge, it is known that upon food encounter or sensing search strategy switches to a more focused one similar to brownian-motion (A. M. Reynolds and Frye 2007; Nauta, Khaluf, and Simoens 2020). Furthermore, computational modeling points how this switch between informed (brownian-like) and random search might be dependent on food encounter uncertainty (Anselme, Otto, and Güntürkün 2017). Together this data suggests that animals food-seeking behavior evolved to deal with uncertain environments and partial knowledge. Moreover environment uncertainty itself modulates the baseline strategy, thus allowing to optimally search for food even when knowledge is not complete.

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