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# Scale-dependent orientation in movement paths: a case study of an African viper

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## Abstract

Decisions relating to the orientation of movement by animals and how this translates into movement patterns can occur at multiple spatial scales simultaneously, but this interaction is poorly understood for many groups of animals. Using the tracks left by moving snakes in their sandy habitat, we studied the movement paths of the African snake Bitis schneideri (Namaqua dwarf adder) for evidence of broad-scale directional persistence and short-range avoidance of exposure. Although snakes clearly displayed directional persistence, they preferentially moved to nearby shrubs, thereby minimizing exposure to solar and thermal radiation and/or predation. Thus, snakes made decisions relating to orientation at a minimum of two scales, the interaction of which resulted in snakes moving ≈17% (mean straightness index = 0.85) further than the simple broad-scale straight-line distance. We assert that the actual path chosen by moving snakes represents a trade-off of various costs and risks that include risk of predation, exposure to the elements, time and energy expenditure. Our study highlights the need for cognizance of the possibility of the scale dependence of orientation and movement in studies of snake movement, and adds to a growing literature demonstrating previously unrecognized behavioural complexity in snakes.

## Introduction

The way an animal moves through its environment (hereafter: movement) is a fundamental component of its life history that has broad implications for its nutritional state, mating success and risk of predation (Nathan et al. 2008). As a result, animal movement has been studied for a long time culminating in the formalization of movement ecology as an important discipline (Nathan 2008). Yet despite the growth of movement ecology as a discipline and the remarkable concomitant advances in biotelemetry (Cooke et al. 2004; Benhamou 2014), our understanding of movement for certain groups of organisms, and movement at certain spatial scales, remains superficial (Holyoak et al. 2008) and limits our ability to generalize across spatial scales or understand the evolution of such behaviour.

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