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1st August 2022

Clarke et al – A Bayesian statistical model is able to predict target-by-target selection behaviour in a human foraging task

Dear Editor,

Foraging has been well-studied in many species that rely on widely distributed food sources, such as bees and birds. Less well understood is how humans approach foraging tasks, and whether there are general policies we can identify that describe how we search for different categories of objects that can vary in quantity and distribution. For instance, people can search for multiple categories simultaneously (expending cognitive effort to maximize the rate of return) or focus on one category at the expense of the others (maintaining a low cognitive load but taking a less efficient path). Foraging tasks have enormous potential for exposing and understanding human trade-offs between cognitive and physical effort.
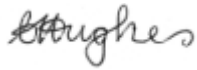
Recently (Clarke et al, 2022) we have presented a Bayesian cognitive model that estimates four parameters from foraging data: 1) a target bias, to select one category of targets over others, 2) a persistence bias, to select the same target as was selected previously and 3) a proximity bias, to select the target that is closest to the current position [and 4) a momentum bias, to continue selecting targets in the same direction as previous targets. We have shown that these parameters can be easily compared across conditions and populations, and our tool can also be used as a generative model to produce simulated data under different hypotheses. However, in our original paper we only considered biases at the level of a trial. During the Scottish Vision Group Meeting in 2022, Dr Martin Lages asked us about the extent to which our model was able to predict target-by-target behaviour within a trial.

In the current manuscript, we address this knowledge gap. We show that our model can do a good job of predicting foraging behaviour within a trial, with a range of accuracy for picking the correct next target from 43% to 69% across participants (with chance being 11%). We also extend our model to see if we are able to predict the location of the first target selection, and we show that participants show remarkably similar and stable initial item selection strategies, meaning that our model is relatively accurate for selecting the initial target. Our work demonstrates one of the key benefits of computational models: we are able to use them to rigorously test how well we can predict behaviour. The failures of the model also allow us important insights into the factors that we may be missing in understanding how participants complete a task, providing new directions for future work.

We confirm that neither the manuscript nor any parts of its content are currently under consideration or published in another journal. All authors have approved the manuscript and agree with its submission to (journal name).

Thank you very much in advance for considering our paper.

Yours sincerely,

Anna Hughes