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A Simple Heuristic Successfully Used by Humans, Animals, and Machines: The Story of the RAF and Luftwaffe, Hawks and Ducks, Dogs and Frisbees, Baseball Outfielders and Sidewinder Missiles—Oh My!

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1. Introduction

Welcome to one of the most interesting but unexpected papers ever submitted to *topiCS*. This is the story of a *natural heuristic* that was discovered by the Royal Air Force (RAF) just prior to War World II. It is a *dynamic adaptive heuristic* in that it updates repeatedly in real time. To expand on our title and to warm up to our subject, it might be best to start with the story of the *gaze heuristic* as told by Gigerenzer and Brighton (2009).

How does a baseball outfielder catch a fly ball? By solving a series of complex differential equations? Or by doing something simpler? According to Gigerenzer and Brighton (2009), outfielders rely on simple heuristics to catch flyballs. The most simple of these is the gaze heuristic, which is successful when the ball is already high up in the air:

> Fixate your gaze on the ball, start running, and adjust your running speed so that the angle of gaze remains constant.

Using this heuristic, a player does not have to estimate any of the variables necessary to calculate the ball's trajectory, including the initial angle and speed, spin, and direction of wind, nor solve differential equations to calculate the point where the ball

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will land. Rather, the gaze heuristic will guide him to that point without computing the exact spot.

While our author has no beef with this description, he points out that the gaze heuristic described is the weak, earthbound version of a more elegant heuristic used by some mammals, birds, and insects who fly as well as by some (rats) that do not. The stronger, iterative version of the gaze heuristic is able to deal with living targets that, unlike the ball, can intentionally change their trajectory in an attempt to escape from being caught. In Hamlin's words, it "takes the best input at the best time"—this is why he refers to it as take-the-best[2]—and enables hawks and enabled World War II RAF pilots to adjust their trajectory when their targets, the duck or the Luffwaffe pilot, change trajectories.

The story of the human discovery of *the interception heuristic* is a quietly exciting piece of wartime drama. During World War II, the Germans used their radar to send guidance from ground-based radar systems to Luftwaffe pilots. As Hamlin argues, this was an effective and technically very sophisticated system to which "enormous technical resources" were devoted. However, "[d]espite this, the Luftwaffe's interception systems remained relatively cumbersome, inefficient, highly restricted in their capacity and demanding great concentration and skill by both pilot and controller." In contrast, the RAF discovered and implemented the 3-D version of the gaze heuristic with devastatingly effect on the Luftwaffe, helping to win the Battle of Britain.

Interestingly, the story of this technology did not end with World War II but continued into the 1950s and to today with the development of a highly effective air-to-air missile system, the *Sidewinder AIM9*, which, in effect, combined German technology with British discovery of the gaze heuristic. Our author calls the Sidewinder AIM9 "one of the simplest systems either mechanical or biological that is capable of making decisions and completing a task autonomously," and the descendants of this system are still in use today.

Of course, while the story of wartime drama makes this an usual tale for *Topics in Cognitive Science*, or for any other cognitive research journal, the larger point is that of a simple heuristic outperforming a much more complex and cumbersome decision-making system. Research has uncovered a number of heuristics with similar success sotries (for an overview, see Gigerenzer, Hertwig, & Pachur, 2011). The recognition heuristic, for instance, can successfully steer behavior in situations where name recognition correlates with the criterion, such as in sports, where the quality of a contestant and the proportion of people who have heard of his or her name is correlated. Thus, the heuristic recommends that if you have heard of contestant A, but not of B, then predict that A will win. In fact, it has been shown twice that this heuristic predicts the winners of the 127 individual matches in Wimbledon Gentleman's tournament as or more accurately than the *Association of Tennis Professionals* (ATP) rankings and the Wimbledon experts. Like the gaze heuristic, the recognition heuristic pays attention to only one variable—one which humans and animals have discovered through experience and have used to successfully deal with problems as varied as food choice and college choice.

Each of these heuristics is adapted to its domains, just as hammers are made for nails and screwdrivers for screws. Continuing with this analogy, decision making then resembles a toolbox containing diverse heuristics, and intelligence means selecting the right tool for the right job. As the article by Hamlin shows, the gaze heuristic solves quite a number of problems across species, as well as for humans and machines. And a major lesson is that complex problems do not generally require complex solutions. Rather, they can often be solved by simple heuristics. Animals and humans tend to find these solutions—some faster and some not so fast, as the contrast between the RAF and the Luftwaffe illustrates.

In fact, the standard approach to decision making is still based on the assumption that complex problems require complex solutions, and a glance into any journal in decision making will likely encounter highly parameterized models that integrate all possibly relevant variables, Bayesian or otherwise. In banking, for instance, capital requirements are estimated by calculating the value-at-risk of a bank, which for a large bank may involve estimating thousands of risk factors and covariation coefficients in the millions. As much manpower and documentation as these calculations involve, their success is similar to that of the complex mathematics the RAF tried before they discovered the gaze heuristic, as Hamlin describes in detail. These calculations have neither predicted nor prevented a single crisis. To decrease the probability of further crises, both simplicity and robustness must be high. Along these lines, Andrew Haldane, economist-in-chief of the Bank of England, titled his 2012 Jackson Hole talk, "The dog and the Frisbee" (Haldane & Madouros, 2012). To the surprised audience of central bankers and finance ministers, he argued that catching a Frisbee is as difficult as catching a financial crisis. But whereas dogs rely on the gaze heuristic and successfully solve their problem, central bankers rely on complex models and fail theirs. His call for simple rules that enable a safer world of finance was named the "Speech of the Year" by the *Wall Street Journal*.

Although simple heuristics are still science fiction for banking, the gaze heuristic has made its inroads into the minds of financial regulators.

Albert Einstein is said to have advised us that "everything should be made as simple as possible, but not simpler" (Calaprice, 2010). The biography of the gaze heuristic is an excellent case story of how bats, hawks, baseball players, and the RAF discovered the robust efficiency of a simple heuristic.

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