New research has identified a specialized bundle of cells in plant seeds that work in a similar way to human brains in order to determine when to start sprouting. The study was published Monday in the *Proceedings of the National Academy of Sciences*.

“Seeds most definitely think in the sense that they use many pieces of information from the environment (light, temperature, nutrients) and integrate this in order to make decisions,” lead author George Bassel, a professor of bioscience at the University of Birmingham, tells *Inverse* in an email.

The timing of seed germination is incredibly important. Too soon and the seed will die from exposure to the elements. Too late and it will be outcompeted by other plants that were less conservative.

Bassel’s research team discovered that a specific group of cells are responsible for this balancing act in the *Arabidopsis*, or thale cress, species. There are actually two types of cells — one type promotes dormancy while the other promotes germination. These groups communicate with each other using hormones. They take in information from the external world, and eventually the signal from the cells that promote germination overtakes the signal from the cells that promote dormancy, and the sprouting begins.
This is a 3-D digital reconstruction of a plant embryo, showing location of decision-making components, on a mathematically-modelled background.

The physical separation of the two cell types helps the plant negotiate the trade-off between speed and accuracy — between being first to germinate and germinating in the most opportune environmental condition. The human brain makes a similar calculation when it decides to, say, point a finger at an object. The faster the hand moves, the less accurate it can be. This principle is known in the world of cognitive neuroscience as Fitts’s law.

These plant cells aren’t neurons, and plants don’t have nervous systems, and yet they function in an analogous way. “The way the cells are organized in seeds is the same as in regions of the human brain,” says Bassel. “In both cases there are cells which each promote and inhibit decisions competing with each other to ultimately make a single output. This is a fascinating example of convergent evolution between plants and animals, demonstrating that they think alike.”

Convergent evolution describes cases where organisms separately evolve characteristics that look similar or serve a similar function. This plant “brain” arose entirely separately from animal nervous systems, and yet it works the same way.

“While plants don’t have a brain in the traditional sense, the research does provide a unique insight into how cells make decisions in complex organisms,” says Bassel. “The similarity in the arrangement of the human brain and cells in the decision-making centre of the seed demonstrates this to be an effective way to reach effective decisions in biology. Evolution has chosen this same arrangement multiple times in very different organisms.

Plants perceive and integrate information from the environment to time critical transitions in their life cycle. Some mechanisms underlying this quantitative signal processing have been described, whereas others await discovery. Seeds have evolved a mechanism to integrate environmental
information by regulating the abundance of the antagonistically acting hormones abscisic acid (ABA) and gibberellin (GA). Here, we show that hormone metabolic interactions and their feedbacks are sufficient to create a bistable developmental fate switch in Arabidopsis seeds. A digital single-cell atlas mapping the distribution of hormone metabolic and response components revealed their enrichment within the embryonic radicle, identifying the presence of a decision-making center within dormant seeds. The responses to both GA and ABA were found to occur within distinct cell types, suggesting cross-talk occurs at the level of hormone transport between these signaling centers. We describe theoretically, and demonstrate experimentally, that this spatial separation within the decision-making center is required to process variable temperature inputs from the environment to promote the breaking of dormancy. In contrast to other noise-filtering systems, including human neurons, the functional role of this spatial embedding is to leverage variability in temperature to transduce a fate-switching signal within this biological system. Fluctuating inputs therefore act as an instructive signal for seeds, enhancing the accuracy with which plants are established in ecosystems, and distributed computation within the radicle underlies this signal integration mechanism.

Plants have evolved to "hedge their bets", having their seeds germinate at different times. In agriculture this challenges uniform crop yields. Maths finds cell machinery that "rolls the dice" for this hedging, and ways to harmonize.