A toast-based proof of a malevolent God

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Introduction

We've all experienced it. It's Monday morning, you've slept through your alarm and are now in a hopeless rush to get in on time. The toast comes out of the toaster, you give it a quick sweep of butter, or in these more health-conscious times, margarine, and pick it up to take over to your newspaper on the kitchen table. And then it happens. Whether it simply slips out of your fingers, or it burns slightly and you subconsciously release it, the toast begins to drop towards the filthy floor. You watch in dismay as the toast falls, neatly performing a half-turn and landing flat on the floor, butter-side down in the grime. You don't even know why you tentatively hoped for the toast to land otherwise – the Universe seems out to get you as far as free falling toast is concerned. Well, in fact it is.

The butterside-down eventuality is the necessary outcome due to a specific combination of parameters concerned with the dimensions of humans and ultimately the fundamental structure of the universe. This argument-by-design, therefore, not only conclusively demonstrates the existence of the Creator, but that he is a cantankerous old git who organised the Universe in this way to continually torment us with dirty toast.

Methods

A mathematical model of the toast situation can be constructed in order to demonstrate the butter-side down condition as the invariant outcome. To simplify the situation, the cuboid of toast is modeled as a rigid rod with uniform density and length $2a$. Thus rotation in only in one plane, a change in pitch, is considered, and roll and yaw during the descent are ignored. At the initial condition, the moment of release, the toast is horizontal and supported only at one extreme by the breakfaster's finger. The weight of the toast has become an unbalanced force, and so creates a turning moment and thus rotation about the pivot (finger). This turning force is equal to the component of the weight perpendicular to the surface of the toast. Figure 1 below shows the situation when the toast has pitched down through an angle of θ.

As long as the toast remains in contact with the pivot the rate of rotation increases. When the toast has pitched down to a certain dip-angle static friction between bread and finger is overcome and the toast slips off the pivot. The toast now enters freefall towards the floor, rotating at a steady rate about its

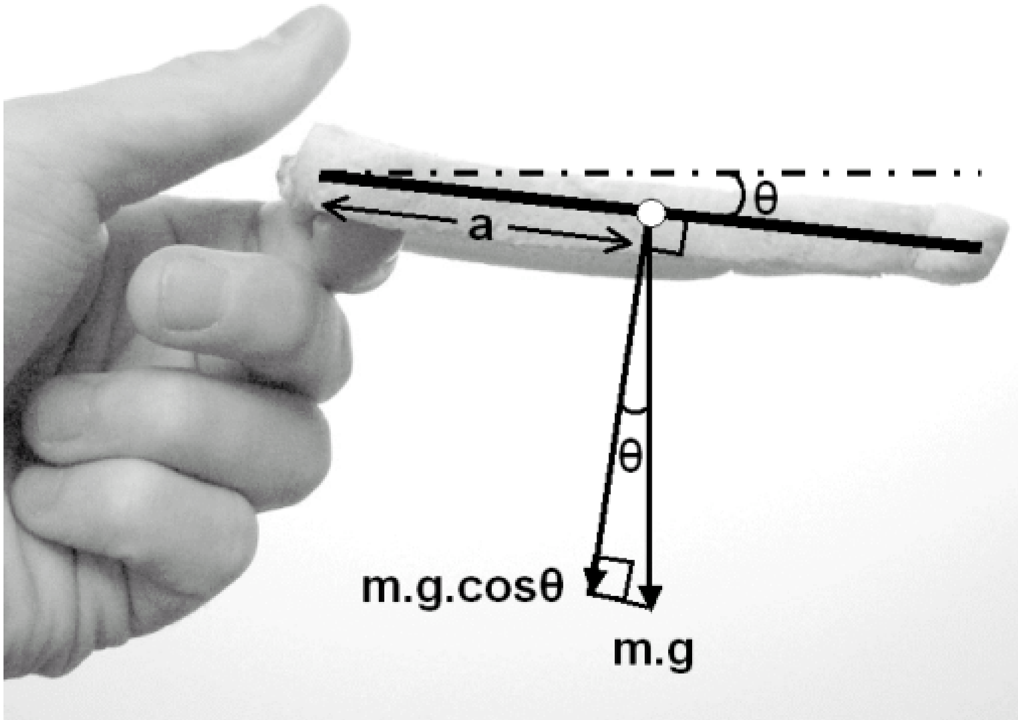

Figure 1. Diagram of the situation when the toast has pitched down by θ

centre of mass. The total drop height is given as *h*. The analysis is made simpler by two assumptions; that the size of the toast is insignificant compared to the drop height, and that the pitch angle at the point of slippage is a negligible proportion of a complete turn, ie:

$$a \ll h \quad \text{and} \quad \theta \ll 360^\circ$$

The calculation of the number of turns completed before landing on the kitchen floor proceeds as follows:

After rotation through θ, toast center of mass has dropped $a \sin\theta$

∴ loss in potential energy $mga \sin\theta$

∴ gain in kinetic energy of CoM rotating round pivot

$$\frac{1}{2} m v^2 = mga \sin\theta$$

$$v = \sqrt{2\, ga \sin\theta}$$

Circumference of complete turn $2\pi a$

∴ time to complete a single turn

$$\frac{2\pi a}{\sqrt{2 ga \sin\theta}}$$

Distance traveled during acceleration

$$s = \frac{1}{2}at^2$$

$$h = \frac{1}{2}gt^2$$

∴ time until toast impacts floor

$$t = \sqrt{\frac{2h}{g}}$$

Number of turns completed before toast impacts floor

$$\sqrt{\frac{2h}{g}} \Big/ \frac{2\pi a}{\sqrt{2ga\sin\theta}}$$

Simplifies to…

$$\sqrt{\frac{h\sin\theta}{\pi^2 a}}$$

Results

Thus, two expressions are derived; one for the length of time required for the tumbling toast to rotate through a complete turn and the other for the time taken before the freefalling toast hits the floor. The number of rotations completed by the falling toast before it lands is the ratio of these two calculated times. The formula can be evaluated by substituting in average values for the parameters. A slice of Kingsmill square-cut thick white bread, which the author finds optimal for toasting, is 15cm long, giving a the value of 0.08m. The most natural posture to carry toast betwixt toaster and kitchen table is at a height just below elbow level, making h = 1m. After an extensive empirical study into the mean dip-angle that toast slides off the pivot θ was found to be 15°. Inserting these values into the derived formula yields 0.573 revolutions... The toast rotates an almost exact half-turn. Because toast is carried butterside-up this half-turn always results in it landing messy side down. In fact, this situation only occurs because the three relevant variables; drop height (h), angle before sliding (θ) and size of toast (a) seem to have very specific values that allow the toast to only rotate half a turn. Figures 2 and 3 display the parameter space of these three variables. The graphs show contour lines of how far the toast has rotated when it lands on the floor. The red colour coding indicates the danger area between 90° and 270° that results in a butterside-down impact. These graphs show that varying any one of the variables by only a small amount moves the toast out of the danger area, and it completes either less than a quarter-turn, or has time to complete almost a whole turn. The actual values for a, h and θ seem to be maliciously 'tuned' to be exactly those that guarantee a butterside-down catastrophe.

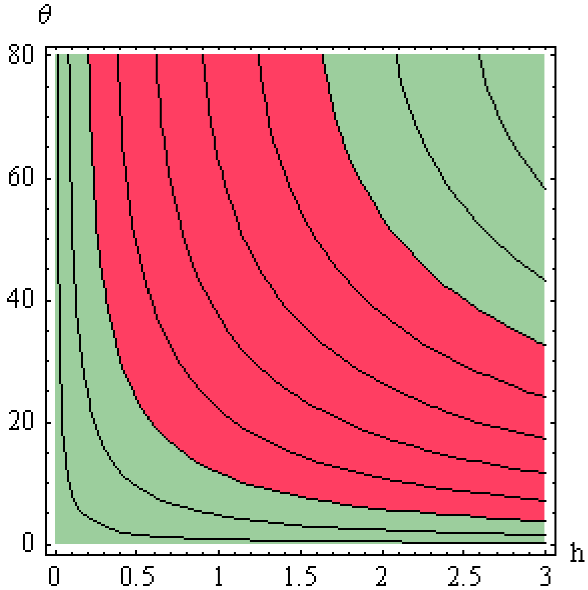

Figure 2. Parameter space of h and θ

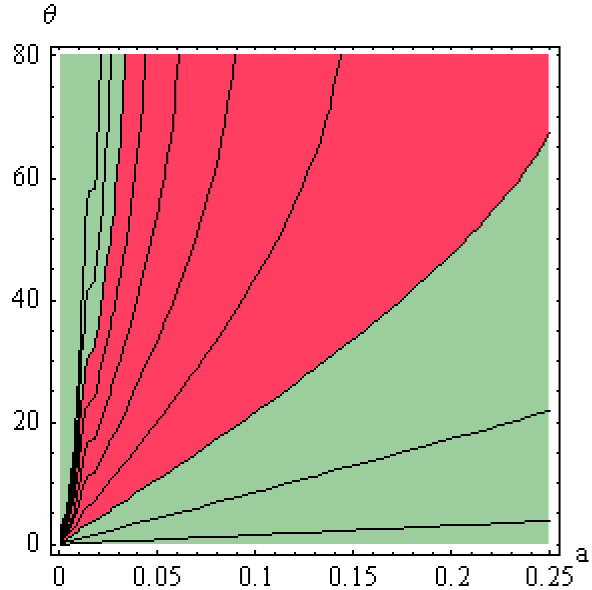

Figure 3. Parameter space of a and θ

Discussion

The result of 0.573 revolutions is uncannily mathematically precise, and the three variables, a, h, and θ have been apparently perfectly balanced to ensure that toast always lands butter-side down. This surely must be the result of intelligent design rather than coincidence. Other examples of such an extreme fine-tuning are known for many of the constants of physics. Change the proton mass by a tiny amount and bonds cannot hold molecules together, minutely alter the fine structure constant and all stars would rapidly burn through their fuel and form black holes, or tweak the strength of gravity and the universe would have collapsed long before life could have evolved. The Universe appears to have been exquisitely adjusted to allow our existence, and some have cited this as strong evidence that a benign Creator designed it so for our benefit. But this study has proven that not only has God designed the Universe to be clement to life, but he specifically arranged a few things to guarantee that the toast of intelligent beings always lands butterside down. This presumably can only be part of some petty point-scoring or one-upmanship intended to continually remind us who really is boss.

The height of an intelligent life form is surprisingly tightly constrained. A brain complex enough to be self-aware and intelligent needs to be supported, both in structural and nutrient/energetic terms, by a body of a certain minimum size. There is an important upper limit on body size as well. In order to have appendages free for manipulation of the environment, like hands, a body cannot be too large or it would break the first time it trips over. The maximum size is determined by the ratio of electrostatic attraction (which ultimately gives the structural strength to bones and other tissues) to the size of the gravitational constant (which determines how hard something hits the ground when it falls). Both of these were defined by the Creator in the Beginning. Notably large animals, such as the brontosaurus or blue whale, either have necessarily slow metabolisms, or have no nimble appendages with which to create and use tools. Therefore, it is no coincidence that humans are between 1m and 2.5m tall - it could never be any other way. This restricts the drop height, h, to between 0.65m and 1.60m. The size of a piece of toast is, of course, directly linked to the size of the animal eating it. The angle at which the toast slides off the finger, and thus how much rotational speed it picks up, is dependent on the degree of stickiness between the two surfaces and so was also set by God. Gecko-based intelligent life would presumably be spared this torment then, as their finger-tip suckers would hang on the toast long enough so that it completes a full turn and lands safely.

The particular values of a, h, and θ have been specially selected to ensure that toast *always* lands butterside down. The Universe was therefore designed by a malevolent God. QED.

All is not lost, however, and the *Null Hypothesis* can exclusively reveal the Top 5 methods for beating this cosmic design, and thus poking a finger in the eye of the horrible Creator that tried to outwit us.

1. Always carry toast butterside-down so that if it gets dropped it will perform a graceful half-turn and cleverly land butterside-up. The daily dripping of butter onto the floor is a small price to pay for this victory over an omnipotent Creator.
2. Stop dropping toast. Co-ordination night classes can help here.
3. If, despite all of your concentration, you feel the toast slipping, and fear that it is already too late to save, fling it as high into the air as you can, and if possible give it a good flick so it starts spinning nice and fast. That way the drop height and rate of rotation are randomised away from the values known to result in a butterside-down catastrophe. The chance of a buttered floor is reduced from near certainty to 50:50, that of a fair coin toss. There is unfortunately, however, the significantly increased risk of the toast landing butterside-up on the ceiling. It's your call.
4. Wear stilts when making breakfast. Toast rotates half a turn when dropped from a normal height, so make yourself at least 3.5m tall. Tripping over from such a height will result in your untimely death though. See above.
5. Bake your own bread. The turning rate is dependent on the size of the slice (a) and so varying this can ensure your toast lands safely. However, for the toast to rotate either less than 90˚ or more than 270˚ so that it lands butterside up, the toast must be either smaller than 3cm or bigger than 25cm. And you'll never fit a slice of bread the size of a textbook in the toaster in the first place.