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Problem A: Sweet Tooth and Heavy Metal

A recent study demonstrated that some chocolate products may have high levels of heavy metals. Eating contaminated chocolate may lead to the bioaccumulation of the materials in the people who eat the chocolate treats. Assuming the results of the survey are correct, what does this imply about the long-term accumulation of heavy metals in the people who eat contaminated chocolate?

To help explore this question, construct a model that will help researchers track the long-term dynamics associated with heavy metal levels in a person who consumes contaminated chocolate. Use your model to determine the long-term patterns for an individual and determine the impact for different levels of consumption. Additionally, use your model to determine what happens to children who might consume a large amount of candy at certain times of the year. For example, a child might have large amounts of candy for certain holidays as well as for their birthday. Will the trends be different for a child whose birthday is a long time before and after other major, recurring holidays? Is there a difference if a parent has the children consume their treats over a long period after a holiday rather than allowing a child to binge during the holiday?

Bibliography

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Problem B: Narrative Influences

Researchers examined the role of how a person's mood impacts how receptive they are to certain messaging. They found that people were more likely to recall associations between items when a narrative context was created. One example of the associations created was in the context of influencing the propensity of a person to get a flu shot in terms of symptoms associated with the H1N1 influenza virus [1].

The findings raise a number of potential questions. For example, what are the larger impacts of making use of these kinds of methods to influence people to obtain a vaccination? Can a small change in vaccination rates make a large difference in the health impacts and costs associated with influenza outbreaks? Additionally, there is a movement to dissuade people from obtaining vaccinations. How can an awareness of the associations and moods be used by people trying to create a negative relationship associated with vaccinations?

To explore these questions, suppose there are two movements designed to influence people with respect to a particular choice. One movement is trying to get more people to agree to a set of actions. The other movement is trying to dissuade others from agreeing to the set of actions. Create a mathematical model that will model the situation and explore how the efficacy of the different movements depends on their use of the positive versus negative messaging. What are the broader health and economic impacts with respect to the varying use of methods to improve how well the messaging is received? Will a negative message always be more effective, or will a positive message always win? What are the long-term trends as the results of different kinds of messaging become more evident?

Bibliography

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Problem C: Standing Against a Mammoth

One of the most basic tools human beings have used to hunt is a spear with a Clovis point. The shaped stones attached to the end of a spear marked a great leap forward in technology for early hunters. It is not clear, though, how humans used the spears.

One conjecture is that the spears were thrown at large herbivores. The advantage to this approach is that it allowed people to better manage the distance between them and the animals they hunted. The disadvantage is that the physical impact of the weapon might have a limited effect.

Another conjecture is that the spears were braced in a way that held them in place. Used in this way a charging animal would run into the end of the spear, and the resulting impact would cause greater damage to the animal. This would require people to be closer to their prey, but it would increase the lethality of the weapon**.**

Which conjecture is correct? Some experiments indicate that the second method may be more effective, and the potential distance for the first method might be exaggerated. Some researchers have been building large demonstrations at great cost to test the two methods. Can you produce less expensive analysis and provide evidence by using a mathematical model to compare the efficacy of the two methods? What speed for an animal approaching a human represents similar impacts as throwing a spear? What aspects and shapes of a spear would be more effective as a thrown weapon as opposed to a braced weapon? Are the differences enough to help provide evidence based on what is known about the shape and configuration of a weapon that uses a Clovis point?

Bibliography

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