

The Hunger Pains: Ghrelin, Weight Loss, and Maintenance

By Lynn M. Diener

In this case study, good friends Sara and Mallory discuss Sara's recent healthy weight loss and her difficulty in maintaining that weight loss. Sara recently heard about a hormone called *ghrelin* in the news and wonders if that chemical may have something to do with her difficulty maintaining her weight loss. Mallory, a biology major, learns a little bit about ghrelin, an amine hormone released by the stomach, and shares what she's learned with Sara. The dialogue between the two friends is presented in a "Facebook" or online discussion type of format, something most students are familiar with and easily engage with.

I wrote this case for an introductory-level physiology course. I used this at the start of a section on digestion and metabolism. Many students are interested in the topic of weight loss, and a case study that shows some of the hormones that may impact weight loss and maintenance of weight loss is very engaging to them. This case would also be appropriate for an introductory-level biology class before talking about metabolism. It could also be used to hone students' graphing and data interpretation/analysis skills.

It is useful if students have some background knowledge before the case study. Students should have some familiarity with hormones. They should also have some experience identifying dependent and independent variables and graphing

data. Students will also benefit from a review or basic introduction to standard error, how it is graphed, and how it is interpreted before this case study.

Objectives

The goals of the case study are to:

- understand what a hormone is and what hormones do, with a specific focus on ghrelin and growth hormone;
- understand catabolism and anabolism;
- explore the effect of sleep and diet on ghrelin;
- make and interpret graphs; and
- critically assess a research study.

Classroom management

This case was given to students at the beginning of a section on digestion and metabolism. We had touched briefly on hormones earlier in the semester, but most of our exploration of hormones occurred after this case study. The case was used as an introduction to metabolism and data analysis. We used one 70-minute class period to complete the case study, but you could easily finish it in one or two 50-minute class meetings depending on whether you give the first section to students to complete in advance.

Students worked in small groups of two to three. I normally distribute the first part of the case study to students in advance of completing the case study in class, asking them to complete the first section prior to our next

class meeting. This is a good way to save class time and encourage a more thorough exploration of hormones. You can also allow them to complete it in class, in which case it should take around 25 to 30 minutes to complete. Part I (see Figure 1) requires students to do some research, using their textbook and the internet. I generally let them work in small groups or on their own outside of class but require each student to bring in his or her own answers to the questions.

All of the data in Parts II and III (see Figures 2 and 3) are based on real data from studies cited in the references. Part II generally takes approximately 10 to 15 minutes for students to complete, though you may find students get kind of excited about the results and want to discuss it longer than anticipated. You may also want to give students either the article or data from the article so that they can compare their graph with the graph in the article (TaHERI, Lin, Austin, Young, & Mignot [2004] is the reference for the data in Part II). Part III can take students a little bit longer to graph, but I generally allot approximately 10 to 15 minutes for this section as well. This is another section that tends to elicit discussion. Students are excited to see that researchers saw a decrease in weight in participants who ate dessert for breakfast every morning. I like to remind students that there are many different variables in this particular study and it's hard to attribute the weight loss

FIGURE 1

Part I: You Look Fantastic!

 **Mallory Messner** Hey Sara, it was great to see you during break! It's been way too long. And by the way, congratulations on the weight loss, you look fantastic. Do you mind if I ask how you did it?
April 5 at 1:32 p.m. [Like](#)

 **Sara Finnegan** Mal, it was great to see you too! Thanks for noticing the weight loss, it required a lot of hard work. I started exercising 5 days a week and restricting calories (eating smaller portion mainly).
April 5 at 1:45 p.m. [Like](#)

 **Mallory Messner** You'd think I already realize there is no trick when it comes to weight loss, being a biology major and all—sigh. I just hoped maybe you had found some magic solution. Haha.
April 5 at 1:50 p.m. [Like](#)

 **Sara Finnegan** I gotta tell you though, I'm having a heck of a time keeping the weight off. It seems like I'm always hungry! You know, they always say that only 10% of people who lose weight ever keep it off long term. I'm hoping to remain in the 10% but right now I'm not so sure. =(

Have you heard about some hormone called ghrelin in any of your biology classes? I've been reading about it in the news lately, I wonder if it has anything to do with my struggles...
April 5 at 1:55 p.m. [Like](#)

 **Mallory Messner** Actually I do recall learning something about ghrelin in class. Let me take a look and get back to you. I'll send you an e-mail!
April 5 at 1:57 p.m. [Like](#)

Questions

1. Craft an e-mail from Mallory to Sara explaining some of the basics of ghrelin. Your e-mail should explain what a hormone is and what kind of hormone ghrelin is. It should also explore ghrelin's effect on growth hormone and metabolism. Feel free to use your textbook and reliable internet sources.
2. What is the effect of growth hormones on metabolism? Pay special attention to its effect on protein, bone, fatty tissue, and carbohydrates.
3. What does anabolic mean? What about catabolic? How would you classify growth hormone?

FIGURE 2

Part II: Sleep Is Important

 **Mallory Messner** So ghrelin seems like an intriguing possibility, huh? Did you know that it's generally elevated in people after they lose weight? Even a whole year after they lost the weight!
April 5 at 6:03 p.m. [Like](#)

 **Sara Finnegan** Yeah, thanks for the email. I can't believe that a chemical like ghrelin can help to increase your appetite. And the fact that it's elevated in people after they lose weight, ugh!
April 5 at 6:09 p.m. [Like](#)

 **Mallory Messner** I found some other really interesting studies about ghrelin. How are you sleeping lately?
April 5 at 6:12 p.m. [Like](#)

 **Sara Finnegan** I'm a college sophomore, just like you, how do you think I'm sleeping?
April 5 at 6:14 p.m. [Like](#)

 **Mallory Messner** Haha, point taken. Well one study found some correlations with sleep and ghrelin levels. More sleep, less ghrelin! I found their data on the correlation between hours of sleep and BMI interesting as well.

Hours of sleep	Average BMI	Standard error
6.10	32.15	0.70
6.55	31.4	0.25
7.40	31.05	0.25
8.25	31.4	0.30
9.10	31.6	0.50

April 5 at 6:23 p.m. [Like](#)

Questions

1. Make a line graph of the data. Don't forget to include error bars using the standard error. Make sure to identify and label the dependent and independent variables; this will dictate their placement on your graph.
2. Explain the trend you see in the data.
3. Using a ruler, show which error bars overlap and don't overlap on the graph.
4. Without knowing the results of any statistics done on the data, which data point(s) may be significantly different from each other based on the data provided? Which data did you rely on to come to your conclusion?
5. Knowing that less sleep means more ghrelin, what suggestions might you make to Sara if you were Mallory? What is a takeaway message for this study?

to any one over the other. Ideally students will really get into that discussion during the final section of this case. This is another point in the case where you may like to show students the paper or the actual data from the article so that they can compare their graph to the real thing (Jakubowicz,

Froy, Wainstein, & Boaz [2012] is the reference for the data in Part III).

Part IV (see Figure 4), the final part of this case, can take anywhere from 10 to 15 minutes depending on how long you allow for discussion. I generally let the small groups discuss on their own for 5 minutes and then we come

together as a big group and share all of our thoughts. I like to write ideas on the board and use the ideas as jumping-off points for further discussion.

Note: An expanded version of the teaching notes and the answer key to the questions for this case may be found

FIGURE 3

Part III: Dessert for Breakfast



Sara Finnegan Maybe I need to start prioritizing my sleep just a little bit...
April 5 at 7:01 p.m. [Like](#)



Mallory Messner Seriously! Me too... =) Another really fascinating recent study looked at the timing and composition of calories ingested, focusing specifically on breakfast. Are you familiar with those high protein diets?
April 5 at 7:04 p.m. [Like](#)



Sara Finnegan Oh yeah, my roommate is trying to lose weight that way.
April 5 at 7:06 p.m. [Like](#)



Mallory Messner Well researchers had one group of obese individuals eat a small (calorie-wise) protein-enriched breakfast in the morning. The other group ate many more calories high in carbohydrates and enriched in protein. Both ingested the same number of calories over the course of the whole day, the differences were in the timing and quantity of fats, carbs and protein. The amusing part is that the second group of dieters also had dessert with every breakfast. =D
April 5 at 7:10 p.m. [Like](#)



Sara Finnegan Seriously??? I'd love to start every morning with dessert. I bet I know who lost weight and who didn't.
April 5 at 7:13 p.m. [Like](#)



Mallory Messner Seriously! And we're talking doughnuts, cake, chocolate bars. You might find the results surprising though. Here, take a look at the weight loss data. They were "dieting" from weeks 0 until 16. Weeks 16-32 were follow-up, when they were trying to maintain their weight loss.

Time (weeks)	Low calorie breakfast average weight (kg)	Dessert for breakfast average weight (kg)
0	89	91
4	85	87
8	82	85
12	77	82
16	75	78
20	78	76
24	81	74
28	84	72
32	87	71

April 5 at 7:21 p.m. [Like](#)

Questions

1. Make a line graph of the data.
2. What is the trend the researchers saw? You should focus on which group lost more weight and had more successful weight loss maintenance.
3. Do you think Sara is surprised by the results?
4. Does ghrelin make you hungry or leave you feeling satisfied?
5. Knowing what you do about ghrelin, in which case do you think the researchers saw a greater decrease in ghrelin after eating?

at the National Center for Case Study Teaching in Science at http://science-cases.lib.buffalo.edu/cs/collection/detail.asp?case_id=655&id=655.

References

Jakubowicz, D., Froy, O., Wainstein, J., & Boaz, M. (2012). Meal timing

and composition influence ghrelin levels, appetite scores and weight loss maintenance in overweight and obese adults. *Steroids*, 77, 323–331.

Taheri, S., Lin, L., Austin, D., Young, T., & Mignot, E. (2004). Short sleep duration is associated with reduced leptin, elevated ghrelin, and

increased body mass index. *PLoS Medicine* 1(3), 210–217.

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FIGURE 4

Part IV: Easier Weight Loss?



Sara Finnegan Mal, that's a seriously cool study.
30 minutes ago [Like](#)



Mallory Messner I know! And they saw all sorts of other things change in the dessert group. Levels of ghrelin decreased after meals, feelings of satiety (satisfaction) increased, and cravings decreased.
28 minutes ago [Like](#)



Sara Finnegan Haha, maybe I'll try the dessert for breakfast diet to combat my difficulty in maintaining.
25 minutes ago [Like](#)



Mallory Messner Well, it's only one study. I'm not sure I'd change your whole diet outlook based on one study, but the results are definitely compelling. There really is a lot left to learn about ghrelin and weight loss in general.
20 minutes ago [Like](#)

Questions

1. Speculate about why the dessert for breakfast group saw decreases in cravings and increases in satiety.
2. Would you change your diet based on the study? What kind of evidence is necessary to make you "believe" a research study?
3. If you were doing research in this area, what would be your next step?

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