FEATURE ARTICLE

Why Weightlifters Grunt: A Classroom Exercise That Introduces Students to Evolution

H. CHARLES ROMESBURG

Abstract

A classroom exercise is described in which college students take part in creating and supporting an evolutionary hypothesis that explains effort grunting. The exercise holds their interest throughout and readies them to understand hypotheses of animal and plant evolution. It informs them about the dependence of cultural evolution upon biological evolution, and it connects widely to curricula.

Key Words: *Introducing students to evolution; effort grunting; cultural evolution.*

Introduction

When introducing students to evolution, there is much to be said for exercises that, in Pobiner's (2012) words, let the students see evolution "as personally meaningful," tapping into their "enormous interest in themselves." I designed and teach such an exercise for my research methods course, and it is suitable for college biology courses. It involves an evolutionary hypothesis to explain effort grunting – that is, why we often grunt when exerting ourselves close to the limit of our capacities against a resisting force, as when helping push a car out of a ditch, lifting heavy barbells, or twisting off a tightly stuck bottle cap.

Prior to the exercise, I guide the students through the development of the hypothesis – but they don't yet know its substance. At key points in the discussion, I stop to ask them what they would do next, which gives them a sense of contributing to its development. (Teachers can use the method of this exercise with the effort grunting hypothesis or with another of their choosing.)

I assess the students' understanding of the exercise with examinations and my judgment of the quality of their participation in class discussions about it. On these measures the course receives good marks. Steps 1 and 2 of the exercise are done in parts of two lecture periods, and the final step 3 in a subsequent laboratory period.

> *"What drove the adaptations of the anatomical and neural circuitry involved in effort grunting?"*

Step 1 (15 minutes)

I show the students two one-minute sections from among the many YouTube videos of weightlifting competitions, one of a man, one of a woman. "Tell me, why are they grunting?" I ask. Usually the students say that grunting provides strength, but they cannot say how. The class ends with an assignment to read sections of articles on effort grunting (cited below in step 2) and do Google Scholar searches on it.

Step 2 (45 minutes)

We discuss the assigned readings on effort grunting. These establish that – with one exception, described below – whenever we begin what we expect will be a taxing exertion, we take a deep breath and hold it, closing the glottis (the space between the vocal cords). As our effort nears the most we are capable of, the glottis opens, resulting in a grunt (McCune et al., 1996). Human infants between 8 and 24 months old have been observed grunting during efforts to crawl, stand up, or reach for a toy, which indicates that the behavior is innate, not learned (McCune et al., 1996). The exception: effort grunting belongs to the class of innate human responses, like yawning, that we can voluntarily suppress after a few years of age (Bradshaw, 1997, p. 134). Indeed, some fitness gyms have "no-grunt" policies to placate patrons' wishes for quietness, and weightlifters have no trouble complying.

Second, we discuss two readings that agree with the students' belief about effort grunting increasing strength. In Davis et al.'s

The American Biology Teacher, Vol. 81, No. 7, pp. 474–478, ISSN 0002-7685, electronic ISSN 1938-4211. DOI: https://doi.org/10.1525/abt.2019.81.7.474.

(2016) research poll of 378 athletes (48% female, 52% male), 56% thought that grunting made them stronger. And a newspaper article agrees: "Those Gym Grunts May Have A Purpose" (Cromley, 2006).

Third, we discuss an unassigned article reporting that this generally held belief is false. In that research study (Morales et al., 1999), a group of college men 17–35 years old, 15 of whom were college athletes and 16 nonathletes, each did three dead lifts during which they grunted, and three during which they suppressed grunting. The authors found that grunting had no effect on maximum force production. Besides, professional weightlifters would know if it did help, yet videos of competitions show that many do not grunt. And Google Scholar searches find no research accounting for effort grunting providing strength.

Fourth, I guide the students Socratically to make the following logical deduction. Given the fact that effort grunting is innate, it must be a consequence of our genes; therefore, its cause must lie in our evolutionary past. I tell the students:

> The next time we meet in lab, I'll lead you through much but not all of the thinking I went through in creating and supporting a hypothesis about the evolution of effort grunting. Where I don't provide the thinking, I'll ask you to. For this you will need to draw upon information in the readings for next time about the lives of our ancient ancestors of the genus *Homo*, from about 2.1 million years ago onward. I want you to understand evolution as the scientific community does, even if personally you don't accept it [this in recognition of the difference between understanding and accepting; Glaze & Goldston, 2015].

To prepare for step 3, I give the students five assignments. The first is to use the Internet to learn about Darwin's theory of evolution by natural selection and restate its crux in ≤100 of their own words. The second is a reading from Khanna (2004, p. 76) about research on fossils indicating that by 300,000–400,000 years ago, early humans had a larynx, necessary for a glottis. The third is a reading from Fagan's (2011, p. 64) description of how early humans lived in large groups, which was essential because the environment teemed with carnivores, with which early humans often competed for meat, "with only the simplest of weapons for protection." Fagan notes that large-group living has

> dramatic advantages for hominins [i.e., any of the lineages of humans] living in environments where resources come in large "parcels" that are irregularly distributed across the landscape. Members of a group can search for food individually or in pairs, then share it with others, allowing the group as a whole to cover a much larger area. (p. 4)

The fourth assignment is to read from a Smithsonian National Museum of Natural History (2010) web page showing that early humans did heavy work. Stonecutting tools and animal bones at butchering sites indicate that as early as 2.6 million years ago in East Africa, humans were transporting to these sites the carcasses of large animals such as zebras, likely obtained from scavenging. By at least 790,000 years ago, humans were moving stone to construct hearths, and gathering and transporting wood for fire (likely for cooking, warmth on cold nights, and keeping predators away). By 500,000 years ago, humans were hunting large animals and transporting the carcasses. By 400,000 years ago, humans were collecting and transporting material to build post-hole-supported shelters. The fifth assignment is to read McHenry's (1992) analysis, using the hind-limb joint size of fossils, predicting that early human males weighed in the range of 136–165 pounds.

○ Step 3 (2 hours)

First, the class critiques several of the students' capsule statements of Darwin's hypothesis of evolution by natural selection. These must include (1) the condition that individuals of a species have heritable anatomical and physiological features that vary among them; and (2) the substance of Darwin's statement that

> any variation, however slight and from whatever cause proceeding, if it be in a degree profitable to an individual of any species, in its infinitely complex relations to other organic beings and to external nature, will tend to the preservation of that individual and will generally be inherited by its offspring. The offspring also will have a better chance of surviving. (Darwin, 2007 [1859], p. 40)

If, in explaining evolution, students use the phrase "the survival of the fittest," I tell them that it is wrong for a number of reasons (Paul, 1988); for example, the phrase is tautological, meaning "the survival of the survivors."

Creating an Evolutionary Hypothesis That Explains Effort Grunting

Next, the students and I go over the instructions (Box 1) on how they are to reason out the answers to questions I'll pose. I begin by asking them to picture workers in a scrap metal yard. In groups of two or three they drag and lift pieces too heavy for one, yelling "Heave-ho!" in unison. I ask: "What is it about *heave-ho*?" If needed, I guide them with Socratic prompting to see that it is a timing signal meaning "Let's all together have our strongest effort right now during these same few seconds." Then we shift attention; we know that ancient *Homo* weighed less than we do, yet they transported objects too heavy for any one of them (e.g., carcasses of ungulates weighing hundreds of pounds, from which it follows by deduction that they must have coordinated the application of their forces to drag and lift; to the class: "Again, note the use of deduction"). Two or more could do the transporting, provided they combined their efforts. I ask, "What was their timing signal? Remember, they were unable to speak." The students will see (with a little more Socratic questioning, perhaps) that it is hard to fault effort grunting as a way to automatically coordinate the efficient application of individual strengths in cooperative tasks of heavy exertion, concentrating their forces. An individual's effort grunt communicated "Help out, right now." (If students suggest that the timing signal could be grimacing rather than grunting, noting that weightlifters grimace, I tell them yes, but let's postpone the discussion of grimacing until later, when we support the hypothesis.)

Box 1. Instructions for Students on How to Reason in Creating & Supporting Evolutionary Hypotheses

(1) Your reason must not be your unsupported opinion. A declaration of the form "I think X" will not do.

(2) You must make a compound declaration of the form "I think X *because* Y." Moreover, your reason, Y, must conform with Darwin's theory of evolution by natural selection.

(3) Often this will mean that your reason will be about ways that groups of early humans bested others in effectiveness or efficiency in using or obtaining some resource necessary for surviving and then reproducing.

It is a principle of physics that, unless individuals of a team apply their maximum forces as simultaneously as possible, team strength cannot rise above individual strength. To fix this principle in the students' memory, I mention that timing methods are engineered into various machines. For instance, the 27 main engines of the Falcon Heavy rocket can launch a payload of 140,000 pounds only when all are fired at once. And timing methods are essential in certain group sports, efficiently mustering individual strengths into one. (1) The snap count in football games sets the offense in motion with explosive force. (2) In rowing crews, the rowers time their strokes with that of the "stroke" (the rower nearest the stern) because

> as every experienced rower and coach knows, rowing in a crew is much more efficient when the coordination between crew members is high. . . . Efficient rowing will result in the highest boat speed for a given power input. (Hill, 2002)

Continuing with the Socratic method, I ask the class, "What drove the adaptations of the anatomical and neural circuitry involved in effort grunting?" Answer: It was variation in how closely members working together in groups applied their forces in unison. Groups whose members consistently came mutually closest gained a survival advantage for their offspring over groups that did not, for they could more efficiently drag heavy animal carcasses and move survival resources like heavy boulders and trees. Because groups of close relatives are thought to have worked together, I also bring up the concept of inclusive fitness. Thompson (2015) explains its evolutionary power this way:

> The more genes individuals have in common, the greater the evolutionary payoff of cooperating. One's own fitness – that is, the number of one's own genes that make it into the next generation – includes the fitness of close relatives. Fitness is inclusive of relatives, so the term "inclusive fitness" is used for this expansion of the scope of one's own fitness. . . . If you have three siblings and they all have three offspring, more of your genes will make it into the generation than if you have one offspring and they have none. (p. 175)

Supporting the Evolutionary Hypothesis of Effort Grunting

To the class: "The hypothesis is reasonable, so why continue searching for independent supporting information that wasn't used to create it?" Answer: Any further evidence found will strengthen its credibility.

So, with the help of Socratic questioning and the instructions for reasoning in Box 1, the class zeros in on the following six supporting items.

(1) Effort grunting is a sound, best for a timing signal. Guide the students to this item by getting them to suggest and conclude that a visual signal, such as instinctively motioning with a hand to join in, is less efficient: to motion, those needing help would need to take a hand off the object they were trying to transport. Furthermore, a student is likely to say that a visual signal works only in daylight.

(2) Effort grunting is low pitched, best for a timing signal. Guide the students to this item by getting them to conclude that our ancestors lived with the high-pitched sounds of birdsong and calls of small mammals around them; against this acoustic backdrop, effort grunting's low pitch would tend not to be mistaken. Moreover, acoustical theory and experimental evidence show that low pitch is best for carrying across distances and in forests (Wiley, 2015). Students' familiarity with the loud bass sounds of car stereos helps them understand this.

(3) Effort grunting (today and presumably in the ancient past) occurs at or near an individual's maximum effort, best for using all of a group's potential strength. To the class: "If individuals effort grunted at, say, 60% of their maximum effort, how would that be at variance with Darwin's theory of evolution by natural selection?" Answer: It would leave the individuals with energy to spare, wastefully sending the call for others to join in.

(4) Cooperative dragging exists among other species. Showing students a few minutes of a video on the Internet (MRKNIGHTNDAY, 2012) of about 200 ants dragging the body of a lizard leaves no doubt about cooperative dragging aiding group survival. To the class: "Do you know of other examples of cooperation among individuals aiding group survival?" Answer: schooling in certain species of fish; murmuration in flocks of starlings.

(5) Effort grimacing is a related behavior. To the class: "Just as simple biological characteristics of creatures have evolved into complex ones (e.g., light-sensitive skin spots offering survival advantages and subsequently, through millions of generations of minute adaptations, becoming eyes), effort grunting might have an evolutionary precursor. What might it be?" Answer: effort grimacing. Our earliest bipedal ancestors, before they had a larynx, conceivably evolved the instinct of tightly pursing their lips and/or pressing their tongues against the roofs of their mouths, holding their breath against this when heavily exerting themselves, and this produced a grimace; they learned that it signified a call to help out. To the class: "How is effort grunting an advance on grimacing?" If needed, guide them to the answer: Because it is a sound, those working as a team did not have to, as with grimacing, be looking at each other to time their helping out, nor did they need daylight to detect it. (It is easy for students to test effort grimacing's mechanism. Sitting at their desks or tables, have them take a breath, leave their glottis open, and purse their lips and/or press their tongues against the roof of their mouth, trapping air in their lungs. With their hands, have them lift as hard as they can on the desk's or table's underside; the result will be a grimace.)

(6) Consistent with effort grunting today, in ancient times responding to an individual's effort grunting was learned, not innate. An innate response would not have been favored by evolution because it would have automatically brought help from everyone within hearing range,

regardless of how much help was needed to move a weight. For instance, when three would be enough, it is a waste to summon six. Therefore, deciding whether to respond to the call of another's effort grunting to join forces was probably learned by the individuals of each generation through imitation and operant conditioning. I visually project a summary of these two types of learning (Box 2), have a student read it aloud for the class, and they discuss it. (An associated learning takeaway for the class: The exercise relies on the subject of psychology. From my experience of teaching the exercise, Socratic questioning has never failed to result in the class agreeing on the above six supporting items.)

Box 2. Summary of Learning by Imitation & Learning by Operant Conditioning

With imitative learning, Glenn (1991) explains,

> many of the specific activities passed from one generation to the next are acquired by individuals through imitation. . . . Once imitation of several different responses produces reinforcing consequences, new responses can be acquired by imitation in the absence of reinforcement. (p. 60)

And with learning by operant conditioning, Coon and Mitterer (2010) explain,

> we associate responses with their consequences. The basic principle is simple: Acts that are reinforced tend to be repeated. . . . The probability of a response is altered by the effect it has. Learning is strengthened each time a response is followed by a satisfying state of affairs. . . . Thus, operant conditioning refers mainly to learning *voluntary* responses. (p. 226)

Although today, in the gym, a grunting weightlifter straining at his or her capacity is not wanting others to help out, the tendency to grunt is automatic. And outside the gym, there are situations in which effort grunting remains useful as a timing device (e.g., when several people lift or slide a heavy piece of furniture or drag a Christmas tree they have cut from deep in the woods).

The Criteria for Accepting Evolutionary Hypotheses

Although the hypothesis is seemingly reasonable and well supported, students may wonder whether it could be wrong. Therefore, for discussion I visually project and have a student read to the class Isbell's (2009) advice:

> As Darwin showed so well, the best that can be done with evolutionary theories is to examine them from every available angle. If the evidence builds against the theory over time, then we can feel more confident that life really did not happen that way and we can look for other explanations. If the evidence cannot tear it down, then we can feel progressively better about the veracity of the theory. (p. 126)

Against the background of this advice, a question for the class: "What would be grounds for replacing the evolutionary hypothesis of effort grunting with another?" The class should readily answer that, other things being equal, it would have to be shown that the proposed replacement better conforms to Darwin's theory of evolution by natural selection or is better supported by evidence independent of that used to create it.

Evolutionary Science Is in the Form of Stories

Students will appreciate realizing that evolution's narrative aspect is something it shares with several subjects in their humanities curricula (e.g., literary studies, theater arts, and history). As Le Guin (1994) said, "Story is our only boat for sailing on the river of time" (p. 147). The hypothesis of the evolution of effort grunting interests students because it is about a feature of theirs they are familiar with, and even more so because it is a science-based story. Niehaus (2018) identifies another benefit of science in story form: "We remember stories because our brains are wired to: we find them more interesting and are more likely to retell information if it's presented as narrative rather than exposition."

From Biological Evolution to Cultural Evolution

To begin the last part of step 3, I motivate the students with words along these lines:

> You are going to see that without effort grunting among our – your – ancient ancestors, the modern world might not be. And likely, neither would you. When we are finished, you be the judge of whether or not that is true.

By increasing the effectiveness of transporting heavy carcasses to butchering sites, effort grunting brought a greater and more regular supply of meat to early humans' diets. This supplied high-calorie nourishment in the form of fats and protein necessary for the biological evolution of a larger brain (our brain uses ~20% of our energy; Pobiner, 2013, 2016). According to Lieberman (1998), fossil evidence in Africa indicates that by ~150,000 years ago, our ancestors' evolution had reached the point that they had lips, tongues, larynxes, mouths, and brain mechanisms necessary to produce articulate speech and express complex thoughts. Lieberman concludes: "We are able to think because we can talk" (p. 4).

Language and thinking facilitated cultural evolution. Unlike biological evolution, which passes from generation to generation, parent to offspring, cultural evolution is more rapid because information can be passed to members of different groups. As Cavalli-Sforza and Feldman (1973) note:

> The diffusion of information is thus more akin to the spread of an epidemic than to that of genes. . . . Because of the passage of information of the "infectious type" one would expect, in principle, that cultural diffusion, and evolution, can be much faster than the diffusion and evolution of genes. (p. 42)

Quite possibly, then, if the anatomy and neural circuitry responsible for effort grunting had not evolved, their lack would have constrained the extent and rate of our subsequent cultural and technological evolution. I read to the class from Ambrose (2001): "A mere 12,000 years separate the first bow and arrow from the International Space Station."

○ Conclusions

This exercise introduces the principles of biological evolution, which the AAAS report *Vision and Change* recommends as key for biological literacy (Brewer & Smith, 2011). It holds students' interest, challenges them to think, readies them to understand hypotheses of animal and plant evolution, and informs them of the dependence of cultural evolution upon biological evolution. It widely connects to their curricula, including literary studies, cultural studies, theater arts, history, physical education, and psychology as well as STEM courses.

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H. CHARLES ROMESBURG is a Professor in the Department of Environment and Society, Quinney College of Natural Resources, Utah State University, Logan, UT 84321; e-mail: charles.romesburg@usu.edu.