

sheds a direct light on such questions and the consequences of the answers. When individual needs yield to responsibility writ large, there is much to be admired, even when it does not line up with unambiguous heroism. The luxury of 20/20 hindsight, now that we know the full extent of the Holocaust and, yes, the first two atomic bombs, makes us contemporaries shudder.

While I was translating my parents-in-law's letters, I was acutely conscious that certain passages in them would raise eyebrows for many with different life experiences. False dichotomies so easily arise. I understand historic judgment and its merit in establishing valuable markers for future generations. Yet I also think that the bulk of the correspondence is persuasive as an example of courage and honor during horrific times.

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I read with interest Silvan Schweber's review of *My Dear Li: Correspondence 1937–1946* by Werner Heisenberg and Elisabeth Heisenberg, and I noted with sadness Schweber's passing on 14 May 2017.

I knew Werner Heisenberg quite well, having worked in the Max Planck Institute for Physics under his directorship for two decades, beginning in 1950. I had the opportunity to talk with him about his work during the war. I also frequently met Elisabeth Heisenberg at various events.

Schweber captures well the feelings and thoughts Heisenberg expressed in letters to his wife from 1937 to September 1939. Schweber's comments on the later letters, however, need some clarifications.

Working on the German atomic bomb was not Heisenberg's decision. He was drafted in September 1939 to serve with

other leading scientists in a group later known as the Uranium Club. Heisenberg was tasked with finding out whether the energy released by nuclear fission could be used for military and civilian purposes. After extensive studies he decided that applications of that type would be possible theoretically but that practical implementation of them would require a huge and lengthy industrial effort.¹

As a result, Minister of Armaments Albert Speer terminated the bomb project in 1942 and concentrated all available resources on weapons production. Nevertheless, the German Army Ordnance Office continued military uranium research with its own small group, with which Heisenberg was not involved. He continued to focus on cosmic rays, S-matrix theory, and construction of a small test reactor.

It is true, as Schweber suggested, that Heisenberg identified with his beloved Germany, but he did not identify with the Nazi ideology. He did not join the Nazi Party, and he had many Jewish friends and pupils and maintained friendly relations with his Jewish colleagues. He probably felt a certain admiration for the rapid advances of the German armies in 1939–41. Like many non-Nazi Germans at the time, he did not want Hitler to win the war, but he did not want Germany to lose it.

Schweber takes exception to Heisenberg's statement to his wife, made after his visit with Niels Bohr, that he had "his assigned part . . . to defend our system." But what else could Heisenberg have done when, unavoidably, the circumstances of German occupation of Denmark came up in conversations? He had to assume that his words and actions were carefully observed by the Gestapo. He also had to expect that Bohr might unwittingly disclose what he had said. Any remark showing opposition to or even dissatisfaction with the Nazi system might have had severe consequences.

Heisenberg also had to face the question of whether to leave Germany in 1933 after the Nazis took over. Lise Meitner didn't leave until 1938, when her Austrian passport no longer protected her from Nazi persecution; she later said she had "committed a great moral wrong" by not leaving earlier. Schweber believed that the same was true of Heisenberg. Indeed, Heisenberg discussed leaving in 1933 or 1934 with Max Planck, president of the Kaiser Wilhelm Society for the Ad-

vancement of Sciences. Planck believed that the scientists who were not forced to leave Germany should stay and try to preserve as much as possible of the nation's culture and former scientific excellence. He compared Nazism to a storm that causes major damage but will pass eventually. All forces would then be needed to rebuild the country, as happened after World War I.

Heisenberg hoped for a similar reconstruction after World War II. However, only he, with his international scientific reputation, attracted foreign students and collaborators. German universities as a whole had lost their pre-1933 excellence because of the expulsion of leading Jewish physicists and Hitler's contempt for modern "Jewish" physics. The center of excellence in physics had moved to the US.

Reference

1. K. Gottstein, <https://arxiv.org/abs/1609.02775>.

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A universal human constant?

Forty-four years ago, Joseph Keller wrote in "A theory of competitive running" (PHYSICS TODAY, September 1973, page 43) that "world records for running provide data of physiological significance," since the record times are very close to the ultimate capabilities of the human body. By comparing the relative performances of men and women in multiple sports and various event types and distances, I thought we might find something universal that is independent of the particular physical capabilities and requirements of any sport.

I decided to investigate how the record running times for women and men compare over different distances by looking at the simple measure of the record time for men divided by the record time for women—that is, relative average speed.

For example, for the 200 m dash, Usain Bolt holds the men's outdoor world record of 19.19 s. Florence Griffith-Joyner holds the women's outdoor world record

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of 21.34 s. The ratio of their times is 0.899.

Checking the results for 30 running categories for races from the 60 m indoor and 100 m outdoor through the half marathon and full marathon, we find the ratio of times ranges from 0.820 for the 30 km track event to 0.923 for the 60 m indoor. For nine indoor distances, from 60 m to 3 km, the mean women/men speed ratio is 0.90 ± 0.01 , and for the 21 outdoor distances, from 100 m to marathon, the ratio is 0.89 ± 0.02 .

The ratio is essentially constant. So let's check a different type of sport, kayaking, with distances of 200 m, 500 m, 1000 m, and 5000 m and the number of paddlers being one, two, or four. For those 12 categories, the mean ratio is 0.88 ± 0.01 .

Now let's look at another sport, swimming, where both arms and legs are involved. For a total of 30 categories of events in freestyle, breaststroke, backstroke, and butterfly, with distances of 50 m to 1500 m in 50 m pools and 25 m pools, the mean ratio is 0.90 ± 0.02 .

Track cycling has only three categories of events that have the same distances for men and women. For the 200 m flying start, the ratio is 0.90. For the 500 m flying start, the ratio is 0.85. In endurance cycling, what is measured is the distance cycled in one hour. The record for men is 54.5 km, and for women 47.98 km, which gives a ratio of 0.88. For all three cycling categories, the mean ratio is 0.88 ± 0.02 .

In rowing, the crew size can be one, two, four, or nine (eight rowers and the coxswain). Two competition categories are based on the weight of the crew. The two types of rowing are sweep, with one oar per rower, and sculling, with two. The competitions are all for a fixed distance of 2 km. For 10 categories of rowing, the mean ratio is 0.90 with a standard deviation of only 0.01.

Speed skating on ice is powered by both arms and legs. It's reputed to be the fastest human-powered sport. The standard track for competitions is a 400 m oval. The events that are common to men and women are 500 m, twice 500 m, 1000 m, 1500 m, 3 km, 5 km, and 10 km. For those 7 categories, the mean ratio is 0.92 ± 0.01 .

Summarizing all the sports, we have 90 categories with a narrow distribution of ratios: a mean ratio of 89% with a standard deviation of only 2%.

It seems we have a universal constant, an invariant: that the best women com-

petitors can reach a speed of about 89% of that of the best men competitors. Those ratios have held for at least 50 years.

If the constant is universal, its explanation must be simple and basic to the physiology of the two genders.¹ But what could it be?

A hint at a possible answer is the hemoglobin concentration: In the general population, for men it is 13.6–17.5 grams per deciliter. For women, it's 12.0–15.5. The ratios vary from 0.88 at the low end to 0.89 at the high end.²

I welcome comments from readers.

References

1. R. Van Damme et al., *Evol. Ecol. Res.* **10**, 229 (2008).
2. S. J. McPhee, M. A. Papadakis, eds., *Current Medical Diagnosis and Treatment*, 48th ed., McGraw Hill/Lange (2009), p. 1530.

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Correction

October 2017, page 52—In the figure, the geological map on the office wall is of the Korea Peninsula, not Finland. PT

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