



REPLY TO RAISON AND RAICHLLEN:

Why does nutrition impact social decision making?

Soyoung Q. Park^{a,1} and Sebastian M. Schmid^{b,c}

In our PNAS article (1), we show how the macronutrient composition of a meal can impact social decision making. Specifically, with a greater protein intake, participants' plasma tyrosine levels were elevated, which resulted in a more tolerant participants' response toward unfair offers. In other words, with a greater carbohydrate intake, participants' responses were more sensitive to unfairness. In their letter, Raison and Raichlen (2) suggest an overarching evolutionary perspective on and inspiring interpretation of our previously published data (1) on social decision making in the context of nutritional composition. We very much welcome this important question on the profound sense of an evolutionary mechanism modulating distinct human social behavior. On the background of the Darwinian "survival of the fittest" concept in a narrower sense, it truly might have been an evolutionary advantage to use protein-mediated social tolerance versus carbohydrate-mediated social punishment for enhanced survival and reproduction during times with only intermediate and mostly limited food availability.

Today, however, we do not live in times when protein and carbohydrate availability depends on a hunter's luck and gatherer's effort. In our modern Western world, we are not menaced by the struggle for food but rather the consequences of continuous food access and hyperalimentation, leading to decline in survival and reproduction (3). To push the evolutionary question of Raison and Raichlen (2) even further, we ask whether the reported findings reflect a relic of ancient survival strategies, or more an adaptive mechanism, in the context of interpersonal relationships and social norms. It is tempting to speculate that in a modern world with a steadily growing population, nutritional modulation of social decision making is

more than an ancient survival kit, but a highly adaptive tool of human nature to ensure different cultures living together.

Although the preference for protein, as reflected by liking of the basic taste of umami, is highly conserved across cultural background (4), socioeconomic status, culture, and market availability at short notice modulate the preference for carbohydrates/sweet taste (5). While more data are needed on ethnical differences, not only in consumption but processing of ingested macronutrients, there is a clear variation in social decision making across different cultures and socioeconomic status (6, 7). For example, a meta-analysis demonstrates that Asian samples show greater social punishments during the ultimatum game, compared with United States samples (8). Additionally, socioeconomic status of the opponent plays a modulating role in the ultimatum game (9).

As suggested by Raison and Raichlen (2), future studies are needed to explicitly target the evolutionary hypothesis of the link between nutrition and human cooperation behavior. We are confident that such an investigation will significantly contribute not only to understanding the origins and mechanisms of this link, but also to developing possible strategies to explicitly use this knowledge for possible intervention strategies. Together, an interdisciplinary and holistic research approach will enable us to answer why nutrition impacts on human social behavior.

Acknowledgments

This work was supported by Deutsche Forschungsgemeinschaft Grants CRC-TRR 134-C07 (INST 392/125-1) and PA 2682/1-1 (to S.Q.P.).

- 1 Strang S, et al. (2017) Impact of nutrition on social decision making. *Proc Natl Acad Sci USA* 114:6510–6514.
- 2 Raison CL, Raichlen DA (2018) An evolutionary perspective on nutrition and social decision making. *Proc Natl Acad Sci USA* 115:E1331.
- 3 Kramer CK, Zinman B, Retnakaran R (2013) Are metabolically healthy overweight and obesity benign conditions?: A systematic review and meta-analysis. *Ann Intern Med* 159:758–769.
- 4 Sorokowska A, et al. (2017) Dietary customs and food availability shape the preferences for basic tastes: A cross-cultural study among Polish, Tsimane' and Hadza societies. *Appetite* 116:291–296.

^aDepartment of Psychology, University of Lübeck, 23562 Lübeck, Germany; ^bDepartment of Internal Medicine 1, University of Lübeck, 23562 Lübeck, Germany; and ^cGerman Center for Diabetes Research (DZD), 85764 Neuherberg, Germany

Author contributions: S.Q.P. and S.M.S. wrote the paper.

The authors declare no conflict of interest.

Published under the [PNAS license](#).

¹To whom correspondence should be addressed. Email: soyoung.q.park@gmail.com.

- 5 Mazarello Paes V, et al. (2015) Determinants of sugar-sweetened beverage consumption in young children: A systematic review. *Obes Rev* 16:903–913.
- 6 Strang S, Park SQ (2017) Human cooperation and its underlying mechanisms. *Curr Top Behav Neurosci* 30:223–239.
- 7 Park SQ, et al. (2017) A neural link between generosity and happiness. *Nat Commun* 8:15964.
- 8 Oosterbeek H, Sloof R, van de Kuilen G (2004) Cultural differences in ultimatum game experiments: Evidence from a meta-analysis. *Exp Econ* 7:171–188.
- 9 Holm HK, Engfeld P (2005) Choosing bargaining partners—An experimental study on the impact of information about income, status and gender. *Exp Econ* 8:183–216.