Macronutrient Valuation: A Novel Tool to Study Food Preference and Choice

Olga Davidenko

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3   Olga DAVIDENKO[1]

4   1 UMR PNCA, AgroParisTech, INRA, Université Paris-Saclay, 75005 Paris, France

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6   Corresponding author: Olga Davidenko, PhD, UMR 914 PNCA, AgroParisTech, 16 rue Claude

7   Bernard, 75005 Paris, France, olga.davidenko@agroparistech.fr

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18   In a study published in this issue of the Journal of Nutrition, Buckley et al. (1) develop a

19   computerized task to measure macronutrient valuation that they define as the "value that humans

20   place on a calorie derived from fat, carbohydrate, and protein". In the same paper, they then use the

21   new method to explore how protein valuation correlates with body composition in a separate sample

22   of community-dwelling elderly. The authors suggest that macronutrient valuation is a driver for food

23   preference that might contribute to explaining food choices. According to this framework, preference

24   for highly palatable and sweet foods might for instance result from a higher valuation of

25   carbohydrates and fats, while higher protein valuation might explain preference for foods that are

26   rich in protein. Studying protein valuation from this point of view is of particular interest: while our

27   capacity to choose high-protein containing foods is essential for health, we cannot rely on a

28   consciously perceptible sensory stimulus, as it is the case with texture for fat (2) or sweet taste for

29   sugars. Indeed, despite evidence about the red color (3) or umami taste (4) being markers of dietary

30   protein, there is no specific sensory characteristic that is shared among all high-protein containing

31   foods. Therefore, it is more likely that our ability to choose dietary protein sources is based on

32   conditioning that occurs throughout our life when we experience association between consumption

33   of specific foods (here, sources of dietary protein) and beneficial nutritional outcome (here,

34   suppression of amino acid depletion). While precise mechanisms that lead to such conditioning

35   remain yet to be discovered as of today, studies in rodents and humans demonstrate that animals

36   compose their diet in a way to ensure sufficient protein intakes, and a diet that is depleted in protein

37   or essential amino acids provokes aversion and lower intakes as a result of experienced metabolic

38   distress (5). In a natural setting, measure of protein valuation could thus be a useful method to

39   explore how humans choose dietary sources of protein for their diet.

40   The procedure presented in the paper by Buckley and colleagues (1) consists in a

41   computerized two-alternative forced-choice task using foods varying in macronutrient content. The

42   task uses pictures of 25 foods that are often consumed by the British population, selected in a way to

43   minimize inter-correlations between fat, protein and carbohydrate content. The task included 25

44   foods to generate 300 two-alternative choice trials. The volunteers made their choice while

45   imagining that the food they chose would be the only food they could consume during the day.

46   Valuation of a single macronutrient was then measured as the odds ratio of choosing a food if it

47   contains 1 kcal/g more of that macronutrient than the second food alternative.

48   The authors studied test-retest reliability of the method on a sample of 90 healthy adults

49   who completed the task twice on two separate days. They succeeded in demonstrating strong

50   positive correlation in odds ratios for protein, carbohydrate, fat and energy density across sessions. It

51   should however be noted that correlation for protein valuation was less strong compared to other

52   odds ratios (protein: $r=0.71$; carbohydrate: $r=0.97$, fat: $r=0.90$ and energy density: $r=0.86$,

53   respectively). Another noticeable result was that protein and carbohydrate appeared to be valued

54   more than fat.

55   Higher protein valuation might help dietary protein detection and ensure adequate protein

56   and essential amino acid intake. It remains to be studied whether higher protein valuation might

57   facilitate choice of high-protein containing foods leading to enhanced appetite control, or explain

58   overeating linked to lower protein-calorie dietary ratio known as the protein leverage effect (7). The

59   issue is even more important for populations with specific needs as the elderly, in whom inadequate

60   protein intake is associated with reduced muscle mass (8). The second study presented in the paper

61   by Buckley et al. (1) tested the relationship between strength of protein valuation and fat-free mass

62   index in a group of 84 community-dwelling older adults. They observed that individuals with higher

63   protein valuation also displayed higher fat-free mass index. This observation shows potential

64   importance of macronutrient valuation as a driver of healthy eating habits.

65   In summary, Buckley and colleagues develop a task that is reliable in the way that it is robust

66   to test-retest and is not subject to self-reporting bias inherent to food preference questionnaires. It

67   will be of use to the scientific community in a range of studies on food choice related to protein

68   content, expected satiety or energy density. The principal limit appears to be the selection of foods

69   for the task, as one needs to avoid inter-correlation in macronutrient levels while also keeping foods

70   familiar and well accepted by the volunteers. Thus, the task will need to be adapted when used in

71   novel populations, especially in those with specific diets or food intolerance; however, such

72   adaptation also confers flexibility to the method.

73   The perspectives of the study of macronutrient valuation are broad, however further studies

74   should consider not only the influence of separate macronutrients but also interactions between

75   them. A recent functional MRI study used a willingness-to-pay task to demonstrate that combination

76   of fat and carbohydrate might increase food valuation in a supra-additive way (9). Studying

77   interactions could shed additional light at the findings by Buckley and colleagues, which so far

78   indicate that fat is the least valued macronutrient.

79   The origin of macronutrient valuation also needs clarification. Is it purely a result of a

80   physiological drive to meet nutritional needs, or is it influenced by cognitive factors? Finally, the

81   major step to make is to establish the link between macronutrient valuation and actual dietary

82   choices. Although the study on elderly revealed a positive relationship between protein valuation

83   and fat-free mass index, the authors did not observe interaction between protein valuation and

84   protein consumption and suggest that this might be due to differences in individual habits or dietary

85   environment. Therefore, while macronutrient valuation can be a marker of predisposition to

86   consume certain foods, it is still unclear how much weight it has on shaping our dietary choices.

87   Ultimately, study of macronutrient valuation has to consider food environment in which individuals

88   are able to make a finite number of choices. This last point sends us back to the fundamental issue of

89   fostering healthy eating in an environment that offers unhealthy food choices.

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95   References

96   1.   Buckley C, Austin S, Corfe B, Green M, Johnstone A, Stevenson E, Williams E, Brunstrom JM.
97   Protein valuation in food choice is associated with lean mass in older adults. in press;

98   2.   Drewnowski A. Sensory Properties of Fats and Fat Replacements. Nutr Rev. 2009;50:17–20.

99   3.   Dominy NJ, Lucas PW. Ecological importance of trichromatic vision to primates. Nature.
100   2001;410:363.

101   4.   Luscombe-Marsh ND, Smeets AJPG, Westerterp-Plantenga MS. Taste sensitivity for monosodium
102   glutamate and an increased liking of dietary protein. Br J Nutr. 2008;99:904–8.

103   5.   Tomé D, Chaumontet C, Even PC, Darcel N, Azzout-Marniche D. Protein status modulates the
104   rewarding value of foods and meals to maintain an adequate protein intake. Physiol Behav.
105   2019;206:7–12.

106   6.   Leidy HJ, Ortinau LC, Douglas SM, Hoertel HA. Beneficial effects of a higher-protein breakfast on
107   the appetitive, hormonal, and neural signals controlling energy intake regulation in
108   overweight/obese, "breakfast-skipping," late-adolescent girls. Am J Clin Nutr. 2013;97:677–88.

109   7.   Simpson SJ, Raubenheimer D. Obesity: the protein leverage hypothesis. Obes Rev. 2005;6:133–
110   142.

111   8.   Castaneda C, Charnley JM, Evans WJ, Crim MC. Elderly women accommodate to a low-protein
112   diet with losses of body cell mass, muscle function, and immune response. Am J Clin Nutr.
113   1995;62:30–9.

114   9.   DiFeliceantonio AG, Coppin G, Rigoux L, Edwin Thanarajah S, Dagher A, Tittgemeyer M, Small
115   DM. Supra-Additive Effects of Combining Fat and Carbohydrate on Food Reward. Cell Metab.
116   2018;28:33-44.e3.

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