Problems with using stability, specificity, and proportionality as criteria for evaluating strength of scientific causal explanations: commentary on Lynch et al. (2019)

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Received: 20 July 2019 / Accepted: 14 January 2020 / Published online: 12 February 2020
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Abstract

Lynch et al. (Biol Philos 34:62, 2019) employ stability, specificity, and proportionality as criteria for evaluating microbiome causal explanations. Although these causal characteristics signify relevant differences between causal roles, I suggest that they should not be used as general criteria for strong or good causal explanations.

Keywords Causal explanation · Causal strength · Microbiome · Proportionality · Specificity · Stability

Introduction

Microbiome research is a growing field, which seeks to explain central aspects of health and disease by the composition and functioning of microbiomes. Lynch et al. (2019) point out and discuss several problems with causal inference and causal explanation in microbiome research and recommend actions for improvement. Problematic issues identified and discussed include questionable assumptions about causal directions and routes, suggested emergent causal properties of whole microbiomes, overlooked common causes and possible confounders, extrapolation without sufficient basis, and a focus on distal causes.

The analysis offered is important and timely. One central recommendation for improving causal explanation in microbiome research is, however, to evaluate «how prospective explanations rank on the dimensions of stability, specificity, and proportionality» (Lynch et al. 2019, p. 21) holding these criteria, suggested

This comment refers to the article available at <https://doi.org/10.1007/s10539-019-9702-2>.

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by Woodward (2010), to pick out stronger and better causal explanations. According to Lynch et al. (2019, p. 6), Woodward's interventionist framework "identifies dimensions that match intuitive scientific ideas about 'good' or 'strong' causal explanations". In the following, I will suggest that the characteristics of stability, specificity, and proportionality are not consistently the most relevant criteria for evaluating the strength of causes or the quality of causal explanations, and that their relevance depends on what we aim to explain and why we want to explain it.

Stability

Stability is in Woodward (2010, p. 291) characterized as the ability of a causal relationship established in one causal context to "continue to hold in a range of other background circumstances". Lynch et al. (2019, p. 8) interpret stable causal relationships to "generate better causal explanations because they are generalizable to more situations". There are, however, many relevant biological contexts in which we consider less stable causal relationships to generate better explanations. For example, in cancer research, many treatments are found to work only on a smaller subset of patients due to differences in causal context, which may typically include tumor genetics. Less stable treatments work better and may be considered stronger causes since they give better outcomes for particular groups compared to more general cancer treatments (e.g. Sharma and Allison 2015). In such cases, it seems more appropriate to evaluate strength of causal explanation in terms of effect size given a relevant background, such as progression-free survival, rather than in terms of stability.

Relating this point to microbiome research, a possibly relevant example discussed in Lynch et al. (2019) is how the effect of microbiome interventions seems to depend on diet. Analogous to cancer treatments, there is a potential for identifying stronger influence of microbiomes or partial microbiomes under certain diets. Explanations involving more sensitive causal relationships like these, would also offer, or at least invite, a more detailed understanding with regard to interactions between microbiomes and their environments. On the other hand, if it is not possible to define consistent effects given particular backgrounds, there is little potential for finding causal explanations that can be used for generating treatments. Thus, *some* level of stability seems to be required to generate a good causal explanation with this interest in mind, but the most stable causes need not give the best explanations (or the best treatments).

There seem to be at least two ways in which more sensitive causal relations can give rise to better explanations than stable causal relationships. One is that sensitive causes can give effects of higher magnitudes when tailored to certain backgrounds, and another is that explanations involving sensitive causal relationships may contribute more detailed accounts of causal interactions. Thus, some criteria for good causal explanations, such as effect magnitude and providing detailed understanding, will on several occasions compete with the stability criterion.

Specificity

Lynch et al. (2019) identify two understandings of specificity in the literature. One concerns how fine-tuned a cause-effect relationship is. If a cause variable can take on many different values that correspond to different values of the effect variable in a one-one fashion, there is high specificity, which allows for detailed control of the effect (Woodward 2010). Another understanding of specificity regards whether a cause-effect relationship approximates a one-one relationship in the sense that the cause only has one effect, and the effect only has one cause (Woodward 2010). My comments will focus on the fine-tuning understanding of specificity.

High specificity in terms of fine-tuning is relevant in contexts where detailed control over the effect is considered important, but this is not always the case. I suggest two relevant features of causal relations that in some contexts are viewed as generating better causal explanations than specificity in the sense of fine-tuning. Again, one is magnitude of effect. Quantitative measures, such as the amount of variation in the effect that can be explained by variation in the cause, are frequently employed measures of causal strength. A cause can in principle be very specific (many small variations in a cause can give many different small variations in the effect) without explaining the main bulk of the total variation in the effect. Treatment interventions that are coarse-grained may in some contexts have a much larger effect compared to more fine-tuned interventions. An example would be how a gastric by-pass (coarse-grained intervention) affect weight loss compared to dieting or medications (potentially more fine-tuned interventions).

What may also render coarse-grained explanations better than fine-tuned ones in certain contexts, is that fine-tuning, even if possible, does not always matter for the relevant outcome, thus there may be a trade-off between specificity and proportionality. I do agree with Lynch et al. (2019, p. 14) that “individuals in the world do not exist as lean or obese”, and that using a binary effect variable taking the values “lean” or “obese” and a microbiome cause variable taking the values “healthy” or “dysbiotic”, are crude classifications. As pointed out in Lynch et al., newer research does include more fine-graining of the values of relevant variables. On the other hand, for much research on weight and obesity, the main interest are various health outcomes. Some of these will suggest a more coarse-grained partitioning of variables. A healthy weight is found within a rather large interval, and whether you weigh 67 or 68 kg is not expected to have an impact on your health. Thus, a focus on weight and health outcomes may suggest a relatively coarse-grained partitioning of the values of the variables, although, as argued by Lynch et al., binary variables may be too coarse-grained.

Proportionality

Proportionality is in Lynch et al. (2019, p. 6) either understood as when “the most appropriate cause and effect variables are selected from a causal chain” (Kendler 2005) or as when “the causal relationship is described neither too broadly

(including irrelevant information), nor too narrowly (excluding relevant information)” (Yablo 1992; Woodward 2010). I will here briefly comment on the latter.

I agree with a central criticism in Lynch et al. (2019) that microbiome research, when invoking the whole microbiome in causal explanations, offers low proportionality and therefore poor causal explanations. However, although causes with low proportionality generate inferior causal explanations, they may still be considered strong causes in the sense of having significant effects, exemplified by how FMTs cure serious *Clostridium difficile* infections (van Nood et al. 2013). As noted by Lynch et al. (2019), when a successful treatment is in place, this overrides explanatory goals, and lack of proportionality is not that important.

Conclusive remarks

Lynch et al. (2019) hold that the causal characteristics of stability, specificity, and proportionality identify strong scientific causal explanations and suggest that seeking to establish explanations scoring higher on these dimensions, will improve microbiome research. I have pointed to research contexts where these criteria are less relevant and where other features of causal explanations are regarded more important. In particular, what is regarded a strong or good causal explanation often coincides with establishing what causal factor or factors influence the effect the most on a relevant background, according to some quantitative measure. However, what is considered a good or strong causal explanation may not always coincide with what is regarded a strong cause, as in the case where a cause-effect relationship may have low proportionality but a high treatment effect.

I have suggested that we can have strong cause-effect relationships that have low specificity, low stability, and/or low proportionality. Some of these strong causes may generate good causal explanations, some not. Thus, the question of what is a good causal explanation, does not correspond directly to identifying strong causes via interventions. Additional features also matter: sometimes detailed and context-dependent mechanisms give better explanations than stable causes, and sometimes coarse-grained variables are favored because they better represent what we are interested in explaining.

In a recent paper I, in collaboration with Anders Strand, suggest an alternative way of defining, evaluating, and explicating differences between causal explanations in an interventionist framework (Strand and Oftedal 2019). Rather than defining one concept of cause and add a discussion of a range of possible explanatory differences among them with regard to features such as stability, specificity, and proportionality, we define many different causal concepts by applying various restrictions to a minimal definition of cause. Restrictions with regard to e.g. specificity, normality, and redundancy will generate a range of different causal concepts and make evident how causes differ. Our account gives a framework for explicating differences between causes and evaluate causal parity, which also could prove helpful for microbiome research. Whether one causal explanation is better than another will, however, still

have to be based on different criteria in different contexts and will relate to the goal of the causal inquiry.

Acknowledgements This work was supported by the Norwegian Research Council (Grant No. 231106). Open Access funding was provided by the University of Oslo.

Funding Open access funding provided by Oslo University & Oslo University Hospital.

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References

- Kendler KS (2005) "A gene for": the nature of gene action in psychiatric disorders. *Am J Psychiatr* 162:1243–1252
- Lynch KE, Parke EC, O'Malley MA (2019) How causal are microbiomes? A comparison with the *helicobacter pylori* explanation of ulcers. *Biol Philos* 34:62. <https://doi.org/10.1007/s10539-019-9702-2>
- Sharma P, Allison JP (2015) Immune checkpoint targeting in cancer therapy: toward combination strategies with curative potential. *Cell* 161:205–214
- Strand A, Oftedal G (2019) Restricted causal relevance. *Br J Philos Sci* 70:431–457
- van Nood E et al (2013) Duodenal infusion of donor feces for recurrent *Clostridium difficile*. *NEJM* 368:407–415
- Woodward J (2003) *Making things happen: a theory of causal explanation*. Oxford University Press, Oxford
- Woodward J (2010) Causation in biology: stability, specificity, and the choice of levels of explanation. *Biol Philos* 25:287–318
- Yablo S (1992) Mental causation. *Philos Rev* 101:245–280

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