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Rebuttal to: 'Deconstructing the Rio Scale: problems of subjectivity and generalization'

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Scientists regularly communicate their results to the media, which depends on them to explain the importance of their work, and to connect it to the lives of the broader public. For most physical scientists this is to some degree an 'amateurish' effort, in the sense that few of them have professional training in the social sciences relating to how their discoveries will or could be received, or in formal public relations of how to manage the media. This outreach is nonetheless important, useful and appropriate.

The Rio scales are attempts to explain to journalists and the public the science behind potential detections, in two dimensions that we, the authors of those scales, have expertise in:

(i) the likelihood that the detection is correct, and
(ii) an estimate of the degree of contact that is established, or has the potential to be established in the future.

Like the Richter scale, the Rio scale is designed to be a good tool to communicate with people without scientific background all around the world. Regardless of language, people will understand that an earthquake with an 8.4 magnitude on Richter scale is stronger than a 7.4, without needing to know the details of how this has been computed by experts.

As an example, Fast Radio Bursts (FRBs, see Lorimer *et al.*, 2007, Zhang *et al.*, 2018) are very strange radio signals, and it has been hypothesized that these could be produced by extraterrestrial intelligence (ETI) (see e.g. Lingam and Loeb, 2017).

The Rio 2.0 scale gives two very clear answers to this hypothesis:

(1) The FRB sources are in other galaxies, so even if it was a technological signature there would be no consequence for us ($Q = 2$).
(2) It's a real phenomenon ($A = 9$), without instrumental effect ($B = 10$) but there's a very low probability that it's not natural ($C = 4$).

The final result is $R = 0.0006$, and $R = 0$ is a simple fact journalists can remember and share with their audience in a headline. Indeed, the value $R = 0$ is potentially the most useful aspect of the scale; it permits an immediate opportunity to label a discovery/claim as a deliberate hoax or otherwise bogus. In a 24 h, 'post-facts' news cycle it is desirable to be able to discredit this sort of activity as quickly as possible, something that Traphagan (2018)'s paper does not mention.

The presumption behind the scale is that social impact of interactions with another technological species will increase with both the credibility of a claim and the potential for interaction, which seems reasonable and consistent with the idea of presenting the scale.

Traphagan (2018)'s primary focus is then not on the mathematics or the astronomy behind the Rio scales (which is the focus of Forgan *et al.*, 2018) but on the *interpretations* assigned to the numerical scores. The accusation that

> '*as it stands the scale…*' [Traphagan means the interpretations, not the numbers] '*…is entirely the product of the subjective experiences of the scientists who created it*'.

This is certainly true, and we do not deny this at all; indeed it seemed so obvious to us that it never occurred to us to state it explicitly in the text.

The reason for this subjectivity is that when physical scientists talk to the press about the importance of their work, this personal, subjective assessment of that importance is what they

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are conveying. When the press asks scientists why their work is important, they are not asking for the latest social science studies of the effect of the research on the everyday lives of people around the world, they are asking for the scientists to assign importance to the work they are describing so they can convey that assessment to their readers. The Rio scale is a tool that they can use to do that. It is then natural that the interpretations attached to Q in the Rio scale represent our opinions on the matter.

It is also obvious to us that humanity does not act or possess beliefs as a single entity, and that different peoples and cultures are likely to react in very different ways (if at all) to scientific knowledge regarding ETI. We claim that while SETI's efforts may not affect the daily lives of all humans, there are sufficiently large subsets of the global population that are in some way intensely interested in the question of ETI, and hence there remains a need for tools like Rio.

Traphagan correctly notes a long history of human thinking about non-human intelligence, in both science and religion. A key purpose of SETI is to provide observational data to assist this reasoning. In essence, Rio 2.0 describes the validity of specific observations to these long-standing arguments. The fact that such arguments exist, and that there are many attempts to inject erroneous or irrelevant observational data into these arguments, underlines the need for the Rio scale.

As for the issue of ordinal versus distance measures on a scale, we certainly understand the difference between a metric and a rank, and the exact criticism Traphagan is making here is unclear. Our best guess is that this is a restatement of the central thesis: that neither the numbers in the scale (measured with distances) nor the interpretations (which are ordinal) are backed by social science research, and so it is inappropriate to connect them. But this presumes a level of scientific rigor on the interpretations of Q that we did not intend, nor intended to convey.

We are also aware that, as a revision to a preexisting scale, Rio 2.0 is not the final word on attempting to quantify the impact of detection of ETI. If a superior formulation should arise, Rio 2.0 will, no doubt, be supplanted.

We welcome the work of social scientists on a way to convey SETI work to the public, and to help SETI practitioners convey to the media and the public which stories about extraterrestrial life are credible and potentially important, and which are not worth their attention. Rio 2.0 is, from an astronomy perspective, a superior formulation to Rio 1.0 because it captures more of the potential discovery space and more of the claimed detections, making it more applicable to contemporary SETI, and so was worth publishing.

We acknowledge that more work can and should be done to understand how to best communicate SETI work, both leading up to and after detection of ETI. We look forward to future improvements to the scale, incorporating the expertise of researchers from a variety of domains.

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