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## Independence, weight and priority of evidence for sentience

Commentary on [Crump et al](#) on *Decapod Sentience*

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**Abstract:** This commentary maps out relationships of dependency between the criteria proposed in the target article (Crump et al. 2022), identifying the criteria that carry most of the weight of the evidence, and suggesting which criteria should have priority in research on sentience.

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**1. Overview.** Crump et al. provide a rigorous review and analysis of the evidence for sentience in decapod crustaceans. The focus of this commentary is not on the specific conclusions drawn by the authors, but on the framework itself, and how it might be applied further to this and other taxa where sentience is under study.

The target article provides a concrete example of how to apply a Precautionary Principle in extending animal welfare protections (Birch 2017). In theory, there are several ways to do this. One is to use criteria which are largely independent and designed primarily to differentiate between ‘mere’ nociception and pain. Satisfying even one or two of these criteria is then pretty strong evidence of sentience and can be acted on by extending welfare protections. I defend something like this in Irvine (2020). Birch’s own original 2017 proposal seems to be along similar lines (Section 3.2).

1. **Nociception**
  2. **Sensory integration**
  3. **Integrated nociception**
  4. **Analgesia:** (a) endogenous (b) exogenous
  5. **Motivational trade-offs**
  6. **Flexible self-protection**
  7. **Associative Learning**
  8. **Analgesia preference:** (a) self-administer (b) location (c) prioritised
- Crump et al.’s 8 criteria**

In the target article, Crump et al. present a wider range of criteria. These are neither obviously independent nor do they differentiate cleanly between nociception and pain, but they are intended to have a wider scope for application. If three or more of the eight proposed criteria are met, it becomes progressively more crucial to provide welfare protection.

There are pros and cons to each approach, although in practice they may not work that differently. However, as an explicit framework for decision making, Crump et al.'s version seems to require more care in interpreting the evidence and criteria. For example, the nematode *C. elegans* satisfies three criteria: nociception (1), analgesia (4a/4b), and analgesia preference (7). This shows 'substantial evidence of sentience'. However, as Crump et al. recommend, considering the broader evidential picture and recognising that not all criteria are equal, it turns out that the roundworm *C. elegans* probably isn't sentient after all: it fails to meet many other criteria, including the (presumably) central criterion: sensory integration (2).

This suggests that it would be useful to map out the relationships between the various criteria in more detail. Which are likely to provide stronger evidence of sentience? Some of this is probably obvious to people in the field, but a more explicit analysis would help to identify priority criteria.

**2. Neurobiological criteria.** Meeting criterion 3 (integrated nociception) guarantees that the animal meets criteria 1 and 2. Criterion 3 may also describe the neurobiological basis for many of the behavioural criteria; it hence carries a lot of evidential weight.

Criterion 4 (analgesia) is a little trickier. As reviewed in Irvine (2020), animals with a nociceptive system always seem to have an anti-nociceptive system too; hence they have the endogenous neurotransmitters in 4a and may well be responsive also to chemically similar compounds as in 4b. Many animals that are *not* sentient may therefore satisfy criterion 4 just in virtue of having a standard nociceptive system. A lot then rests on how one interprets the clause that modulations in behavioural responses must be 'consistent with' the presence of pain. Some of the evidence reviewed in the target article concerns modulations in generic, reflex-like defensive behaviour, including claw extensions in crabs, and tail-flips in shrimps and prawns. These are certainly consistent with the presence of pain, but they are also consistent with the absence of it: *C. elegans* shows similar modulations in whole-body behaviour in similar situations.

There are two ways to deal with this. One is to treat criterion 4 as not particularly informative about the presence of pain over mere nociception, but still useful to consider together with more evidence. The second option is to treat behavioural modulations as more strongly indicative of pain than mere nociception, for example, by requiring evidence that the behaviours described in criteria 5-7 can be modulated. In this case, 4 would be a subset of 5-7, again not providing much additional independent evidence.

**3. Behavioural and cognitive criteria.** As stated in the target article, Criterion 7 (analgesia preference) does not differentiate clearly between pain and nociception (*C. elegans* meets it), although more novel forms of associative learning may well be indicative of sentience. Criterion 6 (flexible self-protection) is harder to apply: it is not clear what counts as 'flexible', or how one might differentiate locally routed protective reflexes from behaviours based on central representations of bodily locations. Criterion 5 (motivational trade-offs) is more clearcut: it is set up to differentiate between nociception and pain (and meeting 5 effectively also provides evidence for 3). Of these three then, 5 provides strong evidence on its own. Stronger versions of 6 and 7 can also provide important evidence.

Criterion 8 (analgesia preference) is again trickier. As Crump et al. note, the sub-criteria here are essentially ways of evaluating whether the other behavioural criteria are modulated when

an analgesic or anaesthetic is provided. Criteria 8a and 8b concern associative learning (criterion 7), and criterion 8c concerns motivational trade-offs (criterion 5), whereas 8c does not require *flexible* trade-offs; hence meeting 8c may be possible with nociception only. There are also connections here to 4. Presumably one way to satisfy 4b is to satisfy any part of 8. So, there may be a lot of duplication here.

**4. Prioritising criteria:** Based on the above analysis, here is one way to prioritise studies on animals that may well be sentient: Criterion 5 (motivational trade-offs) clearly does a lot of evidential work. If an animal meets 5 convincingly, that provides indirect evidence for 3, and hence also for 1 and 2. If 1 is supported, then this would provide indirect evidence for weaker readings of 4a and 4b. Mapped back to 5, one might then expect the animal also satisfy to 8c (which is a subset of 5). This is of course not the same as direct evidence; but meeting 5 provides indirect evidence for a very wide range of other criteria. Finding independent lines of evidence is then left to 6 and 7. [See also Jablonka & Ginsburg 2022]

Two interesting implications follow from this. One is that current lists of criteria for animal sentience contain a lot of interdependencies and redundancies. This is fine if these lists are seen as ways to categorise the kinds of evidence and experiments that are currently being used in the literature, but not if the criteria are to be used to make future research more effective and efficient.

The second implication is that certain kinds of experimental work using analgesics and anaesthetics may not be particularly informative beyond any of the other criteria. Having a nociceptive system guarantees that weak versions of criterion 4 will be met, but this does not provide strong evidence of sentience. Stronger versions of criterion 4 rely on the animal's being able to meet other listed behavioural criteria. Criterion 8 consists of weaker applications of criteria 5 and 7, which again do not cleanly separate behaviours driven by nociception and pain. Meeting criteria 4 and 8 is therefore not particularly probative about whether the animal is likely to be sentient. There are obviously other reasons why research using these compounds is useful (e.g., for veterinary care), but 4 and 8 in themselves are not priority criteria.

## References

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