Gibbons, Matilda and Chittka, Lars (2022) A framework for evaluating evidence of pain in animals. *Animal Sentience* 32(28)

A framework for evaluating evidence of pain in animals
Commentary on **Crump et al** on *Decapod Sentience*

Matilda Gibbons and Lars Chittka

School of Biological and Behavioural Sciences, Queen Mary University of London

Abstract: Crump et al. define eight criteria indicating sentience in animals, with a focus on pain. Here, we point out the risk of false negative or false positive diagnoses of pain. Criteria of different levels of inclusivity are useful for using the precautionary principle in animal welfare considerations, and for more formal scientific evidence of pain. We suggest tightening the criteria -- from more general evidence of sentience to pain alone -- because crucial evidence for animal welfare decisions might otherwise be missed for animals subjected to invasive and injurious procedures.

Matilda Gibbons, doctoral candidate at Queen Mary University of London, examines the neurobiology and behavioural responses of bees to determine whether invertebrates have pain experiences. **Website**

Lars Chittka is a Professor of Sensory and Behavioural Ecology at Queen Mary University of London and author of the book *The Mind of a Bee* (Princeton University Press). He researches the sensory, behavioural and cognitive processes of bees, and their neuro-computational underpinnings. **Website**
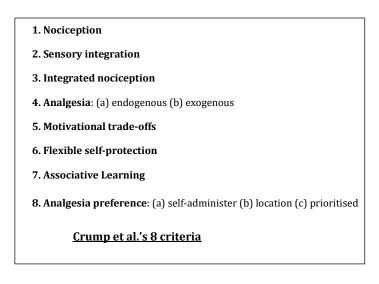
Introduction

Crump et al.'s criteria are useful and pragmatic in assessing the probability of an animal's sentience, and specifically the capacity for pain. We agree with Crump et al. that positive evidence for sentience makes it at least probable that the animal is also able to feel pain, to an extent where risk assessments for animal welfare need to be thoroughly considered. However, it is important to distinguish these (self-professed) "inclusive" criteria, that may raise the alarm bells of potential concerns for animal welfare, from strong scientific evidence for pain in particular. Crump et al. sometimes use more general hallmarks of sentience as potential indicators of pain (e.g. "integrative brain regions"). However, an animal may be sentient without feeling pain. For example, humans with congenital insensitivity to pain are clearly sentient (Nagasako et al. 2003). In this sense, the Crump et al. criteria may induce some 'false positive' conclusions about pain, where animals are diagnosed as sentient but actually may not feel pain. This risk does not invalidate the criteria, as part of a

precautionary judgement, but a stronger verdict comes from direct assessments of whether the animal can feel pain.

On the other hand, criteria that do not directly link to pain may induce false *negatives.* For example, an animal might not show indicators of positive affective states, such as feeling happiness, but still feel pain. For this reason, we caution against using only positive emotion-like states as indicators of sentience, and to extrapolate from these to the possibility that animals feel pain (Andrews 2022; de Waal 2022; Souza Valente 2022). Although assessing positive experiences can have important effects on improving animal welfare (Boissy et al. 2007), the risk of false negative diagnoses of pain is potentially more serious for welfare considerations than false positives. A direct assessment of pain is therefore more valuable.

In what follows, we discuss those of Crump et al.'s criteria (a) where we feel that more exclusive standards might be required for a formal diagnosis of pain experiences (although we recognise the value of inclusivity in erring on the side of caution in considerations of animal welfare). We also discuss (b) where a criterion needs moderate amendments, so as to focus more stringently on pain.

---

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

Criterion 2: Sensory integration in the brain

(a) The convergence of different sensory pathways is a common feature of brains; it might not be indicative of sentience (or consciousness) generally, nor of pain specifically. Thus, Criterion 2, as currently written, should only be taken as a tentative indicator of sentience. Stronger formal evidence for sentience comes from psychological experiments demonstrating multisensory cognitive operations on mental representations, as found, for example, in bees (Giurfa et al. 2001; Lawson et al. 2018; Solvi et al. 2020).

(b) For a more rigorous pain criterion, we propose focusing strictly on the central nervous integration of *nociceptive* processing with other sensory stimuli, perhaps in combination with psychological evidence as outlined above

Criterion 4: Analgesia

(a) Criterion 4 is currently slightly too lenient for a solid indicator of pain experience. Jablonka and Ginsburg (2022) argue that even non-sentient animals are likely to respond to anaesthetics and analgesics. Indeed, local anaesthetics block nociception only and thus do

not indicate any central pain processing (Walters 2022). However, analgesics that work in the brain areas that process nociceptive stimuli would likely affect the subjective experience of pain, as they do in humans (Ossipov et al. 2010).

(b) Following on (a), we argue that that the endogenous neurotransmitter system should involve the brain, and that the analgesic should act in brain areas involved in the processing of nociceptive stimuli. To further clarify: Acting 'in a way consistent with pain', in this context, means a *reduction* in the response to a noxious stimulus, because this is how endogenous nociceptive modulation systems and analgesics work to reduce pain.

Criterion 5: Motivational trade-offs

(a) As is, Criterion 5 is useful for a precautionary approach, but the definition may be too inclusive for a formal diagnosis of pain experience, since a relatively simple trade-off can fulfill the criterion. For example, the nematode *Caenorhabditis elegans* will cross an aversive hyperosmotic barrier to reach a food odor (Ghosh et al. 2016). These two sensory inputs interact via simple neural mechanisms without involving centralized integration (Ghosh et al. 2016, 2017; Irvine 2020; Shinkai et al. 2011).

(b) Stronger evidence for Criterion 5, and better evidence for pain, comes from a demonstration that the trade-off is based on mental representations (e.g. memories) in the brain. For example, in Gibbons et al. (2022), bumblebees make trade-offs between *memories* of conditions associated with noxious and appetitive stimuli, and not those stimuli themselves.

Criterion 6: Self-protective behaviour

(b) We suggest modifying the phrase 'likely to involve representing the bodily location of the noxious stimulus'. We recommend clarifying that this is achieved by directing the behaviour specifically towards the site of noxious stimulation, such as grooming behaviour or protection of an injured limb.

Criterion 7: Associative learning

(a) At its basic level, associative learning is mechanistically simple and does not require the type of conscious awareness usually invoked in the phenomenon of pain. Thus, Criterion 7 may be too inclusive.

(b) As mentioned in Crump et al.'s target article, *certain forms* of associative learning, such as trace conditioning, where in some cases the subject has to keep track of the passage of time between the conditioned and unconditioned stimuli, appear to require conscious awareness (Clark and Squire 1998; Clark et al. 2001; Clark and Squire 1999). This also appears to be the case for some forms of reversal learning, where over multiple reversals an animal appears to understand the rules of the reversal pattern. Where such paradigms incorporate noxious stimuli, they might constitute strong evidence for pain experiences. We thus would amend Criterion 7 to only include these types of nociceptive associative learning.

N.B. We also recommend removing the redundant note that habituation and sensitisation do not fulfill Criterion 7, as these are by definition not associative learning.

References

Andrews, K. (2022). Does the sentience framework imply all animals are sentient? Animal Sentience, 7(32).

Boissy, A., Manteuffel, G., Jensen, M. B., Moe, R. O., Spruijt, B., Keeling, L. J., et al. (2007). Assessment of positive emotions in animals to improve their welfare. Physiology & Behavior, 92(3), 375–397.

Clark, R. E., & Squire, L. R. (1998). Classical conditioning and brain systems: the role of awareness. Science (New York, N.Y.), 280(5360), 77–81.

Clark, Robert E., Manns, J. R., & Squire, L. R. (2001). Trace and delay eyeblink conditioning: Contrasting phenomena of declarative and nondeclarative memory. Psychological Science, 12(4), 304–308.

Clark, Robert E., & Squire, L. R. (1999). Human Eyeblink Classical Conditioning: Effects of Manipulating Awareness of the Stimulus Contingencies. Psychological Science, 10(1), 14–18.

Crump, Andrew; Browning, Heather; Schnell, Alex; Burn, Charlotte; and Birch, Jonathan (2022) Sentience in decapod crustaceans: A general framework and review of the evidence. *Animal Sentience* 32(1)

de Waal, F. (2022). Sentience as part of emotional lives. Animal Sentience, 7(32).

Gibbons, M., Versace, E., Crump, A., Baran, B., & Chittka, L. (2022). Motivational trade-offs and modulation of nociception in bumblebees. Proceedings of the National Academy of Sciences, 119(31), e2205821119.

Giurfa, M., Zhang, S., Jenett, A., Menzel, R., & Srinivasan, M. V. (2001). The concepts of 'sameness' and 'difference' in an insect. Nature, 410(6831), 930–933.

Jablonka, E., & Ginsburg, S. (2022). Pain sentience criteria and their grading. Animal Sentience, 7(32).

Lawson, D. A., Chittka, L., Whitney, H. M., & Rands, S. A. (2018). Bumblebees distinguish floral scent patterns, and can transfer these to corresponding visual patterns. Proceedings Biological sciences, 285(1880).

Nagasako, E. M., Oaklander, A. L., & Dworkin, R. H. (2003). Congenital insensitivity to pain: an update. PAIN, 101(3), 213–219.

Ossipov, M. H., Dussor, G. O., & Porreca, F. (2010). Central modulation of pain. The Journal of Clinical Investigation, 120(11), 3779–3787.

Solvi, C., Al-Khudhairy, S. G., & Chittka, L. (2020). Bumble bees display cross-modal object recognition between visual and tactile senses. Science, 367(6480), 910–912.

Souza Valente, C. (2022). Decapod sentience: broadening the framework. Animal Sentience, 7(32).

Walters, E. (2022). Strong inferences about pain in invertebrates require stronger evidence. Animal Sentience, 7(32).