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Opinion

Theory of Animal Mind: Human Nature or Experimental Artefact?

Caroline E. Spence,[1,*] Magda Osman,[1,*] and Alan G. McElligott[1]

Are animals capable of empathy, problem-solving, or even self-recognition? Much research is dedicated to answering these questions and yet few studies have considered how humans form beliefs about animal minds. Evidence suggests that our mentalising of animals is a natural consequence of Theory of Mind (ToM) capabilities. However, where beliefs regarding animal mind have been investigated, there has been slow progress in establishing the mechanism underpinning how this is achieved. Here, we consider what conclusions can be drawn regarding how people theorise about animal minds and the different conceptual and methodological issues that might limit the accuracy of conclusions currently drawn from this work. We suggest a new empirical framework for better capturing the human theory of animal mind, which in turn has significant political and social implications.

Trends

Current evidence suggests a widespread belief in the mental lives of animals, which has serious consequences for human–animal interactions.

The scientific community has been slow to investigate the mechanisms underlying our Theory of Animal Mind (TAM), due to oversimplification and limited objectivity.

By expanding the study of TAM to encompass a richer multidimensional approach, it is possible to more accurately theorise and empirically validate investigations of TAM.

> 'The difference in mind between man and the higher animals, great as it is, is certainly one of degree and not of kind.' [1]

Thoughts on Animal Thinking

Scientific debate regarding the existence and nature of mental states in animals has a longstanding history [2,3] and covers an extensive range of topics, from mirror recognition to numerosity (Box 1). Yet, the majority of people form beliefs about animal minds based on everyday occurrences, such as when caring for pets [4] or consuming animal products. Understanding how we construct this 'Theory of Animal Mind' (TAM) is therefore likely to reveal important insight, based on people's considerable experience and influence in relation to animals. Additionally, as a form of internal construal of other minds, examination of the psychological mechanisms generating TAM will have broad implications because behaviour interpretation is not confined solely to human–animal relationships [5]. However, little research has been dedicated to exploring the basis on which mental abilities are attributed to nonhuman animals, despite few individuals doubting the existence of animal minds [6,7]. Furthermore, when directly questioned, people often substantiate their beliefs with explanations from personal experience or media sources [7]. As a result, it is unlikely that the psychological mechanisms that contribute to TAM are analogous to the reasoning used by scientific experts to support judgements on animal cognition [8]. This mismatch gives rise to several ethical, scientific, and societal issues. Ethical issues arise because views on the sentience of different species are correlated with attitudes towards their use and treatment by humans [9,10]. Therefore, not only is TAM a potential driver of positive human–animal interactions [11], but also welfare-related decisions for millions of animals are currently based upon psychological

[1]Queen Mary University of London, Biological and Experimental Psychology, School of Biological and Chemical Sciences, London, UK

*Correspondence: c.spence@qmul.ac.uk (C.E. Spence) and m.osman@qmul.ac.uk (M. Osman).

Box 1. The Scientific Theory of Animal Mind

Human beliefs regarding the nature of mind are typically dualistic, with mind and body being viewed as separate entities [57]. By contrast, scientists working in areas relevant to animal cognition predominantly support theories of materialism, in that all mental phenomena derive from the physical brain [8]. Additionally, while most individuals consider mind as 'thoughts' or 'consciousness' [58], among academics, there is no universally agreed definition of mind, animal based or otherwise. In combination with the currently limited understanding of neural correlates of cognitive traits, this means that the empirical validation of mental states in animals is problematic [59], although the increasing use of modern techniques, such as fMRI, promises the visualisation of neural states and/or activity, such as consciousness [60,61]. Consequently, scientific views on animal mentality centre on the examination of specific mental processes that are: (i) empirically measurable; and (ii) considered meaningful components of human mind, thereby suggesting comparable mental experiences when evidenced in nonhuman species.

To this end, a range of cognitive capacities has been investigated, including tool use (acknowledged in a variety of species [62,63]), numeracy [64], and varying forms of memory, with evidence of chimpanzees outperforming humans in short-term memory tasks [65] and of facial recognition in sheep [66]. Indeed, mounting evidence hints at unexpected abilities in long-derided species, such as spiders, tortoises [67,68], and mice, which a recent study suggests experience ownership of their body parts (an aspect of self-consciousness) [69]. Yet, in general, notions of self-awareness among nonhumans have met with resistance, particularly because only a few animals (e.g., chimpanzees, dolphins, and elephants) pass the 'mirror test', a gold standard for self-recognition [70,71]. Likewise, when considering the emotional lives of animals, it is noted that, while the 'nature and range' of emotional experiences is debated, the literature widely assumes their occurrence in animals [72]. However, empathy, although acknowledged in terms of emotional contagion or sensitivity to conspecifics [73], is often disputed when defined at the level of perspective taking [74] or related to ToM [75]. As such, many capacities considered integral to human cognition are still contested in the literature (e.g., language, mental time-travel, and relational reasoning or mentalising [72,76,77]).

These views may also be bolstered by the historical accumulation of experimental evidence (as a proxy for widely held scientific belief) favouring particular animals (e.g., primates or dogs [78]), despite modern scientists using a range of models [79]. Hence, the current scientific opinion remains that animal mentality lies on a varied spectrum with only humans having the combination of complex abilities and thoughts required to generate our unique minds [80].

mechanisms that we know little about. Scientific issues emanate from empirical approaches to animal cognition, which likely contaminate research design and produce a biased or inaccurate snapshot of the overall picture of TAM. Social issues are associated with decision-making in related policy areas, such as animal welfare, food security, and climate change, which are, understandably, driven by current scientific opinion. The behaviour change envisaged by policy-makers is unlikely to be realised if supporting evidence does not accurately capture actual human thought processes [12,13].

As such, this article is important and timely, and designed to expose some of the core issues regarding the evidence available in relation to TAM as well as the research methods commonly used to investigate the phenomenon. Therefore, we start by identifying, and later proposing, a candidate mechanism underlying the development of TAM that generates judgements on the mindedness of nonhuman animals. Given that TAM involves animal 'agents', we also discuss several theories of relevance from social psychology. We then examine ways in which research methods might be affecting the results gained from previous TAM research, and, thus, pose **validity** (see Glossary) and **reliability** issues. We propose a model that allows both conceptualisation and empirical investigation of the initial stages of TAM using a measurement-scale model (specifically **Churchill's Scale Development Paradigm** [14]), which in turn, allows mechanisms contributing to TAM to be determined. We conclude by discussing the importance of reframing TAM in terms of its relevance to ethical and policy issues other than just animal welfare.

TAM As a Mechanism of Belief Formation

People's views on animal mind have been speculated to reflect a simple accumulation of various disparate attitudes and beliefs that are often informed by general society. In essence, we suggest that TAM is more nuanced. It is based on a belief-generating cognitive mechanism

Glossary

Anthropocentrism: the belief that humans are the most important species in existence and source of all value, resulting in the interpretation of reality according to human values, needs, and experience.
Anthropomorphism: the attribution of 'uniquely' human characteristics to nonhuman entities; originally viewed as a hindrance to scientific methods, increasing understanding of animal cognition has generated issues in delineating anthropomorphism as the unjustified attribution of mental states versus interspecies behaviour recognition.
Churchill's Scale Development Paradigm: an eight-step framework for the systematic development of multi-item measurement scales when measuring latent constructs.
Cognitive dissonance: a state of tension arising from inconsistent thoughts, beliefs, attitudes, and actions.
Conspecifics: individuals that belong to the same species.
Construct: an abstract, psychological concept or variable that cannot be directly observed (latent) and exists independently of any resulting measurable phenomenon (e.g., intelligence). Since constructs, such as TAM, represent psychological attributes that vary among individuals, the operationalisation of constructs should allow for participant involvement (i.e., participant generated).
Encoding: the processing and conversion of perceived information into a form suitable for storage in memory.
Phylogenetics: the study and taxonomical classification of organisms based on evolutionary relatedness. Proposed relationships between groups of organism, inferred from similarities in genetic or physical attributes, are presented as a phylogeny or phylogenetic tree. For simplicity when investigating beliefs, animals are often presented as 'phylogenetic bands' or classes (e.g., mammals, birds, etc).
Reflective measurement model: a type of structural equation model that depicts the relationship between a latent, unobserved construct (e.g., personality) and its corresponding indicators within a measure.

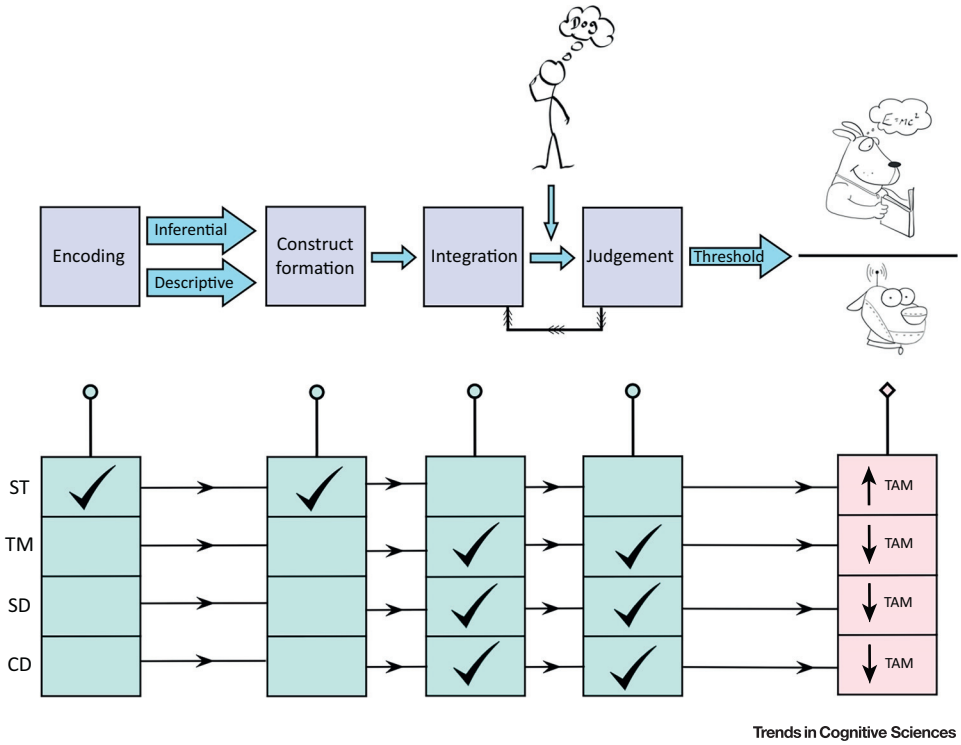

Figure 1. The Proposed Mechanism of Belief Formation Underpinning the Theory of Animal Mind (TAM). The proposed mechanism is conceptualised as a series of connected components allowing relevant information to be perceived, encoded, integrated, and subsequently utilised when forming judgements on the mindedness of nonhuman animals. Judgements are computed 'online' and represent confidence estimates of belief validity [15]. Formulated judgements may be integrated into an individual's bank of perceived knowledge to be reused in future estimates. Each component of the mechanism is susceptible to the influence of specified social theories. For example, we propose that simulation affects perception and encoding of information relevant to TAM through recognition of cross-species behaviours and/or actions. Thus, Simulation Theory (ST), as a rule, acts to increase the likelihood of exceeding the judgement threshold required to attribute mind to animals purely as a result of observing nonhuman species. This mechanism is seen by the higher levels of TAM reported by owners towards their pets [53,54]. Conversely, Terror Management Theory (TM), Social Dominance Theory (SD), and Cognitive Dissonance Theory (CD) all influence the judgement process by reducing the likelihood of exceeding this judgement threshold.

Reliability: the degree to which an instrument measures a specified construct both across time (repeatability) and across scale items (consistency) (e.g., test-retest reliability).
Simulation theory: psychological theory of mind in which individuals use their own mind to model the mental state of a target to make inferences about that target.
Social dominance: an individual's preferences for inequality and hierarchy among social groups, typically measured using the Social Dominance Orientation Scale.
Terror management: psychological theory that individuals are motivated to manage the anxiety caused by awareness of death through investment in belief systems or culture that provide value and meaning.
Validity: the degree to which differences in observed scores on an instrument reflect true differences in the variable of interest. Validity may be confirmed by assessing the ability of an instrument to: (i) effectively and specifically measure the theorised latent construct (construct validity); (ii) capture all facets of the theoretical domain of the construct (content validity); and iii) differentiate between individuals to allow prediction of the future outcomesof a related variable (criterion validity).

that begins by drawing on multiple sources of experience and knowledge that are integrated to formulate a judgement (e.g., to what extent is this animal intelligent?) or belief (e.g., I am of the view that most animals are intelligent); the belief and/or judgement is thresholded, requiring the establishment of criteria on which to assign mindedness to some species over others. The mechanism underpinning TAM comprises multiple components (Figure 1), similar to general models of belief formation [15]. For example, relevant information is **encoded** for later use in generating beliefs about TAM. Encoded information may be descriptive (e.g., chimpanzees can use tools to harvest food) or inferential (e.g., my dog wags his tail when we play ball, playing ball makes my dog happy, ergo my dog experiences emotions). These different types of information become integrated to produce stored schemas or **constructs** regarding TAM. We may actively retrieve, or through associative memory processes, are prompted to draw information from this store as a way of establishing the certitude of our beliefs regarding TAM [16]. In other words, cumulative perceived knowledge and/or experience from multiple sources allows an individual to make an estimate that a specified animal has a particular mental attribute that is indicative of TAM. If the estimate reaches a threshold limit as determined by that individual, the concept of mind is bestowed upon the animal. This process of belief formation is similar to many models attributed to other domains [16,17]. Below, we consider evidence that supports

speculation on several psychological theories in this mechanism and, later, we outline a framework that helps clarify conceptual and empirical issues when investigating some of the key components of TAM.

The Theory of Animal Mind: Evidence of Influencing Psychological Theories

Given that views on the existence of animal mind are influenced by the idea of animals as social agents [7], we consider four theories, with origins in social psychology, and their supporting evidence: **Simulation Theory** (ST), **Cognitive Dissonance** Theory (CD), **Terror Management** Theory (TM), and **Social Dominance** Theory (SD).

Simulation Theory

In interacting with social 'others', we attempt to make sense of behaviour and predict future actions. Therefore, TAM, as the capacity to attribute mental states to nonhumans, is likely to be influenced by ToM capabilities. This is supported by evidence suggesting that, similar to human–human attributions [18], we confer greater mind to animals as we age [11,19], most likely because we accrue more experiences on which to form the beliefs and/or judgements, and to specify the details of the criteria on which they are evaluated. The influence of ToM (specifically as ST) is also supported by people's use of context and behavioural similarity between animals and humans as a central factor in psychological interpretations of the actions of an animal [20]. Notably, we consider species an important determinant of animal mind: 72% of survey participants believed that chimpanzees have human-like capacities to feel pain, while only 30% believed that worms can feel pain to a moderate degree [21]. Previously, this has been interpreted as cognitive ability being a derivative of **phylogenetic** similarity [20], with evolutionarily more recent animals seen as having greater mental abilities [9,22,23]. We suggest that this finding is more likely due to the influence of mental simulation within a TAM mechanism based on the following evidence: (i) where differences in perceptions of species were found, results varied in degree rather than in kind [20], suggesting we are extrapolating or 'simulating' from a human model; and (ii) mirror neuron activation occurs when humans observe both human and nonhuman animals performing similar actions [24].

The idea that humans view specific behaviours and then attribute mind based on this is a common description of how we achieve TAM, and is also supported by findings that, when viewing animal behaviour videos, participants broke down scenarios into specific behavioural 'event units' [5]. Despite not using every event unit to describe the behaviours seen, there was near-perfect agreement on the event unit nature and/or meaning and the total number present per video. This evidence suggests that judgements were made based on recognition of the discrete actions of an agent rather than on their similarity to humans.

A Note on ST As Anthropomorphism

Skilled mindreading of a human target (in relation to ST) requires accurate replication of their mental states, but a simulator's own mental states may contaminate this process [25]. Given that our interactions with animals naturally preclude verbal confirmation of inaccurate mental states, it is unlikely that, over time, with more feedback from our interactions, we will develop improvements in our mindreading. This, combined with the necessity of simulating within a human mind, means that the attribution of **anthropomorphic** mental abilities to animals is unavoidable (e.g., deception or self-recognition). However, labelling these errors as anthropomorphic is unhelpful when investigating TAM. In describing animal minds, people assign psychological terms to specific shared behaviours, regardless of species [20], suggesting 'interpretative' rather than 'imaginative' anthropomorphism [26]. Along with accumulated knowledge and experience, this work shows that we look to simulate the mind of animals by assuming that similar actions to our own reflect similar cognitions.

Cognitive Dissonance Theory

Empirical evidence suggests predominant societal attitudes to meat eating underpin production animals being ascribed lower mental capacities, which is an attempt to reduce the cognitive dissonance arising from this ethically contentious yet widely adopted societal custom [27,28]. As such, these mechanisms of dissonance reduction are likely to impact TAM and manifest as opposing correlations between TAM and support for: (i) animal use (negative) [19]; and (ii) animal welfare (positive) [10]. Given that criteria upon which this dissonance reduction is achieved may vary, we consider CD in relation to TAM as two forms: TM and SD.

In individuals with a preference for social hierarchies, dehumanisation by ridding animals of mind and, therefore, moral worth [29] allows their conception as an out-group and subsequent exploitation [6]. For example, those who support animal experimentation endorse a greater mental divide between humans and other species [9,30]. Conversely, experimental framing of human–animal similarity has been shown to increase moral concern for animals and human outgroups simultaneously [31]. This concept of out-group dementalisation can also be seen in our reduced attributions of mind to pest species compared with other animals [32].

In contrast to our SD orientation, which acts to reduce the perceived cognitive abilities of animals, mechanisms of TM aid dissonance reduction by elevating humans compared with other animals. To avoid the cognitive and emotional experiences inherent in the awareness of human or animal death (mortality salience), particularly as a result of human activity (e.g., farming), we advocate the anthropocentric view that humans' rights should be prioritised on the basis of sophisticated cognitive abilities [6,31,33]. This elevation of own cognitive capacities can be seen in our consistent segregation of humans at the top of mental ability scales [22,30] (for a notable exception, see [34]).

However, despite using different criteria to create distinctions between human and animal mentality, SD and TM show similarities in that they likely depend upon the same belief formation processes. By contrast, ST and anthropomorphism are designed to develop criteria for detecting similarities between humans and animals.

Theory of Animal Mind: Innate or Acquired?

Having set out what we propose as a candidate mechanism that underpins TAM, as well as current theoretical proposals regarding TAM, we now consider a key question that all theories need to address, namely: is TAM innate or acquired? In other words, should a special status be attributed to the formation of TAM? From the theories reviewed, the basic mechanism of TAM is similar to other processes and/or theories of belief formation. However, the bank of perceived knowledge the mechanism uses is subject to several influences that would likely predict individual differences in the types of belief formed. For example, factors such as education [9], exposure to media [7], and political orientation [35] are likely to cause variation in TAM. Therefore, despite evidence of similarities across cultures when ascribing mental states [36], individual and cultural contexts are likely to affect the mechanism, as seen in Japanese students who ascribe greater intelligence to crows compared with other nationalities [10]. However, while observed variations may be considered the result of social traditions and practices, the contribution of specific societal influences on TAM is unsubstantiated, because previous research has predominantly sampled Western, educated, industrialised, rich, and democratic (WEIRD) populations [37].

Are there Limitations to Conclusions Drawn from Empirical Research on TAM?

To summarise, the effects of individual and social factors on the mechanism of TAM are clearly interactive and fluid, and warrant investigation. Yet, despite several variables, such as age,

species of animal, and cultural background, being of consequence, based on the evidence we have at present, the direction and magnitude of effects is often disputed (e.g., meat consumption based on gender). Additionally, even for those factors considered influential, the variance in TAM they account for is typically small [11,19]. These issues suggest that research methods are a potential barrier to not only understanding the underlying mechanics of TAM, but also clearly identifying predictive factors. As discussed above, human tendency to anthropomorphise has received much academic attention, predominantly as a methodological and individual weakness [38]. TAM research often proposes avoidance of the former by claiming to purely substantiate beliefs, rather than to test the accuracy of knowledge. While valid, this perspective is problematic, primarily because variation in experience and encoded knowledge is likely a determinant of beliefs formed [29,39] (as evidenced by the demonstrated effect of psychology-focussed education on TAM [40]).

In conjunction with this issue, heavy reliance on scale-based methods may exaggerate the influence of cognitive dissonance on judgements. TAM research typically presents animals as phylogenetic bands on the basis of mapping onto confirmed, yet incorrect, evolutionarily linear beliefs held by nonscientists [30,32,41]. This runs the risk of reducing TAM to a simple ranking exercise against 'advanced' humans.

These methodological problems combine to perpetuate the idea that TAM is easily explained, prompting a 'dumbing down' of the parameters investigated. Much research has focussed on a single attribute or dimension of TAM [42,43], perhaps because evidence suggests that there are commonalities in assigning TAM across the board [44]. This approach promotes a narrow and unsophisticated demonstration of TAM and distorts the manner in which variation in knowledge and/or information is used to consider the multiple attributes and/or dimensions on which to assign TAM. If the devil is in the detail, understanding specific and unexpected results (e.g., 25% of Finnish people surveyed believed that shrimp can remember **conspecifics**) is surely imperative [45]. Furthermore, restricting the TAM constructs considered worthy of investigation not only limits opportunities for understanding, but also assumes an even weighting in the importance of mental attributes.

The consequences of this inflexibility and lack of precision when using rating scales is highlighted by use of the 'belief in animal mind' scale [41]. When originally devised, the four-part scale showed high internal consistency. No subsequent study has managed to reproduce this level of reliability. This issue could be attributed to views on animal mind having undergone temporal changes, a credible theory since: (i) the amount of research on animal cognition has increased over time [11]; and (ii) exposure to animals via influential media, such as TV [46], has increased. However, minor changes to the scale may well be affecting the reliability of findings on the basis that TAM is more nuanced than previously claimed (for instance, inclusion of the term 'human-like' in surveys appears to reduce participants' willingness to ascribe emotions to animals [40]). Additionally, in the scale's original form, specific categories of animals were provided (mammals excluding humans, birds, fish, and insects) on a five-point scale. Much subsequent work condensed the four groups into 'most animals' (a term typically construed as a mammal [47]) alongside a variety of scale measurements [19,32,47,48] and subtle changes in wording. This highlights the crucial issues of scale construction and vague or dual meanings for cognitive terms.

Much research on TAM has hinged on the generalised concept of 'intelligence'. While this widely used term allows rapid entry into our frameworks of mind [49], there is often little confirmation of what constitutes intelligence to sample populations, despite evidence that it comprises varying constructs to different individuals [50]. Intelligence also involves associations that are alien to the natural world (e.g., IQ tests). With no specifics to work from, people may

simply execute cognitively accessible judgements of 'advanced' mammals, generating repeated correlations between intelligence and phylogeny [43].

We suggest this inconsistency in methods accumulates to produce the varied reported findings detailed previously. Hence, while regression and correlation analyses have provided evidence for relationships between TAM and several other factors, results have rarely been repeatedly substantiated. These discrepancies are understandable on the basis that TAM comprises different constructs within a study, as well as variation in the different species on which TAM is being investigated [48].

Taken together, these concerns reassert the need to have precise scale items for establishing factors that truly influence TAM formation as well as guarding against experimenter bias when designing such scales. As noted, 'respondents are constrained by the categories provided' [44], which are often transferred directly from animal cognition literature to social science studies [51]. This is acceptable if testing transmission of scientific knowledge is our aim, but

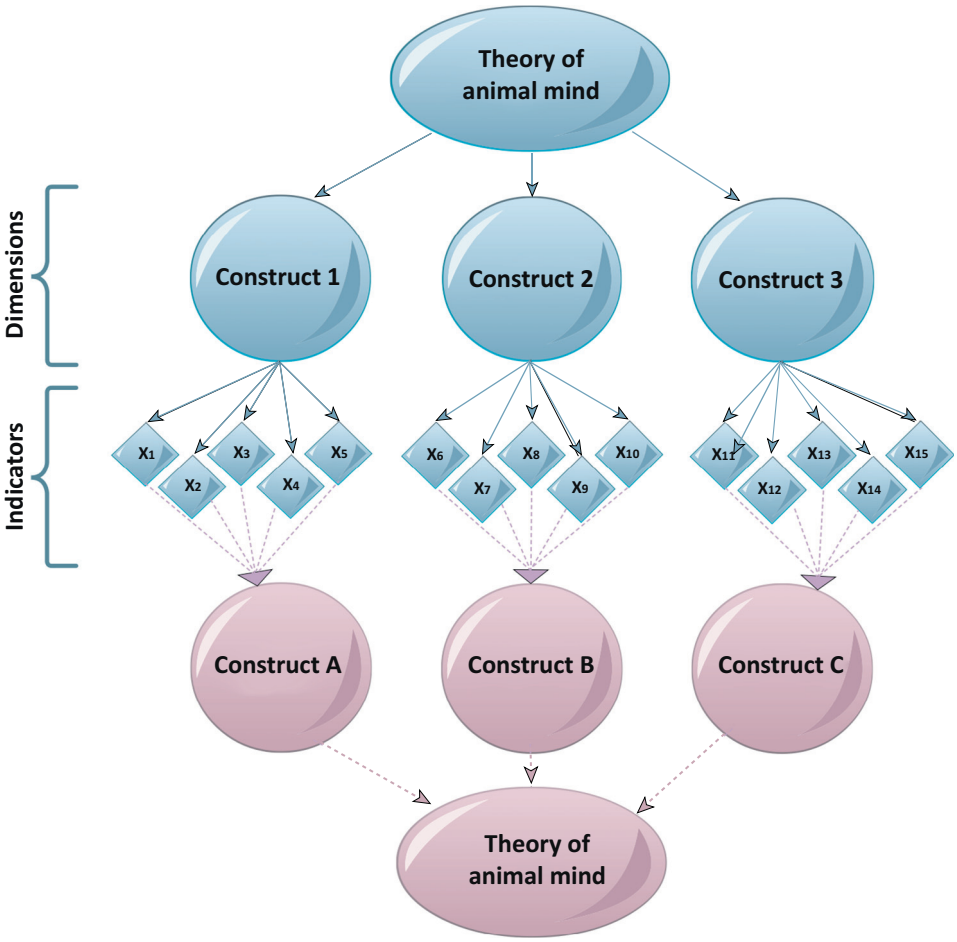

Figure 2. Reflective Measurement Model Depicting the Theory of Animal Mind (TAM) As a Multidimensional Construct. Within this model (in blue), the mechanism of TAM is conceptualised as a second-order, latent construct that underlies multiple first-order constructs (dimensions). Dimensions would be expected to comprise mental traits considered attributes of mind (e.g., agency, as seen in [35]). (Note: this prediction, based on previous findings, would need confirming as part of the process.) Several specific indicators are used to capture the constructs. The model acts to provide a way to both conceptualise and investigate (in purple) the initial stages of TAM development (i.e., construct formation).

precludes accurate understanding of how we construct TAM. Despite suggestions that our attributions of emotion to animals align with scientific views of a basic–higher emotional divide, only a minority of participants believe that animals experience disgust [32]. This demonstrates the importance of ascertaining specific meanings of participant-generated constructs before overlaying scientific theory.

Targeting Issues and Improving Tools of Assessment

To align scale use with meaningful comparisons between studies investigating TAM, we propose a more focussed research program examining the construct formation in TAM. To

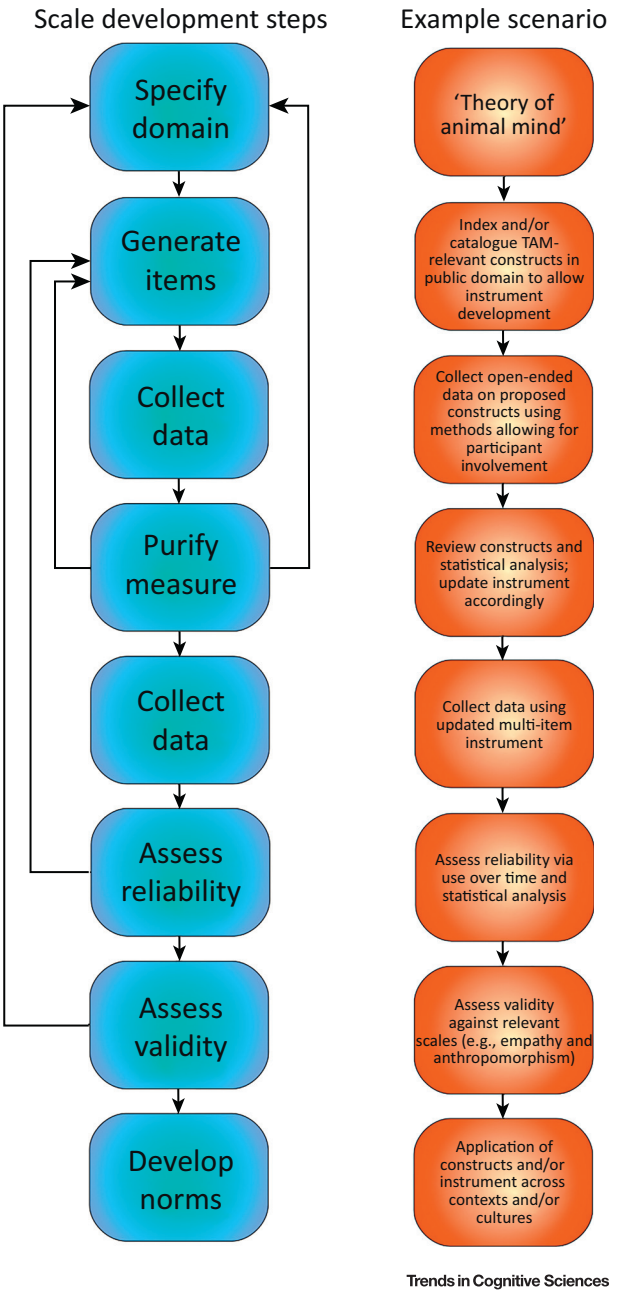

Figure 3. The Use of Churchill's Scale Development Paradigm to Improve Scale Development (in Blue). Definitions of the Theory of Animal Mind (TAM) are numerous [19] and often overlap, resulting in conceptual confusion. Step 1 is designed to address this by providing a delineated definition, thereby improving scale validity and transferability. Use of Rossiter's five definition rules may aid the definition process [55]. Employing a multi-item scale would ensure capturing each dimension in its entirety (i.e., for all animals rather than overly broad groups, such as mammals). Given that TAM is a perceptual attribute and/or implicit theory [50], it is unlikely that literature reviews and researcher introspection will generate sufficient scale items [56]. The use of developmental qualitative research, as proposed by Churchill, would allow rater consultation in Step 2 (namely the public), improving validity. This is important because a significant proportion of TAM research has been based on student populations. Subsequent completion of steps 1–6 of the paradigm avoids subjective 'cherry picking' of cognitive terms [51] and assumes the generation of a measure that is content or face valid [14]. Construct validity could then be assessed by: (i) correlating similar measures; or (ii) confirmation of the scale behaving as predicted (e.g., can it predict an associated measure?). Correlation with connected constructs, such as anthropomorphism, should be assessed to ensure discriminant validity. The final step of developing norms would ensure that Theory of Animal Mind research extends beyond the Western demographics typically sampled, an important exercise since the role of culture has not been thoroughly explored and is likely to influence the development of TAM [10]. A scenario to illustrate the steps is detailed (in red). For methods of statistical analysis to support each stage, see [14].

achieve this, we propose a **Reflective Measurement Model** [52] (Figure 2). This model would allow movement away from considering TAM as a single dimension (supported by the results of [21,35]), allowing greater analysis of the role of specific mental capacities within an overarching belief in animal mentality.

We suggest the use of Churchill's Scale Development Paradigm [14] to generate a valid and reliable model. While full discussion of the model is beyond the scope of this article, in Figure 3 we detail the way in which this eight-step approach to measurement will aid the development of reliable tools for generating theoretical predictions as well as empirically testing a critical but often neglected component of the TAM mechanism, namely construct formation; that is, the way in which knowledge and experience is integrated to formulate constructs that are used to make decisions and/or judgements, and form beliefs.

The benefits of this model are that it would more likely reveal the types of dependency that have been speculated over, such as the association between TAM and empathy. Furthermore, a reliable scale would support empirical work that continues to use innovative methods, such as the assessment of animal behaviour through videos [5,20]. Humans' beliefs, judgements, and decisions of animals are context sensitive [23], and so using techniques like this could allow comparison of how animal mentality may be viewed in both imagined and real terms. Having a measurement framework that comes with the theoretical apparatus to generate testable predictions around construct formation that underpins beliefs, judgements, and decision-making behaviour will elucidate a richer understanding of how we come to our TAM.

Concluding Remarks and Future Perspectives

People's views of the mental abilities of animals, and the resulting moral duty for their welfare, have considerable economic, social, and political consequences. Despite this, TAM has received relatively little scientific attention and the ambiguity in the results generated from work in this area may be attributable to the methods and tools used. More to the point, we propose that construct formation, a core component of the mechanism of TAM, has been particularly underexplored. Future progress on the subject will likely be mediated by the convergence of scientific approaches to determine a wider range of cognitive constructs (see Outstanding Questions), a process that application and examination of the proposed model should aid. Certainly, the use of validated scale measurements in combination with other methods would shift focus away from confirming unwarranted assumptions around TAM. In addition, a richer conceptual framework for generating hypotheses would improve ways of uncovering our assumptions of the mental capacity of animals. Moreover, focussing TAM research away from seeking correlation with diverse attitude measures in an attempt to predict human treatment of animals, would allow exploration of other potentially substantial influences, such as an individual's history of interaction with specific species. This redirection is important because TAM is supported by work from many areas of psychology (e.g., attribution theory, cultural norms, or ToM). In reducing TAM to a single predictable component within a decision-making system focussed only on humane animal use, we ignore its diverse implications by omission.

Outstanding Questions

What are the critical constructs that form TAM and in what way are these at odds with those held by the scientific community?

Which mental attributes of animals are considered of greatest importance when judgements are made about how ethical it is to consume animals?

How do specific cultural influences or practices affect the development of TAM?

To what extent can TAM be considered a distinct psychological phenomenon rather than the by-product of other processes, such as anthropomorphism or adherence to cultural norms?

If higher-order mental faculties form the basis of moral worth, is **anthropocentrism** the dominant mechanism in disqualifying objections to the use of animals that are viewed as being 'of mind'?

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