Opinion

Theory of Animal Mind: Human Nature or Experimental Artefact?

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Abstract

Are animals capable of empathy, problem-solving or even self-recognition? Much research is dedicated to these questions and yet few have considered how people form beliefs about animal minds. Evidence suggests our mentalising of animals may be a natural consequence of Theory of Mind capabilities. However, where beliefs regarding animal mind have been investigated, this review reveals 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 particularly methodological issues that might limit the accuracy of conclusions currently drawn from this work. We suggest a new empirical framework for better capturing people’s theory of animal mind, which in turn has significant political and social impacts.
“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 people construct this “Theory of Animal Mind” (TAM) is therefore likely to reveal important insights, based on their 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 likely have broad implications on account of behavior interpretation not being limited 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 doubting the existence of animal mind [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 highly 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 that are currently based upon psychological
mechanisms 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 that are, understandably,
driven by current scientific opinion. The behavior change envisaged by policy
makers is unlikely to be realised if supporting evidence does not accurately
capture peoples actual 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 non-human animals. Because TAM
involves animal ‘agents’, several theories of relevance from social psychology
are also discussed. Following on from this, we discuss 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 wider relevance to ethical and policy issues than just animal welfare.

**TAM as a Mechanism of Belief Formation**

Often, 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 that begins by drawing on multiple sources of experience and knowledge that are integrated in order to formulate a judgement (e.g., to what extent is this animal intelligent?) or belief (e.g., I’m of the view that most animals are intelligent); the belief/judgement is thresholded, requiring the establishment of criteria on which to assign mindedness to some species over others. The mechanism underpinning TAM consists of 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. People may actively retrieve, or through associative memory processes are prompted to draw, information from this store as a way of establishing the certitude of their beliefs regarding TAM [16]. In other words,
cumulative perceived knowledge/experience from multiple sources allows an individual to make an estimate that a specified animal possesses 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.

**TAM: Evidence of Influencing Psychological Theories**

Because 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, Cognitive Dissonance Theory, Terror Management Theory and Social Dominance Theory.

**Simulation Theory (ST)**

In interacting with social ‘others’, we attempt to make sense of behavior and predict future actions. Therefore, TAM, as the capacity to attribute mental states to non-humans, is likely to be influenced by Theory of Mind capabilities. This is supported by evidence suggesting that, similar to human-human attributions [18], we confer greater mind to animals as we age [19][11]; most
likely because we generate more experiences on which to form the beliefs/judgements, and to specify the details of the criteria on which they are evaluated. The influence of ToM (specifically as Simulation Theory) is also supported by people’s use of context and behavioral similarity between animals and humans as a central factor in the psychological interpretations of an animal’s actions [20]. Notably, people consider species an important determinant of animal mind: 72% of survey participants believe chimpanzees have human-like capacities to feel pain, while only 30% believe worms can feel pain to a moderate degree [21]. Previously, this has been interpreted as a cognitive ability being derived from phylogenetic similarity [20], with evolutionarily more recent animals being seen as in possession of greater mental abilities [9,22,23]. We suggest this finding is more likely due to the influence of mental simulation within a TAM mechanism based on the following evidence: 1) where differences in perceptions of species were found, results varied in degree rather than kind [20], suggesting we are extrapolating or ‘simulating’ from a human model, and 2) mirror neuron activation occurs when people observe both human and non-human animals performing similar actions [24].

The idea that people view specific behaviors 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 behavior videos, participants broke down scenarios into specific behavioral ‘event units’ [5]. Despite not using every event unit to describe the behaviors seen, there was near perfect agreement on the event unit nature/meaning and the total number present per video. This evidence suggests that judgements were made based on
recognition of agent’s discrete actions rather than on their similarity to humans.

A note on Simulation Theory as anthropomorphism

Skilled mind reading of a human target (in relation to ST) requires an accurate replication of their mental states, but a simulator’s own mental states may contaminate this process [25]. Because 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 attribution of anthropomorphic mental abilities to animals is unavoidable (e.g. deception, self-recognition). However, labelling these errors as anthropomorphic is unhelpful when investigating TAM. In describing animal minds, people assign psychological terms to specific shared behaviors, regardless of species [20] suggesting ‘interpretative’ anthropomorphism rather than ‘imaginative’ [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 (CD)

Empirical evidence suggests predominant societal attitudes to meat eating underpin production animals being ascribed lower mental capacities;
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 upon TAM and manifest as opposing correlations between TAM and support for i) animal use (negative) [19] and ii) animal welfare (positive) [10]. Because criteria upon which this dissonance reduction is achieved may vary, we consider CD in relation to TAM as two forms, terror management (TM) and social dominance (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 dementalization can also be seen in our reduced attributions of mind to pest species in comparison to other animals [32].

In contrast to our social dominance orientation, which acts to reduce animals perceived cognitive abilities, mechanisms of terror management aids dissonance reduction by elevating humans in comparison to other animals. In order to avoid the cognitive and emotional experiences inherent in 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 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 employing 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. In contrast,
simulation theory, 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 that
TAM is 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 much like other processes/theories of belief formation.
However, the bank of perceived knowledge the mechanism employs is
subject to several influences that would likely predict individual differences in
the types of beliefs 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 context are likely to affect
the mechanism, as seen in Japanese students who ascribe greater
intelligence to crows compared to 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 as previous research has predominantly sampled WEIRD (Western, educated, industrialised, rich and democratic) 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 is clearly interactive, 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 may be a potential barrier to not only understanding the underlying mechanics of TAM but also in 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 test 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-focused 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 non-scientists [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 focused 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/information is used to consider the multiple attributes/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 believe 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 employing 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 e.g. TV [46] has increased. However, minor
to the scale may well be affecting the reliability of findings on the
basis that TAM is more nuanced than previously claimed (for instance,
clusion of the term “human-like” in surveys appears to reduce participants
willingness to ascribe emotions to animals [40]). Additionally, in its original
use, specific categories of animals were provided (mammals excluding
humans, birds, fish and insects) on a 5-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
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 analysis has provided evidence for relationships between TAM and
several other factors, findings have rarely been repeatedly substantiated.
These discrepancies are understandable on the basis that TAM comprises different constructs within a study, as well as variation for 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 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 precludes accurate understanding of how we construct TAM. Despite suggestions that our attributions of emotion to animals aligns 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

In order to align scale use with meaningful comparisons between findings investigating TAM, we propose a more focused research programme examining the construct formation in TAM. To 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 measurement model [14] in order 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 8-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; the way in which knowledge and experience is integrated in order to formulate constructs that are used to make decisions/judgements, and form beliefs.

The benefits of this model are that, it would more likely reveal the types of dependencies that have been speculated over, such as the association between TAM and empathy. Furthermore, a reliable scale would support empirical work that continues to employ innovative methods to assess animal behavior through videos [5,20]. People’s beliefs, judgements and decisions of animals is context sensitive [23], and so using techniques like this can 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 behavior, 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 findings generated from work in this area may be attributable to methods and tools. 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 people’s assumptions of animal’s mental capacity. Moreover, focusing 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, Theory of Mind). In reducing TAM to a single predictable component within a decision-making system focused only on humane animal use, we ignore its diverse implications by omission.

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Proposed Mechanism of Belief Formation underpinning Theory of Animal Mind. 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 non-human 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 (ST: Simulation Theory, TM: Terror Management Theory, SD: Social Dominance Theory, CD: Cognitive Dissonance Theory). For example, we propose that simulation affects perception and encoding of information relevant to TAM through recognition of cross-species behaviors/actions. Thus, Simulation
Theory, 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 non-human species. This mechanism is seen by the higher levels of TAM reported by owners towards their pets [53,54]. Conversely, CD, TM and SD all influence the judgement process by reducing the likelihood of exceeding this judgement threshold.
Fig. 2 Reflective Measurement Model depicting Theory of Animal Mind as a multidimensional construct. Within this model (indicated as blue), mechanism of TAM is conceptualised as a second order, latent construct that underlies multiple first order constructs (dimensions). Dimensions would be expected to consist of 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 (indicated as purple) the initial stages of TAM development i.e. construct formation.
Scale Development Steps

Specify Domain
-> Generate Items
-> Collect Data
-> Purify Measure
-> Collect Data
-> Assess Reliability
-> Assess Validity
-> Develop Norms

Example scenario

"Theory of Animal Mind"

Index/catalogue TAM-relevant constructs in public domain to allow instrument development

Collect open-ended data on proposed constructs using methods allowing for participant involvement

Review of constructs, statistical analysis and update instrument

Collect data using updated multi-item instrument

Assess reliability via use over time and statistical analysis

Assess validity against relevant scales e.g. empathy, anthropomorphism

Application of constructs/instrument across contexts/cultures
Fig. 3 Use of Churchill’s model to improve scale development (indicated as blue). Definitions of 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 5 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 e.g. mammals. Because TAM is a perceptual attribute/implicit theory [50], it is unlikely that literature reviews and researcher introspection will generate sufficient scale items [56]. Use of developmental qualitative research proposed by Churchill would allow rater consultation in Step 2 (namely the public), improving validity. This is particularly 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 a) correlating similar measures or b) 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 BAM 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 (indicated as red). For methods of statistical analysis to support each stage, refer to [14].
Peoples beliefs regarding the nature of mind are typically dualistic, with mind and body being viewed as separate entities [57]. In 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 empirical validation of mental states in animals is problematic [59], although increasing use of modern techniques such as fMRI promises the visualisation of neural states/activity such as consciousness [60,61]. Consequently, scientific views on animal mentality center on 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 have been investigated including tool use (acknowledged in a range of species [62,63]), numeracy [64] and varying forms of memory, with evidence of chimpanzees outperforming humans in short term memory tasks [65] and 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 recent findings suggest might experience ownership of their body parts (an aspect of self-consciousness) [69]. Previously, notions of self-awareness among nonhumans have met with
resistance, particularly because only a few animals (e.g. chimpanzees, dolphins, elephants) pass the ‘mirror test’, a gold standard for self-recognition [70,71]. Similarly, 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]. And yet 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 Theory of Mind [75]. As such, many capacities considered integral to human cognition are still contested in the literature e.g. language, mental time-travel, 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 employing a range of models [79]. Hence, current scientific opinion remains that animal mentality lies on a varied spectrum with only humans possessing the combination of complex abilities and thoughts required to generate our unique minds [80].

**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
non-human 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 vs. interspecies behavior recognition.

**Churchill’s Scale Development Paradigm**: an 8-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 between individuals, operationalization of constructs should allow for participant involvement (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 organisms, 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.

**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 a target's mental state, to make inferences about a 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 reflects 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 theorized latent construct (construct validity), ii) capture all facets of the construct’s theoretical domain (content validity) and iii) differentiate between individuals in order to allow the predict future outcomes of a related variable (criterion validity).

Outstanding Questions

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

• Which mental attributes of animals are considered of greatest importance when judgments 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 byproduct of other processes such as anthropomorphism or adherence to cultural norms?
If high 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 ‘of mind’?

**Trends Box**

- Current evidence suggests 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 mechanism 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.