Brussels, 17 May 2024

COST 019/24

DECISION

Subject: Memorandum of Understanding for the implementation of the COST Action "An Evolutionary View to Understanding Affective States across Species" (AFFECT-EVO) CA23106

The COST Member Countries will find attached the Memorandum of Understanding for the COST Action An Evolutionary View to Understanding Affective States across Species approved by the Committee of Senior Officials through written procedure on 17 May 2024.

MEMORANDUM OF UNDERSTANDING

For the implementation of a COST Action designated as

COST Action CA23106
AN EVOLUTIONARY VIEW TO UNDERSTANDING AFFECTIVE STATES ACROSS SPECIES (AFFECT-EVO)

The COST Members through the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action, referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any document amending or replacing them.

The main aim and objective of the Action is to develop a new phylogenetic framework for the study of affective states to improve the translatability of research across species.. This will be achieved through the specific objectives detailed in the Technical Annex.

The present MoU enters into force on the date of the approval of the COST Action by the CSO.

OVERVIEW

Summary
Understanding the affective states (emotions and moods) of non-human animals is crucial to understand their needs, improve their welfare, and assess the effects of treatments for affective disorders in animals, be they preclinical models of human disorders, or patients in their own right. Existing knowledge regarding affective states across species is limited and fragmented. For example, it is unclear: (1) whether and to what extent different affective states occur in different species; (2) if these states are expressed and experienced in similar ways by different species; (3) which physiological mechanisms of affective states are shared across species; and (4) which indicators of affective states are valid across more than one species.

AFFECT-EVO brings together an interdisciplinary network of scholars in philosophy, psychology, humanities, social, computational, and natural sciences, with relevant stakeholders from industry, advocacy organizations, and governments. This network will apply an evolutionary framework to evaluate collaboratively and systematically what we know about affective states in non-human animals. This approach will (1) identify gaps in our knowledge, guiding future research; (2) provide a basis for developing strategies to reliably generalize knowledge about affective states across species; (3) develop better methods to assess affective states to improve animal welfare; and (4) develop better treatments for both animal and human affective disorders. We will also explore how the public and policy makers engage with the concept of affective states in animals and how this interacts with the implementation of new laws and policies that affect animals.

Areas of Expertise Relevant for the Action	**Keywords**
● Biological sciences: Zoology, including animal behaviour ● Basic medicine: Evolution of mind and cognitive functions ● Basic medicine: Comparative physiology ● Basic medicine: Cognition (e.g. learning, memory, emotions, speech) ● Philosophy, Ethics and Religion: Epistemology, logic, philosophy of science and technology	● Evolution of Affective States ● Comparative Psychology ● Affective Science ● Animal Welfare ● Affective Disorders

Specific Objectives
To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination
● Agree on a common conceptualisation and associated vocabulary for investigating affective states across species.
● Create a framework to identify affective state characters which can be mapped onto a phylogeny of the animal kingdom.
● Identify crucial gaps in the current knowledge of affective states in well-studied species.
● Develop a strategy for the ethical investigation of affective states in species that have yet to be studied.
● Summarize and identify gaps in the current knowledge about how humans engage with the concept of affective states in animals, individually, societally, and culturally.
● Identify best practices in assessing affective states as part of welfare assessment in different taxa.
● Develop a strategy to better translate treatment of affective disorders across species.

Capacity Building

● Bring together researchers and scholars from the humanities, technology, social and natural sciences into a novel, interdisciplinary network to study affective states.
● Engage with relevant stakeholders in the co-creation of relevant recommendations to maximize the socio-economic impact of the Action.
● Promote Young Researchers and Innovators (YRIs) of varied backgrounds to take leadership roles in the Action.
● Actively involve researchers based in COST Inclusiveness Target Countries (ITCs) to lead on Working Groups, Workshops, and Training Schools, and host Network Activities.
● Encourage YRIs, especially those from ITCs, to attend and participate in the workshops and conference meetings, and to co-author the strategic documents resulting from them.
● Train YRIs in the state-of-the-art of comparative affective science and in dissemination of science to the wider public.
● Build a future workforce which is comfortable in interdisciplinary collaborations across natural sciences, social sciences, and the humanities.

TECHNICAL ANNEX

1. S&T EXCELLENCE

1.1. SOUNDNESS OF THE CHALLENGE

1.1.1. DESCRIPTION OF THE STATE OF THE ART

Brief Summary

A large body of behavioural and neuroscience research suggests that affective states (*i.e.*, moods and emotions) exist throughout the animal kingdom, but there are differences across species in the affective states that are present, how they are experienced, and how they are expressed. The reasons for these differences are not well understood. This COST Action proposes to **develop a phylogeny-based theoretical framework for comparative research on affective states**, which will allow us to differentiate species similarities due to common descent (homology) from similarities due to shared social or ecological environments (homoplasy). Understanding the origin of similarities and differences in affective states is crucial if we want to apply the knowledge gained in one species to other species. Such cross-species translation is core to research and practice in animal welfare and to developing treatments for affective disorders in both humans and non-human animals (henceforth "animals").

The main questions addressed by this COST Action are:

1. **What is currently known about affective states in different species and where are the knowledge gaps that need to be addressed with the highest priority?**
2. **How does knowledge regarding animal affective states influence societal and legislative discussions, decisions, and actions?**
3. **How can current and future knowledge about similarities and differences in affective states across species be used to develop better animal welfare indicators?**
4. **How can current and future knowledge about affective states be used to develop better treatments for affective disorders in humans and animals?**

Affective states

Affective states encompass emotions (short-lived) and moods (longer-lived) (Fig. 1; Kremer *et al.*, 2020). They are an inextricable part of how humans evaluate the world around us, make decisions, interact with each other, and experience wellbeing. Most modern leading theories, whether psychological or philosophical, take the human experience of affective states as their primary explanatory target. This includes (among others) basic emotion theory and affect programs (Ekman *et al.*, 1969; Panksepp, 1998; Tomkins, 1963, 1962), psychological constructivism (Barrett, 2017; Russell, 2009; Zachar, 2022), and the James-Lange theory (in which emotions are feelings generated by perception of physiological states; Prinz, 2004). Most of these perspectives agree that affective states are complex inner states with cognitive, behavioural, motivational, experiential and physiological components (Allen and Trestman, 2020; Kremer *et al.*, 2020; Plutchik, 2001; Scarantino, 2017; Scherer, 1984).

In addition to discussion about the components that make up affective states, there is an ongoing debate about whether different affective states are discrete products of distinct, relatively fixed brain circuits (*e.g.*, fear, lust, *etc.*; Panksepp and Biven, 2012), or whether they are points on a multi-dimensional continuum, with (*e.g.*) the dimensions of valence (positive to negative) and arousal (bodily activation) (Posner *et al.*, 2005), or of positive and negative intensity (Kron *et al.*, 2015). However they are conceptualised, affective states are

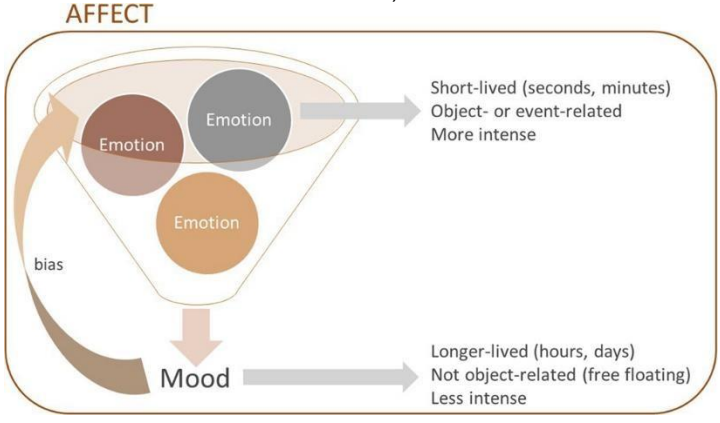


Fig. 1 The relationship between emotion, mood, and affective states (from Kremer et al., 2020).

seen as essential to how individuals interact with their world, helping them to adapt to social and physical environmental changes and make potentially beneficial decisions (Gygax, 2017; Mendl and Paul, 2020). Enactivist and ecological theories emphasise the role of affective states in ecologically relevant behavioural control and communicative displays, while evolutionary psychology explores the adaptive value of the action tendencies of affective states (Colombetti, 2014; Fridlund, 1994; Griffiths and Scarantino, 2008; Scarantino, 2017). Yet, while most authors agree that affective states are the product of evolution, few have explored the origins of species differences and similarities in affective states.

Studying affective states across species

To advance our understanding of affective states, it is critical to understand their evolution, and hence the continuity of, as well as the differences in, affective states across species (Darwin, 1872). This applies not only to which affective states are present, but also to how they are expressed and experienced. A commonly held position is that humans provide the best information about affective states, because most adults can give verbal reports. Therefore, human affective categories are typically used as the framework for studying discrete affective states in other species. However, different human cultures recognize different affective categories (Russell, 1991), calling for caution when applying human discrete affective categories across cultures, let alone across species. This does not mean that discrete affective states do not exist, but it does mean that we cannot assume that our linguistic categorisation of affective states is universal. Accordingly, care is needed with the anthropocentric use of words referring to human discrete affective categories when describing affective states in animals (LeDoux, 2017; LeDoux and Pine, 2016). This makes it a challenge to translate affective concepts, indicators, and contexts from humans to animals, and therefore to draw inferences about the conscious experience of affect in animals (Mendl *et al*., 2022; Paul *et al*., 2020).

Dimensional concepts of affective states sidestep these anthropocentric categorisation issues by characterising different affective states with different combinations of underlying quantifiable features (such as low arousal and negative valence) rather than by directly translating human emotional categories (such as 'sadness'; Mendl *et al*., 2022). Another way of moving away from human affective concepts is to use different definitions of what affective states are. This could be done by breaking them down into "emotion primitives" (aspects of affective states which may have evolved separately) or by identifying affect-generating contexts, and their commonalities. For example, one definition views emotions as states induced by rewards (things animals actively seek) and punishments (things animals actively avoid). This allows one to infer the occurrence of positive or negative affective states in contexts containing rewards or punishments, respectively (Mendl and Paul, 2020; Rolls, 2014, 2005).

Assessment of affective states in animals is also a practical challenge. While we can use language to investigate affective states in humans, we cannot do this with animals. Animals are often put in contexts that are predicted to induce particular affective states, and their responses are interpreted accordingly (*e.g.*, Briefer, 2020; Désiré *et al*., 2006). Specific combinations of physiological and/or behavioural measures that reliably change in these contexts are then identified as potential indicators of the assumed affective state (Paul and Mendl, 2018). Sometimes, these indicators co-occur consistently, and sometimes they do not (Adolphs, 2017). In addition, a hypothetically identical affective state can elicit diverse reactions in different individuals from the same species or even in the same individual, depending on the individual history of experiences and responses, the (social) context, and the features of the trigger event. Conversely, different affective states can sometimes trigger the same behavioural and physiological changes (Boissy *et al*., 2007). A coherent framework that could help predict variation in affective states, their expression, and their experience across species (and situations), and identify reliable indicators of animal affective states, would therefore be very valuable.

Assessing affective states for animal welfare

The improvement of animal welfare is of major importance for ethical, societal, and even economic reasons. Whereas the concept of animal welfare includes physical and physiological aspects (*e.g.*, good health; Sainsbury, 1986), at its core lies the desire that animals should live "a good life" (Fraser, 2008), which implies a life imbued by positive experiences, positive affective states, and a minimisation of negative experiences (Turner, 2019). Therefore, assessing affective states in animals is central to the field of Animal Welfare Science. In this field, there is an increasing emphasis on long-term (days to weeks) affective states ("moods"), as these presumably more strongly influence the animals' cumulative welfare. Short-term states ("emotions"; minutes to hours) are also important as they can trigger longer-term states and as such, an accumulation of many short-term affective states can add up to a more positive or negative experience in the long run (Fig. 1; Eldar *et al*., 2016; Mendl *et al*., 2010).

To assess animal affective states, people have used physiological and behavioural indicators. Examples of physiological indicators include heart rate and stress hormone levels (short-term), and measures of

hippocampal plasticity (long-term; Poirier *et al.*, 2019). An example of a behavioural indicator of short-term pain states in animals is the grimace scale (based on facial movements), which has been developed for a number of species (Mogil *et al.*, 2020), and even suggested for cephalopods (COST Action CephsInAction). In contrast, an example of a putative indicator of longer-term states is the judgement bias test, which assumes that animals in a negative state will interpret ambiguous stimuli as more likely to be associated with a negative than a positive outcome (Mendl *et al.*, 2009). This approach has been used in vertebrates and invertebrates (Lagisz *et al.*, 2020). Whereas most indicators of affective states are adapted for each individual species on a practical level (*e.g.*, the mode of responding may differ in a judgement bias task), there is currently no comparative framework to predict when we expect different species to respond similarly or differently under similar conditions.

Treating (models of) affective disorders across species

The pharmaceutical industry has failed to formulate new medicines for psychiatry based on animal research in the last 50-60 years (Nestler and Hyman, 2010), in part due to the questionable validity of preclinical animal models for psychiatric disorders (Dzirasa and Covington III, 2012; Hernández-Arteaga and Ågmo, 2023). One important contributor to this is the conditions under which laboratory animals are housed and tested. Conventional housing conditions increase the odds of mortality and morbidity (Cait *et al.*, 2022), and animals raised under laboratory conditions are unlikely to represent the "normal" state for this species. Without a normal state, it is difficult to assess whether a pathological state has been induced, or indeed been treated successfully (Lahvis, 2017). Understanding the **conditions required for different species to express their natural affective states** is therefore crucial to redesign housing and testing systems if we want to use these animals as models for human affective disorders.

The categorical systems traditionally favoured by the clinical sciences (*e.g.*, the Diagnostic and Statistical Manual of Mental Disorders - DSM-V) fail to reflect the biological continuity that exists between normal and "clinical" conditions (Sheppard and Mills, 2003). Thus, there is a consistent failure to find clinical markers indicative of "pathological" affective states. **An approach grounded in phylogeny and fundamental psychobiology**, highlighting differences and similarities in the processes of affective states across species, would have greater validity and allow for **better translation of results across species**. This will make use of new approaches to mental health, such as the Research Domain Criteria framework (RDoC), which looks at psychopathology in terms of basic neuro-behavioural domains, like Arousal, Cognition, Social Processes, *etc.* (Anderzhanova *et al.*, 2017; Cuthbert, 2014). The application of a more psychobiological rather than a medical approach to the clinical assessment of animal affective states is already transforming the treatment of affective and behavioural disorders in companion animals (Mills, 2017), and will transform the development of animal models of human conditions. Relevant psychobiological domains include the influence of social or physical environment, nutrition, and gut microbiota, which have all been associated with mental health (Nagpal and Cryan, 2021).

Conclusion

Despite decades of research on human and animal affective states, the field is lacking a coherent approach to understanding animal affective states and to translating findings from one species to another. A stronger consideration of the evolutionary origin and socio-ecological function of these states in different species is required to make major new advances in this interdisciplinary field.

1.1.2. DESCRIPTION OF THE CHALLENGE (MAIN AIM)

In some species, we have validated indicators of affective states. For example, we can relate non-verbal indicators in humans to verbal reports of their affective state. However, how do we know whether these indicators also apply to other species? Are there indicators that can be objectively quantified and used in a wide range of species? Are some aspects of affective state more likely to be similar across species than others? And is this due to common phylogenetic origin, or to similar social or ecological conditions? The main challenge of this COST Action is therefore to:

> **Develop a new phylogenetic framework for the study of affective states to improve the translatability of research across species**.

The secondary challenges are to take this new framework and use it to:

> **Develop valid measurement techniques of affective states across different species for animal welfare assessment.**

and

> **Translate assessments and treatments of affective disorders (including behavioural**

disorders) bi-directionally between humans and animals.

1.2. PROGRESS BEYOND THE STATE OF THE ART

1.2.1. APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE OF THE ART

To date, efforts to identify similarities in affective states and their indicators across species have been *ad hoc*. It is generally assumed that all species experience the same affective states (if they are thought to experience any at all), and that indicators valid in one species are applicable to other species, without questioning deeply whether such a translation is justified. Only by **understanding the origins of similarities and differences** in affective states, in the mechanisms controlling these affective states, in the ways in which affective states are expressed, and in the way these mechanisms and expressions develop, can we reliably begin to translate findings from one species to another. Similarities between species can be **due to common phylogenetic origin (homology) or to similar socio-ecological selective pressures (homoplasy)**. To distinguish these different sources of similarity, and find where the differences are, a **phylogenetic framework** is required (Duda and Zrzavý, 2013). Such a framework is often applied in morphology: characters that are shared within a group of closely-related species can be concluded to be similar due to common origin, and can be hypothesised to be shared by other, as yet unstudied, species in the same group (*e.g.*, feathers in birds, dinosaurs and pterosaurs, Cincotta *et al.*, 2022; Fig. 2); in contrast, features that are shared among distantly-related species are likely to be shared due to some common social or ecological challenge (*e.g.*, wings as an adaptation to an aerial lifestyle in birds, pterosaurs and bats; Fig. 2). By mapping affective characters onto a phylogeny, together with a suite of socio-ecological characters (*e.g.*, social structure, diet, *etc.*) predictions can be made about which understudied species might share those affective characters. **Defining and operationalising such characters is a major task for the Action**, and may include physiological and behavioural responses to affect-inducing situations, as well as the anatomical and biochemical bases for these responses.

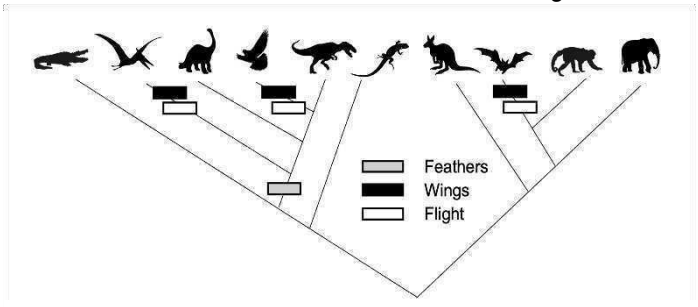


Fig. 2 The phylogenetic framework applied to morphological characters.

To progress beyond the state of the art, our programme will be subdivided into 4 Working Groups (WGs; Fig. 3). WG1 will survey the existing literature on affective states across species and map existing knowledge in a phylogenetic framework. This will identify **where the largest gaps are in our knowledge** of the evolution of affective states and make recommendations for future research. For those aspects of affect and those species about which we already have significant knowledge, WG1 will start **formulating strategies for the measurement and assessment of affective states** in different groups of animals. WG2 has the responsibility to ensure that the findings of the Action have a significant societal impact. To do this, we need a **better understanding of current human attitudes towards affective states in animals** and how such attitudes inform people's behaviour. By working together with stakeholders, we will identify where the biggest current societal and industrial need is for the application of the WG1 findings, and co-develop targets for the final two WGs. WG3 will focus on the measurement of affective states in the context of **animal welfare assessment**, while WG4 will be aimed at the **treatment of (models of) affective disorders in animals**. These goals can only be achieved through **truly interdisciplinary work**. We will therefore bring together experts from ethics, social science, psychology, animal welfare science, neuroscience, philosophy, and evolutionary biology, with stakeholders such as wildlife preserves, zoos, racetracks, policy makers, pharmaceutical companies, public interest groups, charities, farming and fishing organisations, and food retailers.

WG1: Advancing our fundamental understanding of affective states across species

It is difficult to identify affective characters to map onto phylogenies. The goal of WG1 is therefore to agree on a conceptual framework and vocabulary to be used by the Action, and then to use this framework to organize our current knowledge about affective states across species. The anticipated outcomes of WG1 are:

1. **Standardised vocabulary and concepts**. The Action will develop an agreed-upon vocabulary and ontology of affective states. This is particularly important for avoiding ambiguity if the same term can be used for both primitive and derived affective characters

and for behaviours that are defined in both coarse- and fine-grained ways.

2. **Systematising future research within a non-anthropocentric research framework**. Such an evolutionary framework is critical for revealing existing knowledge gaps and pointing the way for new research programmes to determine which characters are homologues and which have convergently evolved, allowing translation to a wider group of species than just the ones that have been studied in detail to date.

To achieve the first outcome, the Action will bring together scholars from different schools of thought about affective states to **discuss the similarities and differences among the different approaches**. Since there is still no consensus on what affect is, it is useful to think of it as an "object of research" (Feest, 2017) in which much affect-related research aims to more clearly delineate an "epistemically blurry" target, rather than to test theories about an already well-understood phenomenon. Part of this definition-seeking involves determining the prediction-supporting features of affect, the scope of affective states in phylogeny, the main types of affective states, and the relation of affective states to cognitive appraisals and conscious experience. The Action strives to formulate an approach that is as non-anthropocentric as possible, with the implicit acknowledgement that as humans, we are constrained in our viewpoints (Burghardt, 1985). The Action therefore aims to **define the contexts that elicit specific affective states across species** (*e.g.*, threat detection and avoidance, or reward recognition and seeking) and map characters relating to the states elicited by those contexts onto a phylogeny.

One of the challenges of WG1 will be to treat affective states (and their constituent parts) as characters that can be homologised, and to trace their innovations and subsequent distributions through the tree of life. The task of defining and empirically confirming homologies is relatively well advanced in genetics, morphology, and development, but less so in behaviour (although a nice example is the evolution of acoustic communication in vertebrates; Chen and Wiens, 2020), and has barely even begun in cognitive and affective science. This COST Action will be the first to fill this gap for affective states. To do so, the Action will **organize focused workshops to discuss the characters that can be identified across species and mapped in a phylogenetic framework**. Three different workshops will focus on (neuro) physiological and neuroanatomical, behavioural and

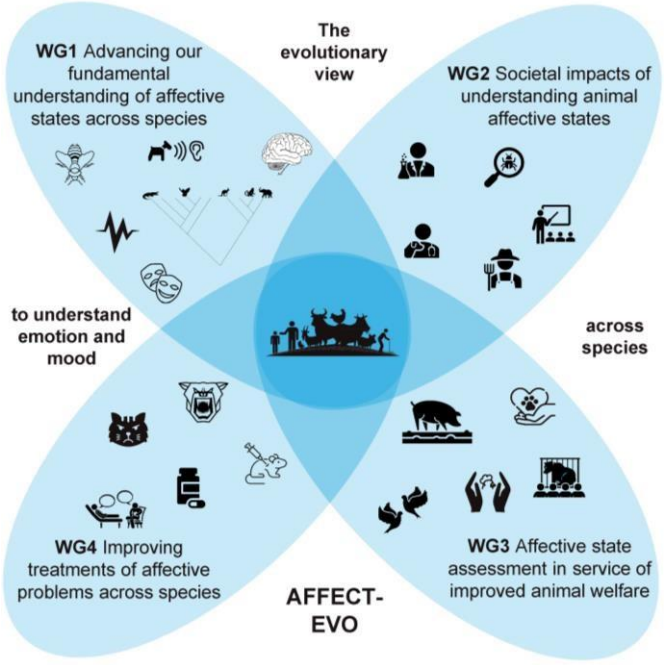


Fig. 3 The structure of the AFFECT-EVO COST Action.

cognitive, and developmental characters, respectively. We expect to find gaps in the animal phylogeny where no affective state data exist, but also to be able to draw conclusions in better-characterised taxa, such as mammals, birds, teleosts, arthropods, and cephalopods. Research tracing neural-structural innovations through phylogeny (Cisek, 2019), theorizing about the evolution of consciousness (Birch *et al.*, 2020; Edelman and Seth, 2009; Ginsburg and Jablonka, 2019; Godfrey-Smith, 2016; Ponte *et al.*, 2022) and providing a common basis for comparison of biological and artificial intelligence (Taylor *et al.*, 2022) provide useful models for our ambitions.

WG2: Societal impacts of understanding animals' affective states

Attribution of affective states to animals can affect human–animal interactions and shape animal welfare laws (Wolfensohn, 2020). However, there is still much to be learned about the factors that influence these attributions, such as familiarity/ownership, moral and ethical frameworks, and pre-existing value assumptions (Morris *et al.*, 2012; Ohl and van der Staay, 2012; Wilkins *et al.*, 2015). The impact of this Action on society stands on the understanding of **how societal perception of animal affective states impacts human behaviour towards animals**. Led by scholars from the social sciences and humanities, including law scholars, WG2 will review the literature on how people understand animal affective states. We will collate how this understanding affects people's attitudes and behaviours towards animals in different human-animal relationship contexts, and how this varies among different socio-cultural and demographic groups. We will review the literature on how human attitudes and behaviours are constrained by value systems, and how attitudes and value systems may be impacted by new information from scientific research (Bastian *et al.*, 2012; Hansen *et al.*, 2003). We will also compare different legal systems, which ultimately codify attitudes within cultural and societal institutions.

Working closely with stakeholder groups (including policy makers, animal welfare advocacy organisations, food industry partners, wildlife preserves, racetracks, zoos, and animal researchers), WG2 will develop an **agenda for future social science and humanities research** to fill the identified knowledge gaps. This will include identifying where there is the most need for qualitative research and where more quantitative data collection might be more appropriate. These approaches will then be adopted by new research collaborations and grant applications that will originate from this Action. Outcomes of the literature review will form the basis for two focused workshops in which the agenda for the final two WGs will be co-developed with relevant stakeholders. One workshop will work with policy makers, lobbying organisations, and law makers, while the other will co-develop an agenda with industry and 3rd-sector organisations. Representatives of the general public will be invited to both workshops. In addition to helping set priorities for WG3 and WG4, WG2's outcomes will also be used to help WG3 and WG4 **co-develop their engagement strategies** with relevant stakeholders. This could include the Action's website, social media campaigns, mass media outlets, as well as pamphlets and publications. Results will be published as **best-practice guidelines** for similar projects.

WG3: Affective state assessment in the service of improved animal welfare

Arguably the dominant view within Animal Welfare Science is that **animal welfare refers to the physical and psychological wellbeing of animals** (including their affective states; Mellor *et al.*, 2020). In particular, the overall balance of positively and negatively valenced affective states matters for welfare – what we will refer to as the ***affective balance*** of an individual. This balance can be considered at any given point in time, but also in terms of the total experience of different affective states over a period of time. It is still unclear exactly how different affective states interact. We need to know more about (1) how separate affective states with positive and negative valence add and subtract from overall welfare experience, and (2) how cumulative positive experiences may work in synergy to improve the overall welfare of animals. The main two challenges for WG3 are therefore to:

1. Develop strategies to design **reliable methods and tools for assessing affective states** of relevant species.
2. Develop a strategy for combining individual affective states into an **overall assessment of *affective balance***.

Some species have been studied more than others, and not all species have been studied in the same contexts. The framework developed in WG1 will help us to understand when we can generalize across species or socio-ecological conditions, and when we should not. Systematic review of the existing literature in this new framework, combined with a consensus approach based on scientific evidence, will allow WG3 to provide recommendations for the development of reliable assessment tools for affective states in different species (*e.g.*, by combining different indicators). WG3 will **evaluate the effectiveness**

of existing affective state indicators in different (groups of) species, when they are applied to 'real world' animal welfare assessment. It will also **make recommendations** on how to judge validity, feasibility, precision, and accuracy of proposed future indicators. This will be done in collaboration with technology companies specializing in the collection of behavioural and physiological data, acknowledging the importance of the different settings in which animals live (*e.g.*, labs, farms, zoos, homes, *etc*). WG3 will also develop strategies for measuring affective balance. An **expert consensus will be sought on how affective balance is defined**; the importance of valence, intensity, and duration; and how affective balance can be evaluated across different time scales to assess welfare. The resulting understanding of how different affective experiences are additive, subtractive, and/or interactive will then be utilised to **make recommendations for a practical affective balance assessment tool**.

Based on the findings from WG1, a first set of workshops in WG3 will each bring together experts in the study of affective states in a particular **phylogenetic group** across different applied contexts (*e.g.*, a mammal workshop, a cephalopod workshop, *etc.*), to discuss what is known about that group and to identify potentially useful indicators of different affective states. Each workshop will produce a summary document setting out the current state of affective state assessment in those species in an animal welfare context, highlighting both recommended approaches and knowledge gaps. Following these workshops, a second set of workshops will be organised by **human usage category** (*e.g.*, farm, lab, zoo, companion). These workshops will be attended by relevant stakeholders and will target the **co-development of recommendations** for affective state assessment for different species in each setting, including possible indicators of affective balance.

WG4: Improving treatments of affective problems across species

This WG focuses mainly on animals that are used in biomedical research as models for humans, and on animals that are treated individually for affective problems, such as companion animals. However, findings might apply more broadly, *e.g.*, to zoo animals. To develop better treatments for both animal and human affective disorders, the first order of business will be to use the outcomes of WG1 **to identify features of affective states that are directly comparable across humans and relevant animals**. WG4 will also **map the effects of different treatments** (pharmacological, microbiological, nutritional, social, environmental, and behavioural) on affective states (or their components) across species. This will be used to determine which manipulations might work in multiple species (including humans) so that better animal models of human affective disorders can be developed. It will also allow us to identify which treatments may be appropriate for affective problems in other species.

Three focused workshops will be organised to explore this translation of treatments for symptoms and mechanisms relating to states akin to depression, anxiety, and pain (focusing on its affective component). The utility of using disease categories (*e.g.,* DSM-V) or componential approaches (*e.g.*, RDoC framework; Cuthbert, 2014) will be debated and **recommendations will be made for a way forward** in each of those areas. Emphasis will be placed on finding reliable indicators of changes in affective states, which can then be used to identify affective problems (in animal models and in animal patients) and to monitor the success of treatment. This will again be done in collaboration with relevant technology companies developing automated methods for animal monitoring and may involve measuring more than one indicator. It may also require observing animals in their home environment, rather than placing them in testing conditions, as the animals may be more likely to express indicators of the relevant affective states in a familiar environment. This is a current trend in the field of laboratory animal science, as evidenced by the COST Action TEATIME (see section 2.1.1) – the outcomes of which will also impact WG4. Recommendations may be made about changing the nature of the housing environments, if this in itself influences the animals' affective states (*e.g.*, if the small cages housing mice induce frustration about the inability to carry out natural behaviours; Cait *et al.*, 2022).

1.2.2. OBJECTIVES

1.2.2.1. Research Coordination Objectives

1. Agree on a common conceptualisation and associated vocabulary for investigating affective states across species.
2. Create a framework to identify affective state characters which can be mapped onto a phylogeny of the animal kingdom.
3. Identify crucial gaps in the current knowledge of affective states in well-studied species.
4. Develop a strategy for the ethical investigation of affective states in species that have yet to be studied.

5. Summarize and identify gaps in the current knowledge about how humans engage with the concept of affective states in animals, individually, societally, and culturally.
6. Identify best practices in assessing affective states as part of welfare assessment in different taxa.
7. Develop a strategy to better translate treatment of affective disorders across species.

1.2.2.2. Capacity-building Objectives

1. Bring together researchers and scholars from the humanities, technology, social and natural sciences into a novel, interdisciplinary network to study affective states.
2. Engage with relevant stakeholders in the co-creation of relevant recommendations to maximize the socio-economic impact of the Action.
3. Promote Young Researchers and Innovators (YRIs) of varied backgrounds to take leadership roles in the Action.
4. Actively involve researchers based in COST Inclusiveness Target Countries (ITCs) to lead on Working Groups, Workshops, and Training Schools, and host Network Activities.
5. Encourage YRIs, especially those from ITCs, to attend and participate in the workshops and conference meetings, and to co-author the strategic documents resulting from them.
6. Train YRIs in the state-of-the-art of comparative affective science and in dissemination of science to the wider public.
7. Build a future workforce which is comfortable in interdisciplinary collaborations across natural sciences, social sciences, and the humanities.

2. NETWORKING EXCELLENCE

2.1. ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

2.1.1. ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

Although affective states have been of interest for a long time (Darwin, 1872), their study has intensified in recent years (Dukes *et al.*, 2021). The study of affective states in animals has moved from "something that cannot be studied with scientific methods" to something of central interest in several fields, including Philosophy, Animal Welfare Science, Behavioural Ecology, Comparative Cognition, and Affective Neuroscience. The problems associated with an anthropocentric approach, as well as the need for a genuinely comparative approach to the study of affective states, are evidenced by the recent special issue on "Building a Truly Comparative Affective Science" in Neuroscience and Biobehavioral Reviews (2019-2021). The **time is therefore ripe for a more coordinated international effort** that goes beyond article collections; an initiative that brings together experts from relevant fields to debate the issues and develop a **multi-perspective approach to theory and practice** involving affective states. Small steps have been made in this direction (*e.g.*, the successful workshop on "Interspecies Comparisons of Welfare" organised by Rethink Priorities in London, April 2022; the symposium on "Animal Emotion Research across Phylogeny" at Behaviour 2023 in Bielefeld), but clearly, a larger, more coordinated effort is required. This Action would provide such coordination on a level not seen before either within Europe or beyond its borders.

International efforts at coordinating animal welfare improvements for specific species are well established. They include the EU Reference Centres for Animal Welfare, EFSA's efforts to harmonize animal welfare data (EFSA *et al.*, 2022), the Open Philanthropy-funded CareFish/Catch network, and COST Actions on group housing of pigs and poultry (GroupHouseNet; CA15134) and on preventing keel bone damage in laying hens (KeelBoneDamage; CA15224). These organisations and Actions are focused on practical issues of improving welfare, such as avoiding particular physical health problems by investigating housing systems and animal behaviour. Although animal affective states are certainly relevant within these initiatives, they are not their main focus. A relatively new area of interest in Animal Welfare Science is the welfare of invertebrate animals like insects, decapod crustaceans, and cephalopods. This is evidenced by recognition of the sentience of the latter two in UK law, as well as recent scientific meetings (Insect Welfare and Ethics Inaugural meeting at the Royal Society of London, 2023; Animal Welfare Research Network workshop on Insects as Mini-Livestock, 2023), reviews on sentience and consciousness (Ponte *et al.*, 2022), and COST Action CephsInAction (COST FA1301). It has also led to the recent foundation of the Insect Welfare Research Society (www.insectwelfare.com).

The most recent COST Action that has been approved in this area (LIFT – Lifting Farm Animals' Lives; CA21124) focuses on promoting positive welfare in farm animals, and therefore includes goals of both measuring positive affect and finding ways to promote it. However, what distinguishes our approach from theirs is our focus on the phylogenetic history and relationships, and socio-ecological context of different species. AFFECT-EVO's scope will expand well beyond LIFT's focus on farm animals and will employ a **deeper theoretical approach**, so as to enable **translation of impacts throughout the animal kingdom**. Importantly, we will also cover both positive and negative affective states. Whenever possible, **AFFECT-EVO will coordinate with these other organisations and COST Actions** to increase our impact, including for the organization of workshops and/or training opportunities.

WG4 partially overlaps with COST Action TEATIME (CA20135, started in 2021), which focuses on the measurement of mouse behaviour in the home cage, in order to apply spontaneous behaviours as outcome variables in preclinical studies. While TEATIME is not focused solely on affective states, the techniques developed as part of that Action are very relevant for WG4's focus on monitoring changes in affective state due to treatments. The **approaches are therefore complementary**, and AFFECT-EVO will coordinate with TEATIME when appropriate in terms of organizing workshops in the area of overlap, and in the training schools offered. There are already some projects in which the translation of affective states between species is being discussed, but such discussions are typically local, rather than pan-European, and involve two rodent species only: rats and mice. These discussions take place under the auspices of such organisations as FELASA, the European Animal Research Association (EARA), the Istituto Superiore di Sanità, or non-profit organisations. Technology companies that develop novel ways to assess behaviour and affective states (*e.g.*, Noldus, TSE, UGO BASILE), animal breeding companies, and companies building animal housing equipment (*e.g.*, Allentown, Tecniplast) all play an important role. AFFECT-EVO will **invite these Stakeholders** to participate in relevant Activities.

2.2. ADDED VALUE OF NETWORKING IN IMPACT

2.2.1. SECURING THE CRITICAL MASS, EXPERTISE AND GEOGRAPHICAL BALANCE WITHIN THE COST MEMBERS AND BEYOND

The comparative approach to understanding affective states we will adopt requires input from different disciplines which have been working on this topic from their own perspectives, often for many years. We have brought together evolutionary biologists with in-depth understanding of how to analyse evolutionary patterns in different characters; psychologists and anthropologists who study human and animal affective states; neuroscientists and physiologists interested in the mechanistic levels on which affective states are regulated and expressed; animal behaviour experts interested in how animals express affective states in social and non-social contexts; and technologists interested in automated monitoring of animals. In order to thoroughly analyse definitions of concepts and turn concepts into characters that can be mapped onto phylogenies, it is crucial to have the input of philosophers and social scientists, who are trained in these endeavours. For WG2 in particular, but also for the analysis of affective states more generally, the Action includes a number of social scientists interested in how people engage with the concept of affective states in animals. In addition, we have brought together people interested in the application of these principles, such as animal welfare scientists, animal behaviour therapists, preclinical psychiatry researchers, and legal scholars who study the application of these concepts and principles within different legal systems. Alongside the **interdisciplinary nature** of the problem, it is also important to have an **inter-cultural perspective**. People from different cultures may have very different attitudes towards the concept of affective states in animals. The Action currently involves people from across Europe (30 COST member countries and one Cooperating Member; 55% ITC), the USA and Hong Kong. We will also invite scholars and stakeholders from a wider group of countries to attend our meetings and workshops. Relevant world experts will also be invited as speakers or teachers at WG Meetings, Workshops and/or Training Schools. Several have already expressed an interest. The gender composition is currently 52% female and 47% male, and the Action includes 29% Young Researchers and Innovators (YRIs). More YRIs will be recruited during the Action.

2.2.2. INVOLVEMENT OF STAKEHOLDERS

The Action already includes representatives from stakeholder organisations, including zoos, animal research organisations, animal welfare organisations, companies involved in animal behaviour assessment, and organisations that specialize in communicating scientific findings to a more general audience. We **will invite other relevant stakeholders** to workshops and meetings, so they may contribute to the building of a knowledge base, and ensure our recommendations are relevant to the interests of the various stakeholders (Fig. 4). WG2 focuses on understanding how public engagement with the concept of animal affective states interacts with the interests of various stakeholders and on determining which stakeholders should be consulted regarding different aspects of the Action. Relevant stakeholders to WG3 include animal advocacy organisations, animal welfare organisations, zoos, animal research organisations, veterinarians, farming and fishery organisations, and animal welfare policy makers (at both national and international levels). In the case of WG4, stakeholders include animal behaviour therapists, animal research organisations, veterinarians, pharmaceutical companies, hardware and software research tool companies, and relevant patient organisations.

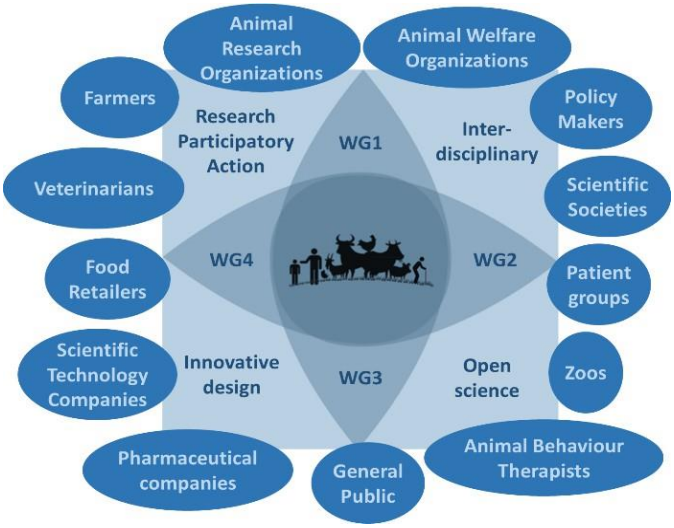


Fig. 4 AFFECT-EVO and its Stakeholders.

3. IMPACT

3.1. IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAKTHROUGHS

3.1.1. SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

Scientific impact: The field of comparative affective science is heterogeneous. Fields as diverse as Philosophy, Behavioural Ecology, Animal Welfare Science, Neuroscience, Anthropology, and Psychology have contributed, albeit with their own specific biases and concepts. Because AFFECT-EVO will bring together all those fields and encourage interdisciplinary dialogue on an unprecedented scale, it promises to be **ground-breaking** in how it combines affective science with evolutionary biology to provide a framework within which to study and assess affective states across species. In WG1, we aim to **build this new framework** for how to study affective states across species. This approach will expose major gaps in our knowledge, including the identification of key species whose detailed and systematic study would help build a clearer picture of the evolution of affective states. This will **generate novel research programmes** and will lead to **collaborative grant applications** in the future. Finally, the Action will **train YRIs**, including PhD students, in the emerging interdisciplinary field of Comparative Affective Science through Training Schools, Short-Term Scientific Missions, and, for ITC participants, through grants to attend international meetings.

Technological impact: Through the contributions of computational scientists and technology companies specializing in automated monitoring of animals, WG3 and WG4 will culminate in published strategies for developing better assessment methods for animal affect, including ideas for new technologies and tools. These will be used in the assessment of animal welfare (WG3) and of changes in affective state due to (pre)clinical treatment of affective disorders (or their models) in animals (WG4). Such future **technological improvements will have a strong impact** on the assessment of interventions designed to improve animal welfare and to treat affective disorders in animals, whether they are patients in their own right, or are being used as models for human disorders.

Socio-economic impact: **(1)** There is abundant evidence that the general public exhibits high levels of **concern about the welfare of animals** under human control, be they farm animals, lab animals, zoo animals, or pets (*e.g.*,84% of Europeans believe welfare of farmed animals needs to be better protected;

Eurobarometer 2023). WG3 will provide more standardized, robust, and reliable methods to assess affective states in a wide range of animal species, and therefore contribute to a wider portfolio of welfare assessment tools. **(2)** This Action is expected to generate new insights into our understanding of the affective states and inner worlds of animals (WG1). As these insights will be developed in conjunction with sustained, participatory engagement with a wide range of stakeholders (WG2), this has **the potential to shift people's awareness** about animals' affective potential - both amongst members of the general public and within various animal user, expert, and regulatory communities. Such shifts may in turn have downstream impacts on societal norms regarding the ethical use of animals in a range of contexts. **(3)** Shifts in societal norms may **result in revised or entirely new standards or laws** governing animal use. In addition, this Action may assist with the enforcement of existing laws prohibiting animal suffering, by providing new approaches to measure the affective impact on animal welfare. **(4)** Application of new technologies will allow farms to **produce higher-welfare animal products** (WG3). This will be reflected in labelling and standardisation schemes that give consumers more confidence that the animal products they consume have been produced under conditions which align with their animal welfare expectations. **(5)** Reliable welfare labelling also **increases the value of the products** for the farmers. **(6)** With the increased awareness of a variety of human mental health conditions in recent years, the public wants **new and improved treatments** for such conditions. Having better translational models (WG4) will benefit patients and their families by leading to more effective treatments. **(7)** A better translational strategy will also **reduce the numbers of animals** used in research, allowing increased adherence to the 3Rs principles of Replacement, Reduction, and Refinement, decreasing the number of animals potentially suffering. Using fewer animals also means a decrease in the cost of the research, which benefits research institutes and pharmaceutical companies. Additionally, the decrease in the number of animals used reduces the emotional burden/fatigue of research staff. **(8)** Finally, the Action will aim to hold most of our in-person activities in ITCs and will prioritize training opportunities for YRIs from ITCs. This will allow ITCs to **build a stronger research base** and to make a larger scientific and ethical contribution world-wide.

3.2. MEASURES TO MAXIMISE IMPACT

3.2.1. KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

Knowledge creation: New knowledge will be generated through this Action primarily by combining diverse viewpoints and datasets into a single phylogenetic framework. To facilitate the communication and dialogue between all experts - academic and non-academic alike - we will create a repository linked to the Action website that is freely accessible. In this repository, key open access papers and collated views will be stored and curated. We will also deposit agreed-upon methodologies for approaches to improve welfare assessments and (pre)clinical treatment assessments. Wherever possible, new datasets (*e.g.*, those generated by systematic literature review and phylogenetic character mapping) will be deposited in a public data repository linked to a published article with permanent DOIs.

Transfer of knowledge - Academia: The new knowledge, insights, and research strategies developed by the Action will be shared by all members of the Action, but also **disseminated widely across relevant fields**. Knowledge transfer to academic stakeholders will occur through open access publications (including guideline articles) in academic journals and presentations at relevant conferences. To foster accessibility of research findings to stakeholders from otherwise under-resourced countries or institutions, video, podcast, and other media will be produced for further dissemination. Wherever possible, the Action will organize symposia or satellite meetings at relevant meetings, or even propose topics for entire meetings. Examples of possible target meetings are those of the Society for Affective Science; the Association for the Study of Animal Behaviour; the International Society for Anthrozoology; the International Society for Applied Ethology (especially their pre-meeting aimed at Lower and Middle Income Countries); Measuring Behaviour (focused on novel methodologies); FELASA; the European Society for Philosophy and Psychology; the European Society for Agricultural and Food Ethics (EurSafe); Animal Law (alaw.org.uk); and the global Zoos & Aquariums Association. Representing 33 countries with over 170 participants, the Action will be able to target many meetings through regular attendees. Whenever possible, the Action will encourage YRIs and representatives from ITCs to lead these initiatives.

Transfer of knowledge – Wider Stakeholders: A major goal of the Action is to engage with all relevant stakeholders, including those outside of Academia. Early on, the Science Communication Coordinator (SCC) will take the lead on the development of a **Dissemination and Engagement Strategy (DES)**, which will include the formal identification of the relevant stakeholders for the different WGs and formal

targets for the number and kinds of stakeholders to reach. These stakeholders will be an integral part of setting the agenda for WG2, WG3 and WG4. In addition to the general public, stakeholders are anticipated to include, but are not limited to: animal welfare organisations, zoos, animal breeders, animal shelters, jockey clubs, veterinarians, farmers, food retailers, lab animal organisations, and tech companies for WG3; and pharmaceutical companies, biomedical scientist organisations, patient organisations, veterinarians, animal trainers, and tech companies for WG4. To transfer knowledge to non-academic stakeholders, we will take a multi-pronged approach. Relevant stakeholders will be invited to workshops and meetings to co-develop the research agenda and eventually formulate recommendations that are relevant to them. For example, representatives from national Animal Research Ethics Committees will be invited to help phrase questions and give input on recommendations that impact the interpretation and implementation of the 3Rs. Members of WG3 and WG4 will attend relevant industry fairs and will present our recommendations. We will also develop brief, targeted leaflets for different stakeholder groups which will be distributed in hard copy and electronically, including through the Action website and social media accounts. Whenever possible, these leaflets will be translated into the relevant local language.

Career development: A special and particularly important form of knowledge transfer is the training and career development of YRIs. The Action will contribute to this through:

Training Schools: Each WG will organize one or more Training Schools (TS) around its main topic. **TS1** will train YRIs about the phylogenetic approach to studying affective states. **TS2** will train YRIs in engagement with different groups of stakeholders about animal affective states. Communication about animal affective states is relevant to any YRI working with animals in any capacity, so this School will be run annually (**TS2.1**, **TS2.2**, **TS2.3** and **TS2.4**), to have the broadest impact possible. The Action will engage with Understanding Animal Research and other similar organisations that specialize in training for public engagement to optimize these WG2 training schools. **TS3** will train participants in the latest techniques and principles relating to assessing affective states for Animal Welfare, and **TS4** will train them in methods for diagnosing and treating (models of) affective disorders in animals, with reference to human affective disorders. **Diversity of the participants** in terms of ITC status, gender, and field of study will be an important criterion in admitting YRIs to these TSs.

Conference grants: The Action will sponsor YRIs from ITCs to attend conferences relevant to, but not organised by the Action. The Action will advertise these Conference Grants widely through our ITC members and will aim to maintain a **balance across gender and field of study in the grant recipients**. The conferences can be in disciplines ranging from Philosophy to Lab Animal Science, and from Public Communication of Science to Affective Science. Successful grant recipients will present their work at these meetings to further disseminate the goals of the Action.

Short-Term Scientific Missions and Virtual Mobility Grants: The Action will advertise grants for Short-Term Scientific Missions and Virtual Mobility secondments to PhD students and other YRIs. The wide range of disciplines represented in this Action guarantees that there will be substantial opportunities for exchanges between research groups to work on collaborative research in this field, or to further develop intellectual integration of different disciplines. Some of these will be done virtually, and some will be done in person, so the Action will be flexible about the types of secondments it funds. As before, the Action will maintain balance across genders, fields of study, and nationalities, with priorities for YRIs from ITCs. The Action will also actively make contacts with relevant research groups outside of the COST member states to help YRIs find relevant placements.

3.2.2. PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

The DES will also identify relevant public engagement events to **target the general public and policy makers** in different countries across Europe. All DES activities will be catalogued, and engagement impact will be quantified and used to optimize impact of further engagement activities. For dissemination, the **Action website** will have public summaries of the most up-to-date developments in a range of different languages. For engagement with a wider audience, we will set up **social media accounts** on relevant platforms, to solicit responses and collect a wider range of opinions. This will help WG2 with its aim to understand how people engage with the concept of animal affective states. Policy makers and organisations specializing in communicating with the public (*e.g.*, European Animal Research Association, Eurogroup for Animals, Animal Research Tomorrow, FENS Committee on Animal Research) will be invited to the relevant workshop (WS2.1) to **co-develop relevant questions and associated engagement strategies**, based on WG2's understanding of the social science literature on the topic. To further advance this understanding, we will **directly engage with local**

stakeholders (including primary and secondary schools) through an engagement activity that can be run in different languages. This will be organised as a satellite to many of the Action's meetings, and bring direct input about people's thoughts and attitudes about animal affective states into WG2 and thus allow them to **co-create knowledge**. Wherever possible, these workshops will also be run as part of European Researcher Nights, Pint of Science, and other existing science engagement events. Further engagement activities may include promotional videos, press releases, fact sheets, and promotion articles (*e.g.*, in the Conversation and equivalent sites) to make people aware of what we know about animal affective states. Through the legal scholars in the network, we will also engage with the legal profession in different countries so that the findings of the network (especially WG2 and WG3) have as strong an impact as possible on future legislation and interpretation of existing legislation.

4. IMPLEMENTATION

4.1. COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

4.1.1. DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

The **Management Committee** (MC) will meet once per year in an ITC to set out the agenda for the coming year. Working Group (WG) leaders will be appointed at these MC meetings. In all our appointments (including organizing committees for workshops), the Action will aim for **maximum diversity with regard to gender, nationality, field of study, and career stage**. In practice this means each committee will be made up of at least 30% people from an ITC and at most 60% participants of the same gender. We will also aim to have at least one YRI on each committee. The same criteria will also be used to ensure the greatest possible diversity in meetings and workshops. The Action has 4 major WGs, with results from WG1 and WG2 feeding into WG3 and WG4 (Fig. 5). **Each member ITC will host at least one Workshop, Training School, or Meeting**.

WG Meetings

WG1 aims to apply a novel evolutionary approach in the study of affective states across species, by mapping characters relating to affective states onto a phylogeny, and investigating which characters are similar due to homology and which to homoplasy. To pursue this approach, the inaugural meeting of the Action (**WGM1.1**) will be an interdisciplinary, in-person conference, bringing together philosophers, social scientists, anthropologists, psychologists, and biologists to (1) debate the merit of different approaches to the classification of affective states; (2) agree on a framework for the identification of affective state characters; and (3) agree on a common terminology to take forward into the rest of the Action. In the second year, after the WG1 workshops have been run (see below), another WG1 Meeting (**WGM1.2**) will be organised, at which the WG1 workshops report back to the Action as a whole and strategies will be discussed for how to use the newly developed framework to make recommendations to WG3 and WG4.

WG2 aims to understand how people engage with the concept of animal affective states. In the first meeting of WG2 (**WGM2.1**), social science and humanities expertise will be brought together about which factors are known to influence individuals' understanding, attitudes and behaviours related to affective states in animals. Gaps in knowledge will be identified and a strategy will be designed to fill these gaps. The WG2 workshops will be organised to implement the insights from WGM2.1 into concrete engagement plans.

WG3 aims to take the strategies developed in WG1 and apply them to identifying reliable and comparable animal welfare indicators based on affective states of the animals, including the tools to detect them. The main Meeting of WG3 (**WGM3.1**) will bring together animal welfare scientists, social scientists, computational scientists, and relevant stakeholders to discuss the recommendations from WG1. They will also discuss the concept of *Affective Balance*. At WGM3.1, the work will be subdivided into focused subgroups which will use workshops to explore the application of the recommendations to specific taxa and to disseminate these applications to relevant wider stakeholder groups.

WG4 focuses on the treatments of (models of) affective disorders in animals to develop better preclinical models for human affective disorders and better clinical approaches to animal behaviour disorders. The main Meeting (**WGM4.1**) will bring together preclinical scientists, animal behaviour therapists, and clinicians with other relevant stakeholders to discuss how to apply the principles and strategies developed in WGM1.2 in a (pre)clinical context. The meeting will also decide on the best structure for the workshops.

The **final meeting of the Action** (**FAM**), at which all the findings from the Action will be discussed, will be open to people from both within and outside the Action, both academics and wider stakeholders.

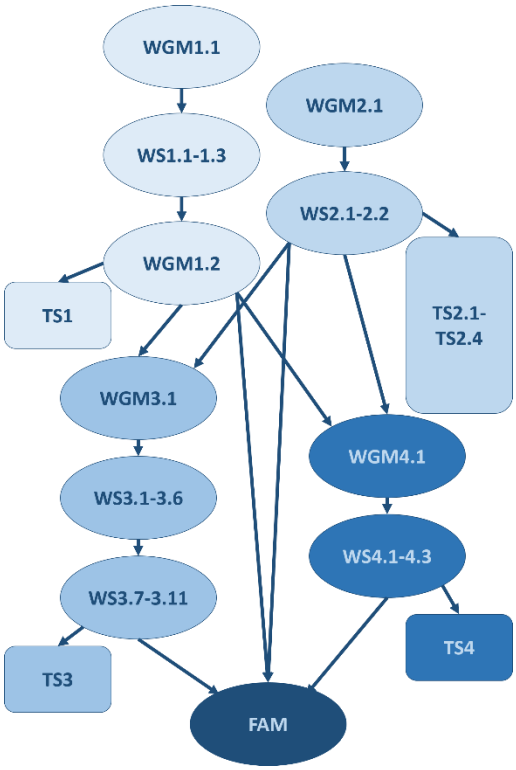


Fig. 5 The dependence of Meetings, Workshops and Training Schools.

Workshops

Workshops (WSs) are smaller, more focused meetings with a specific deliverable (see section 4.1.2). The WSs will follow from the WGMs to dive more deeply into a particular area and report back to the Action. WSs will be organised as in-person meetings preceded by significant preparatory work, including application of **a modified Delphi Panel Method** to combine expert opinions systematically and quantitatively. Preparatory and follow-up work will make use of both off-line discussions and virtual networking, possibly supported by Virtual Networking Support grants. This will make the in-person discussions as productive as possible. WSs could be organised as stand-alone events, or as satellites of other relevant meetings.

WG1 will organize three WSs during which specific characters of affective states will be discussed and mapped onto an animal phylogeny. Participants will prepare for the workshops by collating information from the literature in one virtual location, ready for discussion

at the workshops. The three workshops will be: **WS1.1** Neural and physiological aspects of affective states, **WS1.2** Behavioural, cognitive, and social aspects of affective states, and **WS1.3** Development of affective states and their characters. Evidence will be collected from across the entire animal kingdom where evidence exists. This will also make clear where connections can be made and where the gaps are in the current knowledge.

WG2 will organize two WSs aimed at **engaging with two different sets of stakeholder groups**. **WS2.1** will focus on engagement with policy makers, lobbying organisations, and law makers, while **WS2.2** will focus on engagement with various industry and charitable sector stakeholder organisations with direct interest in affective states in animals. Representatives of the general public will be invited to both WSs.

WG3's workshops will each discuss how to apply the principles and strategies developed by WG1 into practical evaluations of animal affective states for the purpose of assessing animal welfare. Some indicators and strategies may be similar across closely-related animals, while others should be discussed based on the practicalities of the settings in which the animals are used. The Action will therefore organize both types of WSs. The exact breakdown of the WSs will be decided in WGM3.1, based on where the available evidence is strongest. The breakdown of workshops could look like this for Phylogenetic groupings: **WS3.1** Mammals, **WS3.2** Sauropsids (birds and reptiles), **WS3.3** Teleosts, **WS3.4** Cartilaginous Fishes, **WS3.5** Cephalopods, and **WS3.6** Arthropods; and like this for implementation in different settings: **WS3.7** Farm Animals, **WS3.8** Lab Animals, **WS3.9** Companion Animals, **WS3.10** Zoo Animals, and **WS3.11** Wild Animals.

WG4 will organize three WSs on translation of diagnosis and treatment of affective states across species. The WSs will focus on the direct application of such translation, so that the impact can be as focused and concrete as possible. The exact topics of the WSs will be decided at WGM4.1, but one example set could be: **WS4.1** Symptoms and treatments of depression; **WS4.2** Symptoms and treatments of anxiety; **WS4.3** Symptoms and treatments of the affective component of pain.

4.1.2. DESCRIPTION OF DELIVERABLES AND TIMEFRAME

Activity	Deliverable	Time frame
WGM1.1	Working document summarizing the strategy and terminology agreed upon for use during the subsequent WSs	Shortly after WGM1.1
WGM1.1	Manuscript outlining areas of agreement, areas of dissent and knowledge gaps in comparative affective science	Within 1 year of WGM1.1
WS1.1	Publicly available database of neural and physiological affective characters mapped onto a phylogeny	Within 6 months of WS1.1
WS1.2	Publicly available database of behavioural, cognitive and social affective characters mapped onto a phylogeny	Within 6 months of WS1.2
WS1.3	Publicly available database of development of affective characters mapped onto a phylogeny	Within 6 months of WS1.3
WGM1.2	Manuscript summarizing the main findings of the character mapping exercise	Within 1 year of WGM1.2
WGM1.2	Working document with recommendations about how to go about translating different types of affective characters across species	Shortly after WGM1.2
WGM2.1	Working document summarizing knowledge (and gaps) about factors that affect how people engage with the concept of animal affective states	Shortly after WGM2.1
WGM2.1	Action Website and Social Media Accounts set up	Shortly after WGM2.1
WS2.1	White paper outlining the main questions raised by and recommendations for optimal dissemination to lobby groups, policy and law makers regarding information about animal affective states	Within 6 months of WS2.1
WS2.2	White paper outlining the main questions raised by and recommendations for optimal dissemination to industry and charity stakeholders regarding information about animal affective states	Within 6 months of WS2.2
WGM3.1	Working document with strategy for using a comparative approach to develop reliable affective-state-based animal welfare indicators	Shortly after WGM3.1
WS3.1-WS3.6	Working document about affective-state-based animal welfare indicators for each group of animals, to inform the subsequent WSs	Shortly after each workshop

WS3.7-WS3.11	Concrete recommendations for practical affective-state-based animal welfare indicators for each stakeholder group	Within 1 year of each workshop
WGM4.1	Working document with strategy for assessing treatment of (models of) affective disorders in animals	Shortly after WGM4.1
WS4.1-WS4.3	Concrete recommendations for better assessments of treatments for depression/anxiety/affective aspects of pain	Within 1 year of each workshop
FAM	Special Issue of a journal on a Novel Approach to Comparative Affective Science	Within 2 years of the FAM

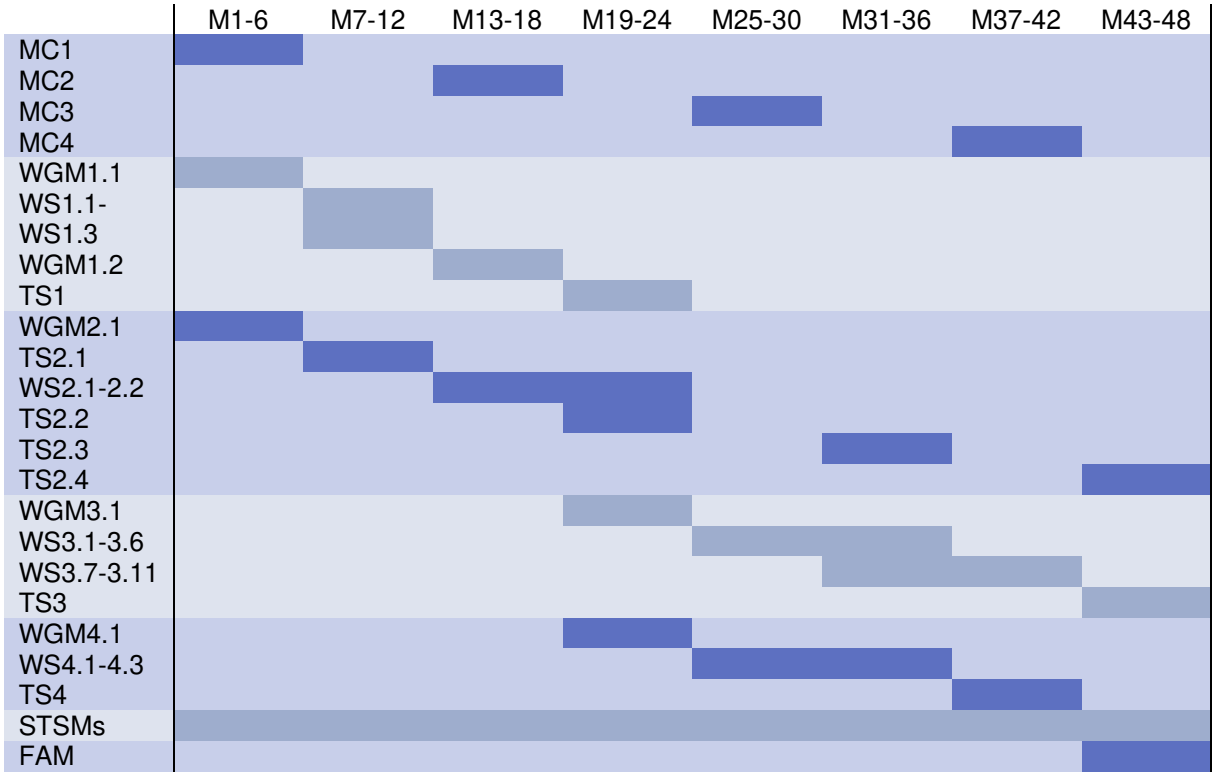
4.1.3. RISK ANALYSIS AND CONTINGENCY PLANS

RISK 1: The purpose of the Action is to bring together people from different perspectives to establish common ground on the question of affective states across species. Not every participant will agree on every point with the final conclusions of any given meeting or workshop. This risk is high. However, **revealing the diversity of points of view and honestly debating where perspectives differ from each other, and how these differences can be worked out or tested against each other is how this field will progress**. There is therefore no risk that disagreement would stop the rest of the Action going ahead, as some levels of disagreement are anticipated. Workshop activities will be structured and facilitators trained to allow for dissent while still moving forward on outcomes.

RISK 2: For certain characters or aspects of affective states, insufficient literature exists to allow us to take a phylogenetic approach and thus differentiate sources of similarity and difference from one other. For those characters or aspects of affect with sufficient literature available, the knowledge base will likely be limited to certain phylogenetic groups. In that case, we will **draw conclusions within groups where data exist** and make recommendations for testing those conclusions in a wider range of species. The risk is very low that NO characters will exist for which there is sufficient literature. Since one of the goals of the Action is to identify knowledge gaps in the literature for developing a future research strategy, the presence of many characters with sparse literature coverage is not a major concern. Workshops will be planned and organized **based on those aspects of affective states in animals where enough literature does exist** (*e.g.*, fear responses), to make novel recommendations.

RISK 3: There may be circumstances that prevent (some) people from travelling to Meetings to participate in person. This represents a medium-level risk. However, during the last period of pandemic-related lockdown and associated travel restrictions, we all became accustomed to remote meetings. Necessary activities can either be organized as **hybrid events**, which would allow a subset of participants to participate remotely, or as entirely **online events,** if absolutely necessary.

4.1.4. GANTT DIAGRAM



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