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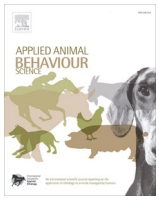

Providing a good life to managed animals: The importance of recognising, understanding and managing individual differences

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ABSTRACT

Inter-individual differences (personalities) influence how individuals perceive, react to, and interact with their environment, conspecifics, and threats. Understanding animal personality makes it possible to predict individual responses to particular situations or stimuli; creating opportunities to provide optimal environments for individual animals. If animal behaviour and welfare scientists are to ensure all animals live 'a good life' then attention must be paid to every individual within a group, something which has been historically lacking. There is an urgent need to recognise the role of individuality in positive animal welfare and to incorporate individual behavioural profiles into evidence-based management, which currently varies across animal disciplines. Personality influences the success of housing and management, the nature of human-animal interactions and animals' affective states, and therefore should be more broadly considered and applied in animal management. Whilst in some species personality is widely assessed and incorporated into management, there is significant disparity across species, alongside practical challenges in implementation across sectors. This paper provides a narrative synthesis of literature on animal personality across the farm and zoo sectors, presenting selected examples to highlight key themes and developments. Across sectors, clear differences are identified in how personality is recognised and applied, with practical constraints limiting implementation at scale. The review outlines opportunities to integrate personality-informed approaches into management to improve welfare outcomes and culminates in recommendations to support the incorporation of animal individuality into management practices, taking into account industry-specific constraints. Finally, this review highlights the need for the development of practical tools to assess and apply personality in managed settings.

1. Introduction

Many terms are used to describe inter-individual differences between animals, and within the field of ethology terms such as 'personality', 'temperament' and 'behavioural syndromes' are often used interchangeably (MacKay and Haskell, 2015), alongside coping style, behavioural profile/profiling, behavioural types, character, and individual distinctiveness (Rutherford et al., 2025). Even within personality, there are many definitions, with some being impacted by the relationship between the observer and the animal (Rutherford et al., 2025). For the purposes of this review, we adopt the definition of Powell and Gartner (2011), that personality is 'individual differences in behaviour that are thought to be stable across time and situations' (Powell and Gartner, 2011). Understanding how personality varies within species, populations and individuals has implications for husbandry in domestic animal species (Réale et al., 2007), yet there is a disparity in how it is recognised and to what degree it is applied in animal management.

The recognition of animal personality has reshaped behavioural and evolutionary ecology by shifting focus from population-level averages to individual-level variation (Weiss, 2018). Despite a growing evidence base, incorporation of individual differences into animal management remains uneven across sectors. In farm systems, personality research has often focused on associations with productivity, robustness, and stress resilience, and the literature highlights both conceptual diversity and practical challenges in measurement (Woodrum Setser et al., 2023). In contrast, zoological institutions have increasingly embraced individual-based management frameworks, driven by goals related to conservation breeding, behavioural diversity, and positive welfare states

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(Whitham and Wielebnowski, 2013; Sherwen et al., 2018; Cole and Fraser, 2018). These differing historical motivations have resulted in distinct research trajectories, methodologies, and applications of personality across sectors.

Across sectors, animals have unique personalities that affect how they perceive, cope and respond to their physical and social environments (Watters et al., 2017). Personality can affect reproductive and production success (Wolfensohn et al., 2018) and can impact on animal welfare (Watters and Powell, 2012), including the likelihood of developing a welfare problem, and in the type of problems they suffer from (Koolhaas et al., 2010).

Ensuring that all animals experience "a good life" is a central goal of contemporary animal welfare science and applied ethology (Farm Animal Welfare Council, 2009; Mellor, 2016). Reaching this goal requires recognising the relationship between personality and wellbeing, and providing targeted, individualised care (Gartner et al., 2016). The extent to which this is reflected in policy and practice varies. Standards of Modern Zoo Practice for Great Britain include reference to the need to create enclosures and have husbandry routines which are suitable for both the behavioural needs of species and individual animals (DEFRA, 2025) with some species-specific recommendations for charismatic megafauna (Bolechova et al., 2023). On farm, EU law recognises that animals must be housed in an 'appropriate way', but whether this involves consideration at an individual level is open to interpretation (Council Directive 98/58/EC, Council, 1998). Industry guidelines (e.g. UK Defra Code of Recommendations for the Welfare of Catttle, (DEFRA, 2021)) emphasise minimising competition and ensuring adequate feeding space, but do not address individual behavioural needs. This review focuses on farm and zoological animals and intentionally excludes companion animals, where individual differences are already widely recognised, expected, and actively managed (e.g. Udvarhelyi-Toth et al., 2024). By concentrating on these sectors, we address contexts where the integration of personality into welfare-oriented management has substantial scope for further development. The aim of this review is to provide a narrative synthesis of current understanding of animal personality within the farm and zoological fields, and how it is applied in animal management. Drawing on selected examples from the published literature, this review highlights key themes and developments and considers how personality-informed management can be more effectively applied to improve welfare within practical and sector-specific constraints.

2. Applying animal personality in farmed contexts

Farm animal management is characterised by herd- or group-level decision-making (Medeiros et al., 2022; Johansen et al., 2025), where animals are typically fed, moved, and handled in groups (e.g. Manteca et al., 2008). This is in direct conflict with our understanding of personality, which is operationalised as a set of traits which characterise an individual (Kaiser and Müller, 2021). Furthermore, current best practice in farm animal welfare assessment is the use of 'animal-based measures' (EFSA, 2012), where measures are collected directly from animals at an individual level (e.g. abnormal behaviours displayed, lameness score) and subsequently interpreted to understand the animals current welfare state (van der Staay et al., 2025). Thus, in a farming context, typical management strategies are at odds with the individualised management strategies discussed in this review and with the advised welfare monitoring protocols.

Given the importance of animal productivity from both local (e.g. farmer: Makapela et al., 2025) and global (e.g. food security: Reynolds et al., 2015) perspectives, it is unsurprising that the earliest research within the field of farm animal personality largely focused on how inter-individual differences affect productivity (e.g. Hemsworth et al., 1981; Grandin, 1984). However, as research increased, it has become increasingly apparent that personality also has strong links to animal welfare (Finkemeier et al., 2018), with certain personality types potentially being more suited to human management compared to others (Richter and Hintze, 2019). There is also evidence of all three elements (welfare, personality, productivity) intersecting, for example, dairy cows with nervous personality profiles may produce less milk (Hedlund and Lovlie, 2015).

Within farmed animals, individual traits are often referred to as 'temperament' rather than personality, with some authors suggesting this is due to moral biases in how farm animals are viewed by the public compared to wild or companion animals (Travnik et al., 2026). In this section, we use the word personality unless otherwise stated by the literature being discussed. A further complication in the farmed animal sector is the relative scarcity of studies which meet the criteria of personality as defined by Powell and Gartner (2011), specifically that the tests are rarely repeated over time and across contexts. Due to this limitation, much of the discussion in the remainder of this section relates to inter-individual variability suggestive of personality traits.

2.1. Personality and productivity

Within the farmed animal sector, there is ample evidence of links between personality and productivity (Neave et al., 2022). Given that personality can influence how an animal reacts to its environment, it follows that personality types that are particularly well-adapted to a given production system may have superior performance (Woodrum Setser et al., 2023). While productivity is often simplistically linked to welfare in the sense that good health is considered necessary to maintain productivity, several indicators show a curvilinear relationship where higher productivity is negatively associated with higher indicator values (e.g. claw and udder health in dairy cows; Hansen, 2023). Therefore, it is not a given that knowledge of links between production and personality will facilitate benefits to animal welfare. The lives of farmed animals are typically split into different production stages, with distinct differences between each stage. Below we outline key aspects of personality relevant to the productivity of animals at each stage of production.

2.2. Early life and weaning

During the early life of farmed mammals management goals typically relate to rapid weight gain, maintaining health and making a smooth transition to solid feed. Weaning is one of the first major management-imposed transitions in a farm animal's life and likely represents a point at which the management of interindividual differences becomes especially salient. Under natural conditions, the shift from milk to solid feed is gradual, socially mediated, and behaviourally flexible, with young animals adjusting their intake and independence in response to maternal cues and their own developmental readiness. Natural weaning progression varies across species (goats (*Capra hircus*): independence begins at 35 days; Bungo et al., 1998, cattle (*Bos taurus*): show interest in grass from six weeks old; Chambers, 1959, sheep (*Ovis aries*): nibble solid feed in first few weeks of life; Lynch et al., 1992), however variation in weaning age is ubiquitous (goats: 12–24 weeks; Collias, 1956, cattle: 26–61 weeks; Reinhardt and Reinhardt, 1981, sheep: 12–16 weeks; Lynch et al., 1992). These extended, flexible transitions contrast with the short time frames and standardised weaning schedules typical of commercial systems (e.g. calves are often weaned off milk or milk replacer at 28–63 days old; Welk et al., 2024, lambs from 30 days onwards; Freitas-de-Melo et al., 2022; and goats between 56 and 90 days; Vickery et al., 2022), which assume behavioural uniformity in readiness to wean and responses.

Calf weaning management has attracted the most research attention which has evidenced that individual differences in feeding behaviour emerge early in life (Provenza and Balph, 1987) and are influenced by rearing environment, feed exposure, and physiological variation (Miller-Cushon and DeVries, 2015). Large variability in solid feed intake is consistently reported even when calves are managed identically (Roth et al., 2009; Heinrichs and Heinrichs, 2011; Neave et al., 2018a), with

variability suggesting that individual behavioural traits, including neophobia, exploratory tendency, and social dependence, play a role in shaping readiness for weaning, although these traits are rarely measured explicitly in commercial settings. Similar differences have been seen in adult goats, Miranda-de la Lama et al. (2011) identified four 'identity profiles' (passive, avoider, aggressive, affiliative), each associated with distinct feeding patterns; passive goats spent the least time feeding, while avoiders spent the most. Neave and Zobel (2020) similarly found that bolder adult dairy goats showed higher aggression and longer feeding times, whereas more fearful individuals fed less.

Attempts to individualise calf weaning have largely focused on intake-based algorithms enabled by automated feeders. Data driven approaches allow calves to be weaned once they reach a target concentrate intake, resulting in wide variation in weaning age (45–98 days: Roth et al., 2009; 58–94 days: de Passille and Rushen, 2016). However, these systems rely on a single behavioural metric (intake) and do not incorporate consideration of personality or affective state. Notably, gradual weaning does not improve outcomes for calves with low preweaning intake (Bittar et al., 2020), indicating that factors beyond nutrition shape weaning success but have not yet been fully explored. Whilst current research to quantify individual differences in weaning does not exist, it is unlikely that on-farm management accounts for individual differences during this time.

2.3. Postweaning

The post weaning feeding behaviour, activity, and social interactions of calves remain highly variable between individuals (Neave et al., 2018a; 2018b). Calves that show lower preweaning concentrate intake or more fearful behavioural profiles exhibit reduced postweaning growth and greater susceptibility to disease (Sutherland et al., 2014). Social regrouping (a common postweaning management practice) is particularly stressful for reactive or subordinate calves, who show increased displacement at feeders and elevated cortisol (Boe and Faerevik, 2003). Despite this, grouping strategies rarely consider compatibility or personality, even though mixing unfamiliar calves is known to increase aggression and reduce feeding in vulnerable individuals (Nogues et al., 2020).

Similar trends are seen across species. In sheep, lamb temperament influences responses to separation, regrouping, and handling: more reactive lambs show stronger behavioural and physiological stress responses to social disruption (Herskin et al., 2004), which may exacerbate the welfare impacts of early or abrupt weaning. Individual differences in grazing behaviour and neophobia persist postweaning (Sibbald and Hooper, 2004), influencing adaptation to pasture based systems. Research investigating pigs' (*Sus scrofa domesticus*) postweaning period identifies it as one of the most challenging phases of production. Piglets differ markedly in coping style (proactive vs. reactive), which predicts aggression, exploration, feeding behaviour, and stress physiology (Ruis et al., 2000; Bolhuis et al., 2005). Proactive piglets engage more in aggression and exploration, while reactive individuals show withdrawal, reduced feeding, and heightened stress responses. These differences influence susceptibility to postweaning diarrhoea, growth checks, and chronic stress (Weary et al., 2008).

2.4. Productive life

Fearfulness is one of the most explored areas of personality in relation to animal production. In dairy cattle, temperament influences feeding motivation, competitive ability, and response to novelty: more fearful or reactive cows show reduced feeding time, lower milk yield, and higher somatic cell counts (Haskell et al., 2014). Aggressive or dominant cows may secure greater access to feed but contribute to social instability and displacement of subordinates (Kondo and Hurnik, 1990). Automated milking systems reveal consistent individual differences in milking order, feeder visits, and activity patterns (Jacobs and Siegford, 2012), yet these data are rarely interpreted through a personality lens. Similarly in beef cattle more excitable animals show higher cortisol, poorer meat quality, and increased risk of injury (Voisinet et al., 1997). Feedlot entry is particularly challenging for reactive animals, who show reduced feeding, greater morbidity, and poorer growth (Cafe et al., 2011). Farmers do often cull extremely aggressive or fearful individuals for the purposes of management (e.g. where a dairy cow that cannot adapt to being milked calmly is not a useful addition to the herd), but this reactive approach does not constitute a systematic integration of personality into management.

Fearfulness has been associated with body weight (chickens (*Gallus gallus domesticus*): de Haas et al., 2013, sheep: Pajor et al., 2008), mortality (chickens: de Haas et al., 2013, pigs (neonatal): Horback and Parsons, 2016), egg weight and egg production (chickens: de Haas et al., 2013; Uitdehaag et al., 2008), feed conversion ratio (chickens: Hemsworth et al., 1994), maternal ability (pigs: Janczak et al., 2003), meat quality (sheep (pH): Deiss et al., 2009), milk ejection (goats: Lyons et al., 1988), lying time (dairy cows: MacKay et al., 2014; Neave et al., 2022) milk yield (dairy cows: Hedlund and Lovlie, 2015) and feed consumption (Schwanke et al., 2022). However, several other production traits have also been associated with personality: aggressiveness in pigs has been linked to weight gain and skin lesions (Horback and Parsons, 2016; Verdon et al., 2016), and reactivity in beef cattle has been associated with pregnancy, calving rate, meat quality, and the weight of the cow's calf at weaning (Cooke et al., 2011; Hall et al., 2011; Cooke et al., 2012; Brandao and Cooke, 2021). Finally, personality traits identified in sheep, such as boldness, fearfulness, calmness, and sociability, are known to be repeatable and to influence feeding, social interactions, meat quality, and stress responsiveness (Murphy et al., 1994; Dodd et al., 2012; Zhang et al., 2021).

2.5. Personality and welfare

While personality considerations are typically not included in everyday management within the farming sector, there are some differences in the opportunities animals have to express personality traits at a system level (Dwyer and Lawrence, 2005; Leeb et al., 2019). Certain production systems facilitate higher levels of behavioural freedom compared to others, where more freedom may allow a greater range of personality expression (e.g. Grunst and Grunst, 2024). Opportunity to respond to the environment in line with their personality traits, rather than being limited by constraints such as housing or group size, may also benefit welfare (Sroka et al., 2024). For example, hill sheep farmers are not actively managing animals based on personality, but the large behavioural freedoms granted to the animals within this system type (Deag, 1996) give opportunities for individuals to interact with their environment in a variety of ways, modulated by personality type (Koolhaas and Van Reenen, 2016). Conversely, conventional indoor pig production offers limited behavioural freedom, with little opportunities to express personality differences such as sociality (fixed pen size with limited opportunity to withdraw from conspecifics), fearfulness (management procedures are carried out on all pigs regardless of fear levels), or exploration (pigs are restricted by the pen limits).

Possibilities for behavioural freedom are highly relevant to welfare (Littlewood et al., 2023) and effects may differ between individuals (Sroka et al., 2024). Other system types which are often developed with the express aim of catering to individuality are Precision Livestock Farming (PLF) systems (e.g. Neethirajan, 2025; Paudel and Brown-Brandl, 2025). These are technological applications which can replace or reduce farm labour, such as automatic milking systems or automatic feeders. However, consideration of individual differences is typically centred on production metrics (e.g. maximising milk yield by permitting individualised milking schedules, Aerts et al., 2022; or maximising growth by facilitating personalised feeding plans, (Hentzen and Holm, 2025). Recent research indicates that even within PLF settings, personality can be highly relevant to both productivity and

welfare (Johansen et al., 2025). For example, cows scoring highly on 'activeness' personality dimensions required fewer 'fetchings' to the automatic milking system, had more frequent milkings, and a higher number of voluntary visits to the automatic milking systems (Brasier et al., 2023). Similarly, cows scoring as more human-fearful were less likely to consume their maximum daily concentrate feed allocation from the automatic milking system feeder (Schwanke et al., 2022) and goat kids with a shorter latency to interact with a novel object were found to visit an automatic milk feeder more often after weaning (Vickery et al., 2024). While precision technologies are increasingly used in cattle management (Jacobs and Siegford, 2012; Rutten et al., 2013), their adoption in other systems (sheep and goats) remains limited due to economic constraints, despite clear evidence of substantial individual variation in feeding and social behaviour.

Farm animal research increasingly demonstrates that traits related to personality are measurable, and linked to both welfare and production. Traditionally coping-styles were discussed more frequently, however a personality-based perspective offers a more nuanced welfare lens than coping style alone. Coping style frameworks (e.g. proactive vs. reactive) highlight consistent behavioural and physiological differences (Koolhaas et al., 1999), but they can obscure the fact that both styles may experience poor welfare. Crucially, individuals who show fewer overt signs of distress are not necessarily faring better; some personality types express negative states through withdrawal or behavioural inhibition rather than through salient behaviours such as aggression or stereotypies (Forkman et al., 2007; Ijichi et al., 2013). This creates a risk that welfare assessments disproportionately detect problems in expressive individuals while overlooking quieter animals experiencing comparable deficits.

From a management perspective, one response may be to breed animals that are better able to cope with existing housing and husbandry conditions. Personality or temperament traits show heritability in several farm species (cattle: Haskell et al., 2014; sheep: Zambra et al., 2015; pigs: Ruis et al., 2000; poultry: Rodenburg et al., 2003), yet breeding indices (e.g. UK DairyCo, Holstein USA; Lohmann Breeders, Germany) typically do not include these traits beyond broad categories such as "ease of handling" or "reduced feather pecking". While breeding for management-friendly personality traits may reduce overt problems (e.g. aggression, handling difficulties), it raises important ethical questions. Selecting for animals that tolerate confinement, social restriction, or barren environments risks normalising suboptimal conditions and adapting the animal to the environment rather than improving the environment for the animal. Additionally, if selection is based solely on expressed personality traits, it would be impossible to distinguish between animals which are truly more capable of coping under suboptimal conditions, and personality types which respond to stress with withdrawal and passivity. This would then risk specifically selecting animals that would not be adapted to their environment but instead would be selecting for animals in negative welfare states. At its extreme, this logic underpins proposals for genetic modification or intensive selection for docility or low reactivity, which challenges notions of animal integrity and naturalness, particularly when extended to genetic modification or extreme selection for behavioural uniformity (Fraser, 2008). Furthermore, as different personality types are adaptively advantageous (Wolf and Weissing, 2010; Wolf and Weissing, 2012), selection of animals with only one type may reduce the adaptability of animals outside of the specific farming contexts they might then be bred for. This is of particular concern as maintaining food security in a world faced with issues such as climate change and biodiversity loss is likely to include systemic shifts in livestock farming systems (Bilotto et al., 2024).

Personality influences how farm animals respond to environmental challenges, how they benefit from welfare interventions, and how they fare in standardised systems. If the goal is to provide a "good life for all animals", welfare assessment and management in farms must move beyond group averages and explicitly accommodate individual behavioural variation. This requires shifting from adapting animals to fit existing systems toward designing systems that support diverse personalities and ensure that all individuals are able to thrive. For example, Moreno García et al. (2020) present a model which distances itself from designing an "optimal animal" but instead aims to create a behaviour-customised herd with an assortment of personalities which are suited to their habitat. They propose the presence of "grazing personalities" which can be included in herds to ensure appropriate grazing distributions and enhance ecosystem services (Moreno García et al., 2020).

3. Applying animal personality in zoos

The concept that animals are individuals and have distinct personalities that are likely to affect an animal's ability to cope, and therefore it's lived experiences and consequent welfare state within zoos, is now well established and accepted (Watters and Powell, 2012). Much research recognises that individual animals behave differently (Roche et al., 2016; Beekman and Jordan, 2017; Kaiser and Müller, 2021; Harrison et al., 2022), however there is a growing body of research which actually considers how specific personality profiles may impact animal experiences and how that relates to the goals of modern zoos (e.g. successful conservation programmes, public education and maintaining good animal welfare). Benefits of recognising and considering animal personality in animal management within zoos are multifaceted; there are clear benefits to the individual animals (e.g. improved welfare), to management of animals (e.g. being able to understand differences in resource use) and to missions of modern zoos (e.g. increased breeding success owing to increased mate compatibility). The inclusion of personality in zoo animal population management has been advocated (Tetley and O'Hara, 2012; Watters and Powell, 2012). Early work on zoo animal personality focused on non-human primates. Whilst personality is still predominantly a mammal centric concept, research is starting to be expanded into other taxa in a range of different contexts (e.g., amphibians (Ghosh and Aravind, 2025), invertebrates (Mather and Carere, 2019) and birds (Pastorino et al., 2019).

3.1. Personality in zoo animal management

3.1.1. Developing and maintaining appropriate social groups

Catering for social groups can be one of the most difficult tasks in zoos, particularly for cognitively advanced species or those with particularly complex social dynamics (e.g. animals that engage in fission-fusion dynamics, where the size and social structure of the group varies in different conditions) (Williams et al., 2018). Whilst individual personality is important in animal management, the impact of those inter-individual differences on group dynamics more broadly is also highly important. A closely bonded social group can have significant benefits for welfare, providing an opportunity to buffer stress, however, a poor social group can have serious negative consequences for individuals and lead to physiological stress and injury (Rose and Croft, 2015).

Personality can affect social cohesion and social interactions amongst individuals in the group. In chimpanzees (*Pan troglodytes*), friendships and choice of social partner is affected by personalities, with friendships being more likely where individuals have similar sociability and boldness scores, postulated by the authors to be as a result of more predictability in social interactions (Massen and Koski, 2014). In Caribbean (*Phoenicopterus ruber*) and Chilean (*Phoenicopterus chilensis*) flamingo personality is a predictor of network structure, with Caribbean flamingo in particular showing significant relationships between personality type and strength of connections in the social network, and willingness to provide social support to conspecifics when they were threatened (McCully and Rose, 2023). It can also affect the likelihood of injuries arising as a result of negative social interactions; in Japanese macaques (*Macaca fuscata*), those rated higher on Anxiety and Confidence received greater wounds, those rated higher on Friendliness

incurred fewer wounds during nonbreeding season (Doelling et al., 2021).

3.1.2. Human-animal interactions during animal training

Although there is limited explicit research, animal personality is an important aspect to consider during animal training. Training is now a routine part of everyday husbandry practices, intending to reduce stressors caused by more invasive husbandry procedures and supporting improvements in animal welfare through opportunities to stimulate animals and promoting mental and physical exercise (Ward and Melfi, 2013). Personality can influence interest and participation in training sessions; chimpanzees that scored higher on Openness were more enthusiastic to engage in training and to enter the specifically designed research pods at Edinburgh Zoo (Herrelko et al., 2012). Similar findings were found in zoo-housed capuchin monkeys (*Sapajus apella*), with an additional negative relationship between Assertiveness and task performance, suggesting not only a trade-off between speed and accuracy, but also that social interactions were prioritised over engagement with cognitive research tasks (Morton et al., 2013). Identifying an individual's personality, prior to commencing training, can assist in the setting of realistic goals, help when adapting training methods and ultimately contextualise expectations. Individual-level training programmes have been developed in sea lions based on personality profiles for example, Calm sea lions (*Zalophus californianus*) were slower to begin training, so require longer decision windows, more explicit initial reinforcement and consistent cue timing (Ramos and Winship, 2025). Furthermore, catering for animal personality is an integral aspect of the constructional approach, which has been advocated in developing zoo animal training programmes (Heidenreich and Pedersen, 2025), and it provides an opportunity to increase keeper safety (Chadwick, 2023).

3.2. Personality and animal conservation

Consideration of animal personality is integral to the success of social groups in zoos and ensuring good welfare, but it is also needed to support self-sustaining breeding programmes between compatible pairs and successful conservation of species within in-situ environments (Tetley and O'Hara, 2012; Watters and Powell, 2012).

3.2.1. Mate choice and reproductive success

Animals gain fitness benefits from choosing high quality or compatible mates (Rosenthal, 2017) with mate choice an output of the costs and benefits of being choosy (Dougherty, 2023). However, within zoological collections, animals are kept in managed environments, and breeding is controlled to ensure the retention of genetic diversity and to maintain pre-defined population sizes (Earnhardt et al., 2001). Personality traits can impact on pair compatibility, including development of successful mating partnerships and actual breeding success and researchers have advocated incorporating animal personality when making selections for breeding pairs (Fox and Millam, 2014).

Reproductive success can be impacted by personality type within individuals: zoo-housed cheetah (*Acinonyx jubatus*) who are considered more Tense/Fearful have lower reproductive success (Wielebnowski, 1999) as do black rhino (*Diceros bicornis*) with high Dominance scores (Carlstead et al., 1999). In captive marmosets (*Callithrix jacchus*), female personality traits are linked to inter-birth intervals and fecundity rates (Masilkova et al., 2022). In some species it is the combined personality types of both partners that contribute to successful breeding and mating. In zebra finches (*Taeniopygia guttata*), birds select males similar to them in Exploration (Faust and Goldstein, 2021), cockatiels (*Nymphicus hollandicus*) have greater success when pairs are dissimilar on Agreeableness scores (Fox and Millam, 2014) and female gray treefrogs (*Hyla versicolor*) who were Bolder were 'choosier' for mates (Feagles and Höbel, 2024). Giant panda (*Ailuropoda melanoleuca*) mating success is also based on Aggressive, Fearful and Stereotypical-Excitable personality traits (Martin-Wintle et al., 2017). It is clear that there are species-specific differences in terms of the effect of personality traits and personality types on interactions. It is thus recommended that researchers consider each species independently, as the importance of certain aspects of personality may differ across species.

3.2.2. Wildlife conservation

Animal personality has fitness consequences within in-situ environments. For example, the increased reproductive success in bolder animals is balanced out by a survival cost, leading to variation in boldness across groups of animals (Smith and Blumstein, 2008). Personality also has impacts on wildlife more broadly, affecting animal decision making, response to environmental conditions, disease transmission, distribution within habitats and survival (Wolf and Weissing, 2012; Aplin et al., 2014; Haage et al., 2017; Spiegel et al., 2017; Webber and Willis, 2020). The importance of animal personality in wildlife conservation has been reviewed by Merrick and Koprowski (2017) and Owens et al. (2024).

Whilst there are a number of areas where personality is relevant, perhaps the most important from an animal management perspective are reintroductions and human-wildlife conflict. It is important to consider personality to ensure more effective management and recovery of populations (Merrick and Koprowski, 2017; Wilson et al., 2022). Releasing genetically important animals into the wild as part of species reintroduction is inherently dangerous and management which increases the success of these introductions is crucial in saving species from extinction. Successful reintroductions rely on a range of personality types being included in the release group (Wu et al., 2024). Less bold or aggressive individuals will explore their environment with greater caution, and as such are more likely to survive after release. Research on swift foxes (*Vulpes velox*) found that survival rates were affected by boldness, with bolder individuals being more likely to survive (Bremner-Harrison et al., 2006). However, those who are bolder and more aggressive will reproduce more successfully which will lead to a rapid population of an area (de Azevedo and Young, 2021).

Animal personality also affects the likelihood of human-wildlife interaction and the response of animals to disturbance. For example, elk (*Cervus canadensis*) with bolder personalities are more likely to exploit human-dominated areas (Found and St. Clair, 2019) and in great tits (*Parus major*), bolder females and shyer males reduce nest visits more when there is noise disturbance (Naguib et al., 2013). Predictive models which embed behavioural principles are increasingly being used to reduce or mitigate human-wildlife conflict (Blackwell et al., 2016; Hahn et al., 2023). Research in elephants (*Elephas maximus*) has indicated that models based on decision-making by individual elephants are important in predicting conflict (Srinivasaiah et al., 2012), which has ramifications for both human and animal survival. It is thus of paramount importance to understand individual animal personalities in in-situ conservation and animal management.

3.3. Personality and zoo animal welfare

Personality affects all aspects of an animal's life within a zoo, thought to be linked to their ability to cope and adapt to environmental changes within their habitat (Vaz et al., 2022). Even when it is not formally discussed, personality often plays a key part in welfare practices within zoos. Comments such as, "the animal does not seem themselves" are often the catalyst for further exploration into an individual's current lived experience, used to highlight changes in behaviour, demeanour or welfare status. In humans, personality is related to subjective wellbeing (Lucas and Diener, 2009) and similar findings have been noted in non-human primates (Gartner and Weiss, 2018).

The link between personality traits and positive or negative welfare is well-established in non-human primate research. In macaques (*Macaca nigra*), high Sociability and Dominance were associated with better welfare (Parry-Howells et al., 2023), in chimpanzees, positive welfare was linked with higher Extraversion and lower Neuroticism (Robinson et al., 2017) and in brown capuchins, Sociability,

Assertiveness and Attentiveness were associated with better welfare, when other variables such as age and sex were controlled for (Robinson et al., 2016). In felids, Bold Asian lions (*Panthera leo*) used more of their habitat and displayed less abnormal repetitive behaviours, highlighting the link between behavioural measures of welfare and personality traits (Goswami et al., 2020).

An important component in incorporating assessment of personality into animal management is the capacity to predict how individuals may fare in different situations, and researchers have suggested the capacity for improved welfare and animal management if personality is used in a predictive capacity, e.g. to predict how they may react to different situations, (Herrelko et al., 2012) or to predict social relationships (Tetley and O'Hara, 2012, Williams et al., 2019b). Personality is now being integrated into welfare assessments, viewed as a way not only as a means of validation but also as a valuable enhancement. The Subjective Well-being Scale, developed by King and Landau (2003), integrates welfare and personality questions, and has been applied to numerous primates housed in zoos, including capuchins (Robinson et al., 2016), orangutans (*Pongo sp*) (Weiss et al., 2006) and chimpanzees (King and Landau, 2003). It has also been used to assess personality and welfare in orcas (*Orcinus orca*) (Úbeda et al., 2021). To promote positive welfare for animals in zoos it is important that personality is more specifically considered and used as a tool to support individualised animal husbandry.

4. Measuring animal personality

There are three principal ways of measuring animal personality: behavioural coding using an ethogram based approach where data are coded in relation to specific personality contexts; experimental assessments where animals are exposed to pre-defined conditions, designed to identify specific aspects of animal personality; and trait rating by knowledgeable informants, where persons familiar with the species and the specific individuals are asked to answer a series of behavioural adjectives to build up a behavioural profile. These methods have been reviewed by Carter et al. (2013) and assessed in relation to their levels of practicality in managed contexts by Rutherford et al. (2025) so will not be repeated here. However, it is important to recognise that the type of personality metric used may influence the personality profiles generated, and this must be considered when personality assessments are undertaken, with multiple metrics utilised whenever appropriate.

The farming sector largely assesses personality via behavioural assays rather than by knowledgeable informants (more common in zoo settings), likely due to the lower ability to truly 'get to know' individual animals under conditions with large group sizes, rapid turnover of animals, and limited time availability per individual (DAERA, 2022). These assays are often grounded in exploring each individual's response to a (perceived) negative situation (Forkman et al., 2007), and thus most conclusions about farm animal personality are centred around how individuals cope with negative stimuli. Methods using knowledgeable informants often include more positive elements such as sociable, environmental interaction and response to keepers (Williams et al., 2019a). Consequently, personality research in farm animals largely explores negative to neutral behavioural responses, rather than positive ones (i.e., lack of a strong reaction in an isolation test does not necessarily signify a positive welfare state). Furthermore, the structure of each test often includes severity limits, which define when an animal is too distressed to continue the test. These severity limits, while essential for appropriate ethical conduct, can obscure behavioural extremes (Vickery et al., 2024).

While the use of knowledgeable informants is unlikely in a farm context, authors such as MacKay et al. (2014) have proposed identifying behaviours performed by an animal in their home pen that may link to personality traits. This approach has the potential to facilitate inclusion of behaviours indicative of positive welfare and increase knowledge of how these interact with personality traits in farmed animals. Thus, this approach could ultimately promote more individualised management, especially if relevant behaviours can be automatically recorded (e.g. feeder visits, automatic milking system visits; Schwanke et al., 2022; Johansen et al., 2026).

Behavioural expression of personality may show variation over time, with influences from environmental or social conditions (Rutherford et al., 2025) and potentially mood-like states, as observed in humans (Hudlicka, 2002). As outlined in the introduction, typically personality traits are characterised by relative consistency between individuals across time and contexts. It is therefore important that personality is monitored across time and contexts, enabling a robust assessment of individual tendencies that includes an understanding of developmental processes on behaviour. The development of species specific, validated, personality assessment tools that can be readily integrated into animal management is of paramount importance in supporting the creation of individualised profiles based on longitudinal data. This approach facilitates recognition of personality as a phenotypic trait that exhibits plasticity in expression and supports adaptive management strategies that accommodate such variation. Further work is also needed to understand the interaction between personality, mood (a longer-term but impermanent affective state), and emotion, to enable a greater understanding of context-dependent expression in personality. Such work should also consider how management practices interact with behavioural development across the lifespan and the consequent implications for welfare.

5. Future directions: moving towards individual-centred animal management

The importance of understanding personality, and applying it to individual-level, evidence-based animal management within the farm and zoo industries is widely recognised, however the implementation is variable and the knowledge base on which to ground such individual-based decisions is taxa dependent. There are three key aspects to this problem: (1) a lack of understanding of how to assess animal personality and how to understand extremes of individual variation without misidentifying personality types; (2) difficulties when applying individual level management to large social groups; (3) the needs of the individual animal, the group of animals and the requirements for humans from the group of animals may be competing, which can lead to significant challenges in implementation, even with the best of intentions. These challenges highlight the need for both improved conceptual understanding and the development of practical strategies to support implementation, which are outlined below.

5.1. Development of validated metrics and personality assessment approaches

We urge practitioners working within the animal management field to consider individual differences within management programmes, but for this to be achieved there is a pressing need to create validated personality assessments which encompass the multifaceted nature of animal personality. New research is advancing our knowledge as to the personalities of understudied taxa (e.g., amphibians) (Ghosh and Aravind, 2025) however this is still rare. For example, despite knowledge that frogs, toads, salamanders and newts all show inter-individual differences in relation to Boldness, Exploration and Activity, there is still little research on their personality (Kelleher et al., 2018). Moving forwards, research should continue to prioritise understudied taxa and work on validating indicators or measures of personality, specifically with the goal of going beyond the traditional Bold-Shy model that is employed for many animals (e.g. Fish: Toms et al., 2010, Sheep: Sibbald et al., 2009, Birds: Cole and Quinn, 2014).

Within this, it is important to consider that personality profiles may be impacted by the assessment type undertaken, with different personality measures showcasing different aspects of an animal's personality.

We therefore recommend prioritising development of validated, species-appropriate, and scalable personality assessment tools that can be incorporated into routine management, taking into account the constraints of different systems.

5.2. Tailoring management strategies

From a welfare perspective, the goal is not to eliminate individual variation, but to recognise and accommodate it where possible. While fully individualised management is unlikely to be feasible in all systems, partial individualisation can be achieved through targeted, low-cost adjustments. We recommend that management strategies are adapted to better align with individual behavioural tendencies. This may include grouping animals based on behavioural compatibility, modifying approaches to animal management based on intake or behaviour, providing choice and flexibility in resource use (e.g. feeding access, space use), to enable animals to manage their own requirements and considering individuality in animal training programmes.

On farm, precision livestock technologies could be well placed to support this approach by enabling continuous individual-level monitoring, even in large-scale systems (Neethirajan, 2020). These technologies can be used to identify individuals that deviate from expected patterns and trigger targeted management interventions and thus data-driven adjustments represent realistic and achievable steps towards incorporating personality into animal management.

5.3. Embedding individual variation within policy and practice

To support wider adoption, we recommend that consideration of animal individuality is explicitly incorporated into legislation, guidelines, and best practice standards for all species. For this to be effectively implemented, consideration must be given to how individual variation can be recognised and accommodated within the practical and economic constraints of different management systems. Many current frameworks largely focus on population-level requirements and rarely account for variation in how individuals experience their environment. Where validated frameworks for assessing individuality exist, these should be incorporated into management toolkits. In parallel, policies should adopt a more flexible, outcome-based approach, encouraging systems that allow animals to express a range of coping strategies. This could include but are not limited to:

- Promoting management systems that offer behavioural choice, enabling expression of different coping strategies
- Encouraging the use of simplified personality profiles where appropriate to support consideration of personality 'types' during animal management, while recognising that animals may differ in their behavioural expression in different contexts
- Prioritising individual-level monitoring where technologies or management regimes permit with targeted management interventions where required
- Supporting participation in research and data-sharing to advance practical implementation in to animal personality, particularly cross-sector and inter-disciplinary collaborations

Embedding these principles within policy frameworks would help shift management away from the "average animal" model and towards systems that are responsive to individual needs.

CRediT authorship contribution statement

E. Williams: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **L. Stratford:** Writing – review & editing, Writing – original draft, Investigation. **F.P. Johansen:** Writing – review & editing, Writing – original draft, Investigation. **H.M. Vickery:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization.

Ethics approval

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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