

A Hidden Gift: The Source of 'Big Picture' Ideas

David J Mellor BSc(Hons), PhD, Hon.Assoc.RCVS, ONZM
Emeritus Professor of Animal Welfare Science and Bioethics
Foundation Director, Animal Welfare Science and Bioethics Centre
School of Veterinary Science, Massey University,
Palmerston North, New Zealand

D.J.Mellor@massey.ac.nz

1. Early Years (1942 to 1961)

I have been fortunate to live a long life – I am now just short of 83 years old. As the years roll by, we increasingly reflect on what we have experienced in our lives. The challenges we have faced and what they taught us, and what led to any successes we might have had.

I was born one of identical twins, the runt of the litter – I now know that was due to my placenta being much smaller than my twin's. I had a rather tenuous hold on life at birth, did not breathe for 30 minutes and had protracted illness. I was still much smaller than my twin at age 6 (Figure 1). Subsequently I had major learning difficulties; after 4 years at school, I was 2 years behind my identical twin.



Figure 1: Twins Ken (L) and David (Centre); elder brother Mike (R)

Teachers, other adults and my peers roundly regarded me as intellectually handicapped; a no hoper who would not amount to anything. Small, wearing glasses and regarded as stupid, at school I was often a target for bullying, verbally by staff, physically by my peers.

My worried parents arranged a tutor for one-on-one sessions on three mornings each week for three years. My tutor was warm, empathetic, encouraging and progressively instilled in me the confidence that I could learn, despite my prior difficulties. Indeed, she saved me in my later life from living *down* to the exceptionally low expectations that most adults, apart from my parents, anticipated would be my future. In 1955, immediately after

this tutoring, I spent a year of *learning-by-doing* on an uncle's farm in South Australia. This was hugely helpful. The outcome at school was that Ds and Es increasingly turned into Cs, being moments of great celebration as if they were As; and Cs increasingly turned into Bs, with smatterings of A-minuses and the occasional A.

2. University of New England (1962 to 1965)

At the age of 19, I gained entry to New England University to study for a Bachelor of Rural Science degree. The foundational framework of the degree was the integrated interactivity of the *Soil-Animal-Plant Complex*. I found this *Big Picture* approach greatly energised my study, which helped because at that stage I was not at all sure that I would be able to meet the higher tertiary education standards.

Much to my surprise and relief, I was able to more than hold my own academically. And retrospectively, I see that even at this early stage I was *inwardly driven* to seek *Big Picture perspectives* in my understanding.

2.1. Change of Degree in my third year

A short Physiology paper in 2nd year enthralled me, so in 1964 I changed to a BSc to major in Physiology. Undergraduate teaching in Physiology dealt with one body system at a time: nervous, respiratory, heart and circulation, gut, kidneys, etc. This was very interesting but felt disjointed. Fortunately, I was *inwardly impelled* to take a *wider view*.

I wanted to understand how all body systems interacted: (1) how together they sustain the lives of animals; (2) how they integrate their functionality in ways that secure each animal's autonomy; and (3) how their cooperative interactions are the essence of each body functioning effectively as a whole biological entity. What I prepared was a chart learning aid for myself, literally a *Big Picture* (Figure 2).

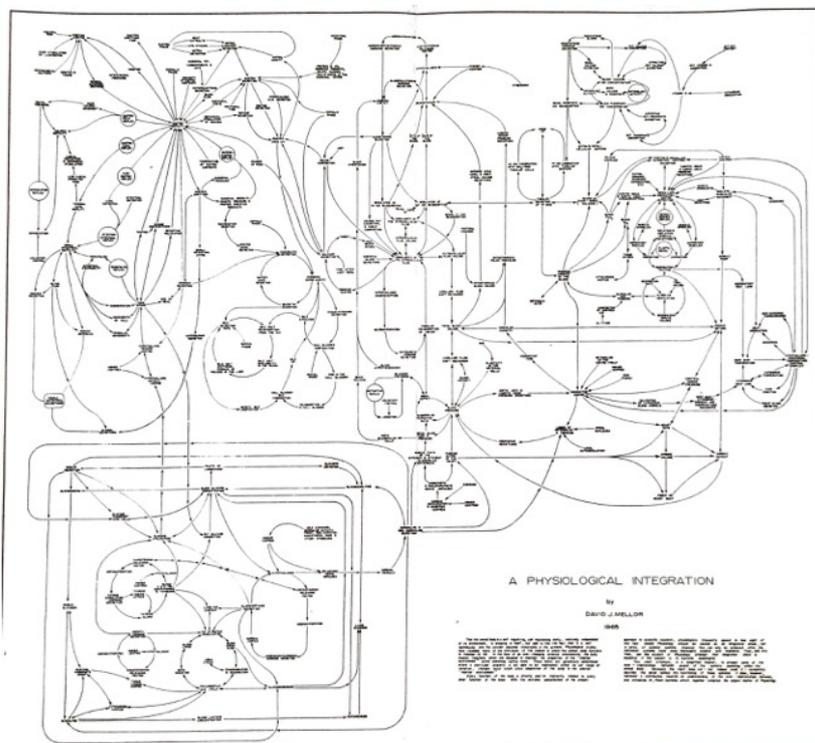


Figure 2. A Physiological Integration

The chart consisted of an A2-sized “mind map” of major interactions between the body systems, which I entitled *A Physiological Integration*. During 1966, the year after completing my BSc(Honours) in Physiology, Drug Houses of Australia published the chart as a teaching aid. It was then distributed to all Physiology Departments in Australia. I discovered only recently that it was used by the Physiology Department at UNE for some years.

2.2. My BSc Honours research year

In 1965, my honours research project was in fetal physiology. Again, I sought a holist, integrated perspective – a *Big Picture*. Its principal features were: (1) the fetus physiologically interacting with its placenta within the uterus; (2) the physiology of the fetoplacental unit interacting with the mother’s physiology via her systems; and vice versa; (3) the mother’s physiology affecting the fetoplacental unit; and (4) the impact of the mother’s environment on her physiology and the impacts of those specific responses of hers on the fetus.

This was the overall conceptual framework within which I conducted individual research projects during my Honours research at UNE, and, during my subsequent PhD research at Edinburgh University.

3. Edinburgh University PhD Studies (1966 to 1969)

Although I was enrolled in the Medical Faculty because my first supervisor was a retired Professor of Human Physiology from London, I was based for my PhD experimental work at the Moredun Research Institute, the only veterinary research institute in Scotland.

During my PhD research I added another dimension to my *Big Picture* interests. It was to explore aspects of placental function in a range of species which had structurally different placentas and different durations of pregnancy. The species were rats, rabbits, guineapigs, goats, sheep and, in collaboration with medical researchers with appropriate ethical approval, human females during elective Cesarean sections.

4. Moredun Research Institute Employment (1969 to 1987)

Upon completion of my PhD in 1969 I was appointed to the Moredun Institute staff as Head of its Department of Physiology. My remit was to provide physiological advice and to establish and lead a Perinatal Studies Group. I remained at the Institute for 18 years, after which I moved to Massey University in New Zealand.

As judged retrospectively, during those 18 years my *Big Picture* predilections were constantly in evidence in the perinatology arena. I will give one detailed example. It involved drawing together different features of the birth process in pregnant sheep, features that were being studied separately by other research groups.

My wide interests led me to recognise a hitherto undescribed single coordinating mechanism. The coordinated processes were: (1) the prenatal maturation of fetal tissues essential for lamb survival after birth; (2) the onset of labour; (3) birth itself; (4) the onset of mother-young bonding activity, and (5) the onset of lactation.

The trigger for all of these was a marked rise in fetal, note *fetal* cortisol secretion leading to endocrine and other secondary triggers. Note that each area was being researched in different laboratories, and it was my *Big Picture* orientation that impelled me to integrate their published findings (Figure 3).

Br. vet. J. (1988). 144, 552

REVIEW

INTEGRATION OF PERINATAL EVENTS, PATHOPHYSIOLOGICAL CHANGES AND CONSEQUENCES FOR THE NEWBORN LAMB

D. J. MELLOR*

Moredun Research Institute, 408 Gilmerton Road, Edinburgh EH17 7JH, Scotland

Figure 3. Big picture perinatal understanding of survival-critical perinatal events.¹

Also note that my *Big Picture* interests in fetal and neonatal phenomena have continued to this day. Below is a list of 11 reviews, omitting at least 15 others, which, around the year 2000 increasingly had animal welfare implications.

- A comparison of energy metabolism in the newborn infant, piglet and lamb².
- Some aspects of perinatal maturation and adaptation.³
- Responsiveness, behavioural arousal and awareness in fetal and newborn lambs: experimental, practical and therapeutic implications.⁴
- Animal welfare implications of neonatal mortality and morbidity in farm animals.⁵
- The importance of 'awareness' for understanding fetal pain.⁶
- Onset of sentience: The potential for suffering in fetal and newborn farm animals.⁷
- Birth and hatching: Key events in the onset of awareness in the lamb and chick.⁸
- Galloping colts, fetal feelings, and reassuring regulations: Putting animal-welfare science into practice.⁹
- Birth transitions: Pathophysiology, the onset of consciousness and possible implications for neonatal maladjustment syndrome in the foal.¹⁰
- Survival implications of the development of behavioural responsiveness and awareness in different groups of mammalian young.¹¹
- Preparing for life after birth: Introducing the concepts of intrauterine and extrauterine sensory entrainment in mammalian young.¹²

5. How my Moredun research (1969 to 1987) laid the foundations of the Five Domains Model

Note that the events outlined here all occurred in the 1970s and 1980s, long before the Model was even a very faint glimmer in the back of my mind.

With the benefit of hindsight, I have identified how features of my long-term studies of pregnant sheep highlighted perspectives that would later underpin my integrative concept of the Five Domains Model for animal welfare assessment and management.

The first version of the Model was published by ANZCCART¹³, six years after I arrived in New Zealand. The original Five Domains were: 1. Nutrition; 2. Environment; 3. Health; 4. Behaviour; and 5. Mental State.

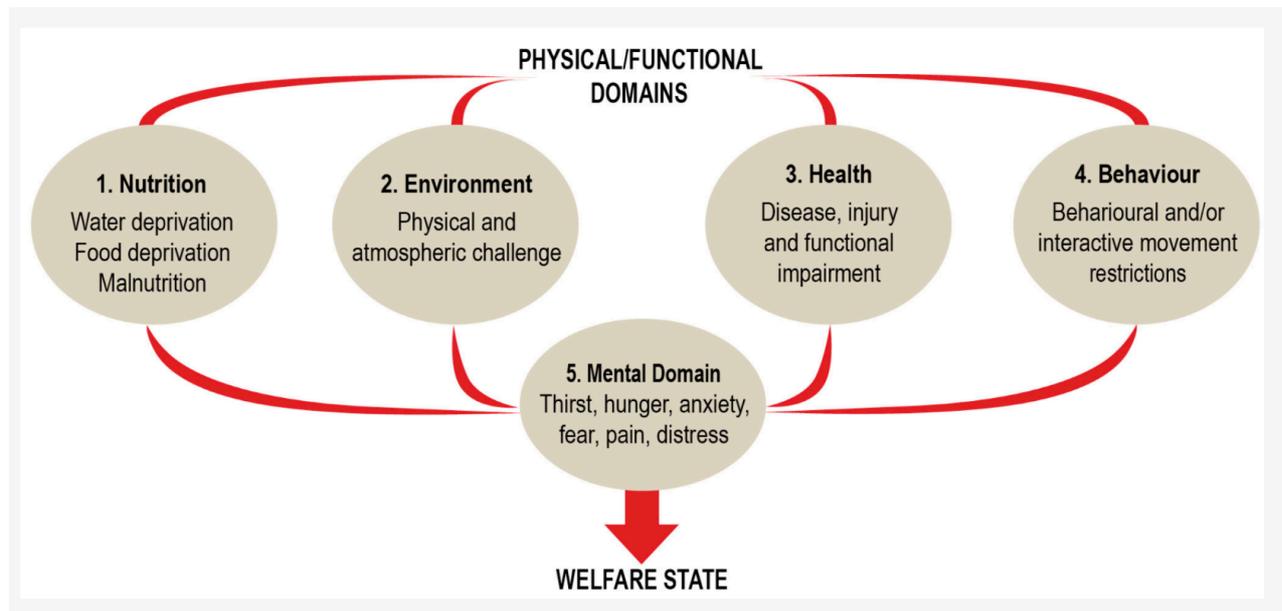


Figure 4. The original structure of the Five Domains Model, redrawn for Mellor et al (2020)¹⁴.

5.1. Developments in fetal research methods: replacing acute with chronic studies

Until 1965 sheep fetuses were studied in anaesthetised ewes with known mating dates so that gestational age was known. They could only be studied for the duration of the maternal general anaesthesia after which the mothers were euthanised. However, in 1965 USA fetal sheep researchers markedly extended the duration of experimental access to individual fetuses. They developed a method to catheterise the umbilical vessels via small tributaries of the placental vessels. This allowed long-term studies of fetuses for days and sometimes weeks after the dams had recovered from the anaesthesia and surgery.

I added to these USA-developed vascular and other catheterisation methods in ways that enabled me to follow individual fetuses for the last two-to-three months of pregnancy *in conscious, fully functioning pregnant ewes*. Many others also added to such methods which eventually became routine. The outcome, pregnant ewes and their fetuses could then be studied for every *post-operative* day until birth.

This resulted in major changes in the management of pregnant ewes for such studies, because individuals had to be maintained for several weeks to months during mid-to-late pregnancy. It immediately became apparent to me that additional factors needed to be managed and/or monitored.

5.2. Factors that needed to be monitored and/or managed

5.2.1. Nutrition

Daily feeding levels needed to match the increasing demands of growing fetuses. Also, daily feeding levels needed to match the greater demands at each stage of any additional fetuses in ewes with twins or triplets. And the compositional quality of the feed needed to be appropriate for pregnant ewes.

5.2.2. Environment

My sheep were studied in well-ventilated, purpose-built animal-houses, in which the temperature ranged from -10°C to $+10^{\circ}\text{C}$. These were common outdoor temperatures during the Scottish Winter and Spring. The ewes' metabolic responses varied with the ambient temperature, and this needed to be taken into consideration, especially for metabolic studies. In contrast, biomedical researchers studied sheep in indoor laboratories at temperatures comfortable for the researchers.

5.2.3. Health

Initially, pregnant sheep supplied for my acute research studies were rejects from the Institute farms and had a variable health status. I think the farm manager wanted to offload his cull ewes. However, given the duration of the chronic studies on each animal, and the objective of studying healthy pregnancies, good health criteria needed to be applied and were therefore implemented.

5.2.4. Behaviour

Pregnant sheep which were brought to my unit directly from the Institute farms had very little prior handling and had rarely been housed. Accordingly, it was a frightening experience to be brought indoors and into individual pens, even though they were kept next to other sheep. Their initial behaviour clearly indicated fear. To ensure that they would be manageable once post-surgical studies of their fetuses began, we tamed and trained each ewe for 10 minutes every day for 6-8 weeks before the time of surgery. By then they were completely at ease in our presence and, using behavioural and physiological parameters, were shown to be completely unstressed.

6. Issues related to mental state

6.1. 1962 to 1965 at UNE

Throughout my undergraduate and Honours studies at UNE, no doubts were ever expressed about whether terrestrial mammals could experience motivating subjective states. I will mention four examples we specifically considered.

Breathlessness: partial or complete obstruction of respiratory passages that impedes alveolar gas exchanges, leads to imbalance in circulating partial pressures of carbon dioxide and oxygen, and of pH, which in their turn lead to intense breathlessness, and the overwhelming desire to clear the obstruction or change breathing patterns to restore breathing comfort.

Thirst: dehydration leads to thirst which elicits water seeking behaviour and then water consumption to slake the thirst and correct the animal's hydration status.

Pain: escape activities, flinching, vocalisations and numerous avoidance responses to blunt-force trauma, cutting, compression, cautery and other invasive actions indicate that

an animal is in pain. The purpose, to alert the animal to tissue damage and the need to avoid the damaging agent.

Other experiences: several other ‘protective’ unpleasant experiences were also identified, e.g., fear, just mentioned.

6.2. Edinburgh during the 1980s

In the 1980s, the common view in Edinburgh, and in fact widely across the animal-based science world was quite different. It was rather like a rigid creed, *an earnest belief*, which you were obliged adopt. The creed was *anti-anthropomorphism*. If you were found guilty of the *sin of anthropomorphism* you were in danger of being *excommunicated*. Cast out of the sanctified halls of the scientific church for bringing its “*hallowed dictum of objectivity*” into disrepute.

For example, with *pain*, the reasoning ran something like this. We do not have a language in common with animals. Therefore, we cannot be *certain* – note *certain* – that they are in pain when we *think* they are. Nevertheless, there are some signs that they might *experience pain* when exposed to stimuli we would find painful ourselves. For example, they exhibit various distinct behaviours and physiological stress responses.

Therefore, with *great caution*, and in a spirit of *admirable trans-species generosity*, we will *provisionally* treat them as if they are in pain when they show the signs of it.

Strangely, at the time, among the most cautious were scientists studying what they called neural pain pathways *in animals!*

6.3. My ‘lightbulb’ realisation

Shortly after arriving at Massey University *in early 1988*, I established a Bioethics Discussion group. I had longstanding *Big Picture* interests in philosophy and ethics which had been sparked by my first wife, a philosopher, ethicist and English Literature scholar from India who died in early 1982.

The Massey group had seven members, one from each of the then seven Faculties. Each month one of our number would present a brief outline of a topic which we would then discuss. At our sixth meeting I earnestly presented the cautious anti-anthropomorphism arguments I had studiously learnt in Edinburgh regarding pain experiences in animals.

The then Professor of Philosophy led the discussion:

“David, do you doubt that animals can and do feel pain?”

“No Graham, I don’t. In fact, I am convinced that they do.”

“So, why do you start from a position of doubt, which requires *you* to prove that they *do* experience pain?”

For me, that was a major “*light bulb moment!*”

I saw immediately that if I started with a confident view, supported by the then available extensive scientific evidence, that animals can and do experience pain, it would put the onus on those who doubt it, to prove that they do *not* experience pain.

I guess this was an assertive form of the *Precautionary Principle* of “If in doubt, find in favour of the animal.”

6.4. Returning to Domain 5 of the Model – Mental State

You will recall that I introduced the question of pain when I began narrating how Mental State became the fifth of the Five Domains. Also, please note that meetings of this Bioethics Discussion Group took place in 1988, six years before the first version of the Model was published by ANZCCART.¹²

In 1994 the original Mental State Domain (i.e., Domain 5) included the following subjective experiences (i.e., affective states): thirst, hunger, anxiety, fear, pain and distress.¹²

The last of these, ‘distress’, was a ‘place holder’ for affects Cam Reid (my co-author) and I did not think the animal welfare, animal behaviour and wider animal-based science communities were then ready to accept.

It is interesting that there are signs that this is still true among somewhat conservative ranks of the veterinary profession.

7. The 30-Year Evolution of the Five Domains Model (1994 to 2024) and the Question of Sentience

You will be pleased to know that I am not going to give you a “chapter and verse” history. In any case, that is available in three readily accessible sources,^{14,15,16} and many others.

It is enough to say that the Model was updated regularly at each stage to incorporate then fresh conceptual frameworks. Each of these frameworks was developed by contributors to animal welfare science and related thinking over the 30-year period. Notably, the notion of *sentience*, implicit in the Model from the start, became increasingly explicit, so that now it is a well-established feature of the Model, and indeed of contemporary animal welfare science thinking.

However, some members of the Profession still refuse to acknowledge the fact that most of the animals they care for as patients or in other contexts are *sentient*. Perhaps they are hoping that they will not need to reflect on the welfare implications of this in the light of some of the contexts in which their clients keep their animals. Whatever their reasons, the sentience of animals of veterinary interest is now very widely asserted in laws, codes of practice or welfare, by veterinary associations, humane societies and in animal welfare scientific and animal welfare ethical reasoning.

Quite simply, sentience is now a foundational principle of veterinary understanding and activities. This is indicated by the fact that on 1 June 2025 (the date of finalising this account) the publication describing the 2020 Five Domains Model¹⁴ had been downloaded in full at least 121,818 times, rising at a sustained rate of ~70 per day; also, to date the paper had been cited 928 times. Note in addition that the strengths of the Model reflect the thinking of an exceptionally large community of animal welfare and other scientists and scholars, not only my colleagues and me.

It is my hope that the members of the Animal Welfare Chapter, in line with this widespread international recognition of sentience, will now vote to formally adopt a

Position Statement that animals of veterinary interest are sentient. In addition, I hope that all other Chapters in the College will do the same.

I would like to acknowledge my six co-authors of the paper describing the 2020 Five Domains Model.¹³ They are Ngaio Beausoleil, Kat Littlewood, Andrew McLean, Paul McGreevy, Bidda Jones and Cristina Wilkins. All of them fully embraced my then latest *Big Picture* vision of the Model and added considerably to its substance,

An infographic of the 2020 Model,¹⁷ prepared by Cristina Wilkins, is available online for downloading at no cost. It is intended as an A3-sized chart for display in offices or on notice boards.



Figure 5: A reduced size view of the 2020 Model Infographic.¹⁷

On a personal note, returning to my “Big Picture theme”, the large size of this infographic seems appropriate, as it captures for me something of my internal compulsion to seek out wider perspectives on matters that engage my attention.

I should make it clear that I have always regarded the Model to be a “work-in-progress”, because there will always be well authenticated new areas of understanding which should be included as they arise.

I should also make it clear that the Model belongs to everyone; no individual owns it. Thinking of my predominantly “Big Picture perspectives”, I see myself merely as one player in a truly vast orchestra of exceptionally talented instrumentalists. Yes, occasionally I have had the great good fortune to have solo parts, but always in the context of the whole orchestra and with a personal aim of facilitating the interests of its other members.

8. Learning About the Five Domains Model

There is an internationally accessible online course, offered by UNE,¹⁸ which is entitled “*Applying the Five Domains Model to the Welfare Assessment of Sport and Recreational Horses*”. This deals explicitly with how to use the Model, and although focused on horses, it provides a level of understanding that helps when applying the Model to other species.

Developed and managed by Cristina Wilkins, the content is engagingly fresh and draws the participants along in a step-by-step fashion, so that each section is a good preparation for the next. Having completed the course myself [and I’m happy to say I passed!] I can recommend it, as do the vast majority of those who have completed the course. So far, they have come from a total of 18 countries. After one member of an organisation has completed it, some organisations require all their members to enrol. Others have made it a mandatory part of their certificates of competence.

I have strong interests in this course because for 10-15 years I have had a special interest in equine welfare, and the Five Domains Model has been a useful tool in that context.

It is 60 years since my last year at UNE. Throughout that period, I have always felt and acknowledged a great debt of gratitude for the quality of my BSc and BSc(Honours) degrees, and for the extraordinary academic experience provided by UNE which laid the foundations of my career as a researcher and scholar. It also equipped me to explore many wonderfully diverse parallel interests. As my Alma Mater, it gives me special feelings of pleasure to know that this online course is offered by UNE.

9. My Other Big Picture Professional Interests

I guess it is not surprising that in parallel with developing the Five Domains Model, I have had other Big Picture interests. Provided here is a selection of 14 refereed reviews that demonstrates this:

- Developing a systematic strategy incorporating ethical, animal welfare and practical principles to guide the genetic improvement of dairy cattle.¹⁹
- New Zealand’s inclusive science-based system for setting animal welfare standards.²⁰
- Extending ideas about animal welfare assessment to include ‘quality of life’ and related concepts.²¹
- Animal emotions, behaviour and the promotion of positive welfare states.²²
- Enhancing animal welfare by creating opportunities for ‘positive affective engagement’.²³
- Positive welfare states and promoting environment-focused and animal-to-animal interactive behaviours.²⁴
- Introducing breathlessness as an animal welfare issue.²⁵
- Updating animal welfare thinking: Moving beyond the ‘Five Freedoms’ towards ‘A Life Worth Living’.²⁶
- Moving beyond the ‘Five Freedoms’ by updating the ‘Five Provisions’ and introducing aligned ‘Animal Welfare Aims’.²⁷
- Equine welfare during exercise: An evaluation of breathing, breathlessness and bridles.²⁸

- Tail docking of canine puppies: Reassessment of the tail's role in communication, the acute pain caused by docking and interpretation of behavioural responses.²⁹
- Welfare-aligned sentience: Enhanced capacities to experience, interact, anticipate, choose and survive.³⁰
- Mouth pain in horses: Physiological foundations, behavioural indices, welfare implications and a suggested solution.³¹
- Translating Ethical Principles into Law, Regulations and Workable Animal Welfare Practices.¹⁶

10. The Hidden Gift: The Source of my Big Picture Ideas

How is it that I did not *consciously decide* to adopt this recurring *Big Picture* orientation both in my personal and professional life? How is it that from my late-teenage years, seeking *Big Picture* understanding *seemed so natural* to me? What was the source of my *inward compulsion* to explore and give expression to *Big Picture* perspectives?

10.1. The answer is multifaceted:

I have the *great good fortune* to be a person blessed with dyslexia. Earlyish in my life's path, *empathetic* and *supportive* people took an interest in me. Importantly, they encouraged me to focus on *what I could do*, NOT on *what I could not do*. The rise in confidence this generated helped to reduce the noxious impacts of persistent bullying.

They did not insist that I comply with the largely linear thinking of the 80-90% of the population who do not have the gift of dyslexia. The principal gift is a *form of brain wiring* that both makes possible and generated an interest in a wider contextual understanding in any area that engages the attention of those of us with dyslexia. Finally, and this one is critical: it is the support we have been fortunate enough to receive which enables us to develop the confidence we need to explore these new, usually exciting, wider perspectives.

10.2. However, it is not all plain sailing

The *creators* of currently accepted knowledge inevitably become *custodians* whose first response to new ideas is to assess if those ideas can be accommodated by adjustments within the original foundational tenets of the knowledge. If so, this can lead to enhancement of that knowledge base.

However, if to be incorporated such new ideas require marked changes in the foundational tenets, the custodians often become defenders of the status quo and endeavour to find fault with the challenging ideas. This may appear to betray defensiveness, but it is legitimate and important to test all new ideas before adopting them. But these dynamics often change to resolute protectionist resistance when *Big Picture* perspectives bring forward transformative fresh conceptual frameworks that supersede those currently accepted.

It can be reputationally challenging for those who created the intellectual content of the status quo to discover that their past contributions are likely to be overtaken or very substantially modified. In addition, status quo ideas may underpin a wide range of animal-based activities. If so, threats to their foundations could have far reaching consequences for those whose employment, sporting or other activities rely on the conceptual foundations that have now convincingly been found wanting.

Initiators of fresh conceptual frameworks derived from *Big Picture* perspectives may thus find themselves the focus of a wide variety of extremely unpleasant responses from those deeply threatened by the consequences of the new compelling ideas. However, I have found my natural inclination to include in my *Big Picture* perspectives an *appreciative historical awareness* reduces such responses.

Accordingly, I have made a point of acknowledging and affirming the earlier contributions that others have made to the progressive development of the subject areas that have underpinned my work. In time, as the fresh frameworks begin to be adopted, the negative responses to them subside, and many of those who had initial misgivings begin to find the new frameworks are helpful to them.

11. Warmly Felt Acknowledgements

I have written many works of scholarship during the 60 years since my fledgling UNE Honours Project. In so doing, I have drawn together contributions from numerous enthusiastic and brilliantly insightful scientists and other scholars. Many were talented postgraduate students, colleagues, and wise mentors who I knew well and who became good friends. And there were very many others who I did not know personally, but whose dedication to their science and widely ranging scholarship in other areas I came to greatly respect. As a result, each of them in their own way became mentors in absentia. I owe them all a huge debt of gratitude for the diverse ways they, knowingly or unknowingly, fully participated in what for me has remained throughout a journey of delight-with-discovery and wonder at the mystery which is life. Sadly, many have died, but living or not, I warmly thank them all.

On the home front, for almost 36 years now I have been blessed by the loving, thoughtful, reflective, resourceful, courageous and practical support of my dear second wife Lynda who, together with our son Thom, and his partner Grainne, have been the emotional focus of my life. They have enriched my personal life immeasurably. I could not have sustained the intensity and breadth of my professional activities without them being such a fundamentally important and loving part of my daily life.

References

1. Mellor, D.J. (1988). Integration of perinatal events, pathophysiological changes and consequences for the newborn lamb. **British Veterinary Journal** **144**, 552-569.
2. Mellor, D.J. and Cockburn, F. (1986). A comparison of energy metabolism in the newborn infant, piglet and lamb. **Quarterly Journal of Experimental Physiology** **71**, 361-379.
3. Mellor, D.J. (1993). Some aspects of perinatal maturation and adaptation. In: Foetal maturation: comparative aspects of normal and disturbed development. **Equine Veterinary Journal Suppl. 14**, 17-22.
4. Mellor, D.J. and Gregory, N.G. (2003). Responsiveness, behavioural arousal and awareness in fetal and newborn lambs: experimental, practical and therapeutic implications. **New Zealand Veterinary Journal** **51** 2-13.
5. Mellor, D.J. and Stafford, K.J. (2004). Animal welfare implications of neonatal mortality and morbidity in farm animals. **The Veterinary Journal** **168**, 118-133.
6. Mellor, D.J., Diesch, T.J., Gunn, A.J. and Bennet, L. (2005). The importance of 'awareness' for understanding fetal pain. **Brain Research Reviews** **49**, 455-471.

7. Mellor, D.J. and Diesch, T.J. (2006). Onset of sentience: the potential for suffering in fetal and newborn farm animals. **Applied Animal Behaviour Science** **100**, 48-57.
8. Mellor, D.J. and Diesch, T.J. (2007). Birth and hatching: key events in the onset of 'awareness' in lambs and chicks. **New Zealand Veterinary Journal** **55**, 51-60.
9. Mellor, D.J. (2010). Galloping colts, fetal feelings and reassuring regulations: Putting animal welfare science into practice. **Journal of Veterinary Medical Education** **37**, 94-102.
10. Diesch, T.J. and Mellor, D.J. (2013). Birth transitions: pathophysiology, the onset of consciousness and possible implications for the neonatal maladjustment syndrome in the foal. **Equine Veterinary Journal** **45**, 656-660.
11. Mellor, D.J. and Lentle, R.G. (2015). Survival implications of the development of behavioural responsiveness and awareness in different groups of mammalian young. **New Zealand Veterinary Journal** **63** (3), 131-140.
12. Mellor, D.J. (2019). Preparing for life after birth: Introducing the concepts of intrauterine and extrauterine sensory entrainment in mammalian young. **Animals** **9**(10), E826; doi:10.3390/ani9100826
13. Mellor, D.J. and Reid, C.S.W. (1994). Concepts of animal well-being and predicting the impact of procedures on experimental animals. In: **Improving the Well-being of Animals in the Research Environment**. Australian and New Zealand Council for the Care of Animals in Research and Teaching, Glen Osmond, South Australia pp 3-18.
14. Mellor, D.J., Beausoleil, N.J., Littlewood, K.E., McLean, A.N., McGreevy, P.D., Jones, B. and Wilkins, C. (2020). The 2020 Five Domains Model: Including Human–Animal Interactions in Assessments of Animal Welfare. **Animals****10**(10), 1870; <https://doi.org/10.3390/ani10101870>
15. Mellor, D.J. and Burns, M. (2020). Using the Five Domains Model to develop Welfare Assessment Guidelines for Thoroughbred horses in New Zealand. **New Zealand Veterinary Journal** **68**, 3. 150-156. Available online at: <https://doi.org/10.1080/00480169.2020.1715900> (accessed 15 March 2020); https://www.tandfonline.com/doi/full/10.1080/00480169.2020.1715900?utm_source=CPB&utm_medium=cms&utm_campaign=JPC13697
- 16.. Mellor, D.J. and Uldahl, D.M. (2025). Translating Ethical Principles into Law, Regulations and Workable Animal Welfare Practices. **Animals** **15**, 821. <https://doi.org/10.3390/ani15060821>
17. Five Domains Model Infographic (2020). Available online at: <https://app.box.com/s/88rakysmtmseh4eha21fx4jdy6ps47fp>
18. Applying the Five Domains Model to the Welfare Assessment of Sport and Recreation Horses, available online from the University of New England at <https://www.openlearning.com/une/courses/une-equine-course/?cl=1>
19. Fisher, M.W. and Mellor, D.J. (2008). Developing a systematic strategy incorporating ethical, animal welfare and practical principles to guide the genetic improvement of dairy cattle. **New Zealand Veterinary Journal** **65**, 100-106.
20. Mellor, D.J. and Bayvel, A.C.D. (2008). New Zealand's inclusive science-based system for setting animal welfare standards. **Applied Animal Behaviour Science** **113**(4), 313-329.
21. Green, T.C. and Mellor, D.J. (2011). Extending ideas about animal welfare assessment to include 'quality of life' and related concepts. **New Zealand Veterinary Journal** **59**, 316–324.
22. Mellor, D.J. (2012). Animal emotions, behaviour and the promotion of positive welfare states. **New Zealand Veterinary Journal** **60**, 1-8.

23. Mellor, D.J. (2015). Enhancing animal welfare by creating opportunities for 'positive affective engagement'. **New Zealand Veterinary Journal** **63**, 3-8.
24. Mellor, D.J. (2015b). Positive welfare states and promoting environment-focused and animal-to-animal interactive behaviours. **New Zealand Veterinary Journal** **63**, 9-16.
25. Beausoleil, N.J. and Mellor, D.J. (2015). Introducing breathlessness as an animal welfare issue. **New Zealand Veterinary Journal** **63**, 44-51.
26. Mellor, D.J. (2016). Updating animal welfare thinking: Moving beyond the 'Five Freedoms' towards 'A Life Worth Living'. **Animals** **6**(3). 21; doi.org/10.3390/ani6030021
27. Mellor, D.J. (2016). Moving beyond the 'Five Freedoms' by updating the 'Five Provisions' and introducing aligned 'Animal Welfare Aims'. **Animals** **6**(10), 59; doi:10.3390/ani6100059.
28. Mellor, D.J. and Beausoleil, N.J. (2017). Equine welfare during exercise: An evaluation of breathing, breathlessness and bridles. **Animals** **7**(6), 41; doi:10.3390/ani7060041. Click on: <https://www.mdpi.com/2076-2615/7/6/41>
29. Mellor, D.J. (2018). Tail docking of canine puppies: Reassessment of the tail's role in communication, the acute pain caused by docking and interpretation of behavioural responses. **Animals** **8**(6) 82. <https://doi.org/10.3390/ani8060082>
30. Mellor, D.J. (2019). Welfare-aligned sentience: Enhanced capacities to experience, interact, anticipate, choose and survive. **Animals** **9**(7), E440; [doi:10.3390/ani9070440](https://doi.org/10.3390/ani9070440)
31. Mellor, D.J. (2020). Mouth pain in horses: Physiological foundations, behavioural indices, welfare implications and a suggested solution. **Animals** **10**(4), 572; <https://doi.org/10.3390/ani10040572>