

Improving feline welfare: The role of digital technology in pain detection

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Disclosures

- Companion Animal Veterinary Adviser Zoetis
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Agenda

- Pain as a disease
- The welfare impact
- What makes cats unique?
- Digital technology
 - Measurement
 - Detection / Recognition
 - Acute pain tools
 - Chronic pain tools
 - Benefits and Challenges
- The road ahead



Pain as a disease

“An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage” WSAVA GLOBAL PAIN COUNCIL 2022

“Emotions affect pain perception”

Monteiro B. P. (2020). Feline Chronic Pain and Osteoarthritis. *The Veterinary clinics of North America. Small animal practice*, 50(4), 769–788

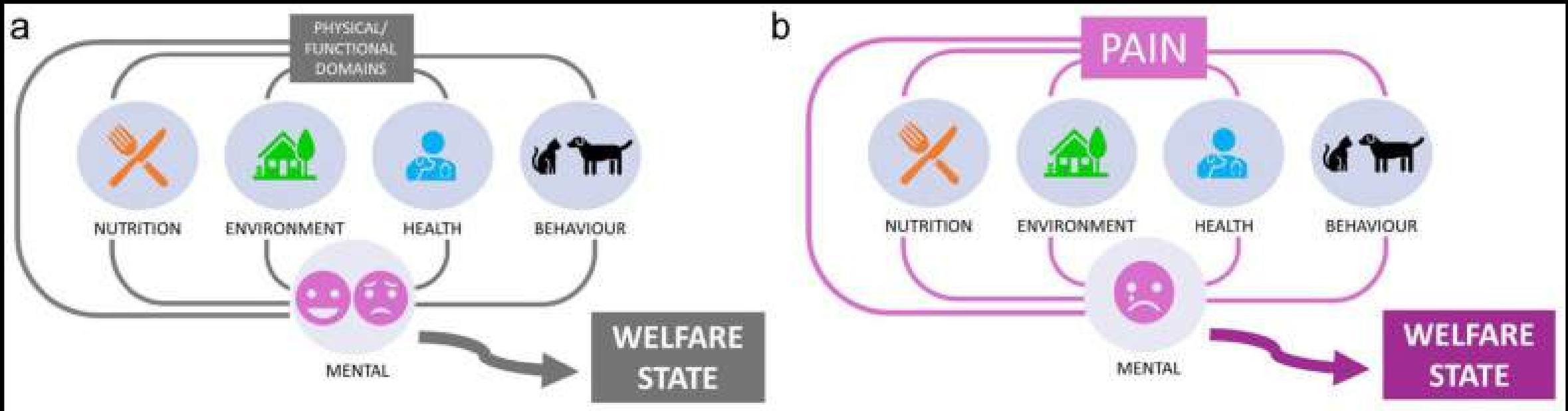


Pain as a disease

- Acute v chronic pain
 - **Acute pain** : serves a purpose, short lived , pain resolves when injury/inflammation resolves
 - **Chronic pain** : maladaptive, long standing, pain pathway modifications
 - **Chronic pain is a terminal disease for cats**



The welfare impact of pain



The welfare impact of pain



- Pain Impacts all five domains of (feline) welfare ^{2,3}
 - Appetite impacted – what, how much and where
 - Environment – need for cats to get vertical, ability to engage in object play
 - Health – immunosuppression, healing, increased morbidity
 - Behaviour – protective responses, predatory behaviour, grooming, toileting
 - Mental – decreased opportunities for positive emotions and increased opportunities for negative emotions

What makes cats unique?



- Have evolved as small mid level predators as well as prey to larger animals ¹
- Solitary hunters
- Outward demonstrations of pain attract predators- concealment advantageous
- Survival strategy is most commonly to avoid or escape conflict

What makes cats unique?



- Both caregiver and veterinary teams experience challenges in recognition
- Pain not “hidden” rather spoken in a different language
- Caregiver observations are critical to recognition ²

What makes cats unique?



- Pain, fear and anxiety closely related ⁴
- A cats' experience at the vet clinic makes it difficult to separate out these emotions for diagnostic purpose
- Management of pain is challenged by
 - Feline comorbidities
 - Negative impact of treatment on the cat caregiver relationship ⁵



Detecting and measuring pain - the “holy grail”

A system that allows pain detection that is

- Prompt
- Accurate
- Specific
- Validated
- Appropriate for use in various environments

Current use of digital technology in pain



- Measurement
 - Digital algometers
 - Ground Reaction forces
- Detection acute pain
 - Feline Grimace Scale ©
App
- Detection Chronic pain
 - Activity monitors

Measurement of pain : sensory 7,8



- Digital algometers
 - Measure sensory response to localised mechanical pressure
 - Increasing pressure applied to metacarpal and/or metatarsal pads
 - Behavioural reaction => stop applying stimulus
 - Cats with OA withdraw their paws faster than healthy

Measurement of pain-gait analysis



- Pressure sensitive walkways ^{9,10}
 - Measure ground reaction forces through gait analysis
 - Data captured for each limb including
 - Vertical forces (predominant)
 - High- and low-pressure areas
 - Stance characteristics

Measurement of pain tools

Benefits

- Specific
- Accurate

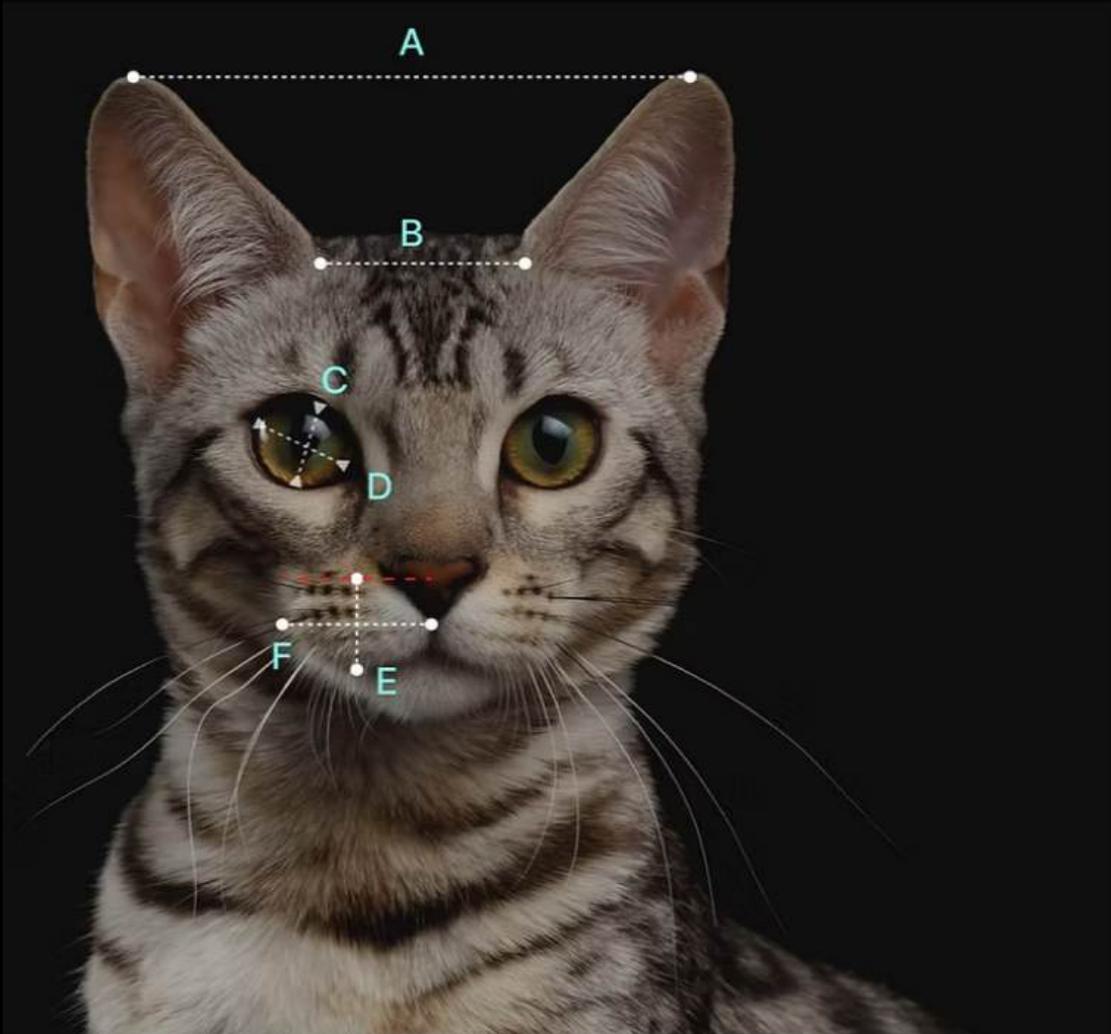
Challenges

- Does not take into account effects of central sensitisation
- Equipment
- Habituation required- time
- Impractical for routine clinical use ¹⁹



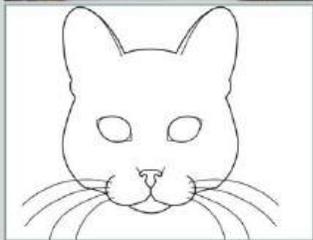
Digital technology in detection of acute pain

Feline Grimace Scale and FGS[©] App



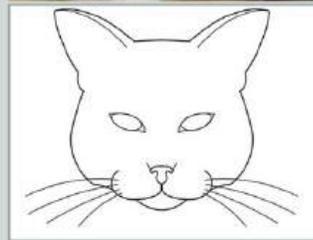
- Used widely in laboratory species : rats, mice; sheep.
- Facial expression-based scoring system for acute pain assessment
- 5 action units, scored 0-2

FGS[©] Action Units



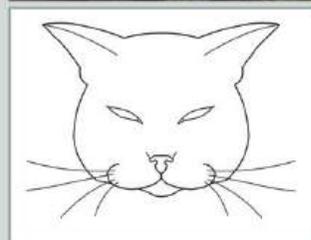
0 = AU absent

- ❖ Ears facing forward
- ❖ Eyes opened
- ❖ Muzzle relaxed (round shape)
- ❖ Whiskers loose and curved
- ❖ Head above shoulder line



1 = AU moderately present

- ❖ Ears slightly pulled apart
- ❖ Eyes partially opened
- ❖ Muzzle mildly tense
- ❖ Whiskers slightly curved or straight
- ❖ Head aligned with shoulder line



2 = AU markedly present

- ❖ Ears flattened and rotated outwards
- ❖ Squinted eyes
- ❖ Muzzle tense (elliptical shape)
- ❖ Whiskers straight and moving forward
- ❖ Head below shoulder line or tilted down (chin towards chest)

- Validated scale for use in adult cats or kittens ^{10,11}
- Reliably used by vets, veterinary nurses, students and feline caregivers ¹²
- Total score indicates if analgesia is required (>4)
- Improved analgesic management for hospitalised cats

Detection of acute pain : at home



Feline Grimace Scale App

- Used by feline caregivers to understand if their cat is in pain and when to seek veterinary advice
- Can be used reliably to assess acute pain for over 1000 feline caregivers from more than 20 countries ¹⁴
- Current Use : detection of pain using scale and app at home- “compare your cat to the image...”
- Future use : Deep learning model developed that can be used for the development of an automated, smartphone application for acute pain assessment in cats ¹⁵

Feline Grimace Scale & App

Benefits

- Validated
- Prompt
- Accurate
- Different environments

Challenges

- Acute pain only
- Front on view required for assessment
- Variation in AU sens and spec

Challenges of AI use in general

- Race between technology and science?



Detection of chronic pain

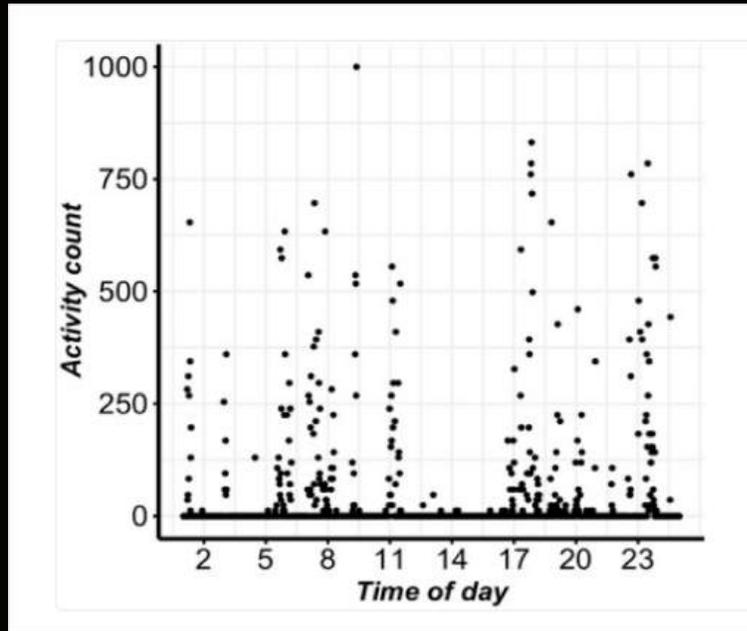
- Most common cause of chronic pain in cats
OA/DJD, dental disease, cancer
- 90% of cats >12 with presence of OA in 1+ joint²⁴
- Radiographic evaluation provides accurate assessment and diagnosis of DJD.
 - But challenges in performing radiography in a patient
 - Does not allow for assessment of pain
- Client Specific Outcome (CSOMs))
 - most reliable assessment tools currently^{6,16}
 - various validated questionnaires that focus on the presence or absence of normal or abnormal behaviour Eg FMPI, MI-CAT-c or v



Digital technology : smartphone video



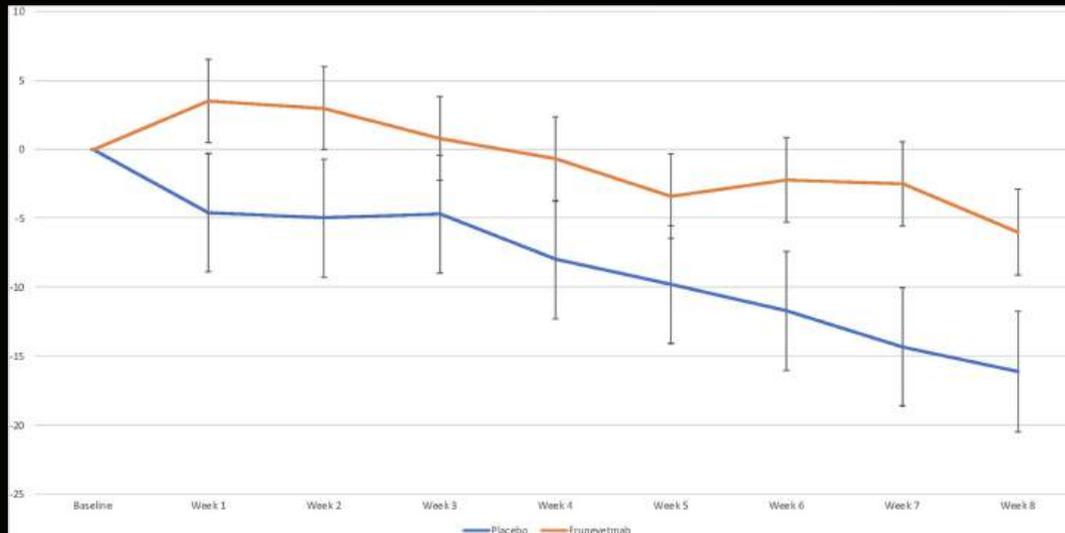
Detection of chronic pain: activity monitors^{16,17}



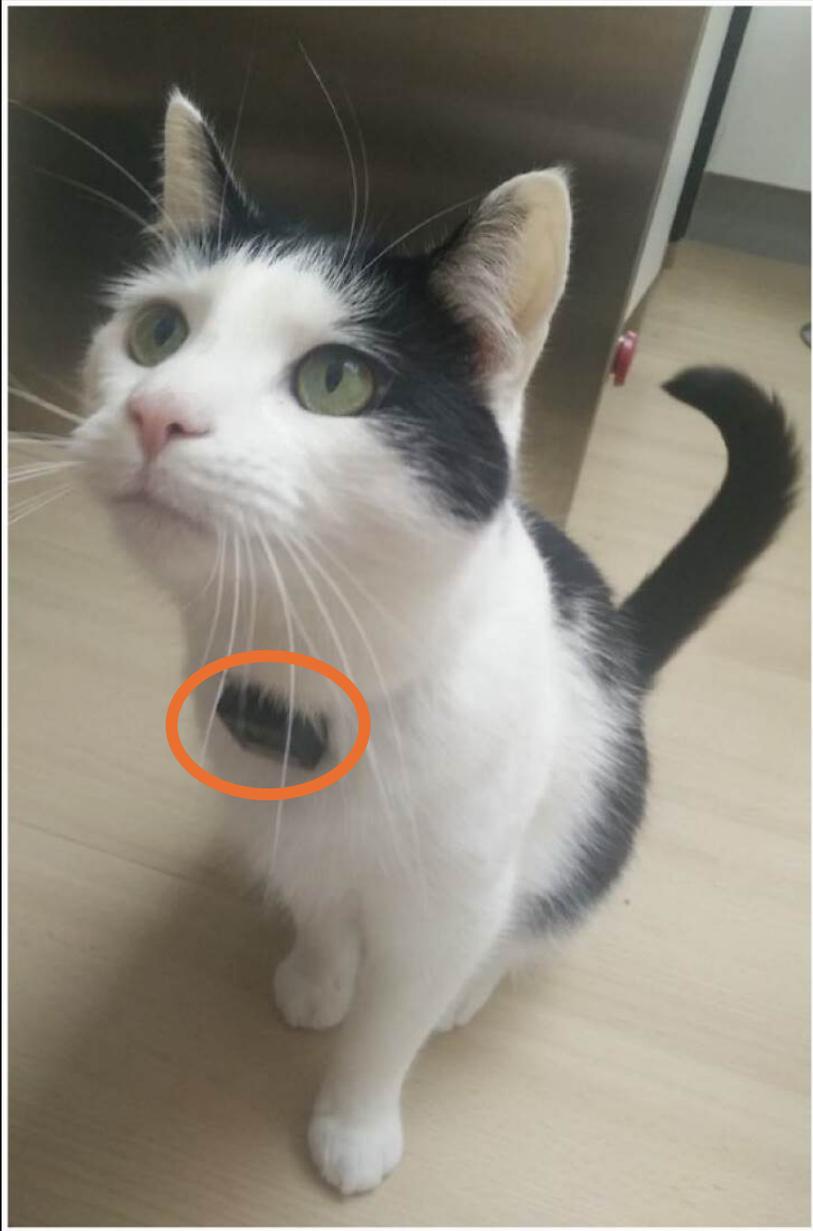
Xu et al 2021

➤ Activity monitors

- Surrogate measure of distance moved and activity
- Objective data generated in freely moving subjects over long periods of time
- Cat needs to act as its own control
- Mean activity or high volume activity data analysis



Gruen et al 2021



Detection of chronic pain: activity monitors

- Now show accuracy in recording other feline activity including jumping, grooming and rest periods ¹⁹
- Used to measure response to pain Rx (Meloxicam ²⁰ and Frunevetmab ²¹)
- Validated against owner reported observations ²²
- **Could we use to detect DJD earlier?**
 - When combined with machine learning, Montout et al suggest this is possible ¹⁹

Activity Monitors

Benefits

- Accurate
- Prompt
- Specific

Challenges

- Mean activity counts provide limited information
- Indoor versus outdoor cats
- Habituation
- Controls
- Data analysis cumbersome (ML)



The road ahead for detection of pain in cats



- Artificial intelligence pipelines for automated pain (and other emotions?) recognition in cats eg FGS ²³
- Activity monitor development with machine based learning algorithms
- Telemedicine platforms to help diagnosis at home.

Summary

- Cats experience some unique challenges when it comes to both diagnosis and management of pain
- Chronic and acute pain significantly impact their welfare and can even be terminal diseases
- Any tool that helps us to intervene earlier and reach more painful cats is highly valuable
- Digital technology promises many benefits, we need to ensure options are validated, accurate, specific and flexible



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