PAIN Pictured

Ontogeny and phylogeny of facial expression of pain

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1. Background

Facial expression of pain offers an important opportunity for better understanding, assessing, and managing pain. Certain facial muscle movements are sensitive and specific predictors of the presence and severity of pain. The facial display of pain has been found to be relatively consistent across human development (from infancy to adulthood),[11] and between humans and nonhuman animals (see below).

2. Facial expression of pain in humans

Pain assessment in humans typically relies on self-report; facial expression can be used to quantify pain in individuals who are unable to express themselves verbally (eg, infants, young children, those with verbal or cognitive impairments). This approach was made possible by the Facial Action Coding System of Ekman and Friesen,[3] which taxonomizes human facial muscle movements into "action units" (AUs). Certain constellations of these AUs reliably correspond to different human emotional states. The corresponding figure identifies the AUs most commonly associated with pain in infants (Figure A)[4] and adults (Figure B).[10] The study of facial expression of pain in infants, using the Neonatal Facial Coding System (NFCS),[4] provided objective evidence at a time when many doubted the ability of infants to perceive pain. Facial expression of pain is largely a spontaneous reflexive reaction to noxious stimuli, but is, to a certain extent, subject to voluntary control; children as young as 8 years of age are capable of manipulating their facial expression of pain.[8]

3. Facial expression of pain in nonhuman animals

A plethora of new measures of spontaneous pain have been recently developed in response to criticism that preclinical pain researchers were over-reliant on withdrawal responses.[9] Given the similar nonverbal status of infants and nonhuman animals, facial expression of pain would seem to provide a solution, especially given Darwin's[2] direct prediction of phylogenetic continuity of facial expression of emotions. Langford et al.[7] adapted the human NFCS to the mouse to create the Mouse Grimace Scale, featuring similar AUs to humans plus 2 rodent-specific changes (in whisker and ear position) (Figure C). Grimace scales have subsequently been developed for the rat,[12] rabbit,[6] horse[1] (Figure D), and cat.[5] Quantifying pain through facial expression in these species has proven to have high accuracy and reliability, is useful for indicating both procedural and postoperative pain, and for assessing the efficacy of analgesics. The approach is being increasingly adopted in both veterinary research and care.

4. Conclusions

The similarity of facial expression of pain in humans and other animals provides evidence for evolutionary psychological accounts of pain communication[13] and represents an impressive example of cross-species translation in pain research. There is a movement towards automated computerized measurement of facial expression of pain, which should eliminate some of the time burden currently associated with its use. Clinical pain continues to be undermanaged in both humans and nonhuman animals. We believe that the study and use of facial expression of pain can effectively address both problems.

The authors have no conflicts of interest to declare.

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A high resolution version version of this image is available online as Supplemental Digital Content at http://links.lww.com/PAIN/

References

[1] Dalla Costa E, Minero M, Lebelt D, Stucke D, Canali E, Leach MC. Development of the Horse Grimace Scale (HGS) as a pain assessment tool in horses undergoing routine castration. PLoS One 2014;9:e92281.
[2] Darwin C. The expression of the emotions in man and animals. London, United Kingdom: Albemarle, 1872.
[3] Ekman P, Friesen W. Facial action coding system. Palo Alto, CA: Consulting Psychologists Press, 1978.
[4] Grunau RV, Craig KD. Pain expression in neonates: facial action and cry. PAIN 1987;28:395–410.
[5] Holden E, Calvo G, Collins M, Bell A, Reid J, Scott EM, Nolan AM. Evaluation of facial expression in acute pain in cats. J Small Anim Pract 2014;55:615–21.
[6] Keating SCJ, Thomas AA, Flecknell PA, Leach MC. Evaluation of EMLA cream for preventing pain during tattooing of rabbits: changes in physiological, behavioural and facial expression responses. PLoS One 2012;7:e44437.
[7] Langford DL, Bailey AL, Chanda ML, Clarke SE, Drummond TE, Echols S, Glick S, Ingrao J, Klassen-Ross T, LaCroix-Fralish ML, Matsumiya L, Sorge RE, Sotocinal SB, Tabaka JM, Wong D, van den Maagdenberg AMJM, Ferrari MD, Craig KD, Mogil JS. Coding of facial expressions of pain in the laboratory mouse. Nat Methods 2010;7:447–9.
[8] Larochette AC, Chambers CT, Craig KD. Genuine, suppressed and faked facial expressions of pain in children. PAIN 2006;126:64–71.
[9] Mogil JS. Animal models of pain: progress and challenges. Nat Rev Neurosci 2009;10:283–94.
[10] Prkachin KM. The consistency of facial expressions of pain: a comparison across modalities. PAIN 1992;51:297–306.
[11] Prkachin KM. Assessing pain by facial expression: facial expression as nexus. Pain Res Manag 2009;14:53–8.
[12] Sotocinal SG, Sorge RE, Zaloum A, Tuttle AH, Martin LJ, Wieskopf JS, Mapplebeck JCS, Wei P, Zhan S, Zhang S, McDougall JJ, King OD, Mogil JS. The Rat Grimace Scale: a partially automated method for quantifying pain in the laboratory rat via facial expressions. Mol Pain 2011;7:55.
[13] Williams AC. Facial expression of pain: an evolutionary account. Behav Brain Sci 2002;25:439–55.

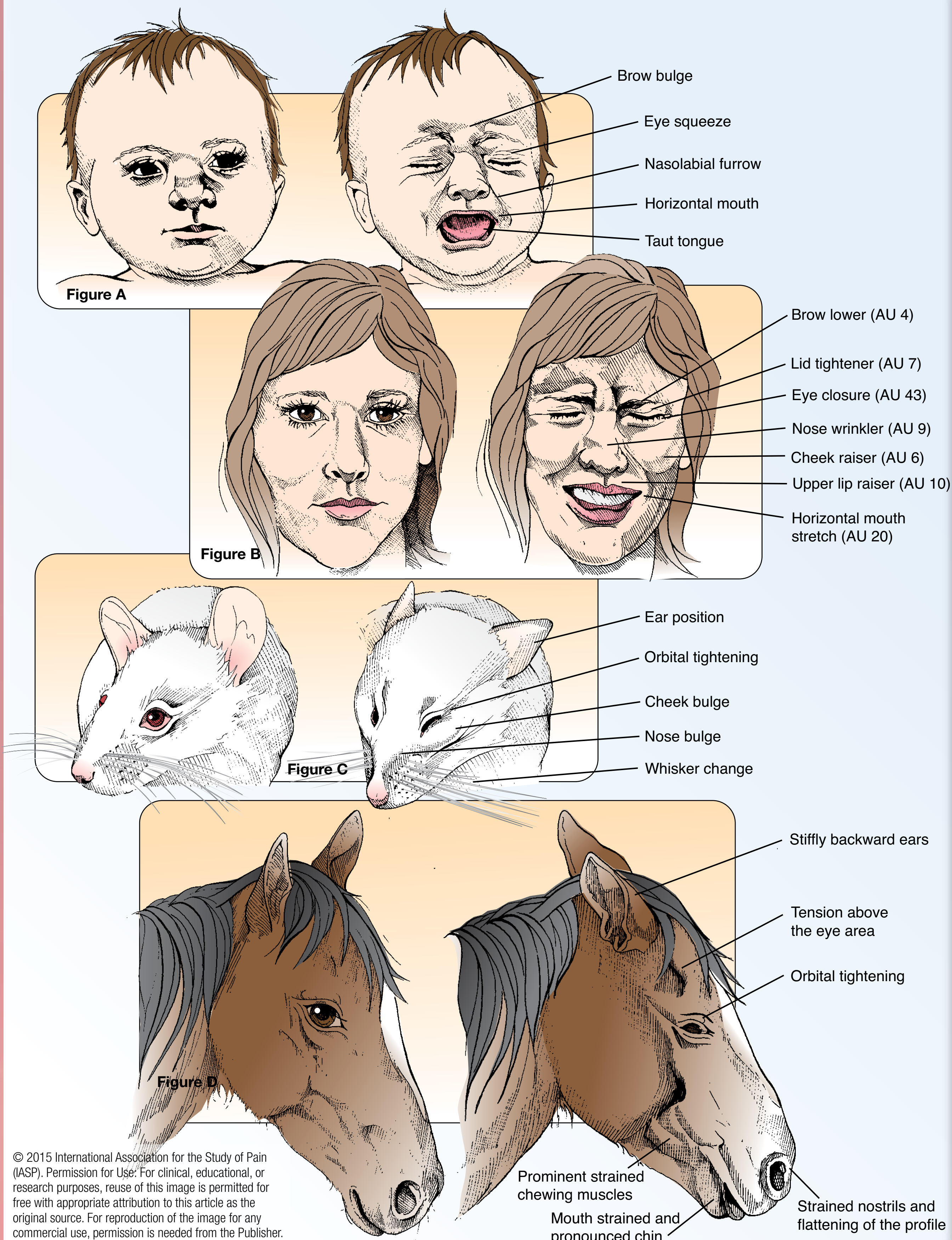
Figure A
Brow bulge
Eye squeeze
Nasolabial furrow
Horizontal mouth
Taut tongue
Figure B
Brow lower (AU 4)
Lid tightener (AU 7)
Eye closure (AU 43)
Nose wrinkler (AU 9)
Cheek raiser (AU 6)
Upper lip raiser (AU 10)
Horizontal mouth stretch (AU 20)
Figure C
Ear position
Orbital tightening
Cheek bulge
Nose bulge
Whisker change
Figure D
Stiffly backward ears
Tension above the eye area
Orbital tightening
Prominent strained chewing muscles
Mouth strained and pronounced chin
Strained nostrils and flattening of the profile