Milestones in pain development

- 4 wks: Basic structures of nervous system established.
- 4 wks: Earliest neurons in the cortex are born.
- 7 wks: Synapse formation begins in cortex.
- 8-10 wks: Spinal circuitry for pain detection is established. *The fetus is capable of reacting to painful sensory input.*
- 8-10 wks: Subcortico-frontal pathways established.
- 12-18 wks: Spino-thalamic pathways established. *The fetus is capable of mature pain perception.*
- 22-24 wks: Long-range cortical projections form.
- *25 years of age:* Cortical circuitry reaches a "mature" state.

Neural circuitry for pain perception is in place by 18 weeks

14 weeks

At this stage, pain reflexes are established and circuitry for pain perception is developing.

At this stage, circuitry for pain perception is complete.

18 weeks

20 weeks post fertilization

Pain circuitry in the thalamus is complete. Rarely, a fetus born at this age survives.

Courtesy of Dr. Colleen Mallory
Neonatology, Northwestern University

Developmental Medicine & Child Neurology 1999, 41: 364–374

Consciousness in congenitally decorticate children: developmental vegetative state as self-fulfilling prophecy

D Alan Shewmon* MD, Pediatric Neurology, UCLA Medical Center, Los Angeles, CA;
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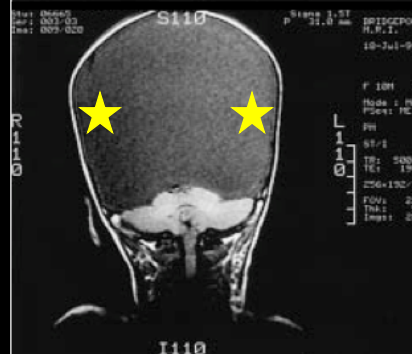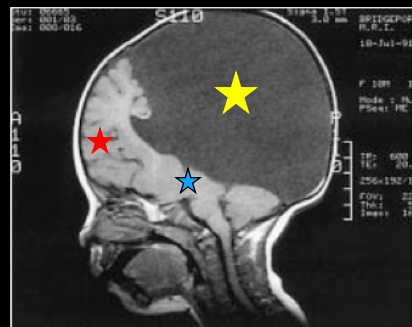
OCCASIONAL PAPER

Stimulation of the human cortex and the experience of pain: Wilder Penfield's observations revisited

Laure Mazzola,[1,2,3] Jean Isnard,[2,4,5] Roland Peyron[1,2,3] and François Mauguière[2,4,5]

- Analyzed and videotaped behavioral responses of alert patient to 4160 cortical stimulations.

- The authors note, "Pain responses were scarce (1.4%)."

- **Conclusion:** Even for adult humans, the cortex is largely not involved in conscious perception of pain. Pain perception is localized to the thalamus, *and this circuitry is in place by 18 weeks post fertilization*.

Pain Behaviors are seen in premature infants at 23 wks

Courtesy of Dr. Colleen Mallory

Brows:
lowered, drawn together

Forehead:
bulge between brows,
vertical furrows

Eyes:
tightly closed

Cheeks:
raised

Nose:
broadened, bulging

Nasolabial fold:
deepened

Mouth:
open, squarish

Facial expression of physical distress and pain in the infant

Hormonal response to pain

Courtesy of Dr. Colleen Mallory

- Stress hormones are released with needle puncture for blood draw at 20 wks in-utero:
  - 590% rise in β-endorphin
  - 183% rise in cortisol
- Pain response is identical for a 20 wk fetus, a premature infant (20-35wks) and an adult.

Why fetal pain matters for our society and for us

Baby Boy A

- We are horrified by pictures of the infants brutally killed by convicted murderer, Kermit Gosnell.
- Yet we tolerate this same brutality (and worse) for humans at 20 weeks of development
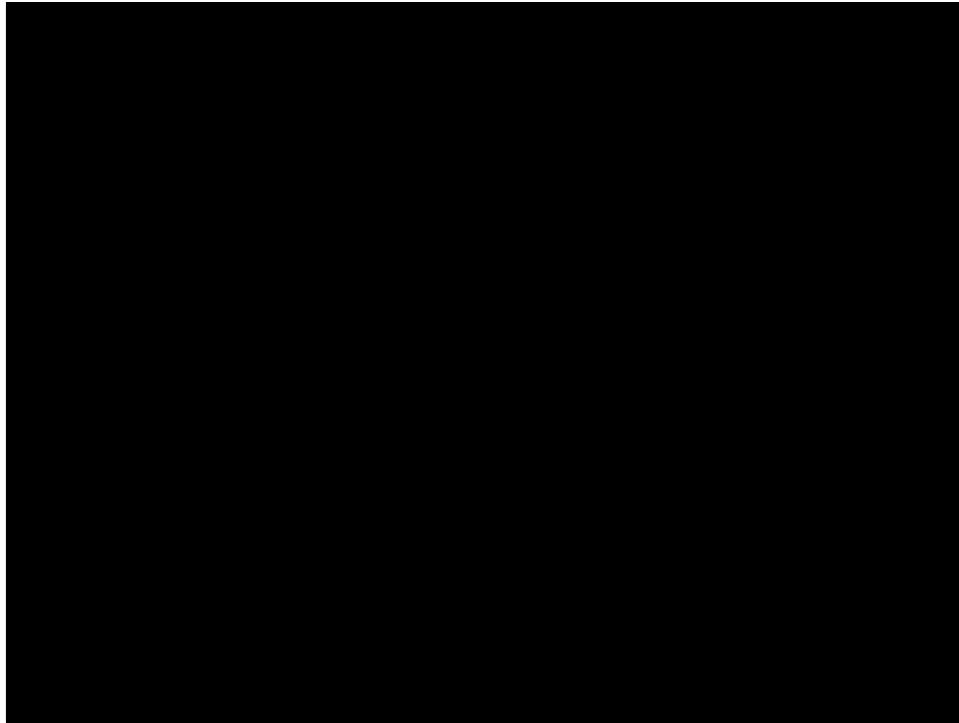
Anesthesia for fetal surgery

Elaina E. Lin, MD[a,b], Kha M. Tran, MD[a,b,*]

- ♦ "Providing anesthesia for fetal surgery is challenging for many reasons… there is little margin for error."

- ♦ Yet, the authors *do not* justify embarking on this difficult task for merely pragmatic reasons (like suppressing fetal movement). Rather, they justify use of anesthesia based on the *fetus' experience of pain.*