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Are you responding on behalf of an organisation or as an individual?

Individual

Name of organisation (if applicable):

Position in organisation (if applicable):

Profession:

Neonatologist

Please describe your interest in the questions raised by the inquiry:

I've been performing scientific research in this field for 20 years

Do you wish for your evidence to be kept anonymous? (please select)

No

Questions

1. Fetal development and activity - current state of evidence

(Please note if you only have expertise in one area of fetal development, feel free to provide evidence only for that area. For all evidence provided please provide citations. Please give fetal age in weeks from conception.)

1.1 Please provide an outline of the current evidence regarding fetal development and what age of development each milestone is likely to begin to occur.

Examples of areas that can be covered in this section: Fetal response to light, sound,

taste/smell, touch, noxious stimuli and the response that is likely to occur eg limb movement, change in pulse rate, adrenaline level, facial expression; fetal awareness and learning.

Today we know that the fetus is a pluri-sensorial being whose senses enter into action with a pre-ordained sequence: first, tactility is manifested; then the chemical; the sense of balance; hearing; and finally sight.

The early development of the senses in the uterus has a double function: that of forming the central nervous system, providing stimuli which interact with the growth of groups of neurons, directing it on a physiological path, and of introducing the unborn to the exterior world — bringing about a kind of learning in the uterus.

Already in the eighth week after conception the receivers of touch are present in the fetus in the area of the mouth, which later are extended throughout the whole surface of the body in a few months. But it is around the 22nd to 24th week when the connections will be ready with the cerebral cortex. The fetus responds to the stimuli that come through the mother's womb.

Toward the 25th week of gestation, the fetus has developed hearing. Within the uterus the mother's voice comes with much greater intensity than another's voice — or the father's! — and the fetus gets used to this voice, so much so that several experiments have shown us that the newborn is able to distinguish the mother's voice from that of a strange voice, just as it is able to distinguish the mother's scents.

This will serve to recognize the maternal milk, which has a taste and smell similar to the amniotic fluid which for nine months has soaked its tongue and lips.

Research was published in Pediatrics in 2001 which showed that at the moment of weaning the child prefers tastes that it perceived in the uterus in a certain period, although these tastes were not given to it during lactation. Therefore the fetus has memory.

This, which seemed to be only the prerogative of psychiatrists, today is the patrimony of the pediatrician to explain several phenomena.

We recently carried out a study on what happened to the children of ballerinas who during pregnancy did not stop dancing: They needed to be rocked to sleep more energetically than the others!

Moreover, what is it to rock the newborn to sleep if not to reconstruct that serene environment he had in the uterus: rhythmic movements, the mother's perfume, an indistinct voice but present and humming, darkness — but the presence of walls and limits that he would not find if left abruptly in a bed?

We demonstrated that the fetus gets used to external stimuli as a child that is already born.

We have used sonorous stimuli sent through the wall of the uterus and have measured echo-graphically how the fetus reacts, ill-at-ease, blinking his eyes and then how it gets used to the noise.

Studies on the premature newborn give increasing data on the characteristics of sleep in the uterus.

In 2000, professor Rivkees of Yale University showed the presence of a day-night rhythm from the midpoint of gestation. Today we know that from the 28th week of gestation the phases of sleep can be differentiated. From the 30th week, active sleep is present, which is equivalent to an adult's REM sleep, when most dreams take place.

Therefore nothing prevents us from saying that in the uterus the fetus has all the "instruments" to dream: an appropriate cerebral electrical activity and the presence of stimuli that will make their contents.

Sleep is also most important in the uterus because the greatest proliferation of nervous cells occurs there, and the preferential production of certain hormones.

The fetus has a world of sensations, but also of actions. The fetus responds in its own way to external stimuli. It is frightened if it hears noise; it responds to patting.

But it exercises itself for life in the open air: It does breathing exercises constantly, even when immersed in the amniotic fluid, and attempts have been registered to emit sounds visualizing the vocal cords.

It has hiccups and makes faces as though smiling or crying. Its movements respond to phases of calm or movement of the mother, and also of the amount of sugar the mother eats.

REFERENCES TO MY STUDIES:

Bellieni CV, Severi F, Bocchi C, Caparelli N, Bagnoli F, Buonocore G, Petraglia F. Blink-startle reflex habituation in 30-34-week low-risk fetuses. *J Perinat Med.* 2005;33(1):33-7.

Bellieni CV, Cordelli DM, Bagnoli F, Buonocore G. 11- to 15-Year-old children of women who danced during their pregnancy. *Biol Neonate.* 2004;86(1):63-5.

1.2 Please provide an outline of psychological, physical or behavioural examples of how life in utero might impact later life, whether childhood or adult.

Beyond what I've reported above (maternal dancing activity in pregnancy), infantile colics can be influenced by the pregnant mother's movements

Bellieni CV, Odent M, Cordelli FM, Cordelli DM, Bagnoli F, Perrone S, Buonocore G. Ante partum bed rest and unexplained infantile crying. *Minerva*

Pediatr. 2005 Aug;57(4):163-6

AND

mothers' bed rest during pregnancy can provoke motion sickness:

Bellieni CV, Bagnoli F, Perrone S, Caparelli N, Cordelli DM, Melissa B, Buonocore G. Long-term effects of antepartum bed rest on offspring. Biol Neonate. 2003;84(2):147-51

2. Fetal pain and use of analgesia - current state of evidence

2.1 Please provide an outline of the current evidence regarding fetal pain.

(Eg 4D ultrasound, EEG signals, fetal analgesia for surgery in utero, children with hydranencephaly, measurable physiological responses to needling, mesodiencephalon/CNS maturity, extremely premature babies (20 weeks) etc)

Fetuses can feel pain since the half of their pregnancy. We retrieved 217 papers of which 157 were highly informative; some reported similar data or were only case-reports, and were not quoted. Most endocrinological, behavioral and electrophysiological studies of fetal pain are performed in the third trimester, and they seem to agree that the fetus in the 3rd trimester can experience pain. But the presence of fetal pain in the 2nd trimester is less evident. In favor of a 2nd trimester perception of pain is the early development of spino-thalamic pathways (approximately from the 20th week), and the connections of the thalamus with the subplate (approximately from the 23rd week). Against this possibility, some authors report the immaturity of the cortex with the consequent lack of awareness, and the almost continuous state of sleep of the fetus.

CONCLUSIONS:

Most studies disclose the possibility of fetal pain in the third trimester of gestation. This evidence becomes weaker before this date, BUT we cannot exclude IT since the beginning of the second half of the gestation.

REFERENCES TO MY STUDIES:

1: Bellieni CV, Buonocore G. Is fetal pain a real evidence? J Matern Fetal Neonatal Med. 2012 Aug;25(8):1203-8. doi: 10.3109/14767058.2011.632040. Epub 2012 Apr 6. Review. PubMed PMID: 22023261.

2: Bellieni CV. Pain assessment in human fetus and infants. AAPS J. 2012 Sep;14(3):456-61. doi: 10.1208/s12248-012-9354-5. Epub 2012 Apr 18. Review. PubMed PMID: 22528505; PubMed Central PMCID: PMC3385812.

I also edited a book on this issue:

Buonocore G, Bellieni, CV Eds: Neonatal Pain. Suffering, Pain, and Risk of Brain Damage in the Fetus and Newborn. Springer 2017

2.2 In your opinion, from what age would you consider that a fetus:

(i) Is very likely to feel pain (>90% certainty of pain)

23w

(ii) Probably feels pain (>50% certainty of pain)

20w

(iii) Possibly feels pain (>10% certainty of pain)

19w

(iv) Is unlikely to feel pain, but is theoretically possible to (>1% certainty of pain)

less than 19w

2.3 What reasons might a fetus have for experiencing more acute pain than an adult, and to what extent might this be experienced?

2.4 As medical science advances and surgery in utero can be performed even earlier, in your opinion, what will be the earliest fetal age that consultants need not administer any fetal analgesia and give muscle relaxant only?

Since 20 wks. Please consider my studies:

1: Bellieni CV, Vannuccini S, Petraglia F. Is fetal analgesia necessary during prenatal surgery? *J Matern Fetal Neonatal Med.* 2018 May;31(9):1241-1245. doi: 10.1080/14767058.2017.1311860. Epub 2017 Apr 16. PubMed PMID: 28337942.

2: Pelizzo G, Bellieni CV, Dell'Oste C, Zambaiti E, Costanzo F, Albertini R, Campagnol M, De Silvestri A, Calcaterra V. Fetal surgery and maternal cortisol response to stress. The myelomeningocele sheep model. *J Matern Fetal Neonatal Med.* 2016;29(4):633-7. doi: 10.3109/14767058.2015.1015412. Epub 2015 Feb 24. PubMed PMID: 25708491.

3: Bellieni CV, Tei M, Stazzoni G, Bertrando S, Cornacchione S, Buonocore G. Use of fetal analgesia during prenatal surgery. *J Matern Fetal Neonatal Med.* 2013 Jan;26(1):90-5. doi: 10.3109/14767058.2012.718392. Epub 2012 Sep 27. Review. PubMed PMID: 22881840.

2.5 In your view, what will a fetus potentially experience during these procedures performed under the current published guidelines in the UK:

(i) Dilation & evacuation (used from around 15 weeks of pregnancy)

(ii) Feticide by potassium chloride (used from around 22 weeks of pregnancy)

3 Views on the law, guidance and practice

3.1 Giving reasons, in your opinion, are the current guidelines (eg RCOG Fetal Awareness 2010) relating to fetal development and activity effective:

(i) For medical practitioners?

I think that the idea that fetuses do not feel pain while in the womb, but that they feel pain as soon as they have been delivered, or that a fetus of 30 weeks does not feel pain while a premature baby born at the same gestational age can feel pain, are both difficult to accept (while RCOF does). I brought evidences on these issues:

Bellieni CV, Vannuccini S, Petraglia F. Is fetal analgesia necessary during prenatal surgery? J Matern Fetal Neonatal Med. 2018 May;31(9):1241-1245. doi: 10.1080/14767058.2017.1311860. Epub 2017 Apr 16. PubMed PMID: 28337942.

(ii) For women requesting an abortion?

(iii) For the fetus?

3.2 Please make any recommendations for changes in the following areas that you think would reflect the current evidence regarding fetal development and activity:

a) Law

b) Guidance for:

(i) Medical practitioners

(ii) Women requesting an abortion

c) Education

3.3 Giving your reasons, do you think the current systems (eg RCOG/DH) in place that develop and review guidelines on issues such as fetal development and activity are effective, accountable and impartial to outside interest? Can you suggest ways in which the current systems can be made more effective, accountable and impartial?

They need to be compared with available medical and biological literature, that show different evidence

3.4 In what ways can you suggest improvements in reassurance to mothers requesting a late term abortion that their fetus will not suffer in terms of:

(i) Fetal pain

(ii) Being born alive after abortion

3.5 In what ways can you suggest to improve data collection and reporting on abortions (including, but not limited to, fetal pain and babies being born alive after abortion)

3.6 In your view, are there any useful precedents for abortion legislation or professional guidance reflecting evidence on fetal pain, awareness and physiological responses from other jurisdictions?

Yes

If yes, please specify:

In USA, but I have not sufficient data

3.7 Do you have any personal examples or experiences relating to fetal development and activity that you would like to communicate to this Inquiry?

If you want to read the papers I have quoted above, you'll find data and information. If you need their full-texts, do not hesitate to ask me.