Handouts for Lecture 3

Frontal Lobes - Progressive Cognitive Control
Babies & Toddlers*

- With the development of the prefrontal cortex there is a gradual overseeing and regulation of the behavioral responses initiated by the more ‘primitive’ parts of the brain (e.g. limbic portion, sensory, motor)
2Babies & Toddlers- Piaget*

• Four main ‘stages’ of cognitive development
• 1/Sensorimotor (birth-18months) - learning to represent the world internally
• 2/Preoperational or symbolic (18 months-7 years) - learns to differentiate self from external world
• 3/Concrete Operations (7-11 years) - emergence of logical thought
• 4/Formal Operations (11-+ years) - ability to think abstractly
Piaget – Sensorimotor

• Birth-18 months
• Throughout this period babies know the world through motor activities and sensory impressions.
• At beginning of this period babies have not learned to use mental representations - Out of sight - out of mind.
• By 8 or 9 months this changes - search for a hidden object.
• Object permanance - the understanding that objects continue to exist even after they are no longer seen.
• In blind children also present but based on touch.
Piaget – Sensorimotor*

- Birth-18 months
- What, if any, early or precursor executive (prefrontal lobe) function can be seen in this period?
- Bear in mind that the prefrontal lobes play a central role in generating cognitive strategies as opposed to habits, evaluating these strategies, monitoring both one’s own behaviour and the effects of one’s behaviour on other people.
- Initiation of a motor response
- Degree of attention
Piaget – Sensorimotor*

• Birth-18 months

• Babies tend to have larger right hemisphere from birth to second year and then left hemisphere catches up.

• Typical behaviour at this age - e.g. Importance of touch, spatial relationships when beginning to crawl
Piaget - Preoperational or Symbolic Stage*

- 18 months - 7 years
- Begins to represent things with something else (e.g. drawing) - mental representations of objects and events
- Language develops, thinking in words
- Make believe plays, pretending to go to sleep
Piaget - Preoperational or Symbolic Stage*

- 18 months - 7 years
- Important cognitive activities that are still not present or quite immature
- Egocentric - difficulty in understanding that other people may perceive the world differently (ostrich effect)
- Lack understanding of relational terms - darker, larger
- Lack conservation - physical attributes stay unchanged even if appearance changes - e.g. put an equal amount of water into a glass tumbler and a tall thin glass - if asked whether both contain the same amount - will say no. Another example - round piece of clay, flatten it in front of child - ask whether it still contains the same amount of clay - child may answer ‘no’
Preoperational or Symbolic Stage*

- 18 months - 7 years
- What executive functioning (some in immature forms) is appearing during this stage?
- Again, bear in mind that the prefrontal lobes play a central role in generating cognitive strategies as opposed to habits, evaluating these strategies, monitoring both one’s own behaviour and the effects of one’s behaviour on other people.

- More sustained attention
- Expressive language
- Initiate activity, anticipation, humour, working memory, planning & organization
- Reading
Piaget - Preoperational or Symbolic Stage – Reading

- fMRI studies have shown 3 neural pathways for reading
- Two slower, analytical ones for the novice reader
- parietal-temporal - analyzes a word pulling it apart.
- Broca’s area in ventrolateral frontal region articulation, linking letters to sound and word analysis
Once child has correctly read a word several times the neural model for hat word is stored in the occipito-temporal region.

This is the express pathway used by a skilled reader.

The whole word is seen as a pattern (including spelling, pronunciation & meaning).

For an experienced reader, seeing a word in print activates the word form and all relevant information automatically.

So, once again, as things become automatic- the frontal lobe’s role is diminished.
Piaget-Concrete Operations*

• 7-11 years
• Gained understanding of conservation
• Characterized by child’s ability to mentally manipulate concrete ideas such as dimensions of objects - seriation - putting objects in order of size
• Understand reversibility - the fact that many physical changes can be undone by reversing the original action
Piaget-Concrete Operations*

- 7-11 years
- What new executive functions are appearing during this stage?
  - Awareness of consequences of action and anticipation of consequences
  - Beginning of thinking strategically
  - Monitoring and evaluating performance
  - Some degree of flexibility
  - Greater attention and beginning inhibition of interfering behaviour
Piaget - Formal Operations*

- 12-+ (adult)
- Children become capable of hypothetico-deductive reasoning
- When faced with a problem they can formulate a general theory that includes many or all possible factors
- From this they reason deductively to formulate specific hypotheses which then can be tested based on existing or acquired evidence
Piaget - Formal Operations*

• 12-+ (adult)
• What aspects of executive functioning are now present?
  • planning and organizing to achieve the goals
  • initiating behaviour toward achievement of goals
• inhibiting behaviour that would interfere with achieving the goals
• maintaining sustained attention
• monitoring and evaluating performance in relation to the goal
• integration of past and new information (working memory)
• solving problems flexibly if obstacles (foreseen or unforeseen) arise
• thinking strategically
Welsh (1991) E.F. factors identified in normative sample

Anatomical underpinnings:

- Speeded Response (reaction time); performed well at 6 years of age
- Areas 4 & 6 (motor)
- Areas 9 & 46 and medial to those areas
- Updating & Maintenance of information (working memory); performed well at 10 years of age
- Areas 44, 45, (ventrolateral)
- Planning (including inhibitory control); performed well at adolescence
- Areas 10, 11 (orbitofrontal) and medial to those areas
Adolescents/teens & Frontal Lobe*

• Before going on to discuss particular teen behaviour and an ‘immature’ prefrontal cortex lets reiterate ‘mature’ aspects of executive function-keeping in mind a teenager’s behaviour
• Focusing attention
• Organizing thoughts and problem solving
• Foreseeing and weighing possible consequences of behavior
• Considering the future and making predictions
• Forming strategies and planning
Adolescents/teens & Frontal Lobe*

- Ability to balance short-term rewards with long term goals
- Shifting/adjusting behavior when situations change
- Impulse control and delaying gratification
- Modulation of intense emotions
- Inhibiting inappropriate behavior and initiating appropriate behavior
- Simultaneously considering multiple streams of information when faced with complex and challenging information
Teens and Risk Behaviour*

• Without the prefrontal cortex's executive functions to inhibit impulses, weigh consequences of decisions, prioritize, strategize, separate fact from opinion, weigh the validity of information, and analyze risk, teens make decisions based on emotional, reactive, rather than logical, reflective, responses.

• Until these networks are mature, things adults consider obvious and even dangerous may not be interpreted that way by the still incomplete frontal lobes of teenagers.

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