Introduction

Organisation of behaviour and experience is required for intelligent, aware planned action. Without it, chaotic behaviour would be the only result, as appropriate or effective behaviour would not be possible.

Executive function – EF – the high level cognitive functions enabling individuals to plan, initiate and act out goal-directed behaviour in an organised, thought-out manner. Reflects **Fodor**'s model – basic low-level cognitive modules (e.g. processing of sound, vision) feed higher level, executive functions such as planning, organising, integration etc.

Important from a developmental perspective as:

- Executive control of actions develop – babies have little control; a 10 yr old has a great deal
- Impairments in control are likely to contribute to behavioural problems – knowledge of this can lead to effective intervention
- Understanding of capacities at different ages is key to developing effective teaching strategies. Deficits may underlie learning difficulties. Understanding leads to better targeting of remedial support.

History and Definition

'Simon says' game shows errors occur that are automatic and beyond conscious control. Children that don't make errors therefore demonstrate a greater level of executive control.

Cognitive psychology distinguishes between two types of human action:

- Habitual actions – e.g. driving to work – require automatic responses and little conscious processing
- Adaptive responses to novel situations – e.g. driving while abroad – effortful control needed

Book 3 Chapter5 – Executive functions in childhood: Development and Disorder

Executive function is an umbrella term for the processes needed to support effortful control. Specifically, it is argued that it is needed for:

- Learning new skills
- Planning / decision making
- Error correction / troubleshooting
- Starting a novel sequence of actions
- Dealing with danger or technical difficulty
- Conscious moment by moment control
- Overcoming strong habitual responses

'Simon says' game requires the last two. To succeed at the game, conscious control of behaviour is required and the habitual copying response needs inhibiting.

Early distinction between automatic and controlled actions – **James** – went to change clothes and got into bed instead.

Automatic does not imply simple – driving a car is a complex activity that becomes automatic with practice.

Controlled actions differ from automatic ones as:

- The execution of a novel sequence of actions is required to be performed
- A choice needs to be made between alternative responses
- The execution of such acts are accessible to consciousness

Executive function is of interest to clinical psychologists – i.e. the study of the effect of injuries on the brain. Damage to the prefrontal cortex => impairment to plan and perform abstract thinking plus changes in personality. Case of Phineas Gage is an illustration; recovered from his accident with speech, learning and memory intact but his social behaviour was greatly impaired – he was 'no longer Gage' (**Harlow**).

Executive function is not a single cognitive function but is a set of related ones – EF is ***fractionated*** (**Shallice and Burgess**). Many different models of EF, but distinctions are made between:

- Cognitive flexibility
- Planning and working memory
- Inhibitory control

Cognitive Flexibility: the ability to orchestrate different elements of cognition and behaviour (**Cavanagh & Perlmutter**). Example – reading; automatic at times for skilled readers; at other times more effort is required to assimilate the text. For young readers, demands on executive control are high as cognitive resources are required to decode the text at the expense of extracting meaning. **Baker and Brown** showed that this can be so effortful that young readers often do not realise the aim is to extract meaning from the words.

Planning and Working Memory: - planning is something done to achieve a goal.

e.g. Communicating something difficult to someone requires a plan, and then the ability to adjust that plan in accordance with their reaction. Without the ability to make those adjustments, the communication is not likely to be effective.

Hughes et al – study into antisocial behaviour, communication skills and EF. 40 'hard to manage' children cf. 40 control children. Aged 3;6- 4;6.

- Video taped and coded play with a friend for social & communicative behaviour
- Verbal ability, EF and ToM tests – one of the EF tests was the Tower of London task.

Findings were:

- In the 'hard to manage' group there were significantly more instances of ASB and more violent pretend play.
- ASB correlated to poorest communication skills when playing with a friend.

- Violent pretend play and ASB significantly correlated with performance on Tower of London (**Shallice**) task – poor performance => high level of ASB

Study therefore suggests planning skills, play and communication skills are inter-related.

Development of Executive Function

EF used to be thought as being mainly relevant to adults due to the rate at which the prefrontal cortex develops – **Luria (1973)** argued it only became mature in adolescence. However, more recent research suggests this is not the case.

Inhibitory control is one aspect of EF development that has since been studied in children.

Inhibitory Control: Is important, as the ability to focus on a task and shut out distractions is key to activities like study. Involves the prioritisation of stimuli, inhibition of irrelevant stimuli to enact a plan of study, with a goal of finishing it.

Some young children have EF related disorders that mean they find it difficult to prioritise and so are less able to complete tasks. They are unable to inhibit response to *prepotent* stimuli.

Prepotency is important in everyday life – e.g. a red traffic signal; mother's breast for an infant.

Psychologists are therefore interested in the way children develop the ability to inhibit responses that are nothing to do with their current plan of action. As they do this, behaviour becomes less haphazard and more strategic and *organised*.

Stroop task is an example of inhibitory control, but requires reading skills. The handgame and knock/tap have been developed to minimise the need for such skills and still allow the study of inhibitory control in younger children. Both tasks based on work by **Luria**.

Measuring its development: is difficult. Structured observation is one method – e.g. **Diamond** – 0;8-0;11 – observation of problem solving tasks like taking an object from a box. Concluded 0;9-0;10 infants showed evidence of inhibitory control.

Piaget – A not B task – unclear if it is the prepotent stimulus of having first found the object under cloth A that keeps drawing the child back to it, even though they saw it put under cloth B => lack of inhibitory control or if they are unable to switch their strategy => lack of cognitive flexibility. By 1 year, they are able to perform the task so if cloth A is a prepotent stimulus at first, it does not remain so.

Drewe – Go/NoGo task – press spacebar on a computer keyboard whenever a letter is displayed (Go) unless it is an X (NoGo). 'Simon says' is an equivalent task. Failure not to press the spacebar => lack of inhibitory control. **Mahone et al** in a study of 87 children found ability to inhibit improves between ages 3 and 6, thought 3 year olds only tend to make a few mistakes.

More complex tasks (**Luria**'s Day/Night, Handgame, Knock/Tap) require not only the inhibition of a response but to execute a rule guided action. Nearly all 3 year olds fail these tasks but the majority of 4 year olds pass.

fMRI scans (**Casey et al**) show children and adults have similar activation patterns in the prefrontal cortex when performing the Go/NoGo task. However, more activation was present in children – probably due to greater demands being placed on their EF to complete the task. Increasing skills => decreasing activation in the prefrontal cortex. Greater activity in the prefrontal cortex => greater accuracy of performance.

Inhibitory control in child development: it is possible to ask at what age it becomes impossible to distinguish a child from an adult rather than when development is 'complete'.

Chelune and Baer – report steady improvement on the **Grant and Berg** WCST from 6 years of age onwards; adult levels achieved by age 10. Results replicated in other studies **Levin et al, Welsh et al**.

The development of any skill shows that more conscious effort is required at first, and hence places greater demands on EF. Paradoxically, EF is least well developed in young children – the people who need it most to develop new skills.

As EF develops, children's abilities to learn new skills improve. They stay 'on task' longer. They are able to inhibit responses to prepotent stimuli. They are able to orchestrate elements of thinking and behaviour. They are able to become better at planning and decision making.

Executive dysfunction

If the development of EF is impaired, the consequences are:

- A requirement to understand the experiences and needs of children and adults directly affected
- Investigating dysfunction increases knowledge of the cognitive processes at work and what contribution they make to typical development.

This section concentrates on problems in inhibitory control, but EF dysfunction also takes the form of cognitive inflexibility, planning difficulties and working memory problems.

Lack of inhibitory control is more apparent in later childhood (as it is a feature of early childhood). One group who have difficulties in this area are those with Attention Deficit Hyperactivity Disorder – **Barkley**.

ADHD – three subtypes:

- Distractibility
- Hyperactivity
- Impulsivity

Difficult to diagnose before age 6. Distractibility and Impulsivity likely to be strongly related to poor inhibitory control. As it is not an 'all or nothing', there is a continuum from typical development to a condition such as ADHD – we all have problems in inhibiting stimuli at times. Good evidence exists for executive dysfunction being involved with ADHD. Brain structure – delayed myelination in the prefrontal cortex and depletion of dopamine – **Levy and Swanson** fMRI shows reduced prefrontal activation for those with ADHD when performing the Go/NoGo task – **Rubia et al.** Cognitive Function – 24 boys with ADHD on an aged-normed test battery of attention and executive function showed global deficits, but especially in tests of sustained attention and suppression of prepotent responses – **Manly at al**. The same findings are not present in groups of 'hard to manage' children – **Brophy et al**. Much debate as to whether inhibitory control problems cause ADHD or are simply one feature of the condition. Regardless, it has a profound affect on children's social, emotional and cognitive development – all strongly associated with poor inhibitory control. *Tim Holyoake 2009, http://www.tenpencepiece.net/*		