Developing a Paediatric Neurocognitive Intervention Model:
Accommodating emerging evidence from neuropsychological, developmental and systemic approaches

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❖ Introduction:
Paediatric Neurocognitive Interventions (PNI) draw on several fields of complex scientific and clinical endeavour. Current models tend to focus on neurocognitive variables OR psychosocial ones, rather than integrating the two. The model presented here aims to provide clinicians and researchers with a systematic approach to deliver and evaluate appropriate care whilst minimising the obstacles to successful outcomes, by:
- Mapping neurocognitive mechanisms that need to be addressed
- Highlighting systems and resources that need to be considered before and during PNI

❖ Developmental Factors:
- Current theories of typical development indicate that the maturing brain is self-structuring, with dynamic and cyclical change processes. Multiple interactions at multiple levels result in interdependent development of different cognitive functions (e.g., Goswami, 2008).
- Development is, therefore, difficult to categorise into specific stages or sequences but a model that assumes some of these processes is necessary to guide rehabilitation hypotheses.
- A child's goal is to reach maturity, therefore, adult models of cognitive function can be helpful. For example, Shallice and Cooper's (2011) model can help us consider the reliance of 'higher order' skills on more fundamental processes.

- *Shallice and Cooper's (2011) model highlights the inter-dependence of cognitive skills in adults. They describe a 'cognitive computational engine' which comprises three basic aspects: i) semantic elements in thought, ii) short-term retention, buffers, priming and working memory, and iii) operations.*
- *Additional highly specific properties such as supervisory systems processes, episodic memory, thinking and consciousness are then added on to this 'cognitive computation engine'.*
- *In PNI we can use this model to ask at relevant developmental stages "if an intervention for high-order skills is not effective, is it because a more basic aspect of the 'engine' is impaired?"*

❖ Current Paediatric Rehabilitation Frameworks:
- World Health Organisation – International Classification of Functioning, Disability and Health – Children and Youth (2007): provides a framework for considering components of care that are essential for rehabilitation
- Paediatric neuropsychology approaches (e.g. Byard *et al.*, 2011; Wright & Limond, 2004) describe psychosocial and neurocognitive needs specific to children.
- However, there are currently no models that provide a structured progression to guide clinical/research decisions of how to prioritise intervention targets.

❖ Proposed PNI Model:
Consistent with Shallice and Cooper (2011), this model hypothesises that the success of higher level interventions is dependent on lower level skills being as close to age appropriate as possible.
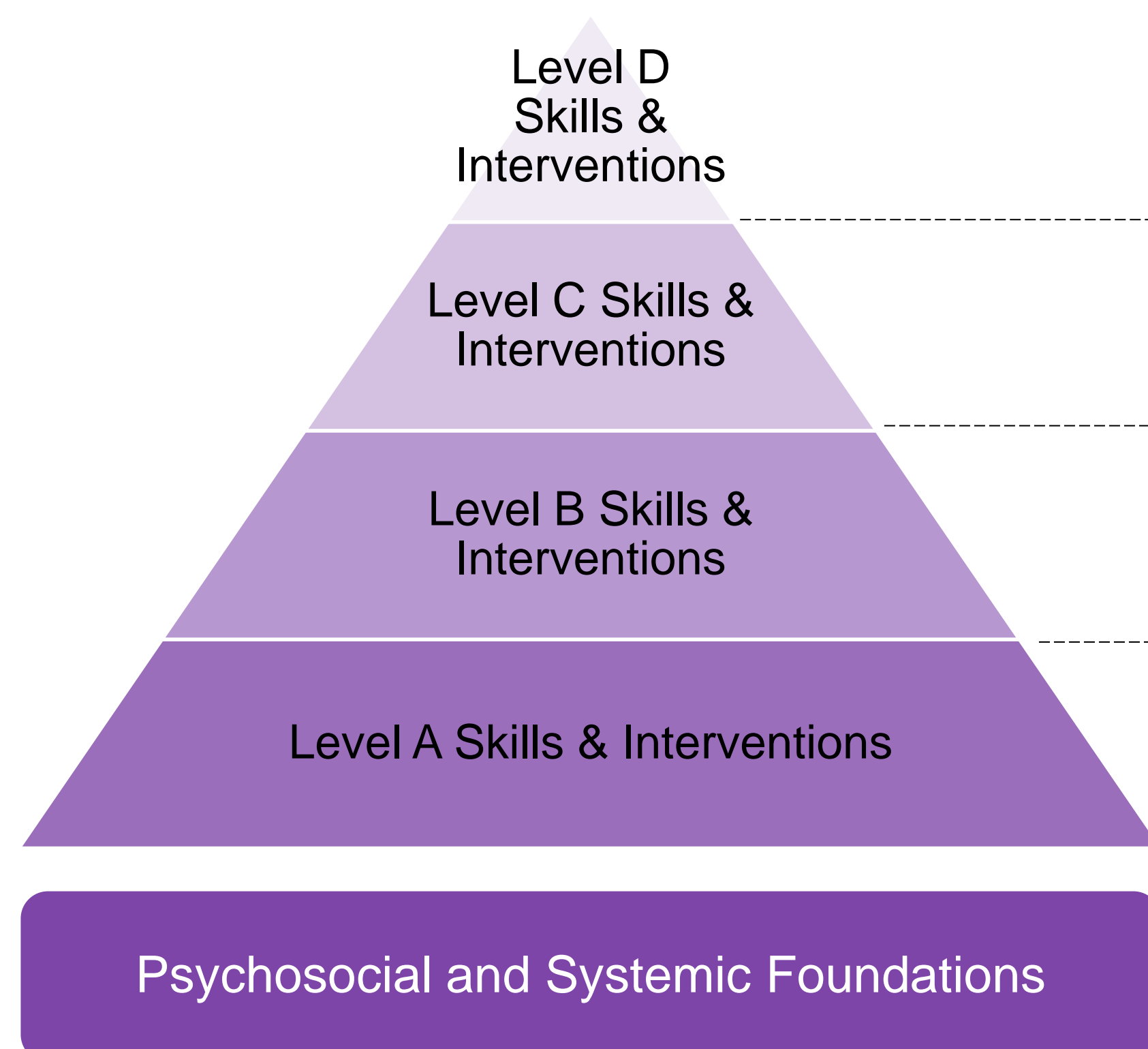
Cognitive Skills/Impairments	Intervention Aim	Intervention Examples
Specific cognitive skills e.g. episodic memory, visual processing, language skills	Compensatory strategies to be used independently	Training in use of e.g. mnemonics, retrieval strategies, visual compensation
Evaluative skills e.g. metacognition, supervisory processes and reasoning	Training to support general cognitive functioning	Training of e.g. goal management skills, prospective reminding, "stop and think"
Core skills e.g. working memory, inhibitory control, processing speed and sequencing	Remediation of skills	Intensive practice e.g. working memory, attention processes, and speed training
Semantic knowledge, adaptive functioning and specific cognitive skills (e.g. episodic memory)	Compensatory strategies cued and supported by others	Providing techniques e.g. precision teaching, errorless learning, elaborative encoding and rehearsal

Psychosocial and Systemic Foundations - Supporting health needs, sensory impairments, pragmatic and social care issues (e.g. visual processing, diet, exercise, financial and practical resources). Addressing systemic factors (e.g. family chaos). Ensuring positive behavioural support for challenging behaviour. Accessing parenting skills training to ensure development of emotional competence. Providing psychotherapy for mood disorders.

❖ Using the PNI Model through Childhood and Adolescence:

Case Vignette
Severe traumatic brain injury at 10 years, adaptive functioning equivalent to 5 years.
Verbal IQ – low / low average
Performance IQ - low
Working Memory – exceptionally low
Processing speed – exceptionally low
List Learning - low
Delayed Memory – exceptionally low
Delayed Recognition – low average
Selective attention - average
Sustained attention – low average
Dual attention – low
Switching – exceptionally low
Inhibition – exceptionally low
Fluency – exceptionally low
Planning – exceptionally low
Problem-solving - low

Figure adapted from Savage, 2007, North American Brain Injury Society conference

(Time point 1; age 11 years)
Psychosocial support - for family and school to adapt to changes in expectations, managing challenging behaviours and supporting environmental adaptations.
Level A - interventions addressing adaptive functioning, re-establishing knowledge base and supported episodic memory
Level B - processing speed training (challenging behaviour prevents working memory training)

(Time point 2; age 13 years)
Psychosocial support – for child to address comparisons with peers and anxiety. Liaison with school and family to support environmental adaptations.
Level A - adaptation of earlier strategies, introduction of more complex supported strategies
Level B - working memory and processing speed training
Level C - self-regulation and impulse control interventions

(Time point 3; age 16 years)
Level C interventions for metacognitive and self-regulation skills.

(Time point 4; age 18 years)
Psychosocial support - adolescent and family adapting to the impact of increasing independence and changes in roles (e.g. mother as main caregiver facilitating independent routines and new experiences).
Level B - working memory and processing speed
Level D – independent episodic memory strategies

❖ Conclusions:
This model has been evaluated by several paediatric neuropsychologists who report good face validity. It is presented here as a working model for clinicians and researchers.
Future research aims to - establish cognitive processes of normal development and maturation.
- test predictions/hypotheses from the PNI model e.g. successful level B interventions require level A skills; define and measure obstacles and outcomes.
- evaluate individual differences e.g. emotional, gene and stress factors, to consider their effects on successful outcomes of interventions.

❖ References:
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