The Brain, Learning and the Early Years

Executive Summary:

Within an early years (EY) setting:

- The quality of children's interaction with adults (and other children) is a critical issue that predicts their later school readiness, especially "teaching for learning" interactions that also **train regulation and attention**
- A scientific understanding of learning amongst teachers and carers can help support these interactions (as an act of **engaging, constructing** and **consolidating**)

The importance of early teaching and learning in the early years

What is quality in early years education and care? There are many ways to think about this and many views and opinions. However, one way to measure it might be to identify what features of pre-school education and care appears to influence later achievement in school. In the UK, the EPPE project tracked 3000 children in 141 settings, from ages 3 to 7 years(Sylva et al., 2004). They found the following factors predicted school readiness:

- **Qualification** of staff, proportion of **trained** teachers on the staff.
- Warm **interactive relationships** with children
- Settings that view **educational** and **social development** as complementary and equal in importance
- Interaction traditionally associated with the term **"teaching"**
- Provision of **instructive learning environments**, '**sustained shared thinking**' to extend children's learning.

Apart from an early start to acquiring curriculum, there is another good reason why very young children benefit from high quality "teaching-like" interactions with adults. These types of experience encourage the development of basic mental abilities of attention and emotional regulation. These skills are foundational for future learning.

When teachers were asked what school readiness really meant to them, their responses could be summarised as

- communicate wants and needs verbally,
- be enthusiastic and curious in approaching new activities,
- pay attention and not be disruptive
- be sensitive to other children's feelings

All these abilities require self-regulation, which is the ability to monitor and inhibit one's own emotional arousal. Children are not born self-regulated and it is something they need to learn through experience and practice. These teachers' opinions align with our scientific understanding of how important self-regulation is for classroom learning. Classroom learning is very different to simpler types of learning – such as learning to be frightened of something or learning to associate a particular behaviour with a reward. These simple types of learning can be achieved by many other animals and, generally speaking, the more emotionally aroused you become the more you learn (see Fig. 1). Classroom learning, on the other hand, requires more of a balanced emotional state. You need to be sufficiently aroused to be attentive and alert, but too much emotion reduces the ability for higher reasoning and thought.

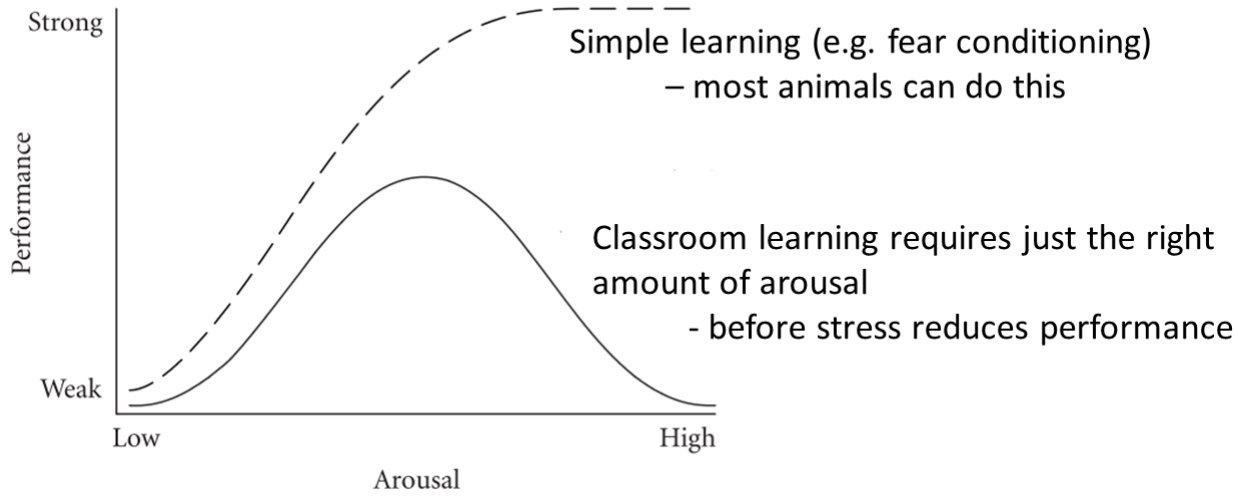


Fig. 1 Different levels of emotional arousal are optimal for different types of learning.

Children also develop their attentional skills from an early age. Researchers have shown that infants will occasionally notice their parent looking toward what she is holding (see Fig. 2), and will then tend to look in that direction(Deák and Triesch, 2006). It is known that in children, as well as adults, spontaneous joint attention activates those brain regions that process reward and are bound up with our motivation (Oberwelland et al., 2016). This supports the idea that acquisition of eye-gaze following – a key social skill that can lead to shared attention – is achieved through interaction in the first 1-2 years of life with a care giver. (Triesch et al., 2006) (see Chapter 3). When we have learnt to gaze follow, then we can much more efficiently learn from a potential teacher – and begin to learn, for example, the beginnings of language.

Fig. 2 Infants will occasionally notice their parent looking toward what she is holding, and will then tend to look in that direction (Deák and Triesch, 2006). This helps form the basis of a shared attention to learning.

These very early attentional skills provide the basis for shared attention, allowing the child or the teacher/parent to initiate periods of shared attention – which are fundamental for learning from another. The more episodes of shared attention are experienced, the more a child develops their skills to pay attention and learn from another.

When a child has developed sufficient understanding to communicate, their care-givers can practice interactions that "teach for learning". These further train attention and emotional self-regulation in readiness for school and the world of formal leaning.

Teaching for Learning

Teaching for learning involves purposefully interacting with a child in order to encourage learning. A simple framework for teaching for learning might comprise three types of event. The learning process can be assumed to begin with engagement of the child's interest before scaffolding (helping) the child to construct new thought that builds on what they know already. These fresh ideas will be temporary and effortful until they become established through practice and rehearsal. Therefore, these elements might be represented diagrammatically as below in Fig. 3:

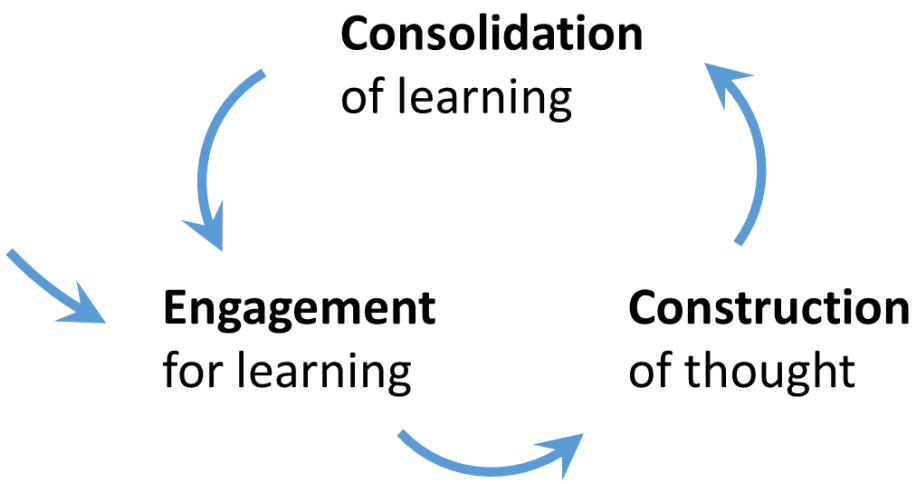
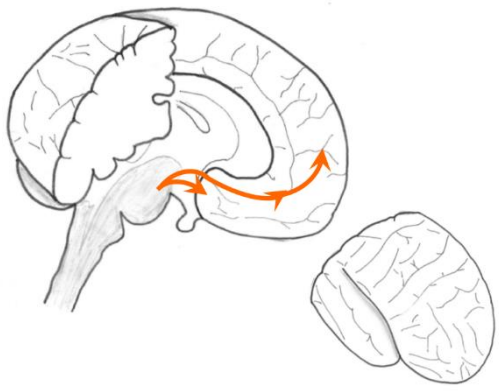


Fig. 3 Teaching for learning can be considered to begin with engagement of the learner, helping the learner construct new thoughts and then supporting their consolidation of this learning through appropriate practise and rehearsal. In reality, learning can be more considered as a constant cycle of engagement, construction and consolidation.

The brain science of teaching for learning

The brain processes involved with engagement, construction and consolidation develop throughout childhood.

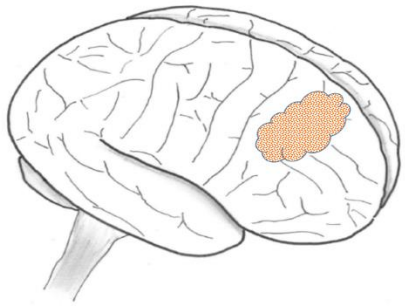
Engagement often involves an emotional response to a particular situation, topic or context. A positive "approach" response in the brain can be triggered by various features of a situation. For example, this can happen by simply sharing attention with someone else, or noticing some novel aspect to a situation, or anticipating praise. Emotional response can involve the activation of pathways that begin deep in the brain but which influence regions critical for learning and for attending to new information.



Our emotional and attentional response to a potential learning experience can involve activation of pathways that begin deep in the brain – but which end up influencing the function of our frontal cortex – which is essential for learning ……

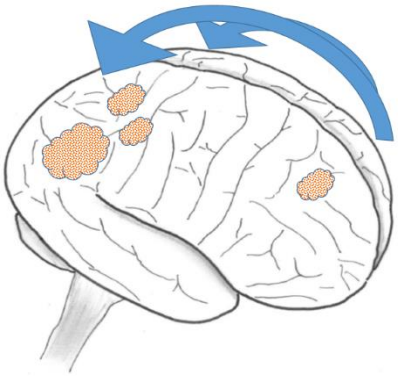
The ***construction*** of meaningful new thoughts and ideas requires children to build upon whatever knowledge they possess already (prior knowledge). To ensure a child's readiness to learn new

material, teachers monitor their students' prior knowledge in different ways. They note responses to questions and reflect on the questions that children ask themselves, they look closely at students' class work, noticing how they think and what they know about the world. However, a teacher's role here is not *just* to ensure the required prior knowledge exists before progressing to the next stage. There are key regions in the frontal cortex involved with consciously attending to new ideas, and for connecting these to prior knowledge. These regions are immature in young brains, and young children in particular will need support in making these connections. Moreover, our capacity to just represent new information in the frontal cortex has to develop during childhood. Even as adults this capacity is limited, and it requires constant effort to consciously think about freshly learnt ideas.



Consciously attending to new ideas involves representing them in our frontal cortex. Our ability to do this develops throughout childhood, but even as adults our capacity to do this is limited and requires effort.

Consolidation occurs when new ideas are rehearsed enough for them to become automatic, accessible and useful, and new memories are "laid down" in long term memory for them to become more permanent. When a child first holds new ideas in their brain, they are ore fragile and likely to be lost, and they also work with them more consciously and must apply more effort in doing so. Rehearsing new ideas helps their representation move away from working memory regions (in the front of the brain) to regions more involved with automatic unconscious processing (toward the back of the brain). In other words, practice helps consolidate freshly-learnt ideas until we can use the ideas almost without thinking, so reducing the burden of fresh learning on working memory. This is important because, when our limited working memory is liberated, it is ready to be occupied by new information and so we become ready to move on and learn more



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Scientific research that is relevant to each of these three areas has been briefly reviewed in preceding elsewhere (Howard-Jones, 2016c, Howard-Jones, 2016b, Howard-Jones, 2016a) but the implications of this research is summarised in Table 1:

ENGAGEMENT	• Every learner's brain is different and students vary in what most engages their attention and the extent to which they can control their attention, making it important for teachers to monitor engagement and vary approach accordingly. • Teachers employ a variety of tactics that are known to stimulate an "approach" response in the brain. These include rewards such as praise and tokens acknowledging achievement, novelty, and shared attention. The anticipation and receipt of rewards can release neuromodulators capable of improving attention and memory. • In contrast, fearfulness can avert attention, and anxiety can diminish a student's learn by reducing the brain's ability to process information. • Engagement can be diminished by teachers' and students' notions that there is a fixed limit to what a student can learn. But the brain is plastic, and both teacher and student have an important role in constructing its function, connectivity and even its structure.
CONSTRUCTION	• Being aware of students' prior knowledge is important for a teacher, because this is the foundation on which the students' new knowledge will build. • Teachers can help students think meaningfully about new ideas by encouraging them to make connections with their prior knowledge. This is particularly important for children, whose neural circuitry for this connection-making process is still developing. Differences in learning and development will result in diverse individual differences within any class. • The brain is multisensory, and clear, concise instruction using all the senses aids the communication and student understanding of new knowledge. • Our Mirror Neuron System helps us read each other's minds. Gestures and faces communicate knowledge and emotions both consciously and unconsciously, supporting the teacher's transmission of concepts, confidence and enthusiasm.
CONSOLIDATION	• Practice and rehearsal of freshly-learnt knowledge causes it to become automatically accessible. This frees up the brain's limited capacity to pay conscious attention, and so be ready for further learning. • Testing, applying knowledge in new situations, discussing it with others or expressing it in new forms consolidate our learning through helping us to store it in different ways – making it easier to recall and apply it. • Sleep plays an important role in the processes that consolidate our learning. A good night's sleep helps attend to today's learning but also makes yesterday's learning more permanent.

Table 1. Scientific concepts identified with potentially relevant to core teaching practices

Thinking about adult-child interaction in terms of engagement, construction and consolidation

Teachers can probably spot instances of how they frequently engage their learners, and help construct and consolidate their learning. Think, for example, about this everyday conversation between an adult carer and a toddler shown in Fig. 4.

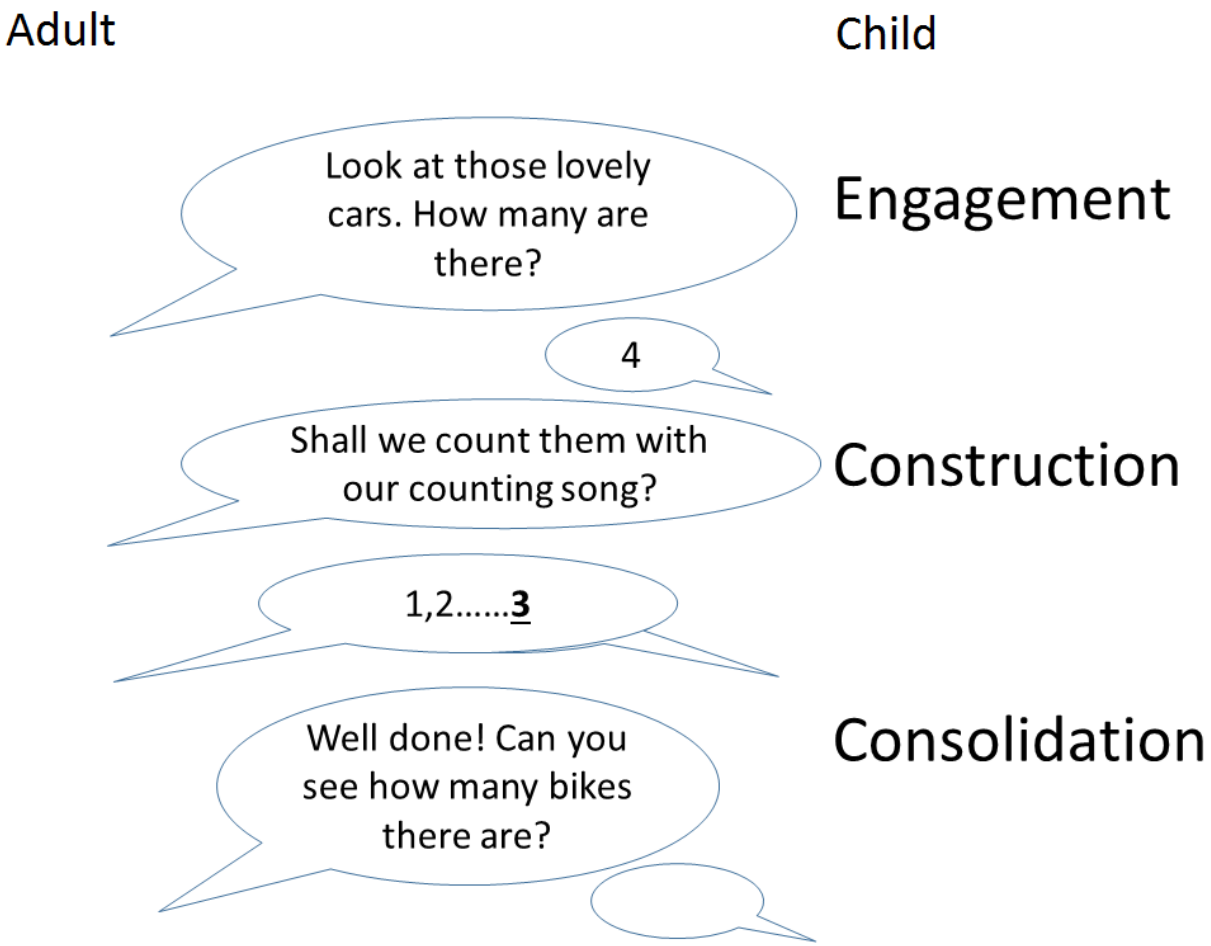

Fig. 4 In this imagined adult-child conversation about number, the adult is **engaging** the child with a novel context they consider is of personal interest to them. The teacher is identifying prior knowledge when they discover the child incorrectly thinks there are 4 cars not 3. They encourage the child to activate their prior knowledge of an engaging song. They "scaffold" (support) their understanding that the last word in the counting song is the number of cars present. In this way, they are helping the child **construct** how the cardinality principle operates (i.e. the last number in the counting sequence indicates the number in the set). They offer praise to maintain engagement, and then

encourage the child to **consolidate** their learning by practicing the cardinality principle in a new context.

This type of teaching-for-learning interaction (whether in literacy, numeracy or some other topic) encourages the development of basic mental abilities such as emotional self-regulation and attention. It is the type of teacher-like interaction associated with children becoming better prepared for later learning. A rudimentary grasp of the brain processes involved helps us understand how this type of conversation is effective. In this way, neuroscience may help provide insight for teachers and policy-makers that leads to more effective practices in early education and care.

References

DEÁK, G. O. & TRIESCH, J. 2006. The emergence of attention-sharing skills in human infants. *In:* FUJITA, K. & ITAKURA, S. (eds.) *(Eds.), Diversity of cognition* Kyoto: : University of Kyoto Press.

HOWARD-JONES, P. A. 2016a. Consolidation of Learning: Scientific insights with potential relevance for supporting students' consolidation of their learning. *Briefings arising from the IBE-IBRO fellowships.* Geneva: International Bureau of Education.

HOWARD-JONES, P. A. 2016b. Construction of thought: Scientific insights with potential relevance to teacher-guided construction of student thinking. *Briefings arising from IBE-IBRO Fellowships.* Geneva: International Bureau of Education.

HOWARD-JONES, P. A. 2016c. Engagement for Learning: Scientific insights with potential relevance for teachers' engagement of students in their learning. *Briefing arising from IBE-IBRO Fellowships.* Geneva: International Bureau of Education.

OBERWELLAND, E., SCHILBACH, L., BARISIC, I., KRALL, S. C., VOGELEY, K., FINK, G. R., HERPERTZ-DAHLMANN, B., KONRAD, K. & SCHULTE-RUTHER, M. 2016. Look into my eyes: Investigating joint attention using interactive eye-tracking and fMRI in a developmental sample. *Neuroimage,* 130**,** 248-260.

SYLVA, K., MELHUISH, E., SAMMONS, P., SIRAJ-BLATCHFORD, I. & TAGGART, B. 2004. Effective Pre-School Education: A Longitudinal Study funded by the DfES (1997 – 2004). Nottingham: Institute of Education.

TRIESCH, J., TEUSCHER, C., DEAK, G. O. & CARLSON, E. 2006. Gaze following: why (not) learn it? *Developmental Science,* 9**,** 125-147.