



Neuroscience and early childhood development

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This article will explore neuroscience and its impact on museum learning, including how the young brain is formed, what influences its growth and development, and ideas for nurturing young brains through museum environments, resources and social interaction.

HOW DO YOUNG CHILDREN'S BRAINS GROW?

Babies' brains are amazing powerhouses. Research shows that babies are born with around 100 billion neurons and with about a quarter of the connections, called synapses, already made between them during gestation in the womb.¹ By comparison, a fully grown adult brain only has an estimated 86 billion neurons, of which 83% is grown in the first two years of life.²

In fact, babies' brains make billions of new connections with everything they experience as they contextualise and make sense of it using all their senses. This process is called synaptogenesis and happens most prolifically between the ages of birth to three. By age two, a staggering 700 new connections are formed every second.³

It would be natural to assume that our genetic predispositions to certain interests and strengths (our DNA) are what cause these connections to be made. However, with the help of neuroimaging (PET, MRI, EEG and DTI scanners⁴), neuroscientists are discovering that synaptogenesis is as much influenced by the environment in which children are brought up and their real life experiences in the early years as their DNA.

This combined influence of nature (DNA) and nurture (environment + experiences) sets out the blueprint for each child's personality for the rest of their lives. It is what makes us uniquely who we are, mentally, physically, spiritually, biologically and emotionally, in the same way that DNA makes us uniquely who we are genetically.

Neuroscientists Shonkoff and Philipps⁵ have demonstrated in their research that positive personal, social and cultural experiences are more critical in the early years for the development of healthy brains and well-rounded personalities than at any other time during the rest of childhood and adulthood.

These critical experiences help children to make meaning, hone skills and deepen their understanding of themselves and the world around them. If they are denied these experiences, they have a much lower chance of thriving and reaching their potential later on in life.⁶

THE IMPACT OF SOCIAL INTERACTION ON EARLY BRAIN DEVELOPMENT

Children's experiences of the world are dependent on their relationships with others and, as such, parents and carers have the biggest influence on their child's brain development and early learning⁷. The model a parent provides influences the way a child will think, feel and act, ie how they will relate to others, manage stress, regulate their responses and develop emotional attachments for the rest of their life. Neural connections bloom through positive emotional relationships, and a well-bonded, attuned relationship increases a child's confidence and competence to explore the world around them. This sets the scene for developing other skills such as language, coordination, proprioception (sensing how and where to move our body parts to without having to look at them), self-control, imagination and creativity.

HOW THE BRAIN'S SHAPE AND SIZE IS DETERMINED IN THE EARLY YEARS

So why doesn't the adult brain have more connections than a baby's brain? After all, adults have a lot more experience than babies. One of the reasons is that between the ages of three and adolescence, the brain starts a process of pruning out billions of weak or underused synapses to make room for the stronger ones to grow. Just as with a rose bush, pruning clears out the 'dead wood', which stimulates a greater concentration of nutrients to the stronger connections and makes the brain more effective. Once this process is complete at the end of adolescence, the brain's size and shape hardly changes again and our ability to grow new synaptic connections is significantly reduced, although not impossible.

This is why it's so important to ensure that all children are exposed to a wide range of positive, creative and safe opportunities in the first three years of their lives, whilst those key foundations for their present and future personalities are being established. If we do so, the synapses that are predisposed to those faculties for love, communication, curiosity, reciprocity and creativity will grow strong, and connect.

Given the impact on brain development that early experiences have, it is not surprising that several studies have uncovered significant long-term impacts of creative environments. They highlight how creative activities that encourage positive relationships can support the rapid blooming of synapses, leading to the formation of well-rounded personalities, good attachment, self-esteem and better mental health.⁸

However, we need to bear in mind that the impact of different experiences on different parts of the brain is incredibly complex, and goes far beyond what existing research has revealed. In fact, the majority of what happens during early brain development is unknown and we still have a huge amount to learn. [Click here to see an interactive map of the brain.](#)

WHAT DOES THIS MEAN FOR MUSEUM LEARNING?

Museums with strong early years provision play an important role in helping young children build knowledge and understanding about the world through social, familial and cultural experiences. Their provision is full of potential because it is:

- child-centred – respecting the rights of every child, no matter how young, to enjoy and benefit from cultural experiences
- developmentally appropriate – understanding how young children learn and maximising engagement possibilities for different ages and stages of development
- open-ended – offering a key to unlocking children’s enormous bank of potential interpretations based on their own contexts and prior knowledge
- interactive – enabling co-learning to develop between adult and child
- play based – engaging a child in the way they learn best, ie holistically, heuristically (learning through exploration) and through all the senses simultaneously
- empowering – giving children choices, opportunities for mastery and control of their own learning journeys.

These qualities should be visible throughout the design, programming, marketing, signage, language and staff interactions in museums.

The following aspects offer starting points for ensuring museums have an effective impact on early brain development for birth to three year olds.

Environment

Space is often a novelty for young children who may wish to run around on entering a gallery. This apparent rushing around from exhibit to exhibit helps a child orient herself in the space and carry out what’s called ‘cognitive mapping’⁹, and afterwards she feels able to settle down more easily. Having oriented herself, a child will then be able to slow down and explore the exhibits more purposefully and at her own pace, often not following the curated route that is intended but following her own interests.

This is especially true of spaces with intuitive design, where exhibits and resources lend themselves to being touched and explored by young hands and bodies, leading to a higher likelihood of children leading their own learning and requiring less adult facilitation or intervention. Helping carers feel comfortable with this can enable a more fulfilling experience with higher levels of concentration and interaction.

As well as being a safe, relaxing and comfortable place for young children to be in, museum furniture, displays and resources should be designed, or organised, to encourage communication between adult and child, and to stimulate the imagination through spontaneous, open-ended play, exploration and discovery.



Photo © Ruth Churchill Dower, Earlyarts, at Yorkshire Sculpture Park 2017.

Having their eyes at a similar physical level means that parents and carers can share the same learning experience with their children. A sturdy step or a lightweight, folding stool carried by an adult, can make all the difference. Exploring or looking at an object together with the parent or carer enables deeper level learning, conversation and relationship-building to be continued and extended in the home, making more sense for the child and the adult. Research shows there is a high correlation between time spent in front of an exhibit, verbal or physical interaction by family members and children's subsequent levels of recall.¹⁰

Resources

The age range of birth to three encapsulates many different developmental milestones depending on the experiences and environments each child is exposed to. No two toddlers will be engaged in the same way or for the same length of time. Therefore the more open-ended resources can be, the easier it is for young children to take control of their own learning, at their own pace.

For this age range, resources should be carefully chosen to stimulate sensory learning experiences, especially enabling non-verbal communicators such as babies to express themselves, but also providing a level of challenge, physical or sensory, to keep fast problem solvers engaged. They should also be a lot of fun!

Tactile resources provide rich learning experiences for babies' brains and bodies to be nurtured and connected. They help babies and toddlers tune in to the experience as kinaesthetic thinkers, whereby the sensory information they gain from handling objects and materials holds their attention for longer because it stimulates thoughts about the experience. As they take in information through their hands, it activates ideas and feelings in their minds (excitement, curiosity, anticipation, delight) which, in turn, are often expressed through their bodies. This connecting up of the physical and emotional parts of their brain and body with the subject matter helps children to make, store and recall important memories about the learning experience.

Interactive resources engage children's curiosity beyond the familiar, and provoke them to seek out new knowledge to build on their existing knowledge. Music and movement objects (such as silk scarves, brushes or feathers) provide opportunities for call and response with babies, helping adults affirm their attachment by imitating their babies' sounds and gestures. Drawing and mark making helps toddlers relax and express themselves by way of helping to explore and control their inner feelings¹¹. At the same time, it refines their observation skills, helps connect brain and body in the process of making and storing symbols with new meanings, enables reflection and the outward expression of their experiences in their own language.

Fantasy resources, including role-play props and materials or costumes that are not predefined (limiting the imagination to a particular character or story-line), encourage young children to actively participate in their own story and their own worlds, rather than being passive participants in ours. Across the world, pretend play is a strongly innate and natural phenomenon and these alternative worlds allow children to function at higher levels than normal, nurturing their executive function¹², imagination, risk-taking, problem-solving and creativity skills. Plots in children's play are often exaggerations of real life situations – it's a child's way of making sense of the world around them.

All resources should have a universal design, ie be specifically inclusive for young children with physical, sensory or learning disabilities, making visits especially inspiring for families who have to overcome obstacles to learning.

RELATIONSHIPS AND SOCIAL INTERACTION

A baby is born both vulnerable and competent; they are biologically programmed with certain types of behaviour to ensure their survival - some behaviours are more developed than others at birth, such as eating behaviours, exploratory behaviours, communication behaviours and attachment behaviours. These behaviours are designed to attract a response from the main adult carer (in most cases, the mother) to provide protection, security or nutrition for the baby and ensure they will stay close¹³. Each behaviour demonstrates an unmet need in the baby and whether or not (and how well) this need is met determines how strong their relationship will grow, and how attuned the baby and mother become to each other.

A strongly attuned relationship creates a deep attachment bond which provides a secure base from which a young child can develop independence, competence and confidence to explore the world around them, knowing that he or she can return at any time for emotional or physical nourishment and comfort. In fact, scientists and psychologists are largely in agreement with John Bowlby's theory¹⁴ that a baby's emerging social, psychological and biological capabilities cannot be understood except in the context of its relationship with his mother or main adult carer.

This relationship is built through physical, emotional and social interaction. Assuming here that the main adult carer is the mother, she responds to her baby's cries by offering physical comfort such as close cuddling. She builds emotional attunement by timing her responses to meet her baby's needs or even anticipate them, comforting and calming her baby from any distress. She offers social interaction to further develop her baby's competence and confidence, eg focussing on a toy or object the baby might like to explore, watching his responses in order to spot signs of happiness and interest, communicating through call-and-response as she helps her baby play with the object, and understanding when to step in and scaffold his further exploration or when to remove an object if he shows signs of danger, distress or disinterest. The same would be true to differing degrees for a father or other carers, including health professionals, educators and childcarers.

Museums are an ideal place to provide the levels of intellectual novelty and opportunities for social interaction that stimulate growth in the relationship between parent/carer and child. The more secure and stress-free the relationship is between parent and baby, the more the baby will be able to explore further into his environment and away from his attachment figure. As a caring relationship is established to meet his needs for physical and emotional security, the baby's brain can focus on fulfilling its higher order needs such as curiosity, imitation, communication, meaning-making and self-control. In short, the ability of a baby to explore a museum environment and engage in social interaction is hugely dependent on its security, which comes from having a strong, positive relationship with its parent or main carer.

Early childhood psychologist, Bruner, proposed the process of ‘scaffolding’¹⁵ young children’s thinking, and thereby enabling children’s competence to be extended beyond what they were capable of doing on their own¹⁶. This process is an important part of building independent thought, self-regulation, critical awareness, memory recall and imagination, and is empowering and effective as a way of bringing objects and exhibits to life.

Several museums employ facilitators, enablers or explainers to help children and their families make the most of their experiences. As children lead their own play through an exploration of exhibits and resources, museum facilitators can help scaffold their play and draw out relevant connections and ideas, rather than dictating it, resulting in deeper ownership of the experience by the child.

In actively seeking opportunities to stimulate and promote children’s own ideas through scaffolding, co-constructing or following their lines of enquiry, we are not just validating children’s own thinking about exhibits. We are also nurturing positive learning dispositions, eg confidence, curiosity, negotiation, risk-taking, self-esteem, enjoyment, independence, self-control, reciprocity, empathy and sustained concentration and thought. Museum learning has an important role to play in this process of engagement and, where trust is high, in modelling it for parents and carers.

HOW DO WE KNOW IT’S WORKING?

Children tell us all the time when we are nurturing their brains and bodies through their observable behaviours¹⁷. We can see that they are intrinsically motivated when they demonstrate higher levels of interest in exhibits and activities and talk about connections with their personal life. They might display increased concentration, alert postures or particular facial expressions such as curious looks or tongues sticking out whilst deep in thought, such as when exploring a skeleton through drawing. They may be deeply immersed in a state of ‘flow’ with ideas that are sustained over time, when deeper connections are made between existing and new knowledge, such as role-playing the ideas from a storytelling session. They might exert more energy when motivated to explore something that captures their interest, or by using a new technique or resource e.g. a baby learning to handle a rattle or exploring themselves in a mirror, especially where this presents a challenge to the child requiring persistence or precision. Young children feel successful and competent when they fulfil a task they have chosen for themselves – mastery is important for the child to feel in control and able to conquer their fears and build their competences.



Photo © Ammie Flexen, Earlyarts, at Eureka! The National Children’s Museum, Halifax 2017.

Children’s satisfaction is often clear to see, as are their frustrations, but sometimes it’s harder to spot the more complex emotions and responses, which is why listening to their languages is crucial – body languages, noises and physical or creative expressions in the case of babies and non-speaking children.

Early Years toolkit

Getting the resources, environments and relationships right means putting in place the right types and quality of opportunities for us to listen to children, and for them to express themselves to us, in an ongoing, reciprocal cycle of communication.

Museums have an important role to play in enabling children and families not only to feel welcome in their museum but also to understand why and how their museum is relevant to them, even at a very early age. This requires museums to be effective communicators, architects and relationship builders and to have an understanding of the ways in which young children learn and develop, how their bodies and brains move and work, and how they relate to the people and spaces around them. Understanding neuroscience can help museums support young children to have positive, developmentally appropriate experiences, and provide them with the best possible start in their lifelong museum adventure.

‘By encouraging creativity and imagination, we are promoting young children’s ability to explore and comprehend their world, increasing their opportunities to make new connections and reach new understandings.’¹⁸

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- 12 Executive functions include basic cognitive processes such as behaviour choices, thinking skills, concentration and memory. Higher level executive functions bring together these basic processes simultaneously to enable reasoning, planning, behaviour management and problem solving.
- 13 **Schore, A.N.** 2000. [Attachment and the Regulation of the Right Brain](#). Attachment and Human Development 2 (1).
- 14 John Bowlby was an eminent child development psychologist whose seminal research in 1969 on Attachment and Loss influenced most clinical and social care strategies for infant and maternal care that exist today. See his more recent summary: **Bowlby, J** (1988), [A secure base: parent-child attachment and healthy human development](#), Routledge.
- 15 Scaffolding is a method of teaching developed by Jerome Bruner whereby young children are supported to focus on the key information or knowledge through developmentally appropriate questioning as they play. As the child forms the knowledge and understanding, the amount of 'scaffolding' required is gradually reduced, just as with scaffolding around a house, until the skills or understanding of a particular concept are complete.
- 16 Bruner was building on **Lev Vygotsky's** theory of the [Zone of Proximal Development](#) which remained unfinished before his untimely death.
- 17 Early childhood theorist, **Professor Tina Bruce**, talks more about the 12 characteristics of observable learning in [Play, the universe and everything!](#) In Moyles, J, ed The Excellence of Play: Second Edition (2005). Open University Press.
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