Memory Development

The following text borrows extensively from Wikipedia, which offers a helpful synopsis of memory development.

The development of memory in children becomes evident within the first 2 to 3 years of a child's life as they show considerable advances in declarative memory. This enhancement continues into adolescence with major developments in short term memory, working memory, long term memory and autobiographical memory.[1]

Recent research on the development of memory has indicated that declarative, or explicit memory, may exist in infants who are even younger than two years old. For example, newborns who are less than 3 days old demonstrate a clear preference for their mother’s own voice.[2]

Cognitive Neuroscience of Memory Development

Declarative memory develops very rapidly throughout the first 2 years of life; infants of this age show evidence of cognitive development in many ways (e.g., increased attention, language acquisition, increasing knowledge). There is a difference in the brain development of explicit and implicit memory in infants. Implicit memory is controlled by an early-developing memory system in the brain that is present very early on, and can be explained by the early maturation of striatum, cerebellum, and brain stem, which are all involved in implicit learning and memory.[3] Development of explicit memory depends on a later developing memory system in the brain that reaches maturity between 8 and 10 months of age. Explicit memory depends heavily on structures in the medial temporal lobe, including the hippocampus and the parahippocampal cortex. Much of the brain system is formed before birth, however the dentate gyrus within the hippocampal formation has about 70% of the number of cells in adults.[4]

Rapid myelination of axons within the central nervous system occurs during first year of life which can dramatically increase the efficiency and speed of transmission in neurons. This can explain the higher processing speed of older infants as compared to younger ones.[5]

Working Memory

According to Baddeley's model of working memory, working memory is composed of three parts. First is the central executive which is responsible for a range of regulatory functions including attention, the control of action, and problem solving. Second, the phonological loop, which is specialized for the manipulation and retention of material in particular informational domains. Finally, the visuospatial sketchpad stores material in terms of its visual or spatial features. The strength of the relationships between the three components of working memory vary; the central executive is strongly linked with both the phonological loop as well as the visuospatial sketchpad which are both independent of each other. Evidence indicates linear increases in performance of working memory from age 4 years through to adolescence.[6]

Central Executive

In children under the age of 4, the memory storage capacity limitation constrains complex comprehension processes. As the child grows older however, less processing is necessary which opens more storage space for memory.[7]

Phonological Loop

Evidence indicates linear increases in performance from age 4 years through to adolescence. Prior to about 7 years of age, serial recall performance is mediated by the phonological store which is one component of the phonological loop. Preschool aged children do not use a subvocal rehearsal strategy to maintain decaying phonological representations in the store but instead they identify visual features of pictures in order to remember them. This is evident first by watching children for overt sign of rehearsal (for example lip movement) and second if the child is given
nameable pictures, there are no differences in retrieval found for long versus short words. At the age of seven, children begin to use a subvocal rehearsal process to maximize retention in the phonological store. As development continues, nonauditory memory material is recoded into a phonological code suitable for the phonological loop when possible.\[7\]

**Visuospatial Sketchpad**
Younger children (under the age of 5) are more dependent than older children or adults on using the visuospatial sketchpad to support immediate memory for visual material. Older children adopt a strategy of verbally recoding pictures where possible and also use the phonological loop to mediate performance of the “visual” memory task. Between the ages of 5 and 11, visual memory span increases substantially and it is at this point when adult levels of performance are reached.\[7\]

**Long Term Memory**
Explicit memory becomes much better over the developmental years. However, there are small effects of age on implicit memory, which could be because implicit memory involves more basic processes than declarative memory which would make it less affected by a child's developing cognitive skills and abilities.

**Pre-school Children**
Infants at as early as 7-months-old can conceptually differentiate between categories such as animals and vehicles. Although infants’ concepts may be crude by adult standards, they still allow infants to make meaningful semantic distinctions. An example is that infants can differentiate between items belonging to a kitchen and those items belonging to a bathroom.\[8\] At the very least, these categories lay a foundation for early knowledge development, organizing information in storage and influence future encoding. Infants from 16 months old are able to draw on their semantic knowledge in generalization and inference. This knowledge can also be used by older toddlers, 24-month-olds, to facilitate acquisition and retention of new information. Their knowledge of causal ordering of events can be used to help to recall the sequence of events.

Knowledge itself will not alter retention performance, rather how well that knowledge is structured will alter performance. Better retention was shown with information that had greater cohesion and more elaborative elements. Familiarity and repetition of an experience can also influence the organization of information in storage for preschoolers and older children.\[9\] Children who experienced an event twice recalled the event better 3 months later than did children who only experienced it once and showed equally good recall at 3 months compared to recall at 2 weeks after experiences.

**School Age Children**
Age differences in memory are attributed to age-correlated growth in the foundation of knowledge. What children know affects what they encode, how that information is organized in storage, and the manner in which it’s retrieved. The greater the background knowledge about the to-be-encoded information, the better that the information is remembered.\[9\] Because older children have more knowledge than younger children, older children perform better than younger children in most memory tasks. When familiarity and meaningfulness of material were equated across age, developmental differences in memory performance was no longer a factor.
Children’s use of memory strategies and the development of metamemory skills are also instrumental in age-related changes in memory, particularly later in childhood years. Knowledge influences memory by affecting retrieval, by facilitating spread of activation among related items in memory and by facilitating the use of strategies. Knowledge also provides better elaboration of information which can strengthen its storage in memory.

Episodic Memory
By school age, the typical child shows skill in recalling details of past experiences and in organizing those details into a narrative form with cohesion. Memories formed at this age and beyond are more likely to stand the test of time over the years and be recalled in adulthood, compared to earlier memories. Young children can sometimes retain information from specific episodes over very long periods of time, but the particular information a child of a particular age is likely to retain over different periods of time is unpredictable. This depends on the nature of the memory event and individual differences in the child such as gender, parental style of communication, and language ability.

Autobiographical Memory
The amount of information that is able to be recalled depends on the child’s age at the time of the event. Children at the age of 1-2 can recall personal events, though only in fragments when questioned several months later. Two-year-old children form autobiographical memories and remember them over periods of at least several months.

Difficulty in assessing memory in young children can be attributed to their level of language skills; this is because memory tests usually occur in the form of a verbal report. It is unclear whether performance on memory assessments is due to poor memory for the event or to the inability to express what they remember in words. However, memory tests assessing performance with a nonverbal photograph recognition test and behavioral re-enactment showed that children had signs of recall from 27 months, as opposed to 33 months, where children showed only reasonable verbal recall.

Childhood Amnesia
Infantile amnesia is the tendency to have few autobiographical memories from below the age of 5. Although autobiographical memories start forming between the ages of 2 and 3 and can be remembered for several months, they are nearly always forgotten by adulthood. This can be attributed to lack of memory rehearsal; young children do not engage in rehearsal of remembered information. There are two theoretical explanations for why this may occur; although they take different approaches, they are not mutually exclusive of each other.

Cognitive Self
Autobiographical memories can only begin to form after infants have developed a sense of self to whom events having personal significance can occur. Evidence of a sense of self develops towards the end of the second year of life, in between 21 and 24 months of age. The development of a cognitive self provides a new framework from which memories can be organized. With this cognitive advancement, we see the emergence of autobiographical memory and the end of infantile amnesia.

Social Cultural Influences
Language and culture play central roles in the early development of autobiographical memory. The manner in which parents discuss the past with their children and how elaborative they are in reminiscing has an impact on how the child encodes the memory. Children whose parents talk in detail about the past are being provided with good opportunities to rehearse their memories. The parents’ use of language at the time in which the event occurred can also play a factor in how the
child remembers the episode. Cultural differences in parenting styles and parent-child relationships can contribute to autobiographical memory at an early age.\[^{[14]}\]

**Memory Strategies**

Memory strategies are ways in which individuals can organize the information that they are processing in order to enhance recall in the future. Memory strategies that are helpful may include but are not limited to verbal rehearsal or mnemonics. The use of memory strategies varies in both the types of strategies used as well as the effectiveness of the strategies used across different age groups.\[^{[15]}\]

**Metamemory**

As children grow older, they show increasing evidence of metamemory which is the knowledge about their memory and how it works.\[^{[1]}\] There is strong evidence that suggests that greater awareness and knowledge about ones memory leads to increased use of memory strategies and greater levels of recall.\[^{[16]}\]

In children under 7, the relationship between metamemory, strategy use, and recall is very weak or absent. This can be seen when comparing older children (over the age of 7) and preschool children on sorting tasks where children are asked to sort objects into groups that go together (for example animals) and attempt to recall them.\[^{[17]}\]

**Preschool Children**

Preschool children use simple tactics for remembering but do not use mental strategies and do not typically differentiate memory and perception. In order to remember objects, they tend to verbally name or visually inspect items and use memory strategies intermittently or inconsistently even if they are aware of how they can improve recall.\[^{[18]}\] Memory Strategies are used more consistently by children if they are reminded and taught to use them each time they are processing something that should be remembered.\[^{[19]}\]

**By age 7**

By the age of 7, the awareness of the benefits of memory strategies in learning arises. The goal is for children to recognize the advantage of using memory strategies such as categorizing rather than simply looking or naming.\[^{[20]}\] At this age, children spontaneously use rehearsal to enhance short-term memory performance and retrieval strategies begin to be used spontaneously without the guidance of others.\[^{[19]}\]

**Late Elementary School**

In late elementary school, children engage in self-directed use of organization and demonstrate the ability to impose a semantic structure on the to-be-remembered items to guide memory performance. For example, if a child is packing their bag for school they can go through each part of their day and think of each item that they need to pack.\[^{[19]}\] Children at this age understand the advantages of using memory strategies and make use of strategies like categorization over looking or naming if they are instructed to think about learning strategies prior to learning.\[^{[20]}\]

**Early Adolescence**

In early adolescence, children begin to use elaborative rehearsal meaning that items are not simply kept in mind but rather are processed more deeply. They also prefer to use memory strategies such as categorization rather than simple rehearsal, looking or naming and use these strategies without needing to think about memory strategies prior to learning.\[^{[20]}\]
References

8. Mandler, Fivush & Reznick, 1987
10. O’Sullivan & Howe, 1998