Learning from Television During Early Childhood

Chapter · January 2012

DOI: 10.1007/978-1-4419-1428-6_1835

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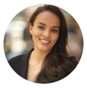

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Encyclopedia of the Sciences of Learning
Springer Science+Business Media, LLC 2012
10.1007/978-1-4419-1428-6_1918
Norbert M. Seel

Infant Learning and Memory

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Without Abstract

Synonyms

Association; Cognition; Encoding; Representation; Retention

Definition

Learning and memory are intimately linked; tests of learning are, in fact, tests of memory. *Learning* is defined as a relatively permanent change in behavior that results from experience. This definition excludes temporary behavioral changes due to arousal, fatigue, illness, medication, or biological rhythms as well as more permanent changes associated with aging, growth, or physiological intervention. *Memory* is the product of a series of processes that include the encoding, storage, and retrieval of the representation of an experience. For learning to occur, the representations of two discrete events must be associated, which occurs when they are simultaneously active in short-term memory (memory *in* learning, associative memory). As long as the memory of the association remains active, it is vulnerable to modification, but once it enters long-term memory (an inactive state), it is relatively permanent. The memory of prior learning can be retrieved (returned to an active state), updated, and either returned to an inactive state or behaviorally expressed on a test (memory *of* learning, retentive memory). The fundamental processes of learning and memory do not change developmentally, but the temporal parameters and contents of memories do.

Theoretical Background

Human infancy extends from birth through 2 years of age. During this period, infants undergo major physical and behavioral transformation, and few vestiges of the newborn are evident when the infancy period ends. Since Freud first concluded that adult behavior could be traced to infantile experiences, the long-term effects of early experience have evoked considerable theoretical interest. Most developmental scientists have assumed that infants' experiences progressively build on one another and are foundational for later cognitive development. Implicit in this assumption is a capacity for long-term memory. If early experiences have an enduring impact on later behavior and cognition, then infants must possess some means of preserving a relatively enduring record of those experiences. Paradoxically, most scientists have also believed that preverbal infants are incapable of remembering their experiences over the long term. The phenomenon of infantile amnesia – the common experience that adults cannot remember events that occurred before 3–4 years of age – lent credence to this belief. This paradox still drives modern research and theory on infant learning and memory (Rovee-Collier et al. 2001).

Important Scientific Research and Open Questions

Infant Learning

The categories of learning that most authorities distinguish, ordered from simplest to most complex, are habituation, classical conditioning, instrumental and operant conditioning, various types of complex learning (conditional discrimination, serial-order learning, categorization, detour learning, context learning), concept learning (oddity concept, same-different concept), imitation, and language acquisition. These categories form a phylogenetic continuum, with the most primitive organisms anchoring one end and the most complex organisms (humans) anchoring the other. For many decades, the ontogeny of learning was thought to recapitulate its phylogeny. Today, learning in all categories has been documented within days of birth.

Initial investigations of infant learning were undertaken to document the origins of adult behavior. Using procedures designed for adults, they provided a disappointing view of infant learning. Pavlov, for example, attributed failed classical conditioning attempts with young infants to cortical immaturity. Decades later, researchers found that increasing adults' optimal interstimulus interval by two to three times produced rapid classical eyelid conditioning in 10-day-olds and even sleeping newborns. (Sleeping adults cannot learn new associations.) Using procedures designed for infants, researchers found that newborns rapidly acquire conditioned feeding reflexes. During a scheduled feeding period, for example, they paired a tone with tactile stimulation to the right cheek, which elicited a right headturn that led to the delivery of milk from the right side. Similarly, they paired a buzzer with stimulation to the left cheek, which elicited a left headturn that led to milk delivery from the left side. Newborns learned to turn right when the tone sounded and left when the buzzer sounded (Rovee-Collier et al. 2001). In another example, infants exhibited a preference for a chamomile odor that had been associated with breastfeeding during their first 8 days of nursing. At 7 months of age, infants presented with differently scented teething rings preferred the chamomile-scented one; at 21 months, they chose to play with a chamomile-scented toy.

The neural mechanisms that support newborn learning become functionally mature during the prenatal period, before they would normally be exercised. The characteristics of the mother's voice, for example, are learned prenatally. After birth, infants orient and root in the direction of the mother's voice, increasing the efficiency of breastfeeding regardless of whether they are being held on her left or right. Also, newborns whose mother had read aloud a Dr. Seuss passage daily during the last 6 weeks of gestation rapidly learned to suck on a nonnutritive nipple to activate a tape-recording of their mother (but not another woman) reading the same passage. Moreover, infants sucked harder to listen to her read the same passage than another one. Similar prenatal learning familiarizes organisms with the linguistic environment into which they will be born.

Beginning in mid-1980, thinking was dominated by the assumption that infants cannot learn a given behavior until the neural circuit that underlies that learning in adults becomes functionally mature. Most scientists believed that a primitive memory system limits infant learning to simple procedures and perceptual-motor skills until 10 months of age, when the brain mechanisms that support adult learning develop. Afterwards, infants can form relational and contextual memories and memories of specific episodes and cognitive associations. More recently, researchers found that infants exhibit adult-like learning long before the brain structures that mediate similar adult learning develop. This evidence indicates that younger infants possess alternate learning circuits (Rovee-Collier and Giles 2010). *What those circuits might be remains to be determined for each modality.* At 3 and 6 months of age, for example, infants learn serial lists, form contextual, functional, and ad-hoc categories of arbitrary stimuli, spontaneously detect correlated attributes, and, at 6 months, use correlated attributes to categorize. They also learn incidental contextual information, form spontaneous cue-context associations, exhibit context-dependent renewal, and spontaneously associate two objects that merely appear together in their visual surround. After watching an adult model a sequence of actions on one of the paired objects, 6-month-olds imitated them on the other object 1 day later; 3-month-olds, who were periodically reminded until they could perform the actions, imitated them on the other object 3 months later.

Six-month-olds remembered the same modeled actions 6 weeks after associating them with the retrieved memory of an operant task that was remembered for 8 weeks. They formed a bidirectional, linear chain of associations that were linked over days by overlapping members and exhibited transitivity of equivalence relations between remote members of the five-object chain. Finally, they indirectly associated the simultaneously activated memory representations of two stimuli in their physical absence (Rovee-Collier and Cuevas 2009). Infants demonstrated the preceding adult-like behavior on transfer tests of *simultaneous* associations – associations that infants younger than 10 months can form rapidly and effortlessly, but 12- and 15-month-olds cannot. Conversely, older infants can form sequential associations, but 3- and 6-month-olds cannot. At 18 months, infants form both. Infants can also learn information from books, television, and touch screens and transfer that learning to real world objects. Although 12- to 24-month-olds learn significantly less from 2D models than from 3D models, termed the *media deficit* effect, 6-month-olds learn from both equivalently (Barr 2010).

By the time infants locomote independently (8–9 months), they have already learned what happens in what places. Afterward, they learn the spatial relationships between these places (a *cognitive map*), facilitating navigation between places. From 12 to 18 months, infants learn to locate objects using landmarks; from 18 to 24 months, they learn to reorient using geometric cues in the environment.

Infant Memory

Early information about infant memory came from paired-comparison studies of looking patterns.

This paradigm exploits the tendency of infants older than 8 weeks to look proportionally longer at a new stimulus than at an old one (Rose et al. 2004). After exposure to one stimulus, a delay is introduced before infants are tested simultaneously with the exposed stimulus and a new one. Recognition of the old stimulus is inferred from a significant novelty preference, and its maximum duration is the longest delay at which infants exhibit a novelty preference. Although the duration of novelty preferences increases throughout the first postnatal year (e.g., 4 months: 0–10 s; 9 months: 75–150 s), it never exceeds seconds to minutes. This duration is within the range of short-term memory (STM) in children and adults, the ISI in classical conditioning, and the delay of reinforcement in operant conditioning. This correspondence suggests that the duration of novelty preferences is a measure of associative memory, or memory in learning.

Current knowledge of long-term memory (LTM) between 2 and 24 months of age has come from operant conditioning and deferred imitation research. In both paradigms, infants of all ages have equivalent retention after short test delays, but older infants remember longer as the test delay increases. Using age-calibrated parameters, researchers found that operant retention increases linearly from 1 to 2 days at 2 months of age to 13–14 weeks at 18 months; retention of the modeling event also increases linearly from 1 day at 6 months to 4 weeks at 18 months (Rovee-Collier and Barr 2010). Although the absolute magnitude of retention in the two paradigms differs, the pattern of retention in both is the same. The duration of retention is not fixed but is altered by changing the parameters of training. The magnitude of these effects is not limited by the immaturity of the infant brain. In fact, the effects are greater at younger ages, when retention is shorter. Increasing the number of sessions from two 9-min sessions to three 6-min sessions, for example, increases operant retention at 2 months from 1–2 days to 2 weeks; increasing modeling duration from 30 s to 60 s increases deferred imitation at 6 months from 0–1 s to 24 h. At all ages, retention is prolonged by increasing session duration, session number, number of retrievals, session spacing, retrieval difficulty, repetitions, the distinctiveness of the training context, stimulus complexity, number of associations, and selective attention to the target. Associating a new learning problem with a retrieval cue for a strong prior association facilitates encoding; maximizing the similarity between the encoding and test contexts facilitates retrieval.

Regardless of paradigm, the basic memory process is the same in infants and adults: Memories are forgotten gradually, reactivated by a reminder, and modified by new information that overlaps with old. The temporal parameters of memory processing change with age, but these changes are not maturational. Three-month-olds, after more retrieval experiences, exhibit the behavioral characteristics of 12-month-olds. *The neuroscience of repeated retrieval experiences is unknown.* Members of new associations can be linked to members of other associations in a complex mnemonic network, the links are strengthened each time a member in the network is activated (retrieved), and the activation spreads through the network. This process is likely to be the mechanism by which the early knowledge base is formed and expanded.

The learning and memory deficits that distinguish atypically from typically developing children are likely to make their first appearance in transfer tasks administered to young infants. The earlier deficits are detected, the sooner interventions can be introduced that could potentially minimize or even alleviate the problem. *This important line of inquiry has yet to be pursued.*

Infantile Amnesia

Early accounts attributed infantile amnesia to infants' inability to form mental representations, enduring memories of events, or rehearse prior experiences by talking about them. The most satisfying recent account resulted from findings that infants could not verbally recall an event that occurred before they possessed words to describe it. Even though the words were in their vocabulary when they were tested, they did not use them. On a nonverbal test with perceptual cues, however, their recognition was excellent. Researchers concluded that (1) memory performance is specific to the conditions of encoding, not testing, and (2) memories encoded in a perceptual format cannot be retrieved by cues from a different format. *These findings leave open the question of the long-term effects of early experience. This question might be addressed if an event memory that was encoded in a perceptual format were used in a transfer task to facilitate new learning (including verbal learning) or solve a novel problem. This question is related to another open question regarding how different learning mechanisms interact with one another.*

Cross-References

Ecology of Learning

Encoding Specificity and Variability: Effects on Learning

Habituation in Infant Cognition

Habituation in Infant Learning

Infant Learning and Development

Memory Consolidation and Reconsolidation

Rapid Learning in Infants

Reactivation and Consolidation of Learning During Sleep

Reinstatement of Learning

Zone of Proximal Development

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