Introduction to infant development

SECOND EDITION

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2007

OXFORD
UNIVERSITY PRESS

CHAPTER SIX

The development of intelligence in infancy

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Introduction

Cognition is a term referring to mental abilities—thinking, memory, problem-solving, categorization, reasoning, language development, and so on. In Chapters 7–10 we focus on specific aspects of cognitive development, and in this chapter we give an account of broad theoretical approaches to the development of intelligence in infancy.

Infancy is a period during which a great deal of intellectual development takes place, and much of it can be seen as falling within four major approaches.

- One of the most influential theorists to develop a theory of cognitive development was Jean Piaget (1896–1980), whose **Piagetian approach,** involving six stages of **sensorimotor** development, is described in the next section.
- The **nativist approach** argues that some forms of knowledge are innate, or present in very early infancy, and form a core around which more mature cognitive functioning will develop.
- The **information processing approach** attempts to understand the reasoning processes used by infants and the ways in which the processing of information changes over time.
- The fourth broad way of looking at cognitive development is the **psychometric approach** which involves testing infants to measure their current level of development, and to predict subsequent cognitive development.

These major approaches take quite different views on cognitive development, stressing different aspects of intellectual functioning and how it changes or remains constant over time. The views therefore complement each other and often shed light on different aspects of development. A point worth emphasizing, and which has been mentioned in other chapters, is that all areas of development impact on each other, so that advances in cognition influence developments in all other areas of development. We will now examine each of the four approaches in turn.

Piagetian approach

Piaget (1937/1954) proposed a theory of infant cognitive development organized around four broad themes: object, space, time, and causality (cf. Kant, 1767/1934). Knowledge in these domains developed in tandem, and they were thought to be highly interdependent. The principal goal of Piagetian theory was to explain **objectification**, the knowledge of the self and external objects as distinct and separate entities, persisting across time and space, and following common-sense causal rules. Objectification is a major cognitive achievement that takes place during the first 2 years, roughly, of postnatal development in most children, which Piaget termed the **sensorimotor** period. During this time, the child's thinking is manifest in overt actions. Objectification stems from the recognition of one's body as an independent object and one's movements as movements of objects through space, analogous to movements of other objects. This, in turn, happens via development and coordination of **schemes**, or action repertoires.

The sensorimotor stages

Piaget suggested that sensorimotor intelligence emerges in six stages, each based on the infant's acquisition of novel schemes and scheme combinations. All ages provided here are approximate.

Stage 1: modification of reflexes (birth to 1 month)

In this stage, termed **modification of reflexes**, the infant engages in reflexive behavior repeatedly in response to stimulation; gradually the reflexes are adjusted to meet the requirements of different circumstances. For example, reflexive sucking behaviors can be modified via actions of the tongue, lips, and swallowing, depending on what is placed in the mouth.

Stage 2: primary circular reactions (1–4 months)

This stage sees the emergence of **primary circular reactions**. A circular reaction is simply a scheme that is repeated; a primary circular reaction is one that is repeated simply because it is interesting in and of itself, and often provides an opportunity to explore the world. In stage 2, for example, sucking becomes a scheme (rather than a reflex) as a means of exploring the environment.

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Stage 3: secondary circular reactions (4–8 months)

In this stage, **secondary circular reactions** are first seen, which Piaget described as 'discovering procedures for making interesting events last.' A secondary circular reaction refers to an activation of schemes to produce an event in the world, not simply for the pleasure of activating the scheme. Production of schemes now results in a specific desired outcome: shaking a rattle in order to hear the sound, hitting a ball to make it roll, or kicking one's feet to see them move. Also in stage 3, schemes are beginning to be organized: in the rattle example, looking, grasping, and shaking schemes are used in a coordinated fashion.

Stage 4: coordination of secondary schemes (8–12 months)

Secondary circular reactions now become coordinated and intentional, a means to an end. This implies a goal, and a plan to reach the goal. For example, the child might push aside daddy's hand to obtain a toy being covered: this is **means–end** behavior where one behavior (pushing the hand) is the means to the end (obtaining the toy). Earlier, pushing the hand might have been interesting enough by itself (and it still might be), but in this case the desired goal is one step removed from this action.

Stage 5: tertiary circular reactions (12–18 months)

In this stage, the child begins to produce behaviors that signal novelty and exploration, or **tertiary circular reactions**. This means combining secondary circular reactions, in a purely exploratory fashion, deliberate trial and error exploration of objects: dropping a toy from the high chair in different ways, to see what happens, or pulling a blanket on which a desired toy rests, to see if that will result in obtaining the toy.

Stage 6: the beginnings of thought—mental representations (18–24 months)

Finally, at the end of the sensorimotor period during stage 6, the child invents **new means via mental representation**: trying out different combinations of actions mentally, and anticipating the consequences without necessarily engaging in overt behaviors.

The development of spatial and object concepts

Piaget proposed as well that the development of spatial concepts and object concepts, leading to objectification, were organized into six stages corresponding to the six stages of general cognitive development just described (Piaget, 1936/1952). Initially (during stages 1 and 2), infants exhibited a kind of recognition memory, for example, seeking the mother's breast after losing contact shortly after birth, and within several months, continuing to look in the direction of a person's exit from the room. These behaviors were not systematic, however, and they were considered more passive than active. For Piaget, active search schemes, initiated by the child, were a critical feature of object concepts, both as evidence for their development, and as a mechanism by which development occurs.

More active search behavior emerges after 4 months, marking the onset of objectification during stage 3. Piaget outlined five examples, in roughly chronological order (i.e., the order in which they could be elicited across stage 3). The first was **visual accommodation to rapid movements**, when an infant responds to a dropped object by looking down toward the floor, behavior that becomes more systematic when the infant herself drops the object. A second behavior, **interrupted prehension**, refers to the infant's attempts to re-acquire an object that was dropped or taken from her hand if it is out of sight briefly and within easy reach. (There is no search if the object is fully hidden.) **Deferred circular reactions** describes the child's gestures when interrupted during object-oriented play activity, resuming the game after some delay (involving memory of object, actions, and context). **Reconstruction of an invisible whole from a visible fraction** occurs when, for example, the child retrieves an object from a cover when only a part of the object was visible. Finally, the infant engages in **removal of obstacles preventing perception**, as when she pulls away a cover from her face during peekaboo, or retrieves a fully hidden toy from beneath a blanket. This behavior marks the transition to stage 4.

During stage 4, the infant will often search actively for a fully hidden object. Search may not be systematic, however, when the object is hidden first at a single location followed by (successful) search, and then hidden in another location, as the infant watches. Here, the infant often tries to find the obstacle at the first location visited by the object, even though she saw it hidden subsequently somewhere else. This response has come to be known as the **A-not-B error**, or the **stage 4 error** (discussed in greater detail in Chapter 8). The transition to full objectification is completed across the next two stages as the infant first solves the problem of multiple visible displacements, searching at the last location visited by the object (stage 5), and then multiple invisible displacements (stage 6). For Piaget, systematic search revealed a decoupling of the object from the action, and knowledge of the infant's body itself as merely one object among many, and brought into an **allocentric system** of spatially organized objects and events. By 'allocentric' is meant that the infant can judge spatial organization with reference to the external world: for example, if an older infant sees a toy being hidden in a location to her left on a small table, and the infant is then moved to the opposite side of the table, she will then reach to her right in order to (correctly) retrieve the object. The younger infant is likely to judge spatial organization **egocentrically** (with respect to her own body), and in this task will reach (incorrectly) to her left even though she has been moved through 180°.

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Overview

Piagetian theory enjoys strong support for many of the kinds of behavior that Piaget described, such as the many replications of the A-not-B error that have been reported. Indeed, in addition to his enormous theoretical contribution Piaget left us a legacy of hundreds of experiments and experimental paradigms which continue to influence and dominate current work on cognitive development. Nevertheless, some researchers have questioned whether cognitive development is as heavily dependent on manual experience, and whether infant cognition is purely sensorimotor. Also controversial is the idea that early concepts of objects and people are subjective, not objective, and a function of the child's own behavior. In the following section we review evidence for alternate views of infant cognition that claim a more sophisticated foundation for intellectual development from an early age.

Nativist approach

A central tenet of nativist theory is that a limited number of early-emerging kinds of knowledge form a central core around which more diverse, mature cognitive capacities are later elaborated. That is, some kinds of knowledge are **innate**. Philosophical discussions of innateness are ancient; historically, these discussions have centered on the extent to which knowledge must necessarily be rooted in, or is independent of, postnatal experience. Plato and Descartes, for example, proposed that some ideas were innate because they were elicited in the absence of any direct tutoring or instruction, or were unobservable in the world, and thus unlearnable (e.g., concepts of geometry or God).

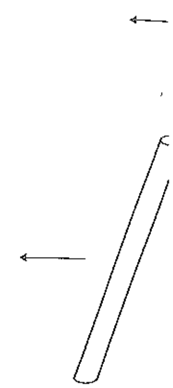
Innate object knowledge

More recently, theories of innate object knowledge have arisen: concepts of objects as obeying physical constraints, such as persistence and solidity across occlusion. Three arguments have been mounted for these hypothesized innate object concepts. First, evidence of object knowledge can be observed in very young infants, perhaps too early to have derived from postnatal learning. Second, infants' detection of apparent violations of physical constraints has been proposed to arise from experience with **contrastive evidence**, opportunities to observe objects behaving in a manner consistent or inconsistent with a particular concept (Baillargeon, 1994). If this proposal is correct, then a concept of persistence across occlusion must be innate, because it cannot have been acquired from observing contrastive evidence: only very rarely are there observable events in the real world in which an object goes out of existence (the obvious examples are a soap bubble or a balloon bursting). Third, there is evidence from nonhuman animals and anatomical specialization in humans for commonality of cognitive function across species (such as working memory for small numbers of objects), and commonality of cortical structure across individual humans (such as Broca's area which deals with speech production, Wernicke's area which deals with language comprehension, and the fusiform face area which deals with face perception), suggesting an inevitability of certain concepts that are 'programmed' via evolutionary pressure (Dehaene, 1997).

There is evidence from a variety of laboratories and experimental settings for infants' representations of objects as solid bodies that are spatio-temporally coherent and persistent, representations that appear to be functional by 4 months after birth. Nevertheless, unequivocal evidence for **innate** object concepts (arising in the absence of experience) has not yet been reported. Moreover, findings from experiments on infants' perception of partly occluded objects, reviewed in brief next, cast doubt on the likelihood that object concepts are innate.

Perception of partly occluded objects

Kellman and Spelke (1983) devised a task to examine the perceptual equivalence of two identical forms, one of which was partially occluded; this paradigm exploits the tendency of infants to look longer at a novel visual stimulus than at a familiar one. After exposure to a partly occluded rod, 4-month-old infants looked longer at two rod parts than at a complete object (see Figure 6.1), implying a representation of unity in the original, partly occluded stimulus. When newborn infants were tested in a similar procedure, however, they responded to a partly occluded object display solely on the basis of its visible parts, failing to perceive completion behind the occluder (Slater, Morison *et al.*, 1990). Johnson and Aslin (1995) found that under some conditions, 2-month-olds would perceive object unity, as when the occluder is made narrow and the distance of perceptual interpolation is thereby reduced, relative to a display in which older infants are able to achieve perceptual completion. A parallel pattern of responses was reported by Johnson, Bremner *et al.* (2003), Johnson (2004), and Bremner *et al.* (2005) in experiments examining perception of object persistence when fully occluded (i.e., an object moving back and forth, becoming completely hidden behind an occluder for a short time before re-emerging). Four-month-olds perceived object persistence only when the object was out of sight for a very brief interval; when it was out of sight for a more extended duration, the infants appeared to perceive only the visible segments of the object trajectory, failing to perceive persistence (see Figure 6.2). In other words, they behaved similarly to newborns viewing a partly occluded object, responding on the basis of what is directly visible only. Six-month-olds seemed to perceive persistence even under the longer occlusion duration.



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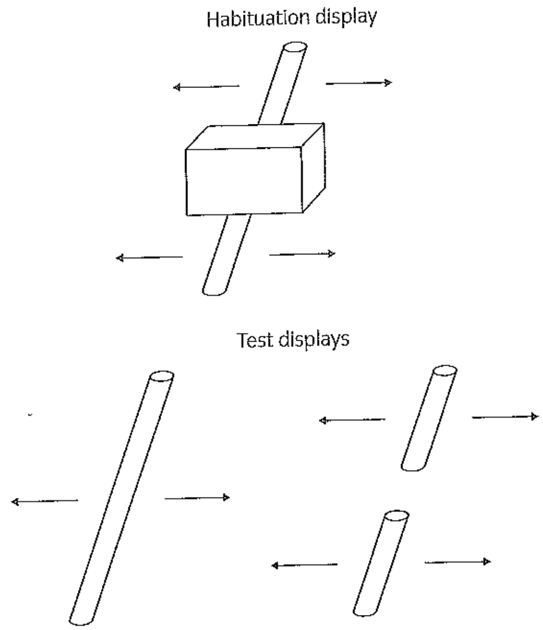

Figure 6.1 Infants are first habituated (top) to a rod that moves back and forth behind an occluder, and on test trials are shown a complete rod and two rod pieces (bottom). Four-month-old infants look longer at the two rod pieces, a novelty preference that indicates that they had seen a complete rod on the habituation trials. Newborn infants, however, look longer at the complete rod, suggesting they had seen two rod pieces during habituation.

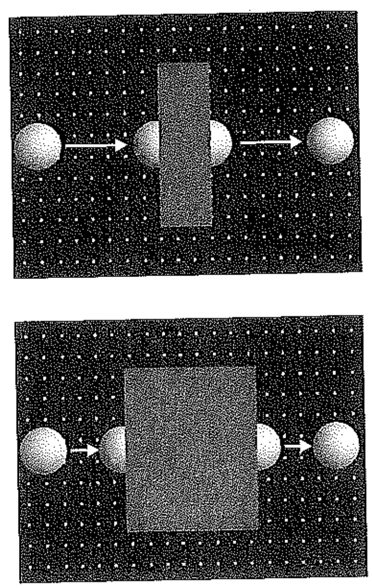

Figure 6.2 When 4-month-olds are shown a ball moving behind a narrow occluder (top), so that it is out of sight for a very short period of time, they see it as one object moving on a continuous trajectory. However, when the occluder is wider (bottom) they see it as two separate objects.

Consider these results in the light of the claims for innateness outlined previously. All evidence to date indicates that perception of occlusion is not available in humans at birth, and without perception of occlusion a functional object concept, and understanding of an object as a whole, is impossible since infants would usually see only fragments of the whole object. How the change occurs toward perception of objects as unified and persistent is unknown at present, but it may well be dependent on postnatal experiences.

A comparison of empiricist and nativist views: innate social knowledge?

In addition to theories of innate **object** knowledge, theories of innate **social** knowledge have also emerged, and in this section we compare two different theoretical views, those of Piaget and Meltzoff and Moore, on the nature and development of infant imitation, particularly of adults' facial gestures. For Piaget the capacity for imitation develops gradually as infancy progresses. For the first 8–10 months there are behaviors that can be interpreted as imitation, but this is often illusory: if a model (i.e., an adult) imitates a sound or a gesture the infant is producing, the infant is likely to continue making the sound or gesture, but this may be simply repeating her own actions rather than reproducing or imitating another's actions. According to the Piagetian account, infants in this age range are unable to imitate actions that require them to use parts of their body that they cannot see, such as tongue protrusion or mouth opening. Around 8–10 months the first 'true' imitation emerges, and for the first time the infant becomes able to produce imitative gestures that she cannot see, such as the movement of her lips. A little later the infant becomes able to imitate novel gestures: an example that Piaget gave was imitation of movements of the forefinger.

Later still, around 18–24 months, the capacity for **deferred imitation** emerges. Piaget gave this example from his daughter Jacqueline, when she was aged 1 year 4 months:

> At 1;4 Jacqueline had a visit from a little boy of 1;6 whom she used to see from time to time, and who, in the course of the afternoon got into a temper tantrum. He screamed as he tried to get out of his playpen and pushed it backward, stamping his feet. Jacqueline stood watching him in amazement, never having witnessed such a scene before. The next day she herself screamed in her playpen and tried to move it, stamping her foot lightly several times in succession.
>
> (Piaget, 1951, p. 63)

What has developed? In this example his daughter reproduced the event some time after it had happened. Therefore, she must have internalized the action at the time of its occurrence and retained a **representation** of the event so that it could be evoked and acted on at a later time.

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We can see that Piaget's account suggested that the capacity for imitation develops slowly over infancy and it progresses concurrently with other aspects of development. The ability to imitate **novel** actions (i.e., those not already in the infant's repertoire) does not appear until around 9 months, around the time that the infant becomes able to imitate actions (such as movements of the lips or tongue protrusion) where she cannot see the imitative actions on herself. The capacity for representation appears towards the end of infancy, around 18 months, or a little earlier, bringing with it the capacity for deferred imitation.

A different account, suggesting that representation is the starting point and not the end point of infancy, has been put forward by Meltzoff and Moore (1977) and elaborated by Meltzoff (2004). Meltzoff and Moore (1977) have proposed an early-developing system in infants for recognizing and responding to other people, a system that is expressed behaviorally in imitative gestures. That is, under some circumstances, infants have been reported to imitate certain facial and manual gestures produced by adults, particularly tongue protrusion and mouth opening (see Figure 6.3).

Some authors (e.g., Anisfeld *et al.*, 2001), have reported failures to replicate imitation of facial gestures in newborn infants, but others have reported successful replications, even in infants within an hour from birth, where the experimenter's face was the first they saw (Reissland, 1988). Imitation by newborn infants seems a remarkable achievement, given that such imitation

Figure 6.3 An infant imitating an adult's tongue protrusion. Photo from Andrew Meltzoff.

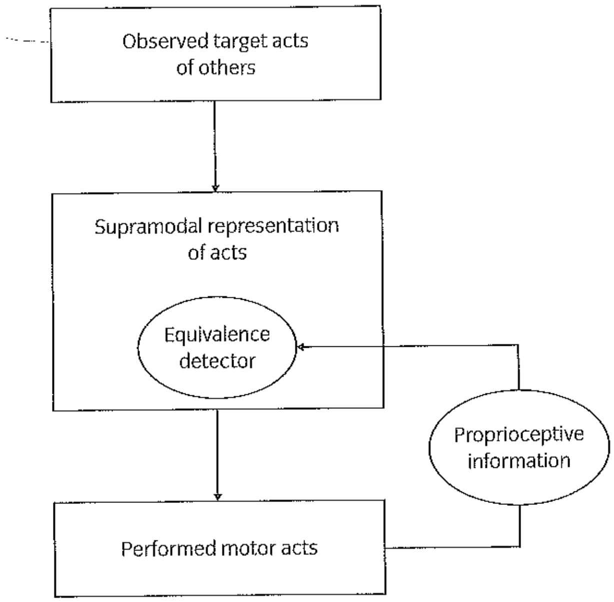

Figure 6.4 Meltzoff and Moore's active intermodal matching model of infant imitation. The infant sees the target act, such as tongue protrusion, and is able to represent the act. She then attempts to imitate the act and the equivalence detector informs her how accurate she is, and through proprioceptive feedback she is able to match her behavior more and more closely to the target act.

occurs without the infant being able to see her own face. How might newborn infants be able to do this? Meltzoff and Moore suggest that it is done by a process of **active intermodal matching**, which is illustrated in Figure 6.4. In this model the infant is able to match her behavior (e.g., tongue protrusion or mouth opening) with the behavior observed from the adult model, because the infant is able to detect **proprioceptive feedback**, which is information about the movement of its own (unseen) facial movements, and match this information to its own imitative behavior. Imitation of the appropriate facial gesture emerges rapidly within a session as the equivalence detector enables the infant to match its own behavior more and more closely with that of the adult model. Meltzoff and Moore (2002) have also reported evidence of deferred imitation in 6-week-old infants. In this study the infants saw an adult producing a gesture (either mouth opening or tongue protrusion) and 24 hours later they saw the same adult, this time presenting a passive face. The infants then produced (i.e., imitated) the gesture they had seen the day before.

The finding of imitation in very young infants suggests that infants are born with a fairly detailed representation of the human face (Meltzoff, 2004) and supports the view that 'newborns begin life with some grasp of people' (Meltzoff, 1995). An intriguing view put forward by Meltzoff and Moore is that infants imitate as a form of social interaction and as a way of learning

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Comparing nativist and empiricist views

As we have seen above, nativist views argue for innate knowledge, i.e., knowledge that the infant is born with and which helps to guide subsequent learning. Empiricist views, on the contrary, argue that the infant is born with little or no knowledge of the physical and social world and knowledge about the world is constructed from the infant's actions and experiences, and emerges over time. Piaget's account of cognitive development is often referred to as a **constructivist** account in that he argued that knowledge was constructed from the infant's experience and actions on the world. We will see in the next section that information-processing approaches typically offer a constructivist view of development.

Information-processing account

Rather than presuppose an unchanging, innate core of cognitive capacities, information-processing theorists posit a set of sensory, perceptual, and (non-conceptual) cognitive processes that are constant across development, such as auditory and visual perception, memory, attention, and categorization (Cohen, Chaput & Cashon, 2002). On this view, knowledge is constructed from the function of these more primitive mechanisms over time, and learning. With development, infants become able to integrate the lower-level units of information into a more complex, higher-level unit, these higher-level units serve as the components for even more complex units, and so on. Concepts are thus formed incrementally rather than being provided innately.

Experiments that examine infants' perception of causality provide evidence for this approach, and studies on this topic that also demonstrate the dynamic shifting between processing lower- and higher-level components of events were reported by Cohen and Amsel (1998) and Cohen and Oakes (1993). Infants 4–10 months of age were shown videos of an object moving into the vicinity of a second object. If objects make contact in such events, and the second object moves away abruptly, adults report a **causal** relation between the two: a **launching event**. Launching is not perceived, however, if there is no contact between the two objects, or if there is a delay between contact and launch (see Figure 6.5). The likelihood of perception of causality at any particular age is a function of the complexity of the events. For example, 6.5-month-olds responded to causality, and not merely the movements of

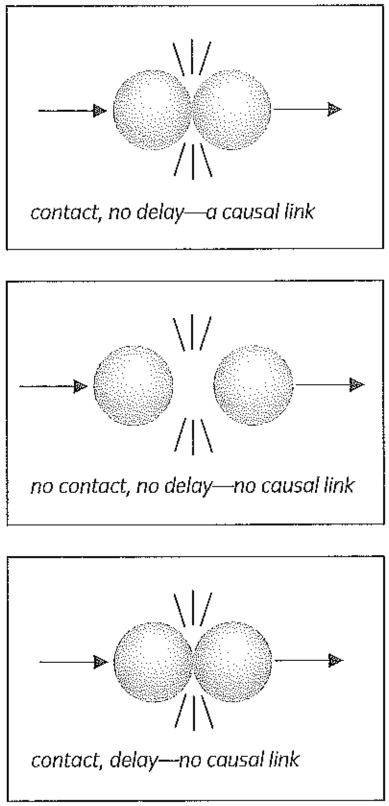

Figure 6.5 Perception of causality. If adults see a display where one object makes contact with another and the second then moves away without a delay (top—a launching event) they typically report that the first object *caused* the second to move. However, if the second object moves without any contact with the first (middle), or if the second object moves some time after the first has made contact (bottom), there is no perception of a causal link between the movements of the two objects.

the individual components of the event, if the objects were simple shapes. If more complex objects participate in such events, infants at this age provide no evidence of causality perception. Ten-month-olds perceive causality in displays with more intricate objects, yet fail when objects change from trial to trial but a causal relation is maintained. Presumably, the infants were compelled to process the events under these circumstances at a perceptual, rather than a conceptual level, due to increased constraints presented by the added complexity of the stimuli.

Important progress has been made in understanding developmental mechanisms underlying causality perception in infants by using **connectionist** models, which are computer programs designed to learn from experience. Connectionist models take as input similar kinds of information as do human observers, coded in terms of input to which a computer can respond, and provide as output a prediction about the next in a series of events. Cohen *et al.* (2002) modeled development of causality perception and found that it can be explained with a combination of sensitivity to the temporal and spatial aspects of the event, in accord with the stipulations of information-processing approaches, rather than by supposing an innately determined 'concept' of

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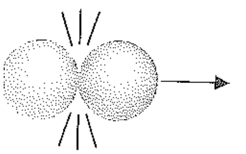

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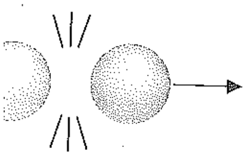

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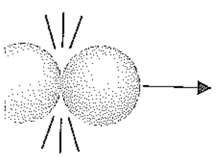

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causality. In other words, causality was constructed from a combination of perceptual sensitivities, memory, and experience. Connectionist models have been used to examine a variety of aspects of cognitive development (see Mareschal, 2002).

Psychometric approach

The **psychometric approach** attempts to measure various aspects of individuals to understand how development takes place, and also to compare the development of individuals with those of a comparable group of people—this is the measurement of individual differences.

Bayley Scales of Infant Development (BSID)

The most frequently used test of infant development is the Bayley Scales of Infant and Toddler Development. Nancy Bayley published the California First Year Mental Scale in 1933, and this included measures of both motor and mental development. It later became the Bayley scales, and the third edition (Bayley-III) appeared in 2005. This test is described in more detail in Chapter 2.

We can ask whether scores on this test predict later IQ, and the answer is that infants' scores on the tests generally do not, although as a measure of overall development the Bayley scales are clearly good. Given that standardized tests of infant cognitive development generally do not predict later development or, by themselves, detect infants at risk of delayed development, the search has been on for alternative measures that might do this, and in this search visual habituation and dishabituation are seen as among the main contenders.

Habituation and dishabituation as measures of cognitive development

Habituation to a visual stimulus, and subsequent recovery of attention to a novel stimulus (dishabituation), as discussed in Chapter 2, is considered an indication of brain integrity and cognitive competence, and rate or speed of habituation, and amount of recovery of attention to a novel stimulus are considered a measure of speed and amount of information processing.

We know that these measures show individual differences between infants, and there have been many studies which report a modest predictive correlation between measures of habituation and dishabituation in infancy and later IQ. In a recent evaluation and analysis of dozens of these studies (known as a **meta-analysis**) Kavsek (2004) suggested that the average correlation between infant habituation/dishabituation and measures of intelligence in later life is .37 and concluded that 'the predictive validity of habituation/dishabituation is substantial and stable up until adolescence' (p. 369). Bornstein *et al.* (2006), similarly, suggested that 'Infants who habituate efficiently are infants who scan and pick up information economically, assimilate that information quickly, or construct memories more easily and faithfully than other infants. Children who successfully solve the perceptual, language, abstract reasoning, and memory tasks that are included in children's intelligence tests do likewise' (p. 157).

Integrating the four approaches

Although the four approaches that we have described might seem quite disparate, their basic aim is the same, that is, to come to an understanding of the ways in which intellectual and cognitive abilities develop and can be measured in infancy. The approaches are also interrelated and draw upon each other. For example, measuring habituation/dishabituation may be seen in the context of the information-processing approach since it clearly involves the infant in taking in information; information-processing methods are used to test concepts that Piaget first drew our attention to; Piagetian tasks, such as object permanence are often incorporated into tests of infant development, such as the Bayley scales. Nevertheless, having different approaches to the growth of intelligence adds to the richness and variety of our developing understanding of infant development, and tells us that intelligence shows both continuities and discontinuities in development.

The effects of early experiences on the development of intelligence

Several authors have discussed the relative contributions of genetic and environmental factors on cognitive development in infancy, and it has often been claimed that, except for extreme deprivation, mental development in infancy follows a genetically predetermined, species-typical growth path, known as a **creod**, a term derived from the Greek words for 'necessity' and 'a path.' Those who adopted this view argued that intervention studies that are aimed at infants from disadvantaged backgrounds, and are at risk for developmental retardation, should begin after the first year or so, since development before this age is genetically determined and not at risk from environmental deprivation: thus, Ramey *et al.* (1984, p. 1923) suggested that 'intervention programs for initially healthy children might be more beneficial

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during early childhood than during infancy'; 9 years later much the same conclusion was reached by Brooks-Gunn *et al.* (1993, p. 746) who offered the view that 'early infant intelligence is canalized ... rendering it relatively impervious to intervention.' (Development that is **canalized** refers to that which is genetically programmed and kept within narrow boundaries even in the presence of disturbing or deprived environments.)

Research over the last 15 years or so, however, has shown that this view is mistaken. Michael Rutter and colleagues (1998) have followed up over 100 Romanian children who were adopted into the United Kingdom after living in conditions that were characterized by extreme neglect, being reared in orphanages where they received little care, stimulation, or attention, with few toys or objects to play with. Half of these children were below the third percentile in body size, head circumference, and levels of developmental function. However, if they arrived in the UK before 6 months of age they made a remarkable recovery and had caught up and reached normal developmental levels in cognitive functioning. Those who entered the UK at a later age showed a degree of developmental catch-up compared with their level of functioning at the time of entry, but on average, this improvement was not complete. In this study, the strongest predictor of cognitive status at age 4 years was the age of entry to the UK. A later study of the same children (Beckett *et al.*, 2002) also found other disturbances, such as a difficulty in chewing and swallowing solid foods at age 6 years, whose prevalence was also related to the amount of time the children had spent in severe deprivation. This is a clear indication that deprivation affects many aspects of development and is rarely confined to cognitive development. These findings, by themselves, argue for early intervention, at least in cases of severe deprivation.

Begun in the 1960s, the **Head Start** program in the United States was one of the first large-scale attempts to support the view that the earlier the intervention, the greater the likelihood of positive results. Early intervention programs are reviewed in Chapter 16.

SUMMARY

Over the last 100 years we have made great inroads into an understanding of the development of intelligence and cognitive abilities in infancy. Before Piaget, whose work on infants and children began in the 1920s, developmental psychology barely existed. Piaget's work demonstrated that the child was an active contributor to his or her own development, and he was the first to demonstrate that major aspects of cognitive development were present and developing in infancy and could be investigated. Piaget's work continues to influence research (e.g., see Chapter 8) and his impact has been and continues to be enormous: Flavell (1996) wrote an assessment of Piaget's contribution, entitled 'Piaget's legacy,' and quotes an anonymous reviewer of his article—'The impact of Piaget on developmental psychology is . . . too monumental to embrace,' to which Flavell simply adds the words 'I agree.'

We also considered the nativist approach, which argues that infants are born with evolutionarily/genetically provided innate knowledge of the cognitive and/or social world and that this knowledge forms a core around which more mature cognitive functioning will develop.

Information-processing approaches view the human mind as a complex system through which information flows. There is not a single information-processing theory, but most approaches along these lines suggest that there are three components to cognitive activity. First, information is taken in from the world and encoded into some meaningful form. Next, a number of internal processes such as memory, recognition, problem-solving strategies work on the information, so that finally individuals are able to change their cognitive structures and knowledge in order to act on the information. As development continues, increasingly improved ways of acting on the world emerge in infancy.

Finally, we considered the psychometric approach, which attempts to measure cognitive development in individual infants in order to compare their development with that of other infants.

Clearly, each of the four approaches makes an important and interrelated contribution to our understanding of infant cognitive development. We now know that development in infancy is rapid and that infants begin learning from before birth. The findings from early intervention and deprivation studies emphasize the importance of development, and of environmental influences, throughout infancy and childhood.

CHAPTER SEVEN

Categoriza

PAUL C. QUINN

Introduction

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