CHAPTER 15

# The Development of Consciousness

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## Abstract

This chapter examines the extent to which consciousness might develop during ontogeny. Research on this topic is converging on the suggestion that consciousness develops through a series of levels, each of which has distinct consequences for the quality of subjective experience, the potential for episodic recollection, the complexity of children's explicit knowledge structures, and the possibility of the conscious control of thought, emotion, and action. The discrete levels of consciousness identified by developmental research are useful for understanding the complex, graded structure of conscious experience in adults.

## Introduction

Despite the explosion of scientific interest in consciousness during the past two decades, there is a relative dearth of research on the way in which consciousness develops during ontogeny. This may be due in part to a widespread belief that it goes without saying that children are conscious in same way as adults. Indeed, most people probably believe that newborn infants – whether protesting their arrival with a vigorous cry or staring wide-eyed and alert at their mother – are conscious in an essentially adult-like fashion. So, although there are dramatic differences between infants and toddlers and between preschoolers and adolescents, these differences are often assumed to reflect differences in the contents of children's consciousness, but not in the nature of consciousness itself.

There is currently considerable debate, however, concerning when a fetus first becomes capable of conscious experience (including pain). This debate has been instigated by proposed legislation requiring physicians in the United States to inform women seeking abortions after 22 weeks gestational age (i.e., developmental age plus 2 weeks) that fetuses are able to experience pain (Arkansas, Georgia, and Minnesota have already passed similar laws). Professor Sunny Anand, a paediatrician and an expert on neonatal pain, recently testified

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before the U.S. Congress (in relation to the Unborn Child Pain Awareness Act of 2005; Anand, 2005) that the "substrate and mechanisms for conscious pain perception" develop during the second trimester. Others (e.g., Burgess & Tawia, 1996; Lee et al., 2005) have suggested that consciousness develops later, during the third trimester (at around 30 months gestational age) – because that is when there is first evidence of functional neural pathways connecting the thalamus to sensory cortex (see Chapter 27).

Inherent in these claims is the assumption that consciousness is an "all-or-nothing" phenomenon – one is either conscious or not, and capable of consciousness or not (cf. Dehaene & Changeux, 2004). This assumption is also reflected, for example, in information-processing models (e.g., Moscovitch, 1989; Schacter, 1989) in which consciousness corresponds to a single system and information is either available to this system or not. From this perspective, it is natural to think of consciousness as something that *emerges* full-blown at a particular time in development, rather than something that itself undergoes transformation – something that *develops*, perhaps gradually. Although the current debate concerning pain and abortion has centered on the prenatal period, there are those who believe that consciousness emerges relatively late. Jerome Kagan (1998), for example, writes that "sensory awareness is absent at birth but clearly present before the second birthday" (p. 48). It should be noted that Kagan believes that consciousness does develop beyond the emergence of sensory awareness, but if you've ever met a toddler (say, a 14-month-old), it may be difficult to imagine that children at this age lack sensory awareness – which Kagan (1998) defines as "awareness of present sensations" (p. 46).

The implications of Kagan's claim are profound. For example, if we follow Nagel (1974), who asserts that the essence of subjective experience is that it is "like something" to have it (see Chapter 3), we might conclude, as Carruthers (1989) does, that it does not feel like anything to be an infant. Carruthers (1996) further tests our credulity when he argues that children are not actually conscious until 4 years of age (because it is not until then that children can formulate beliefs about psychological states). These theorists characterize infants and/or young children essentially as unconscious automata or zombies (cf. Chalmers, 1996; see Chapter 3) – capable of cognitive function but lacking sentience.

Although many theorists treat consciousness as a single, all-or-nothing phenomenon, others distinguish between first-order consciousness and a meta-level of consciousness. For example, they may distinguish between consciousness and meta-consciousness (Schooler, 2002), primary consciousness and higher-order consciousness (Edelman & Tononi, 2000), or core consciousness and extended consciousness (Damasio, 1999). In the developmental literature, this dichotomous distinction is usually described as the difference between consciousness and self-consciousness (e.g., Kagan, 1981; Lewis, 2003). In most cases, the first-order consciousness refers to awareness of present sensations (e.g., an integrated multimodal perceptual scene; Edelman & Tononi, 2000), whereas the metalevel consciousness is generally intended to capture the full complexity of consciousness as it is typically experienced by healthy human adults. Edelman and Tononi (2000), for example, suggest that higher-order consciousness is, according to their model, "accompanied by a sense of self and the ability . . . explicitly to construct past and future scenes" (p. 102). Developmentally, the implication is that infants are limited to relatively simple sensory consciousness until an enormous transformation (usually presumed to be neurocognitive in nature and involving the acquisition of language or some degree of conceptual understanding) occurs that simultaneously adds multiple dimensions (e.g., self-other, past-future) to the qualitative character of experience. This profound metamorphosis has typically been hypothesized to occur relatively early in infancy (e.g., Stern, 1990; Trevarthen & Aitken, 2001) or some time during the second year (e.g., Kagan, 1981; Lewis, 2003; Wheeler, 2000),

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depending on the criteria used for inferring higher-order self-consciousness.

In this chapter, we propose that discussions of the development of consciousness have been hampered by a reliance on relatively undifferentiated notions of consciousness. Indeed, we argue that developmental data suggest the need for not just two, but *many* dissociable levels of consciousness; information may be available at one level but not at others (see Morin, 2004, 2006, for a review of recent models of consciousness that rely on the notion of levels; see also Cleeremans & Jiménez, 2002, for a related perspective on consciousness as a graded phenomenon). Consideration of these levels and of their utility in explaining age-related changes in children's behavior has implications for our understanding of consciousness in general, including individual differences in reflectivity and mindfulness (see Chapter 19), but the focus here is on development during childhood. Many of the arguments regarding *when* consciousness emerges – for example, at 30 months gestational age (e.g., Burgess & Tawia, 1996), at 12 to 15 months after birth (Perner & Dienes, 2003), at the end of the second year (Lewis, 2003), or around the fourth birthday (Carruthers, 2000) – have merit, and we propose that some of the most salient discrepancies among these accounts can be reconciled from the perspective that consciousness has several levels. Different theorists have directed their attention to the emergence of different levels of consciousness; a developmental perspective allows us to integrate these levels into a more comprehensive model of consciousness as a complex, dynamic phenomenon.

## Early Accounts of the Development of Consciousness

For early theorists such as Baldwin (e.g., 1892), Piaget (1936/1952), and Vygotsky (1934/1986), consciousness was *the* problem to be addressed by the new science of psychology, and these theorists made major contributions by showing how children's consciousness, including the way in which children experience reality, is changed during particular developmental transformations. That is, they all understood that the structure of consciousness itself – and not just the contents of consciousness – develops over the course of childhood. For Baldwin, infants' experience can initially be characterized as a state of adualism – meaning that they are unaware of any distinctions that might be implicit in the structure of experience (e.g., subject vs. object, ego vs. alter; e.g., Baldwin, 1906). During the course of development, however, children proceed through a series of "progressive differentiations between the knower and the known" (Cahan, 1984, p. 131) that culminates in transcending these dualisms and recognizing their origin in what Baldwin calls the dialectic of personal growth (by *personal*, Baldwin refers both to oneself and to persons). Baldwin, therefore, suggests that consciousness develops through a circular process of differentiation and then integration (cf. Eliot's poem, "Little Gidding": "And the end of all our exploring/ Will be to arrive where we started/ And know the place for the first time.").

Imitation plays a key role in this dialectic, which starts when an infant observes behavior that is (at least partially) outside of his or her behavioral repertoire. At this point, the infant cannot *identify* with the behavior or the agent of the behavior, so the behavior is viewed solely in terms of its outward or *projective* aspects. By imitating this behavior, however, the infant discovers the subjective side of it, including, for example, the feeling that accompanies it. Once this happens, the infant automatically *ejects* this newly discovered subjectivity back into his or her understanding of the original behavior. Baldwin (1894) gives the example of a girl who watches her father prick himself with a pin. Initially, she has no appreciation of its painful consequence. When she imitates the behavior, however, she will feel the pain and then immediately understand that her father felt it too. Subsequently, she will view the behavior of pin pricking in a

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different fashion; her understanding of the behavior will have been transformed from *projective* to *subjective* to *ejective*. In effect, she will have brought the behavior into the scope of her self- and social-understanding, expanding the range of human behavior with which she can identify. Baldwin (1897, p. 36) writes, "It is not I, but I am to become it," a formulation that seems to capture the same fundamental insight about the development of consciousness as Freud's (1933/1940, p. 86) famous "Wo Es war, soll Ich warden." ("Where it was, there I shall be").

Piaget similarly saw "increasing self-awareness of oneself as acting subject" (Ferrari, Pinard, & Runions, 2001, p. 207) – or decreasing egocentrism – as one of the major dimensions of developmental change, and he tied this development to the emergence of new cognitive structures that allowed for new ways of knowing or experiencing reality. Indeed, for Piaget, consciousness (the experience of reality) was dependent on one's cognitive structures, which are believed to develop through a series of stages primarily as a result of a process of equilibration, whereby they become increasingly abstract (from practical to conceptual) and reflect more accurately the logic of the universe. Consciousness also develops in a characteristic way regardless of children's developmental stage; at all stages, from practical to conceptual, consciousness "proceeds from the periphery to the center" (Piaget, 1974/1977, p. 334), by which Piaget meant that one first becomes aware of goals and results and then later comes to understand the means or intentions by which these results are accomplished. For older (formal operational) children, Piaget (1974/1977) noted, this development from periphery to center can occur quite quickly via the *reflexive abstraction* of practical sensorimotor knowledge. This process, which corresponds to conceptualization or reflective redescription, allows children more rapidly to transform knowledge-in-action into articulate conceptual understanding. In all cases, however, we see consciousness developing from action to conceptualization. Piaget's (1974/1977) emphasis on the role of action in the development of consciousness was summarized concisely at the end of his key volume on the topic, *The Grasp of Consciousness*, where he wrote, "The study of cognizance [i.e., consciousness] has led us to place it in the general perspective of the circular relationship between subject and object. The subject only learns to know himself when acting on the object, and the latter can become known only as a result of progress of the actions carried out on it" (p. 353).

Vygotsky (1934/1986), in contrast to both Baldwin and Piaget, noted that children's consciousness was transformed mainly via the appropriation of cultural tools, chiefly language. Vygotsky, and then Luria (e.g., 1959, 1961), proposed that thought and speech first develop independently but then become tightly intertwined as a result of internalization – a process whereby the formal structure inherent in a cultural practice, such as speaking, is first acquired in overt behavior and then reflected in one's private thinking. Initially, speech serves a communicative purpose, but later it also acquires semantic, syntactic, and regulatory functions. The emergent regulatory function of speech is inherently self-conscious, and it allows children to organize and plan their behavior, essentially rendering them capable of consciously controlled behavior (Luria, 1961; Vygotsky, 1934/1986). Vygotsky (1978) wrote, "With the help of speech children, unlike apes, acquire the capacity to be both the subjects and objects of their own behavior" (p. 26). For Vygotsky, then, consciousness was transformed by language, with important consequences for action.

Contemporary theorists have elaborated on some of these seminal ideas about the development of consciousness – although they have not always explicitly addressed the implications for the character of children's subjective experience. Barresi and Moore (1996), for example, offered a model of the development of perspective taking that builds on Baldwin's (1897) dialectic of personal growth. According to Barresi and Moore, young children initially take a first-person, present-oriented perspective on their own behavior (e.g., "I want candy now") and a third-person perspective on the behavior of others – seeing that behavior from the outside, as it were. Because simultaneous consideration of first- and third-person perspectives is required for a representational understanding of mental states (e.g., "I know there are sticks in the box, but he thinks there is candy"), young children have difficulty understanding false beliefs – both their own and those of others (see Wellman, Cross, & Watson, 2001, for a review). With development, however, children are better able to adopt a third-person perspective on their own behavior, imagine a first-person perspective on the behavior of others, and coordinate these perspectives into a single schema.

As another example, Karmiloff-Smith (1992) builds on Piaget's (1974/1977) idea of reflexive abstraction with her model of Representational Redescription, in which consciousness develops as a function of domain-specific experience. According to this model, knowledge is originally represented in an implicit, procedural format (Level I), but, with sufficient practice, behavioral mastery of these procedures is achieved and the knowledge is automatically redescribed into a more abstract, explicit format (Level E1). This representational format reveals the structure of the procedures, but is still not conscious: Consciousness comes with yet additional levels of redescription or 'explicitation,' which occur "spontaneously as part of an internal drive toward the creation of intra-domain and inter-domain relationships" (1992, p. 18). Level E2 is conscious but not verbalizable, whereas Level E3 is both conscious and verbalizable.

Finally, Zelazo and his colleagues have expounded a model of consciousness, the Levels of Consciousness (LOC) model (e.g., Zelazo, 1999, 2004; Zelazo & Jacques, 1996; Zelazo & Zelazo, 1998) that builds on the work of Baldwin, Piaget, and Vygotsky and Luria – but especially Vygotsky and Luria. Because this model is relatively comprehensive and addresses explicitly the potential implications of neurocognitive development for children's subjective experience, we describe it in some detail. In what follows, we first provide an overview of the model and then show how it aims to provide an account of the way in which consciousness develops during the first 5 years of life (and potentially beyond). Empirical and theoretical contributions to our understanding of the development of consciousness are reviewed in the context of the LOC model.

## Overview of the Levels of Consciousness (LOC) Model

The Levels of Consciousness (LOC) model describes the structure of consciousness and attempts to show the consequences that reflection has on the structure and functions of consciousness, including the key role that reflection plays in the conscious control of thought, action, and emotion via explicit rules. In what follows, we consider the implications of the LOC model for (1) the structure of consciousness, (2) cognitive control via the use of rules at different levels of complexity, (3) the functions of prefrontal cortex, and (4) the development of consciousness in childhood.

### *The Structure of Consciousness*

According to the LOC model, consciousness can operate at multiple discrete levels, and these levels have a hierarchical structure – they vary from a first-order level of consciousness (minimal consciousness) to higher-order reflective levels that subsume lower levels. Higher levels of consciousness are brought about through an iterative process of reflection, or the recursive reprocessing of the contents of consciousness via thalamocortical circuits involving regions of prefrontal cortex. Each degree of reprocessing results in a higher level of consciousness, and this in turn allows for the integration of more information into an experience of a stimulus before a new stimulus is experienced; it allows the stimulus to be considered relative to a larger interpretive context. In this way, each additional level of consciousness changes the structure of experience, and the addition of each level has unique consequences for the quality of subjective experience: The addition of higher levels results in a richer, more detailed experience and generates more "psychological distance" from stimuli (e.g., Carlson, Davis, & Leach, 2005; Dewey, 1931/1985; Sigel, 1993). But the addition of new levels also has implications for the potential for episodic recollection (because information is processed at a deeper level; Craik & Lockhart, 1972), the complexity of children's explicit knowledge structures, and the possibility of the conscious control of thought, emotion, and action.

## Control by Rules at Various Levels of Complexity

According to the LOC model, conscious control is accomplished, in large part, by the ability to formulate, maintain in working memory, and then act on the basis of explicit rule systems at different levels of complexity – from a single rule relating a stimulus to a response, to a pair of rules, to a hierarchical system of rules that allows one to select among incompatible pairs of rules, as explained by the Cognitive Complexity and Control (CCC) theory (e.g., Frye, Zelazo, & Palfai, 1995; Zelazo, Müller, Frye, & Marcovitch, 2003). On this account, rules are formulated in an ad hoc fashion in potentially silent self-directed speech. These rules link antecedent conditions to consequences, as when we tell ourselves, "If I see a mailbox, then I need to mail this letter." When people reflect on the rules they represent, they are able to consider them in contradistinction to other rules and embed them under higher-order rules, in the same way that we might say, "If it's before 5 p.m., then if I see a mailbox, then I need to mail this letter, otherwise, I'll have to go directly to the post office." In this example, the selection of a simple conditional statement regarding the mailbox is made dependent on the satisfaction of another condition (namely, the time). More complex rule systems, like the system of embedded if-if-then rules in this example, permit the more flexible selection of certain rules for acting when multiple conflicting rules are possible. The selection of certain rules then results in the amplification and diminution of attention to potential influences on thought (inferences) and action when multiple possible influences are present.

According to the LOC model, increases in rule complexity – whether age-related (see below) or in response to situational demands – are made possible by corresponding increases in the extent that one reflects one's representations: They are made possible by increases in level of consciousness. Rather than taking rules for granted and simply assessing whether their antecedent conditions are satisfied, reflection involves making those rules themselves an object of consideration and considering them in contradistinction to other rules at that same level of complexity.

Figure 15.1 contrasts relatively automatic action at a lower level of consciousness (1a) with relatively deliberate action at a higher level of consciousness (1b). The former type of action (1a) is performed in response to the most salient, low-resolution aspects of a situation, and it is based on the formulation of a relatively simple rule system – in this case, nothing more than an explicit representation of a goal maintained in working memory. The more deliberate action (1b) occurs in response to a more carefully considered construal of the same situation, brought about by several degrees of reprocessing the situation. The higher level of consciousness depicted in Figure 15.1b allows for the formulation (and maintenance in working memory) of a more complex and more flexible system of rules or inferences (in this case, a system of embedded rules considered against the backdrop of the goal that occasions them).

The tree diagram in Figure 15.2 illustrates the way in which hierarchies of rules can be formed through reflection – the way in which one rule can first become an object of explicit consideration at a higher level of consciousness and then be embedded under another higher-order rule and controlled by it. Rule A, which indicates that response 1 ($r_1$) should follow stimulus 1 ($s_1$),

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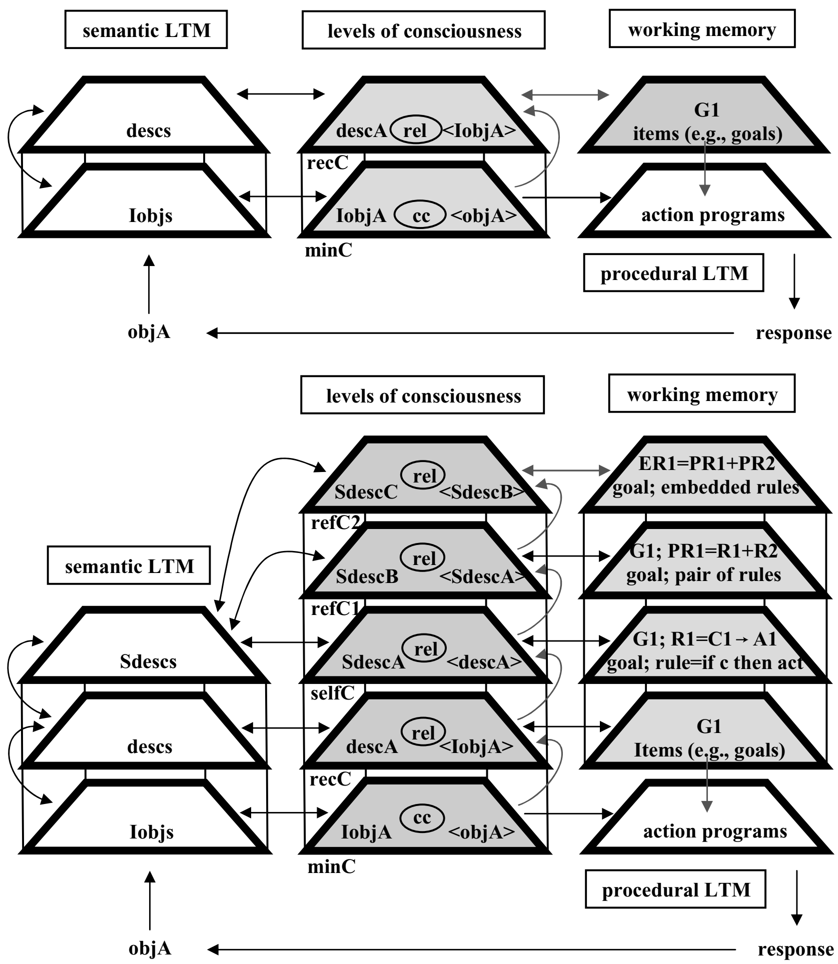


**Figure 15.1.** The implications of reflection (levels of consciousness) for rule use. (a): Relatively automatic action on the basis of a lower level of consciousness. An object in the environment (objA) triggers an intentional representation of that object (IobjA) in semantic long-term memory (LTM); this IobjA, which is causally connected (cc) to a bracketed objA, becomes the content of consciousness (referred to at this level as minimal consciousness or minC). The contents of minC are then fed back into minC via a re-entrant feedback process, producing a new, more reflective level of consciousness referred to as recursive consciousness or recC. The contents of recC can be related (rel) in consciousness to a corresponding description (descA) or label, which can then be deposited into working memory (WM) where it can serve as a goal (G1) to trigger an action program from procedural LTM in a top-down fashion. (b): Subsequent (higher) levels of consciousness, including self-consciousness (selfC), reflective consciousness 1 (refC1), and reflective consciousness 2 (refC2). Each level of consciousness allows for the formulation and maintenance in WM of more complex systems of rules. (Reprinted with permission from Zelazo, P. D. (2004). The development of conscious control in childhood. *Trends in Cognitive Sciences*, 8, 12–17.)

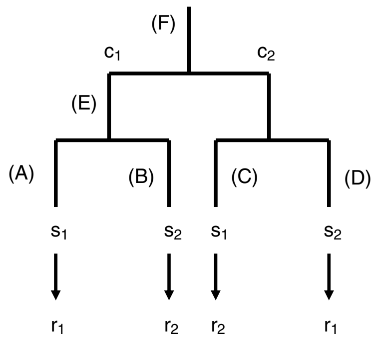


**Figure 15.2.** Hierarchical tree structure depicting formal relations among rules. *Note:* $c_1$ and $c_2$ = contexts; $s_1$ and $s_2$ = stimuli; $r_1$ and $r_2$ = responses. Adapted from Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule-based reasoning., 483–527).

is incompatible with rule C, which connects $s_1$ to $r_2$. Rule A is embedded under, and controlled by, a higher- order rule (rule E) that can be used to select rule A or rule B, and rule E, in turn, is embedded under an even higher-order rule (rule F) that can be used to select the discrimination between rules A and B as opposed to the discrimination between rules C and D. This higher-order rule makes reference to setting conditions or contexts ($c_1$ and $c_2$) that condition the selection of lower-order rules, and that would be taken for granted in the absence of reflection. Higher-order rules of this type (F) are required in order to use bivalent rules in which the same stimulus is linked to different responses (e.g., rules A and C). Simpler rules like E suffice to select between univalent stimulus-response associations – rules in which each stimulus is uniquely associated with a different response, as when making discriminations *within* a single stimulus dimension.

To formulate a higher-order rule such as F and deliberate between rules C and D, on the one hand, and rules A and B, on the other, one has to be aware of the fact that one knows both pairs of lower-order rules. Figuratively speaking, one has to view the two rule pairs from the perspective of (F). This illustrates how increases in reflection on lower-order rules are required for increases in embedding to occur. Each level of consciousness allows for the formulation and maintenance in working memory of a more complex rule system. A particular level of consciousness (SelfC) is required to use a single explicit rule such as (A); a higher level of consciousness (refC1) is required to select between two univalent rules using a rule such as (E); a still higher level (refC2) is required to switch between two bivalent rules using a rule such as (F).

## The Role of Prefrontal Cortex in Higher Levels of Consciousness

The potential role of prefrontal cortex in reflection is arguably revealed by work on the neural correlates of rule use (see Bunge, 2004). Bunge and Zelazo (2006) summarized a growing body of evidence that prefrontal cortex plays a key role in rule use and that different regions of prefrontal cortex are involved in representing rules at different levels of complexity – from learned stimulus-reward associations (orbitofrontal cortex; Brodmann's area [BA] 11), to sets of conditional rules (ventrolateral prefrontal cortex [BA 44, 45, 47] and dorsolateral prefrontal cortex [BA 9, 46]), to an explicit consideration of task sets (rostrolateral prefrontal cortex [or frontopolar cortex; BA 10]; see Figure 15.3).

Figure 15.3 illustrates the way in which regions of prefrontal cortex correspond to rule use at different levels of complexity. Notice that the function of prefrontal cortex is proposed to be hierarchical in a way that corresponds, roughly, to the hierarchical complexity of the rule use underlying conscious control. As individuals engage in reflective processing, ascend through levels of consciousness, and formulate more complex rule systems, regions of lateral prefrontal cortex are recruited and integrated into an increasingly elaborate hierarchy of prefrontal cortical function via thalamocortical circuits. As the hierarchy unfolds, information is first processed via circuits connecting the thalamus and orbitofrontal cortex. This information is then reprocessed and fed forward to ventrolateral prefrontal

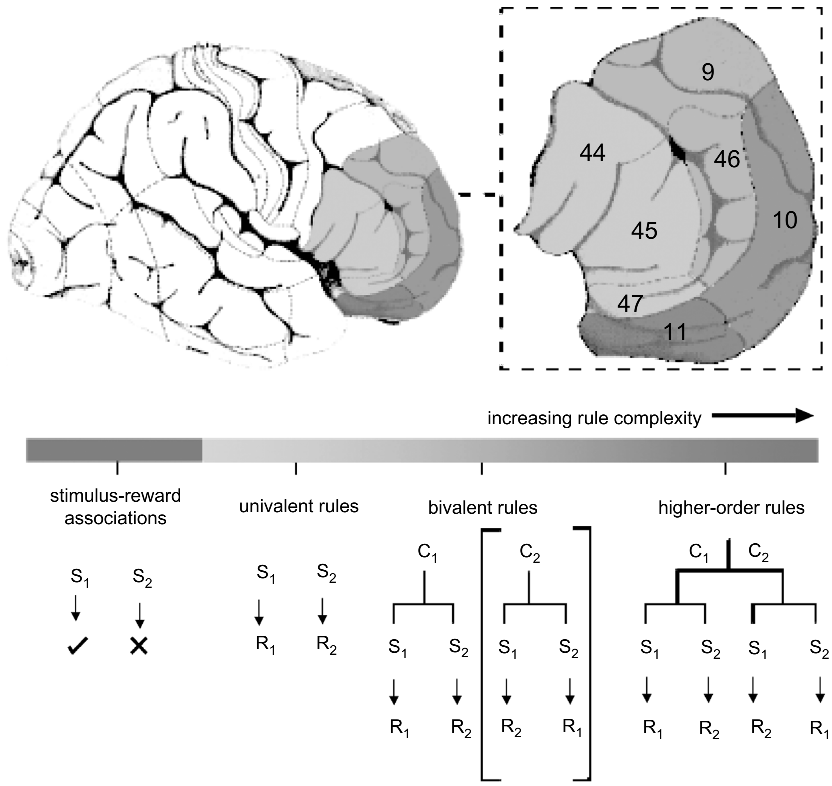


**Figure 15.3.** A hierarchical model of rule representation in lateral prefrontal cortex. A lateral view of the human brain is depicted at the top of the figure, with regions of prefrontal cortex identified by the Brodmann areas (BA) that comprise them: Orbitofrontal cortex (BA 11), ventrolateral prefrontal cortex (BA 44, 45, 47), dorsolateral prefrontal cortex (BA 9, 46), and rostrolateral prefrontal cortex (BA 10). The prefrontal cortex regions are shown in various shades of gray, indicating which types of rules they represent. Rule structures are depicted below, with darker shades of gray indicating increasing levels of rule complexity. The formulation and maintenance in working memory of more complex rules depend on the reprocessing of information through a series of levels of consciousness, which in turn depends on the recruitment of additional regions of prefrontal cortex into an increasingly complex hierarchy of prefrontal cortex activation. *Note*: S = stimulus; check = reward; cross = nonreward; R = response; C = context, or task set. Brackets indicate a bivalent rule that is currently being ignored. (Reprinted with permission from Bunge, S., & Zelazo, P. D. (in press). A brain-based account of the development of rule use in childhood. *Current Directions in Psychological Science*.)

cortex via circuits connecting the thalamus and ventrolateral prefrontal cortex. Further processing occurs via circuits connecting the thalamus to dorsolateral prefrontal cortex. Thalamocortical circuits involving rostrolateral prefrontal cortex play a transient role in the explicit consideration of task sets at each level in the hierarchy.

## Developmental Increases in Children's Highest Level of Consciousness

According to the LOC model, there are four major age-related increases in the highest level of consciousness that children are able to muster (although children may operate at different levels of consciousness in different situations). These age-related increases in children's highest level of consciousness correspond to the growth of prefrontal cortex, which follows a protracted developmental course that mirrors the development of the ability to use rules at higher levels of complexity. In particular, developmental research suggests that the order of acquisition of rule types shown in Figure 15.3 corresponds to the order in which corresponding regions of prefrontal cortex mature. Gray matter volume reaches adult levels earliest in orbitofrontal cortex, followed by ventrolateral prefrontal cortex, and then by dorsolateral prefrontal cortex (Giedd et al., 1999; Gogtay et al., 2004). Measures of cortical thickness suggest that dorsolateral prefrontal cortex and rostrolateral prefrontal cortex (or frontopolar cortex) exhibit similar, slow rates of structural change (O'Donnell, Noseworthy, Levine, & Dennis, 2005). With development, children are able to engage neural systems involving the hierarchical coordination of more regions of prefrontal cortex – a hierarchical coordination that develops in a bottom-up fashion, with higher levels in the hierarchy operating on the products of lower levels through thalamocortical circuits.

*Minimal consciousness.* The LOC model starts with the assumption that simple sentience is mediated by *minimal consciousness* (minC; cf. Armstrong, 1980), the first-order consciousness on the basis of which more complex hierarchical forms of consciousness are constructed (through degrees of reprocessing). MinC is intentional in Brentano's (1874/1973) sense – any experience, no matter how attenuated, is experience *of* something (see Brentano's description of presentations, p. 78 ff.), and it motivates approach and avoidance behavior, a feature that is essential to the evolutionary emergence of minC (e.g., Baldwin, 1894; Dewey, 1896; Edelman, 1989). However, minC is unreflective and present-oriented and makes no reference to an explicit sense of self; these features develop during the course of childhood. While minimally conscious, one is conscious of *what* one sees (the object of one's experience) as pleasurable (approach) or painful (avoid), but one is not conscious of *seeing* what one sees or that *one* (as an agent) is seeing what one sees. And because minC is tied to ongoing stimulation, one cannot recall seeing what one saw. MinC is hypothesized to characterize infant consciousness prior to the end of the first year of life.

In adults, this level of consciousness corresponds to so-called implicit information processing, as when we drive a car without full awareness, perhaps because we are conducting a conversation at a higher level of consciousness (in this example, we are operating at two different levels of consciousness simultaneously). Our behavioral routines are indeed elicited directly and automatically, but they are elicited as a function of consciousness of immediate environmental stimuli (cf. Perruchet & Vinter, 2002). It follows that implicit processing does not occur in a zombie-like fashion; it is simply unreflective (because the contents of minC are continually replaced by new stimulation) and, as a result, unavailable for subsequent recollection.

Consider how minC figures in the production of behavior according to the LOC model (Fig. 15.1a). An object in the environment (objA) triggers a "description" from semantic long-term memory. This particular description (or IobjA, for "intentional object") then becomes an intentional object of minC and automatically triggers an associated action program that is coded in procedural long-term memory. A telephone, for example, might be experienced by a minC baby as 'suckable thing,' and this description might trigger the stereotypical motor schema of sucking. Sensorimotor schemata are modified through practice and accommodation (i.e., learning can occur; e.g., DeCasper et al., 1994; Kisilevsky et al., 2003; Siqueland & Lipsitt, 1966; Swain, Zelazo, & Clifton, 1993), and they can be coordinated into higher-order units (e.g., Cohen, 1998; Piaget, 1936/1952), but a minC infant cannot represent these schemata in minC (the infant is only aware of the stimuli that trigger them). In the absence of reflection and a higher level of consciousness, the contents of minC are continually replaced by new intero- and exteroceptor stimulation and cannot be deposited into working memory.

Thus, minC infants exhibit learning and memory and may well perceive aspects of themselves and their current state implicitly, but they have no means by which they can consciously represent past experiences or states or entertain future-oriented representations. That is, they cannot engage in conscious recollection, although they provide clear behavioral evidence of memory, and they cannot entertain conscious expectations or plans, although their behavior is often future-oriented (e.g., Haith, Hazan, & Goodman, 1988; see Reznick, 1994, for a discussion of different interpretations of future-oriented behavior). At present, there is no behavioral evidence that young infants are capable of conscious recollection (as opposed to semantic memory; Tulving 1985) or explicit self awareness; their experience of events seems to be restricted to the present (see Figure 15.4a) – including objects in the immediate environment and current physical states.

Within the constraints of minC, however, infants may come to learn quite a bit about their bodies in relation to the world (e.g., Gallagher, 2005; Meltzoff, 2002; Rochat, 2001). Rochat (2003), for example, proposes five levels of self-understanding that, from the perspective of the LOC model, can be seen to unfold alongside other aspects of consciousness. The levels that develop in early infancy are characterized by somatic sensation and expectancies about the world, but they are not accompanied by explicit, higher-order representations of self and other. For example, the emergence of *level 1*, or the *differentiated self*, begins at birth, as infants learn to distinguish their own touch from that of another. *Level 2*, which refers to what Rochat calls the *situated self*, emerges at around 2 months and involves implicit awareness of the self as an agent situated in space. In this model, the differentiated and situated selves emerge from the development of (a) expectations of contingency between different sensory modalities (*intermodal contingency*) and (b) a sense of *self-agency* that arises from interaction with the world.

Rochat has emphasized the role of proprioception in the experience of self, and several studies have explored the role of contingency between visual and proprioceptive information in the process of distinguishing self from the world between the ages of 2 and 5 months (Rochat & Morgan, 1995). For example, in one study, infants were shown split-screen images of their legs that were either congruent or incongruent with the view they would normally have of their own legs (i.e., the incongruent images were shown from a different angle). They looked significantly longer at the unfamiliar, incongruent view of their own legs, especially if the general direction of depicted movement conflicted with the direction of the actual, felt movement. The authors concluded that the infants have expectancies about what constitutes self-movement, that self is specified by the temporal and dynamic contingency of sensory information in different modalities, and that by 3 months of age, infants have an *intermodal body schema* that constitutes an *implicit bodily self*.

Based on a series of empirical studies examining infants' actions, then, Rochat has described the self-differentiation process as the systematic exploration of perceptual experience, scaffolded by dyadic interaction, that allows the emergence of an implicit awareness of self and other (Rochat & Striano, 2000). For Rochat, such an implicit, interactive, and somatically based sense of self provides the foundation for the more explicit integration of first- and third-person information that will come later in childhood (see below).

Given this characterization of minC – as the simplest, first-order consciousness on the basis of which more complex consciousness is constructed, we might return to the question of first emergence: When does minC emerge? According to this account, the onset of minC may be tied to a series of anatomical and behavioral changes that occur during the third trimester of prenatal development – between about 24 and 30 weeks gestational age. First, and perhaps

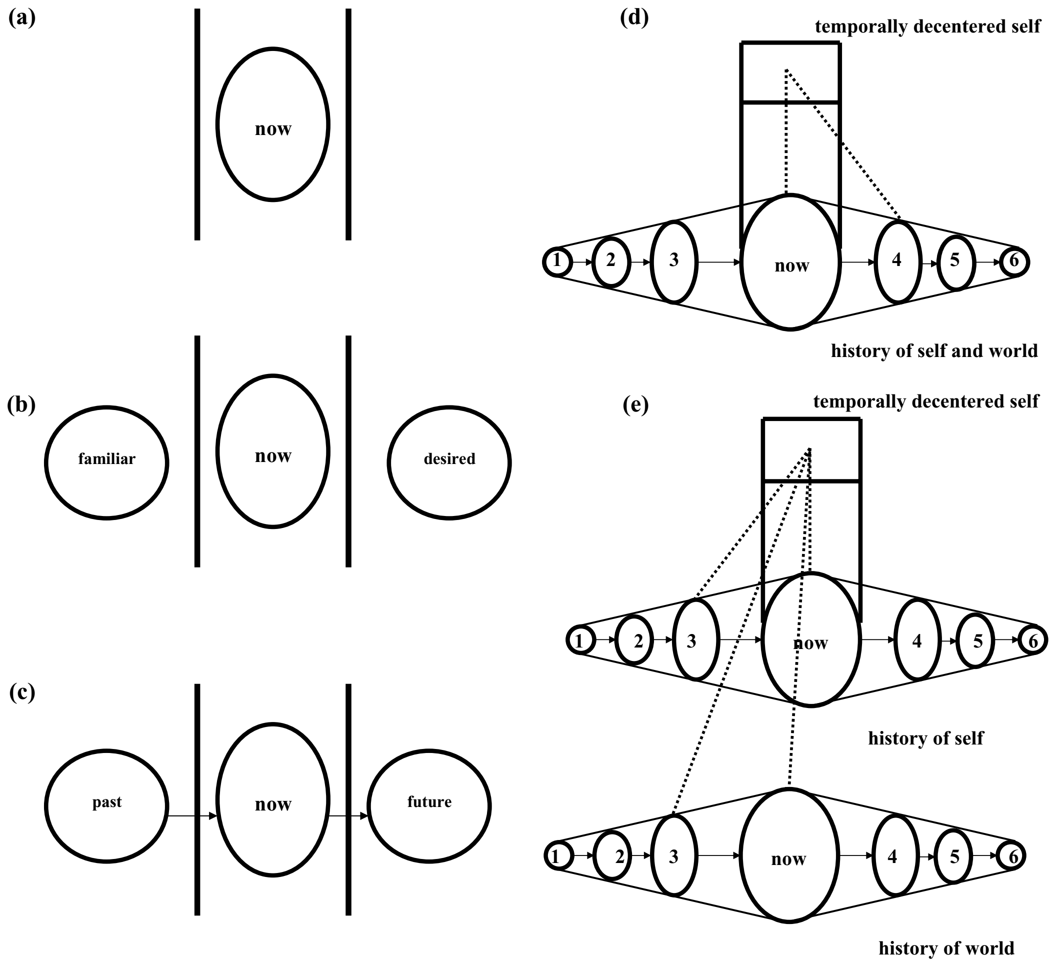


**Figure 15.4.** Levels of consciousness and their implications for the experience of events in time. (2a) MinC. The contents of minimal consciousness are restricted to present intero- and exteroreceptor stimulation (Now). (2b) RecC. Past and future events can now be considered but toddlers cannot simultaneously represent the present when representing past or future events. When descriptions of past experiences become the contents of recursive consciousness, they will feel familiar. Future-oriented states (goals) may be accompanied by a feeling of desire. (2c) SelfC. Children can consider descriptions of past or future-oriented events in relation to a present experience. For example, while conscious of their current state (Now), 2-year-olds can appreciate that Yesterday they went to the zoo. This creates the conditions for a subjective experience of self-continuity in time, but it does not allow simultaneous consideration of events occurring at two different times. (2d) RefC1. From this higher level of consciousness, which allows for a temporally decentered perspective, children can consider two events occurring at two different times, including an event occurring in the present. For example, they can consider that Now, EventA is occurring, but Yesterday, EventB occurred. This is an important advance in the development of episodic memory, but at this point, the history of own's own subjective experiences (history of self) and the history of the world are confounded – there is no means of conceptualizing the history of the world as independent of one's own experiences of the world. (2e) RefC2. From a temporally decentered perspective, children can coordinate two series, the history of the self and the history of the world. (Reprinted from Zelazo, P.D., & Sommerville, J. (2001). Levels of consciousness of the self in time. In C. Moore & K. Lemmon (Eds.), *Self in time: Developmental issues* ( pp. 229–252). Mahwah, NJ: Erlbaum.)

foremost, is the development of thalamocortical fibres that show synaptogenesis in sensory cortex (and not in prefrontal cortex – the provenance of higher levels of consciousness). These thalamocortical connections are established as early as 24 weeks gestational age, but the first evidence of functionality does not occur until about 30 weeks, as indicated by sensory-evoked potentials recorded in preterm infants (Hrbek, Karlberg, & Olsson, 1973; Klimach & Cooke, 1988). A number of other neural events also occur at this time, including the emergence of bilaterally synchronous electroencephalographic (EEG) patterns of activation (bursts) and the emergence of EEG patterns that distinguish between sleep and wakefulness (Torres & Anderson, 1985). Fetal behavior also changes at this age in ways that may indicate the onset of minC. For example, fetuses begin to show clear heart rate increases to vibroacoustic stimuli (Kisilevsky, Muir, & Low, 1992), evidence of habituation to vibroacoustic stimuli (Groome, Gotlieb, Neely, & Waters, 1993), and sharp increases in coupling between their movement and their heart rate (DiPietro, Caulfield, Costigan, et al., 2004). There are also good reasons to believe that fetuses at this age are capable of pleasure and pain (e.g., Anand & Hickey, 1987; Lipsitt, 1986). So, on this account, we agree with those who hold that consciousness first emerges during the third trimester of fetal development, but we emphasize the relatively simple nature of this initial level of consciousness.

According to this account, attribution of minC manages to explain infant behavior until the end of the first year, when numerous new abilities appear within just a few months, from about 9 to 13 months of age. For example, during this period, most infants speak their first words, begin to use objects in a functional way, point proto-declaratively, and start searching in a more flexible way for hidden objects (e.g., passing Piaget's A-not-B task), among other milestones. According to the LOC model, these changes can all be explained by the emergence of the first new level of consciousness – *recursive consciousness* (recC). This new level of consciousness allows for recollection and the maintenance of a goal in working memory, key functional consequences.

*Recursive consciousness.* The term 'recursive' is used here in the sense of a computer program that calls itself. In recC (see Fig. 15.1a), the contents of minC at one moment are combined with the contents of minC at another moment via an identity relation (rel), allowing the toddler to *label* the initial object of minC. The 1-year-old toddler who sees a dog and says, "dog," for example, combines a perceptual experience of a dog with a label from semantic long-term memory, effectively indicating, "That [i.e., the object of minC] *is a* dog." Similarly, pointing effectively indicates, "That *is* that." There must be two things, the experience and the label, for one of them, the experience interpreted in terms of the label, to become an object of recC.

Whereas the contents of minC are continually replaced by new perceptual stimulation, recC allows for conscious experience in the *absence* of perceptual stimulation. Because a label can be decoupled from the experience labelled, the label provides an enduring trace of that experience that can be deposited into both long-term memory and working memory. The contents of working memory (e.g., representations of hidden objects) can then serve as explicit goals to trigger action programs indirectly so that the toddler is no longer restricted to responses triggered directly by minC of an immediately present stimulus. Now when objA triggers IobjA (see Figure 15.1a) and becomes the content of minC, IobjA does not trigger an associated action program directly, but rather IobjA is fed back into minC (called recC after one degree of reflection) where it can be related to a label (descA) from semantic long-term memory. This descA can then be decoupled and deposited in working memory where it can serve as a goal (G1) that triggers an action program even in the absence of objA and even if IobjA would otherwise trigger a different action program. For example, when presented with a telephone, the recC toddler may activate a specific semantic association and put the telephone to her ear (functional a label (descA) from semantic long-term memory. This descA can then be decoupled and deposited in working memory where it can serve as a goal (G1) that triggers an action program even in the absence of objA and even if IobjA would otherwise trigger a different action program. For example, when presented with a telephone, the recC toddler may activate a specific semantic association and put the telephone to her ear (functional play) instead of putting the telephone in her mouth (a generic, stereotypical response). The toddler responds *mediately* to the label in working memory rather than *immediately* to an initial, minC gloss of the situation.

Despite these advances, recursively conscious toddlers still cannot explicitly consider the relation between a means and an end (e.g., Frye, 1991) and hence cannot follow arbitrary rules (i.e., rules linking means and ends or conditions and actions). Moreover, although they are no longer exclusively present-oriented, their experience of time is limited because they have no way to consider relations among two or more explicit representations. As a result, they cannot consider past- or future-oriented representations from the perspective of the present (i.e., from the perspective of an explicit representation of the present, or Now), because this would require an additional element to be represented (namely, a description of Now). Therefore, it should be impossible for these toddlers to appreciate past or future representations *as such* because the concepts of both past and future are only meaningful when considered in relation to a perception of the present circumstances. This situation is depicted in Figure 15.4b. As shown in the figure, recursively conscious infants are no longer restricted to Now, but they cannot explicitly consider events as occurring in the future from the perspective of the present. Similarly, they cannot explicitly consider past events as occurring in the past from the perspective of the present.

Perner and Dienes (2003) present an account of the emergence of consciousness (i.e., when children "become consciously aware of events in the world," p. 64) that seems to be congruent with this account of recC. These authors first distinguish between "unconsciousness awareness" and conscious awareness and illustrate the distinction in terms of blindsight (e.g., Weiskrantz, Sanders, & Marshall, 1974). Patients with lesions to striate cortex may deny that they can see anything in a particular part of their visual field. Nonetheless, if they are asked to guess, they are often quite good at locating objects in that field or even describing features of the objects. Perner and Dienes suggest that the normal healthy visual perception of objects involves conscious awareness, whereas the impaired perception displayed by blindsight patients involves unconscious awareness. In terms of the LOC model, this distinction would seem to map onto the distinction between minC and recC.

Given this distinction, Perner and Dienes (2003) then consider three behaviors for which consciousness seems necessary in adults: verbal communication, executive function (or voluntary control over action), and explicit memory (i.e., conscious recollection). They note that most babies say their first words at about 12 to 13 months of age and that the earliest signs of executive function also appear at about this age. They also argue, on the basis of work with amnesic patients (McDonough, Mandler, McKee, & Squire, 1995), that delayed imitation requires explicit memory. Meltzoff's work (1985, 1988) suggests that infants first exhibit delayed imitation sometime between 9 and 14 months (although see Meltzoff & Moore, 1994).

In addition to these potential behavioral indices of consciousness, Perner and Dienes (2003) consider when children might be said to possess the cognitive capabilities that would allow them to entertain higher-order thoughts about their experiences – consistent with higher-order thought theories of consciousness (e.g., Armstrong, 1968; Rosenthal, 1986). Higher-order thought theories claim that consciousness consists in a belief about one's psychological states (i.e., a psychological state is conscious when one believes that one is in that state), which would seem to require a fairly sophisticated conceptual understanding of one's own mind. According to one version of higher-order thought theory (Rosenthal, 2005), however, the relevant higher-order thoughts may be relatively simple thoughts that just happen to be about one's psychological state. Perner and Dienes observe that children start referring to their own mental states between about 15 and 24 months of age, but they caution that reliance on a verbal measure may lead us to underestimate the abilities of younger children.

Another version of these theories (Carruthers, 2000) holds fast to the suggestion that children will not be conscious until they are capable of metarepresentation – in particular appreciating the distinction between appearance and reality, or the notion of subjective perspective on independent reality, as assessed by measures of false belief understanding. It is fairly well established that children do not understand these concepts explicitly until about 4 years of age (e.g., Flavell, Flavell, & Green, 1983; Wellman, Cross, & Watson, 2001), and it is on these grounds that Carruthers (2000) suggests that children do not have consciousness until this age. Perner and Dienes, however, raise the intriguing possibility that perhaps higher-order thoughts do not require an explicit understanding of subjective perspective, but rather simply a procedural grasp of the notion – as might be manifested in children's pretend play during the second year of life (e.g., Harris & Kavanaugh, 1993).

Evidently, it remains unclear exactly what kinds of higher-order thoughts might be required for conscious experience. Perner and Dienes attempt to clarify this issue in terms of Dienes and Perner's (1999) framework of explicit knowledge, and they end up adopting a stance that resembles Carruthers' (2000) view more than Rosenthal's (2000) view. According to Perner and Dienes (2003), "If one saw [an] object as a circle, but only unconsciously, one might minimally represent explicitly only a feature, e.g., 'circle.' A minimal representation, 'circle' would not provide conscious awareness or conscious seeing since it does not qualify as a full constituent of a higher order thought" (p. 77). Other explicit representations that capture some fact about the object also fail to qualify: "The object in front of me is a circle" and "It is a fact that the object in front of me is a circle." Rather, to be consciously aware of the circle, on this view, one must represent one's psychological *attitude* toward the factuality of the representation: "'I see that [it's a fact that (the object in front of me is a circle)]'" (p. 78).

This version of a higher-order thought theory is hardly compelling from a developmental perspective, however. For example, it is by no means inconceivable that a 3-year-old could be conscious of a fact ("There are pencils in the Smarties box") without being conscious of her attitude (belief) or being conscious that she herself is entertaining the attitude toward the fact. Indeed, this is exactly what the LOC model maintains: RecC allows for conscious experiences that can persist in the absence of perceptual stimulation, but this conscious experience is still simpler than the complex conscious state described by Perner and Dienes. From the perspective of the LOC model, a relatively high level of consciousness (see below), effected by several degrees of reflection, is required to represent one's psychological attitude toward a fact about an object.

As Perner and Dienes (2003) imply, the developmental conclusions to be drawn on the basis of higher-order thought theories are not entirely clear. These authors suggest, however, that the balance of the evidence suggests that children become consciously aware between 12 and 15 months (plus or minus 3 months). In terms of the LOC model, the changes occurring in this age range (or slightly earlier) do not correspond to the emergence of consciousness per se, but they do correspond to an important developmental change in the character of experience – one that allows the (singular) contents of consciousness to be made available to the child in more explicit fashion. Consider again the example of long-distance driving. The difference between MinC and RecC is the difference between the fleeting, unrecoverable awareness of a stop sign that is responded to in passing (without any elaborative processing) and the recoverable awareness that occurs when one not only sees the stop sign but also labels it as such.

Although the neural correlates of the behavioral changes at the end of the first year are still relatively unknown, there are several reasons to believe that these changes correspond to important developments in prefrontal cortical function. For example, in a pioneering study using positron emission tomography (PET), Chugani and Phelps (1986) assessed resting glucose metabolism in the brains of nine infants. Although there was activity in primary sensorimotor cortex in infants as young as 5 weeks of age, and there were increases in glucose metabolism in other areas of cortex at about 3 months of age, it was not until about 8 months of age that increases were observed in prefrontal cortex.

As another example, Bell and Fox (1992) measured EEG activity longitudinally in infants between 7 and 12 months of age and found a correlation between putative measures of frontal function and performance on Piaget's A-not-B task. In the A-not-B task, infants watch as an object is hidden at one location (location A), and then they are allowed to search for it. Then infants watch as the object is hidden at a new location (location B). When allowed to search, many 9-month-old infants proceed to search at A, but performance on this task develops rapidly at the end of the first year of life and seems to provide a good measure of keeping a goal in mind and using it to control behavior despite interference from prepotent response tendencies (see Marcovitch & Zelazo, 1999, for a review). The putative measures of frontal function were frontal EEG power (in the infant "alpha" range; 6–9 Hz) and frontal/parietal EEG coherence. Frontal EEG power reflects the amount of cortical neuronal activity as measured at frontal sites on the scalp, whereas EEG coherence reflects the correlation between signals within a particular frequency band but measured at difference scalp sites. Bell and Fox (1992, 1997) have suggested that changes in power may be associated with increased organization and excitability in frontal brain regions and that increases in coherence may indicate that more posterior regions are coming to be controlled by frontal function.

More recently, Baird and colleagues (2002) used near infrared spectroscopy (NIRS) to compare blood flow in prefrontal cortex in infants who reliably searched for hidden objects (i.e., keeping a goal in mind) and those who did not. These authors found that infants who reliably searched for hidden objects showed an increase in frontal blood flow after the hiding of the object, whereas those who failed to search showed a decrease.

*Self consciousness.* Athough a 12-month-old behaves in a way that is considerably more controlled than, say, a 6-month-old, there is currently no convincing evidence that children are explicitly self-conscious (e.g., at Rochat's third level of self-awareness) until midway through the second year of life, at which point they begin use personal pronouns, first appear to recognize themselves in mirrors, and first display self-conscious emotions like shame and embarrassment (see Kagan, 1981, and Lewis & Brooks-Gunn, 1979, for reviews). In the famous mirror self-recognition paradigm, an experimenter may surreptitiously put rouge on a toddler's nose and then expose children to a mirror. It is well established that most children first exhibit mark-directed behavior in this situation between about 18 and 24 months of age (e.g., Amsterdam, 1972; Lewis & Brooks-Gunn, 1979), and this has been taken to reflect the development of an objective self-concept (e.g., Lewis & Brooks-Gunn, 1979) or the sense of a 'me' as opposed to the sense of an 'I' (James, 1890/1950).

Kagan (1981) also noted the way in which 2-year-olds respond when shown a complex series of steps in the context of an imitative routine. Kagan found that infants at this age (but not before) sometimes exhibited signs of distress, as if they knew that the series of steps was beyond their ken and was not among the means that they had at their disposal. According to Kagan, this implies that children are now able to consider their own capabilities (i.e., in the context of a goal of imitating the experimenter). Consideration of a means relative to the goal that occasions it is a major advance that allows children consciously to follow rules linking means to ends. According to the LOC model, the further development of prefrontal cortex during the second year of life allows children to engage in a higher level of consciousness – referred to as SelfC. This new level of consciousness is what allows children to use a single rule to guide their behavior.

As shown in Figure 15.1b, a self-conscious toddler can take as an object of consciousness a conditionally specified self-description (SdescA) of their behavioral potential – they can consider conditionally specified means to an end. This SdescA can then be maintained in working memory as a single rule (R1, including a condition, C, and an action, A), considered against the background of a goal (G1). Keeping a rule in working memory allows the rule to govern responding regardless of the current environmental stimulation, which may pull for inappropriate responses.

Among the many changes in children's qualitative experience will be changes in their experience of themselves, and of themselves in time – changes in conscious recollection. Unlike recursively conscious infants, self-conscious children can now consider descriptions of events as past- or future-oriented, relative to a present experience (see Fig. 15.4c). For example, while conscious of their current state (Now), 2-year-olds can appreciate that yesterday they went to the zoo (Friedman, 1993). The concepts *yesterday* and *tomorrow* are intrinsically relational because they are indexed with respect to *today*. Thus, for children to comprehend that an event occurred yesterday (or will occur tomorrow), children must be conscious of Now and consider two linked descriptions: a description of the event and a further description of the event as occurring yesterday (or tomorrow). Doing so corresponds in complexity to the use of a single rule considered against the backdrop of a goal that occasions its use. That is, G1; C1 → A1, from Figure 15.1b, is instantiated as follows: Now; Tomorrow → EventA.

When children can consider past or future events *as such*, they will have a subjective experience of self-continuity in time. As a result, they should now be able to engage in episodic recollection, which, according to Tulving (e.g., 1985), involves consciously recalling having experienced something in the past and so depends, by definition, on self-consciousness (or autonoetic [self-knowing] consciousness, in Tulving's terms). The close relation between the changes in children's self-consciousness that are indexed, for example, by mirror self-recognition, and the onset of episodic recollection has been noted by several authors (e.g., Howe & Courage, 1997; Wheeler, 2000), although others, such as Perner and Ruffman (1995), believe that genuine episodic recollection does not emerge until later, coincident with changes in children's theory of mind (see below).

Although the changes occurring during the second half of the second year are remarkable – so remarkable that Piaget (1936/1952) imagined they reflected the emergence of symbolic thought – there continues to be considerable room for development. For example, an additional degree of recursion is required for children to consider simultaneously two different events occurring at two different times (e.g., EventA, further described as occurring Now, considered in contradistinction to EventB, further described as occurring Tomorrow).

This characterization of the limitations on 2-year-old children's sense of themselves in time is similar in some respects to that offered by Povinelli (1995, 2001) and McCormack and Hoerl (1999, 2001), although it differs in others. Povinelli (1995) suggests that, although children between 18 and 24 months of age can pass mirror self-recognition tasks (e.g., Amsterdam, 1972; Lewis & Brooks-Gunn, 1979), they do not yet possess an objective and enduring self-concept. Instead, Povinelli (1995) suggests that children at this age maintain a succession of present-oriented representations of self (termed present selves; Povinelli, 1995, p. 165), and they cannot compare these representations or "integrate previous mental or physical states with current ones" (p. 166). Consequently, their sense of self-continuity in time is temporally restricted, and they might still be said to live in the present. In support of these claims, Povinelli and colleagues (1996) found that even 3-year-olds perform poorly on measures of delayed self-recognition. In their studies, children played a game during which an experimenter surreptitiously placed a sticker on their heads. About 3 minutes later, children were presented with a video image of the marking event. Whereas the majority of older children (4-year-olds) reached up to touch the sticker, few of the younger children (2- and 3-year-olds) did so.

Zelazo, Sommerville, and Nichols (1999) argued that children perform poorly on measures of delayed self-recognition not because they lack a subjective experience of self-continuity in time, but rather because children in Povinelli et al.'s (1996) experiment have difficulty adjudicating between conflicting influences on their behavior (which requires the use of higher-order rules and a higher level of consciousness). More specifically, children in that experiment have a strong expectation that they do not have a sticker on their head (because they do not see it placed there and cannot see it directly at the time of testing). When they are provided with conflicting information via a dimly understood representational medium (e.g., video; Flavell, Flavell, Green, & Korfmacher, 1990), the new, conflicting information may be ignored or treated as somehow irrelevant to the situation. Empirical support for this suggestion comes from a study showing that although 3-year-olds can use delayed-video (and delayed-verbal) representations to guide their search for a hidden object in the absence of a conflicting expectation about the object's location, they have difficulty doing so in the presence of a conflicting expectation (Zelazo et al., 1999, Exp. 3). Because children have difficulty managing conflicting delayed representations in general, poor performance on tests of delayed self-recognition does not necessarily indicate an immature self-concept, although it may well reflect more general limitations on the highest level of consciousness that children are able to adopt.

*Reflective consciousness 1*. The LOC model holds that, in contrast to 2-year-olds, 3-year-olds exhibit behavior that suggests an even higher LOC, *reflective consciousness 1* (refC1). For example, they can systematically employ a pair of arbitrary rules (e.g., things that make noise vs. are quiet) to sort pictures – behavior hypothesized to rely on lateral prefrontal cortex. According to the model, 3-year-olds can now reflect on a SdescA of a rule (R1) and consider it in relation to another Sdesc (SdescB) of another rule (R2). Both of these rules can then be deposited into working memory where they can be used contrastively (via a rule like E in Figure 15.2) to control the elicitation of action programs. As a result, unlike 2-year-olds, 3-year-olds do not perseverate on a single rule when provided with a pair of rules to use (Zelazo & Reznick, 1991).

Of course, there are still limitations on 3-year-olds' executive function, as seen in their perseveration in the Dimensional Change Card Sort (DCCS). In this task, children are shown two bivalent, bidimensional target cards (e.g., depicting a blue rabbit and a red boat), and they are told to match a series of test cards (e.g., red rabbits and blue boats) to these target cards first according to one dimension (e.g., color) and then according to the other (e.g., shape). Regardless of which dimension is presented first, 3-year-olds typically perseverate by continuing to sort cards by the first dimension after the rule is changed. In contrast, 4-year-olds seem to know immediately that they know two different ways of sorting the test cards. Zelazo et al. (2003) have argued that successful performance on this task requires the formulation of a higher-order rule like F in Figure 15.2 that integrates two incompatible pairs of rules into a single structure.

Performance on measures such as the DCCS is closely related to a wide range of metacognitive skills studied under the rubric of theory of mind (e.g., Carlson & Moses, 2001; Frye et al., 1995). In one standard task, called the representational change task (Gopnik & Astington, 1988), children are shown a familiar container (e.g., a Smarties box) and asked what it contains. Subsequently, the container is opened to reveal something unexpected (e.g., string), and children are asked to recall their initial incorrect expectation about its contents: "What did you think was in the box before I opened it?" To answer the representational change question correctly, children must be able to recollect (or reconstruct) their initial false belief. Most 3-year-olds respond incorrectly, stating (for example) that they initially thought that the box contained string.

Three-year-old children's difficulty on this type of task has proven remarkably robust. Zelazo and Boseovksi (2001), for example, investigated the effect of video reminders on 3-year-olds' recollection of their initial belief in a representational change task. Children in a video support condition viewed videotapes of their initial, incorrect statements about the misleading container immediately prior to being asked to report their initial belief. For example, they watched a videotape in which they saw a Smarties box for the first time and said, "Smarties." They were then asked about the videotape and about their initial belief. Despite correctly acknowledging what they had said on the videotape, children typically failed the representational change task. When asked what they initially thought was in the box (or even what they initially said), they answered, "String."

At 3 years of age, then, children are able to consider two rules in contradistinction (i.e., they can consider a single pair of rules) from a relatively distanced perspective – even if they still cannot adopt the level of consciousness required for such measures as the DCCS and the representational change task. The relatively psychologically distanced perspective made possible by RefC1 and the consequent increase in the complexity of children's rule representations allow for a richer qualitative experience than was possible at SelfC. For example, children can now conceptualize Now from a temporally decentered perspective (McCormack & Hoerl, 1999, 2001; see Figure 15.4d). From this perspective, children are now able to consider two events occurring at two different times. For example, they can consider that Now, EventA is occurring, but Yesterday, EventB occurred.

This important developmental advance allows children to make judgments about *history* (e.g., now vs. before). For example, in a control task used by Gopnik and Astington (1988, Exp. 1), most 3-year-olds were able to judge that *Now* there is a doll in a closed toy house but *Before* there was an apple. At this level of consciousness, however, children cannot differentiate between the history of the world and the history of the self. That is, the objective series and the subjective series remain undifferentiated; the two series are conflated in a single dimension. As a result, 3-year-olds typically fail Gopnik and Astington's (1988) representational change task, where they must appreciate that they themselves changed from thinking Smarties to thinking string, even while the contents of the box did not change. According to the LOC model, this failure to differentiate between the history of the world and the history of the self occurs because children who are limited to refC1 are only able to use a single pair of rules, which allows them to make a discrimination *within* a single dimension, but prevents them from making comparisons *between* dimensions (e.g., between shape and color in the DCCS).

*Reflective consciousness 2*. Research has revealed that between 3 and 5 years of age, there are important changes in children's executive function and theory of mind, assessed by a wide variety of measures, and these changes tend to co-occur in individual children (e.g., Carlson & Moses, 2001; Frye et al., 1995; Perner & Lang, 1999). For the measures of executive function and theory of mind that show changes in this age range, children need to understand how two incompatible perspectives are related (e.g., how it is possible to sort the same cards first by shape and then by color; how it is possible for someone to believe one thing when I know something else to be true). According to the LOC model, this understanding is made possible by the further growth of prefrontal cortex and the development of the ability to muster a further level of consciousness – reflective consciousness 2 (refC2). At refC2, the entire contents of refC1 can be considered in relation to a Sdesc of comparable complexity. This perspective allows children to formulate a higher-order rule that integrates the two incompatible perspectives (e.g., past and present self-perspectives in the representational change task or color vs. shape rules in the DCCS) into a single coherent system and makes it possible to select the perspective from which to reason in response to a given question. (In the absence of the higher-order rule, children will respond from the prepotent perspective). In terms of Figure 15.3, RefC2 allows children to formulate and use a rule like F.

Being able to reflect on their discriminations within a dimension (e.g., shape) and considering two (or more) dimensions in contradistinction, allows children to conceptualize dimensions qua dimensions (see also Smith, 1989). In terms of their understanding of the self in time, this ability to consider dimensions qua dimensions (or series qua series) allows children to differentiate and coordinate two series, the history of the self and the history of the world, from a temporally decentered perspective (see Figure 15.4e). As Bieri (1986) notes, to have a genuine temporal awareness, one must differentiate the progression of the self from the progression of events in the world and then understand the former relative to the latter. (The latter corresponds to the objective series, which ultimately serves as the unifying temporal framework). In Bieri's (1986, p. 266, italics in the original) words: "In order to have a genuine temporal awareness, a being must be able to distinguish between the history of the world and the history of its *encounters* with this world. And the continuously changing temporal perspective . . . is nothing but the continuous process of connecting these two series of events within a representation of one unified time."

Behavioral evidence of children's ability to differentiate and yet coordinate the history of the self and the history of the world can be seen in 4- and 5-year-olds' success on Gopnik and Astington's (1988) representational change task. In this task, children now appreciate that they themselves changed from thinking Smarties to thinking string, but that the contents of the box did not change. Thus, against the backdrop of Now, children appreciate the history of the world, on the one hand; that is, they appreciate that in the past, EventA (string in the box) occurred and Now, EventA is still occurring. However, they also appreciate the history of the self, on the other hand: In the past, EventA (believed Smarties in the box) occurred, and Now, EventB is occurring (believe string in the box).

Because refC2 allows children to integrate two incompatible pairs of rules within a single system of rules, it allows them to understand that they can conceptualize a single thing in two distinct ways. For example, they understand that they can conceptualize a red rabbit as a red thing and as a rabbit in the DCCS, and they understand that they can acknowledge that a sponge rock looks like a rock even though it is really a sponge (Flavell, Flavell, & Green, 1983). When applied to *time*, this understanding permits children potentially to appreciate multiple temporal perspectives on the same event (e.g., that time present is time past in time future). This acquisition, at about 4 or 5 years of age, corresponds to the major developmental change identified in McCormack and Hoerl's (1999) account of temporal understanding: At a higher level of temporal decentering, children appreciate that multiple temporal perspectives are perspectives onto the same temporal reality, and they acquire the concept of particular times (i.e., that events occur at unique, particular times).

Children's ability to conceptualize a single thing in multiple ways can also be applied to their understanding of *themselves* in time, where it allows children potentially to conceptualize themselves from multiple temporal perspectives – to understand themselves as exhibiting both continuity and change in time. Müller and Overton (1998) discuss this understanding in terms of Stern's (1934/1938) notion of *mnemic continuity*: "I am the *same one* who *now* remembers what I *then* experienced" (p. 250; italics in the original), and they note that Stern described this understanding as emerging around the fourth year of life.

Work with children during this period of development – the transition to refC2 – has been useful in revealing one of the key roles that language can play in fostering the adoption of higher levels of consciousness; namely, that it can promote reflection within developmental constraints on the highest level of consciousness that children are able to obtain. In particular, labeling one's subjective experiences helps make those experiences an object of consideration at a higher level of consciousness. Increases in level of consciousness, in turn, allow for the flexible selection of perspectives from which to reason. Therefore, for children who are capable in principle of adopting a particular higher level of consciousness, labeling perspectives at the next lower level will increase the likelihood that they will in fact adopt this higher level of consciousness, and it will facilitate cognitive flexibility.

The effect of labeling on levels of consciousness and flexibility can be illustrated by work by Jacques, Zelazo, Lourenco, and Sutherland (2006), using the Flexible Item Selection Task (see also Jacques & Zelazo, 2005). On each trial of the task, children are shown sets of three items designed so one pair matches on one dimension, and a different pair matches on a different dimension (e.g., a small yellow teapot, a large yellow teapot, and a large yellow shoe). Children are first told to select one pair (i.e., Selection 1), and then asked to select a different pair (i.e., Selection 2). To respond correctly, children must represent the pivot item (i.e., the large yellow teapot) according to both dimensions. Four-year-olds generally perform well on Selection 1 but poorly on Selection 2, indicating inflexibility (Jacques & Zelazo, 2001). According to the LOC model, although 4-year-olds may not do so spontaneously, they should be *capable* of comprehending two perspectives on a single item (as indicated, e.g., by successful performance on the Dimensional Change Card Sort and a variety of measures of perspective taking (Carlson & Moses, 2001; Frye et al., 1995). Therefore, the model predicts that asking 4-year-old children to label their perspective on Selection 1 (e.g., "Why do those two pictures go together?") should cause them to make that subjective perspective an object of consciousness, necessarily positioning them at a higher level of consciousness from which it is possible to reflect on their initial perspective. From this higher level of consciousness (i.e., the perspective of Rule F in Figure 15.2), it should be easier to adopt a different perspective on Selection 2, which is exactly what Jacques et al. (2006) found. This was true whether children provided the label themselves or whether the experimenter generated it for them.

In general, the adoption of a higher-order perspective allows for both greater influence of conscious thought on language and greater influence of language on conscious thought. On the one hand, it allows for more effective selection and manipulation of rules (i.e., it permits the control of language in the service of thought). On the other hand, it permits children to respond more appropriately to linguistic meaning despite a misleading context – allowing language to influence thought. An example comes from a recent study of 3- to 5-year-olds' flexible understanding of the adjectives "big" and "little" (Gao, Zelazo, & DeBarbara, 2005). When shown a medium-sized square together with a larger one, 3-year-olds had little difficulty answering the question, "Which one of these two squares is a *big* one?" However, when the medium square was then paired with a smaller one, and children were asked the same question, only 5-year-olds reliably indicated that the medium square was now the big one. This example shows an age-related increase in children's sensitivity to linguistic meaning when it conflicts with children's immediate experience, and it reveals that interpretation becomes

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decoupled, to some degree, from stimulus properties.

Another example of the same phenomenon comes from a study by Deák (2000), who examined 3- to 6-year-olds' use of a series of different predicates ("looks like a . . . ," "is made of . . . ," or "has a . . . ") to infer the meanings of novel words. He found that 3-year-olds typically used the first predicate appropriately to infer the meaning of the first novel word in a series, but then proceeded to use that same predicate to infer the meanings of subsequent words despite what the experimenter said. In contrast, older children used the most recent predicate cues. Again, children are increasingly likely to use language to restrict their attention to the appropriate aspects of a situation (or referent).

Notice that language and conscious thought become increasingly intertwined in a complex, reciprocal relation, as Vygotsky (1934/1986) observed. Thus, language (e.g., labeling) influences thought (e.g., by promoting a temporary ascent to a higher level of consciousness), which in turn influences language, and so on. This reciprocal relation can be seen in the growing richness of children's semantic understanding and increasing subtlety of their word usage. Consider, for instance, children's developing understanding of the semantics of the verb *hit*. Children first understand *hit* from its use to depict simple accidental actions (e.g., an utterance by a child at 2;4.0: *Table hit head;* Gao, 2001, pp. 220). Usage is initially restricted to particular contexts. Eventually, however, reflection on this usage allows children to employ the word in flexible and creative ways (e.g., *I should hit her with a pencil and a stick* uttered metaphorically by the same child at 3;8.6; Gao, 2001, pp. 219).

## Summary and Topics for Future Research

According to the LOC model, there are at least four age-related increases in the highest level of consciousness that children can muster, and each level has distinct consequences for the quality of subjective experience, the potential for episodic recollection, the complexity of children's explicit knowledge structures, and the possibility of the conscious control of thought, emotion, and action. Higher levels of consciousness in this hierarchical model are brought about by the iterative reprocessing of the contents of consciousness via thalamocortical circuits involving regions of prefrontal cortex. Each degree of reprocessing recruits another region of prefrontal cortex and results in a higher level of consciousness, and this in turn allows for a stimulus to be considered relative to a larger interpretive context.

This model aims to provide a comprehensive account of the development of consciousness in childhood that addresses extant data on the topic and establishes a framework from which testable predictions can be derived. Naturally, however, there is considerable work to be done. Among the many questions for future research, a few seem particularly pressing. First, future research will need to explore the possibility that there are further increases in children's highest level of consciousness beyond the refC2 level identified in the LOC model. Compared to early childhood, relatively little is known about the development of consciousness in adolescence, although it is clear that the conscious control of thought, action, and emotion shows considerable development in adolescence. Indeed, to the extent that these functions are dependent on prefrontal cortex, which continues to develop well into adulthood (e.g., Giedd et al., 1999), further age-related increases in the highest level of consciousness seem likely.

Second, future research should continue to search for more precise neural markers of the development of consciousness. Among the possible indices are increases in neural coherence, dimensional complexity, and/or the amount or dominant frequency of gamma EEG power. Such increases could be associated with the binding together of the increasingly complex hierarchical networks of prefrontal cortical regions that we have proposed are associated with higher levels of consciousness. Dimensional complexity (DCx), for example, is a nonlinear measure of global dynamical complexity (for review see Anokhin et al., 2000) that can be derived from EEG data. In a cross-sectional study of children and adults (ages 7 to 61 years), Anokhin et al. (1996) found that whereas raw alpha and theta power only changed until early adulthood, structural DCx continued to increase across the life span. Other research indicates that DCx may show particularly prominent increases during adolescence (Anokhin et al., 2000; Farber & Dubrovinskaya, 1991; Meyer-Lindenberg, 1996). In a study comparing children and adolescents (mean ages, 7.5, 13.8, 16.4 years), Anokhin et al. (2000) found that both resting and task-related complexity (in visual and spatial cognitive tasks) increased with age, as did the difference between resting and task-related DCx.

Finally, although formulated to explain developmental data, this model suggests a framework for understanding the vagaries of human consciousness across the life span, and future research should explore the extent to which this framework is useful for understanding the role of consciousness in adult behavior. One application is to research on mindfulness (e.g., Brown & Ryan, 2003; see Chapter 19). Acting mindfully (and "super-intending" one's behavior) may involve adopting higher levels of consciousness and coordinating these levels so that they are all focused on a single thing – a single object of consciousness. This coordination of levels of consciousness on a single object would result in an experience that differs dramatically from the kind of multitasking observed, for example, when driving a car at the level of MinC but carrying on a conversation at a higher level of consciousness. Conceptualising mindfulness in terms of the LOC model yields predictions regarding the effects of mindfulness meditation on behavior (e.g., attentional control) and neural function (e.g., increasingly elaborated hierarchies of prefrontal cortical regions). From this perspective, mindfulness meditation practice can be seen as a type of training that may increase an individual's ability to enter a more coherent (coordinated) hierarchy of levels of consciousness.

## Conclusion

Discussions regarding the development of consciousness have focused on the question of *when* consciousness emerges, with different authors relying on different notions of consciousness and different criteria for determining whether consciousness is present. In this chapter, we presented a comprehensive model of consciousness and its development that we believe helps clarify the way different aspects of consciousness do indeed emerge at different ages. Our hope is that this model provides a useful framework for thinking about consciousness as a complex, dynamic phenomenon that is closely tied to neural function, on the one hand, and cognitive control, on the other.

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