6 The Development of Dreaming in Children

This chapter adds a developmental dimension to the neurocognitive theory of dreaming. It does so at all three levels of the theory—neural, cognitive, and behavioral. It begins with neuroimaging research on the default network from preschool to early adulthood. This network is very immature in the preschool years and does not begin to approach adultlike levels until ages 9–13. Maturation involves changes in the connectedness within the default network itself and in its relationship with the frontoparietal control network.

The chapter then turns to a consideration of research on the development of dreaming, as documented in both longitudinal and cross-sectional laboratory studies. Strikingly, dreaming, like the default network, does not begin to reach adultlike cognitive complexity until ages 9–11 and only reaches adultlike content between the ages of 12 and 15. However, because the main focus of the chapter concerns neural substrates and cognitive processes, most of the substantive findings on dream content are presented in the next chapter, especially in the case of older children (ages 9–12) and adolescents (ages 13–18).

The findings on dreaming are then compared with the results from studies of the development of waking cognitive capacities. These studies were carried out by both laboratory dream researchers and a wide range of developmental psychologists using experimental designs. Taken together, these three separate literatures reveal dreaming is a gradual cognitive achievement.

The Maturation of the Default Network

Several studies find the default network matures gradually from infancy to adolescence, with much of that maturation occurring after ages 4–7. The basic outlines of the default network can be detected in infants (Bulgarelli et al., 2020). However, as noted above, the default network is immature until late in childhood and early adolescence and is not close to adult levels until the middle of the teenage years. In one of the foundational cross-sectional studies of the development of the default network, which spanned the ages from 7–9 to young adulthood, the default network was only minimally connected at ages 7–9 (Fair et al., 2008, p. 4029). One of the main hubs in the adult default network, the medial prefrontal cortex, is on the periphery of this generally sparse network at ages 7–9, and it is only sparsely and indirectly connected to the parietal areas, which contain important structures within the default network (Fair et al., 2009, pp. 6–7, 11).

The immaturity of the default network at ages 7–9 in part reflects the localized structure of most brain networks at that age, but other factors play a role as well: "synapse formation, the tuning of synaptic weights, synaptic pruning, and myelination all have unique developmental time courses that extend further into development" (Fair et al., 2009, p. 8). In this study, the frontoparietal control network had greater functional connectivity by ages 7–9 than did the default network, which had very few "short-range functional connections" (Fair et al., 2009, p. 2). It was not until two or three years later that the default network's main frontal structures had more than a few connections to each other, even though they are "fairly close in [anatomical] space" (Fair et al., 2009, p. 2).

The cross-sectional neuroimaging study of the default network in 7–9-year-olds also included 54 participants ages 10–15 and 91 participants who were 19–31 (Fair et al., 2009, p. 10). Studies of them confirmed ongoing changes in terms of increased within-network connections. These changes in connectivity and integration can be graphed for visualization purposes in a way that pictures the relationships within the default network as spatially closer as it becomes more functionally integrated. Based on this fictive anatomical configuration, the differences within the default network between ages 8 and adulthood are displayed in figure 6.1. This figure is a truncated and stylized version of a more complex graphic. It originally included three other brain networks, which interact with the default network to varying degrees (Fair et al., 2009, p. 5, fig. 2 and video S1). As figure 6.1 demonstrates, the default network becomes more integrated by age 11 but is not quite adultlike until age 15.

The findings in this foundational study were replicated in an even larger cross-sectional study of 447 Brazilian participants ages 7–15. They came from a wider socioeconomic spectrum and had greater genetic diversity

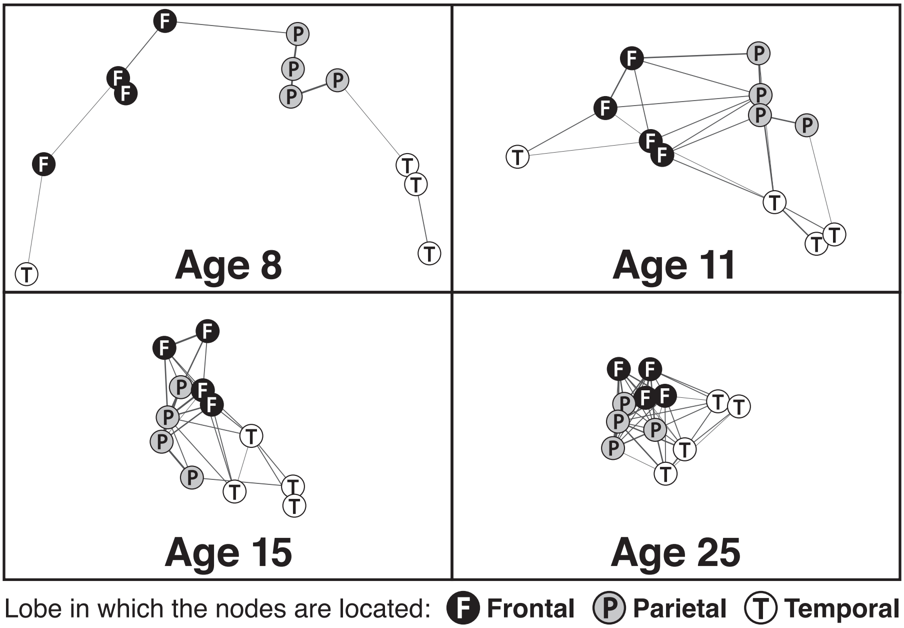

Figure 6.1
The maturation of connectivity in the default network.
Note: The two bottom panels are "smaller" in a fictive anatomical configuration in order to depict the increasing functional connectivity within the default network. Adapted from Fair et al., 2009.

than the American participants (Sato et al., 2014). Once again, the centrality of the major hub regions in the default network increased with age, and the connectivity of the anterior and posterior regions of the network increased (Sato et al., 2014, p. 93). In addition, "the age-related changes in the central executive network [i.e., frontoparietal control network] were less widespread compared with the default network," which is consistent with the greater integration of the frontoparietal control network at an earlier age in the first cross-sectional study (Sato et al., 2014, p. 92). Similarly, a study of social cognition between ages 6 and 12 concluded the default network matures slowly during this age period (Moraczewski, Nketia, & Redcay, 2020).

These results were replicated and extended for the preschool years through adolescence in a cross-sectional study in Australia of 10 preschool children (ages 4–6), 14 school-age children (ages 7–12), and 24 adults (He et al., 2019). In a combined cross-sectional and longitudinal resting-state fMRI study of the default network in China, based on 305 children between the ages of 6 and 12, each of whom was studied twice within the space of a year, the results were close to those from a control group of 61 young adults ages 18–28 by age 12 (Fan, Liao, Lei, Tao, & He, 2021). In particular, the functional connectivity between anterior and posterior regions in the default network increased over this time period.

The results from these several studies are supported and extended in a longitudinal study of both the default network and the frontoparietal control network at ages 10 and 13, based on 45 participants (24 girls, 21 boys) (Sherman et al., 2014, p. 149). The investigators first concluded that "by age 10, the basic functional architecture of the default mode network is in place" (Sherman et al., 2014, pp. 151, 154). As reported in the cross-sectional studies, the integration between the medial prefrontal cortex and posterior cingulate cortex also increased between ages 10 and 13. The frontoparietal control network also became almost fully integrated by age 13. Since the connections found in this study at age 10 were more robust than those with 7–9-year-olds in the cross-sectional studies, the investigators suggest "it is possible that significant maturation between ages 7–9 and age 10 account for differences in our findings" (Sherman et al., 2014, p. 151).

This hypothesis is supported by two studies of the maturation of the cingulum bundle, a white-matter tract that in adults provides the major communication link between the medial prefrontal cortex and the posterior cingulate cortex. The first study, which compared 23 boys ages 7–9 with 22 young adult males, found only one difference between the child and adult groups on their degree of connectivity. It concerned the relationship between the medial prefrontal cortex and the posterior cingulate cortex. The investigators suggest that the relationship between the medial prefrontal cortex and the posterior cingulate cortex is "the most immature link" in the default network (Supekar et al., 2010, p. 290). Consistent with this finding, there is no structural or functional relationship in 7–9-year-old children's default network involving the cingulum (Supekar et al., 2010, p. 297). According to this team of researchers, this relationship develops during preadolescence or early adolescence.

A cross-sectional study, focused directly on the cingulum, confirmed there is a major change in the cingulum's role within the default network between ages 9–11 and 11–13. The study is based on data from nine girls and nine boys (Gordon et al., 2011). In the younger group, the correlation between functional connectivity within the default network and the integrity (completeness) of the cingulum was relatively small and statistically nonsignificant. However, the correlation was large (.73) and statistically significant in the older group. Very importantly in terms of the neurocognitive theory of dreaming, the researchers conclude that "this relationship emerges after age 9, but is more reliable as children enter the preadolescent years" (Gordon et al., 2011, p. 747). This "increased maturation of the cingulum bundle is related to more efficient communication between the medial prefrontal cortex and the posterior cingulate cortex" than is available through other connections at an earlier age (Gordon et al., 2011, p. 747).

In adults, the cingulum bundle "promotes far-reaching antero-posterior connectivity from the retrosplenial and precuneal cortices to the medial frontal lobe and other, partly diffuse, frontal areas of the brain" (Horn et al., 2013, p. 6). The retrosplenial cortex is a component of the default network, as are at least portions of the precuneus, which is also a part of several networks that subserve episodic memory, visual-spatial imagery, and self-reflection (Fransson & Marrelec, 2008; Kaboodvand, Bäckman, Nyberg, & Salami, 2018).

At the same time, there is additional evidence for significant changes occurring between ages 10 and 13 in the frontoparietal control network and in its relationship with the default network. For example, the frontoparietal control network is more integrated than the default network at age 8 years, 6 months, and only functionally connected to a few nodes in the default network. By age 13 years, 2 months, however, the frontoparietal control network is more functionally connected to nodes within the default network (Fair et al., 2009, p. 5, fig. 2). At this point, the default network and the frontoparietal control network become increasingly segregated, with the frontoparietal control network able to modulate and control the default network during waking. This finding is consistent with the findings in the longitudinal neuroimaging study of children at ages 10 and 13: the frontoparietal control network is very similar at age 10 to that of adults but the segregation between the default network and the frontoparietal control network is a work in progress between ages 10 and 13 (Sherman et al., 2014, pp. 151, 155).

The findings on increased segregation and integration are consistent with a major 10-year longitudinal study of changes during sleep in children between the ages of 9 and 18, with 3,500 all-night EEG recordings. Neuronal density declines during this time span, with the largest decline (by 65%) occurring between ages 11–12 and 17. This pruning shows that the brain goes through a dramatic reorganization during this time period, which may make complex thinking more possible (Campbell, Grimm, de Bie, & Feinberg, 2012; Feinberg & Campbell, 2010). Neuroanatomical analyses, based on fMRI studies, demonstrate cortical thinning in bilateral frontal, parietal, and occipital regions in children ages 6–10, which relates to the functional development of the frontoparietal, network, the default network, and sensorimotor and auditory networks (Zhong, Rifkin-Graboi, Ta, Yap, & Chuang, 2014).

Based on these several different studies, adultlike dreaming may not be possible until the default network matures into a more adultlike form between ages 9–11, or more broadly, 9–13 or even 13–17, when more pruning and reorganization have occurred. A more detailed age specification awaits results from future studies. In addition, the default network's relationship with the frontoparietal network becomes better articulated between the ages of 9 and 13, and perhaps a few years beyond. Thus, the expectation from a neurocognitive point of view would be that dreaming becomes more frequent and complex during those four years. This expectation is examined on the basis of laboratory studies of dream recall, dream complexity, and dream content in children's studies, which were carried out a decade or more before the studies of the maturation of the default network began.

Laboratory Studies of the Development of Dreaming

Just as the default network is immature until roughly ages 9–13 and not adultlike until age 15, so, too, dreaming is not fully developed cognitively or in the substance of dream content until the same age period. This conclusion is first of all based on two concurrent longitudinal studies that examined the years from age 3 to age 15 (Foulkes, 1982). It is also based on a cross-sectional study of children ages 5–8, which was designed as a replication and extension of the key findings in the first of the two concurrent studies (Foulkes, Hollifield, Sullivan, Bradley, & Terry, 1990). Finally, this conclusion is based on the findings in a five-year study for ages 9–15, which included 24 participants, 12 girls and 12 boys (Strauch, 2004, 2005; Strauch & Lederbogen, 1999).

In a largely successful attempt to minimize the loss of participants through moves to other cities, the main investigator in the concurrent longitudinal studies began by advertising for participants in the local newspaper in the city where he taught and researched: Laramie, Wyoming, in which the University of Wyoming is located (population 23,000 in 1970). He asked that only parents who intended to remain permanent residents of the city for the next five years should volunteer their children. The potential participants were interviewed and screened and were told they would be paid after each year and a larger amount if they completed the whole project.

The younger subset included 14 children, who were studied in the sleep-dream lab at ages 3–5, 5–7, and 7–9. All of them took part during all five years. They also were involved in two-week "nursery schools" in the first three summers, during which they were observed in playground settings and given a wide variety of personality and cognitive tests (Foulkes, 1982, pp. 14–18). They also took part in two home-based studies of the frequency and recall of dream reports, which determined that the low percentages of dream recall in the lab were not due to the laboratory setting (Foulkes, 1982, pp. 18–19). The 14 members of this younger cohort were supplemented when they were ages 7–9 by seven new female participants. They were added in order to control for possible practice effects resulting from the original cohorts' two previous experiences in the lab. This control condition showed there were no practice effects (Foulkes, 1982, p. 22).

Initially, there were 16 participants at the outset of the second subset of children, who were studied at ages 9–11, 11–13, and 13–15; 12 of them completed the whole study. They too responded to a variety of tests, but they did not take part in a summer program. This cohort was supplemented by six boys at ages 11–13 for control purposes, and once again there were no differences from those who had been in the study from the start (Foulkes, 1982, p. 22). Two nonlaboratory studies with this older group demonstrated that any content differences between lab and nonlab dream reports were due to methodological issues and selective recall of dreams remembered outside the lab (Foulkes, 1979). Altogether, 26 of the 43 participants in the two concurrent studies took part during all five years, eight for at least three years, and nine for at least one year (Foulkes, 1982, p. 22).

A major effort was made to ensure the participants were comfortable. The parents of the younger children were invited to help with the bedtime preparation (Foulkes, 1982, p. 27). After the children were prepared for the study, including the placement of electrodes, they often read, played, or explored the rooms in the laboratory. To help ensure their comfort and avoid introducing any confounds by using several different assistants to do the awakenings, the main investigator personally carried out all of the

2,711 lab awakenings (Foulkes, 1982, pp. 27, 33–34). The children's degree of anxiety and stress was monitored during the prebedtime period and through their sleep patterns. At ages 3–5, they were rated as calm or relaxed on 79% of the nights and as extremely anxious on only 5.4% of the nights. Their median time to fall asleep was 20 minutes. The same children took only 12 minutes when they returned two years later. The median number of spontaneous night awakenings was one or zero, and the median time awake during the night was eight minutes or less (Foulkes, 1982, pp. 33–34). The results on anxiety indicators were very similar to those for the older cohort (Foulkes, 1982, pp. 33–34).

The cross-sectional study of children ages 5, 6, 7, and 8 was carried out in an effort to replicate the striking cognitive changes that occurred at those ages in the first of the concurrent longitudinal studies. This time the study included more waking cognitive tests because the age changes in the first study did not correlate with the many personality tests. The recruitment began with ads in a major newspaper in the metropolitan area of Atlanta because the main investigator was now located at Emory University. The 80 participants who were chosen, half girls and half boys, were within one month of their fifth, sixth, seventh, or eighth birthdays when they were tested. Each participant was awakened a total of 10 times over two nonconsecutive nights. The efforts to reduce and monitor anxiety levels were similar to those in the longitudinal study. Once again, the parents often helped with the bedtime preparation for the youngest participants but the parents of the 8- and 9-year-old participants usually dropped their children off and then drove away. The participants scored low on the 5-point anxiety scale administered on each visit, and they fell asleep 12.5–14.5 minutes after the lights were turned out (Foulkes et al., 1990, p. 454). The main investigator made all 800 awakenings. Overall, the concurrent longitudinal studies and the cross-sectional study involved a total of 124 participants, who were awakened 3,511 times.

Dreaming Is a Gradual Cognitive Achievement

Both the longitudinal and the cross-sectional studies revealed dreaming to be a gradual cognitive achievement in terms of frequency, complexity, and content (Foulkes, 1982; Foulkes et al., 1990). Preschool children in the longitudinal study reported very brief dreams, with a range of 2 to 50 words, after a mean of 27% recall from REM awakenings. This mean recall figure was very likely inflated by two parent-pressured and eager-to-please participants. This hypothesis was supported by the fact that both of them, unlike the other children in the study, reported fewer dreams two years later, at ages 5–7. As a result, the median recall rate of 15% provided a more accurate picture at ages 3–5 (Foulkes, 1982, pp. 44–45, 51–53). The few characters in the reports were most frequently animals, and there were few social interactions. No dreamer was involved in those few interactions (Foulkes, 1982, p. 48).

The median rate of recall doubled to 31% at ages 5–7 and increased to 43% at 7–9. The median report length also increased between ages 7 and 9, to 70 words for girls and 48 for boys (Foulkes, 1982, pp. 113–120, 341). This recall first involved the last REM period of the night, which has parallels with the finding that the rates of recall are higher in later REM periods for adults as well. There were also changes in dream content, starting with more characters and more dreamer involvement in the few social interactions at ages 5–7. These social interactions were 2.7 times more "prosocial" than "hostile" for both girls and boys, and these trends continued at ages 7–9 (Foulkes, 1982, p. 48). Between ages 7 and 9, the normative Male/Female Percent began to appear (Hall, 1984, p. 115). The Animal Percent began to decline but there were no large-scale changes in dream content (Foulkes, 1982, pp. 113, 115, 234, 341). The most important correlates of the changing patterns of recall and complexity in young children from ages 5–9 were in visual-spatial skills, as measured primarily by the block design test and the embedded figures test (Foulkes, 1982, pp. 72–73).

Similar findings emerged in the cross-sectional replication and extension study involving 80 children at ages 5, 6, 7, and 8. The median rate of reporting from REM awakenings was only 20% for all age groups. This finding supported a conclusion in the longitudinal study—the frequency of dreaming does not change dramatically in this age period. However, the imagery in the dream content became more dynamic by age 7, and the dreamer was more frequently a participant in social interactions by age 8. The narrative quality of the dream reports improved considerably at age 8 (Foulkes et al., 1990, pp. 447, 456, table 1).

Several Hall/Van de Castle (HVdC) coding categories were used in a further analysis of these dream reports. The Male/Female Percent was present in all four age groups, and the Animal Percent was down to 12% in the boys and 9% in the girls at age 8 (Domhoff, 1996, p. 89, table 5.6; Hall, 1984,

p. 115). Still other HVdC content indicators led to results similar to those in the original analysis, which used slightly different scales. Generally speaking, there were few social interactions or negative events. The Aggression/Character Index was .11 at ages 7 and 8, and the Friendliness/Character Index was .13 in girls and .05 in boys in those two age groups. There were very few (minor) misfortunes and no failures involving efforts to achieve a goal (Domhoff, 1996, p. 94, table 5.7).

The similar results for the Male/Female Percent and the Animal Percent in both the longitudinal and cross-sectional studies of younger children also provide evidence for the continuity of dreaming and waking thought. This evidence is based on the findings in a HVdC analysis of the characters in a large sample of brief fictional stories that were thought up and verbally reported at the request of investigators, 180 girls and 190 boys who ranged in age from almost age 3 to almost age 6 (Pitcher & Prelinger, 1963). The results for the Male/Female Percent in the children's stories were very similar to those in dream reports, although the gender differences on the Male/Female Percent were even more extreme in the younger children, and the Animal Percent was higher in the stories than in dream reports (Domhoff, 1996, pp. 89–90).

Turning to the findings with the second cohort in the concurrent longitudinal study, the pivotal years in the development of increased frequency of dreaming proved to be in the first phase of the study (ages 9–11). For those years, the sample consisted of eight girls and eight boys. Collectively, they reported dreams after a mean of 65.8% of the 231 REM awakenings, which is about the same as they reported at later age levels (Foulkes, 1982, pp. 149–150, 178, 238, table B). The median recall percentage was even higher, 79% (Foulkes, 1982, p. 149). Moreover, the dream reports had the same cognitive complexity as the reports later provided by these same participants during their teenage years (Foulkes, 1982, p. 149). However, the rates of recall were lower than those in studies of young adults, and there were differences in content compared to later adolescence and compared to general findings with adults as well (Foulkes, 1982, pp. 74, 217). As with the younger cohort, visual-spatial skills remained "a strong predictor of both REM recall and new achievements in the constructional competence of dreams" (Foulkes, 1999, p. 114).

Although these are major changes in the general findings by ages 9–11, there are complexities within these overall findings. These complexities suggest considerable gender and individual variation. To begin with, the girls recalled a mean of 71.8% from REM awakenings and the boys only 60.0%, even though the median age of the girls was 9.8 years and the median age of the boys was 10.4 years. But there were also large individual differences. Two of the girls had mean recall rates of only 27% and 20% and two of the boys had rates of 27% and 25%, even though all four of these children were of average intelligence (Foulkes, 1982, pp. 150–151). On the other hand, the other 12 participants had an overall median report length of 86%, "a value in an expected range for adult research" (Foulkes, 1982, p. 151).

The surprising finding that dreaming does not begin to resemble adult dreaming until ages 9–11 was independently replicated in the first phase of the five-year longitudinal study of 12 girls and 12 boys in Zurich (Strauch, 2004, 2005). Based on a total of 171 REM reports collected for this age period, girls reported a higher mean percentage of dreams (77%) than the boys (58%). The girls remained at the same high levels in the last two sets of dream reports (74% and 82%) but below an adult control group of Swiss women (91%). The boys did catch up to some extent on recall in the second and third phases of the study, with mean recall percentages of 63% and 74%. However, they too remained below the figure of the adult control group (87%) (Strauch, 2005, pp. 157–158). In addition, the findings on wide individual differences in the Laramie study of children ages 9–15 were replicated. Three girls had 100% recall and another had 90.9% in the Zurich study, but two other girls were at 54.5% and 45.5%. The boys had an even wider range. Two participants recalled 100% and another recalled 83.4%, but four boys had very low recall rates of 36.4%, 33.3%, 25.0%, and 12.5% (Strauch, 2004, p. 223, Anhang 2). This longitudinal replication and extension study includes many new findings on dream content, using both new scales and HVdC categories. They are overviewed in chapter 7 as part of the discussion of dream content during preadolescence and adolescence.

For now, it is important to emphasize these three different large-scale studies took place in three very different cities (Laramie, Atlanta, and Zurich) in three different decades. This strengthens claims about the need for cognitive prerequisites for dreaming. These results show why it can be said with a considerable degree of confidence that dreaming is a gradual cognitive achievement. This conclusion is supported in the next subsection by findings on the gradual development of waking cognitive abilities.

Parallels between the Development of Waking Cognition and Dreaming

Drawing on findings generated by developmental cognitive psychologists for their own purposes, as well as on some of the results from cognitive testing carried out as part of the longitudinal and cross-sectional dream studies, it seems likely that there are five cognitive processes necessary for dreaming—the ability to form concepts, the capacity to generate mental imagery, the ability to make use of narrative skills, the capacity to simulate and imagine, and the acquisition of an autobiographical self.

The ability to form concepts is well established at the latest by age 2, and perhaps as early as late infancy (Mandler, 2004, 2012; Nelson, 2004, 2011). However, the other four cognitive capacities are underdeveloped or lacking altogether in preschool children. To start with, the ability to produce mental imagery seems to be lacking during waking in preschool children, a conclusion based on numerous different types of detailed studies of visual mental imagery (Frick, Hansen, & Newcombe, 2013, pp. 386–387, 395; Frick, Möhring, & Newcombe, 2014, pp. 536–538; Kosslyn, Margolis, Barrett, Goldknopfan, & Daly, 1990, p. 995). This conclusion is consistent with findings on visual-spatial skills as the best predictor of the frequency of dream reporting in children ages 5–8 in the longitudinal dream study (Foulkes, 1982, pp. 72–73). Similarly, the mental imagery tests used in conjunction with the cross-sectional dream study of children ages 5–8 did not detect sufficient capacity to create mental imagery at age 5. The investigators therefore concluded "the possibility of kinematic imaging emerges somewhere between 5 and 8 years of age, rather than being generally well-developed in 5-year-olds" (Foulkes, Sullivan, Hollifield, & Bradley, 1989, p. 450).

The findings on the relative absence of mental imagery in the children under age 7–8 in the cross-sectional dream study are also supported by the absence of visual imagery in people who are born blind or lose their sight before age 5. By way of dramatic contrast, people who become blind after age 7 continue to have visual imagery in both their waking lives and dreaming. They "continue to be able while awake to conjure up [visual] mental images of persons, objects, and events, and they continue to dream in [visual] imagery" (Foulkes, 1999, p. 15). This analysis is supported by a study of dream reports from 15 congenitally and adventitiously blind participants that used the word strings for sensory mental imagery for searches of the dream reports on DreamBank.net. The 10 women and men, who ranged in age from 24 to 73, each contributed at least six dream reports that were voice-recorded over a two-month period. Overall they provided 372 dream reports, 236 from women and 136 from men (see Hurovitz et al., 1999, p. 185, table 1, for the nature and degree of the participants' blindness, and the number of dream reports each person contributed).

All forms of the words "see," "saw," "watch," "look," and "notice" were used to provide a starting point for detecting visual imagery. All forms of "hear" and "listen" were used to locate possible auditory imagery. All forms of "taste," "smell," "aroma," "scent," "feel," "felt," and "touch" were used as a starting point for the other three senses. The sensory references were divided into three categories: visual, auditory, and taste/smell/touch, and the percentage of each type was determined. Once the terms were located through the word string searches, the investigators studied the context in which these terms appeared in order to eliminate possible instances of the figurative use of sensory references. The search for figurative usages was especially important with visual terms because of the frequent use of the conceptual metaphor, "knowing is seeing," as discussed in chapter 5, in which understanding something is expressed as "seeing" (Matlock, 1988). In addition, there are many other metaphoric expressions that build on other forms of sensory imagery (e.g., "he's deaf to new ideas," that idea "smells fishy to me," and "that comment left a bitter taste in my mouth").

The high frequencies of visual imagery in the dream reports of those who became blind after age 7 are similar to those for sighted adults in large-scale studies (Snyder, 1970; Zadra, Nielsen, & Donderi, 1998). For two women who lost their sight after age 8, only one of 36 sensory references could be classified in the taste/smell/touch category; five of their sensory references were auditory and the rest (86%) were visual. On the other hand, there were few or no visual references in the dream reports of those who were blind before age 4. The seeming visual exceptions in the dream reports of two such blind participants involved the use of the "knowing is seeing" conceptual metaphor in speaking. As expected, the taste/smell/touch percent was very high in the dream reports of those who were born completely blind, ranging from 48% to 67% in four participants (Hurovitz et al., 1999, p. 188, table 2). This figure is far higher than the 2–3% of gustatory, olfactory, or tactual imagery that is found in the dream reports of sighted people (Snyder, 1970; Zadra et al., 1998).

Taken together, the developmental findings and the results of word string searches in the dream reports of adult blind participants suggest visual mental imagery develops somewhere between ages 5 and 7 (Foulkes, 1999; Frick et al., 2014; Hurovitz et al., 1999; Kerr, 1993; Kosslyn et al., 1990). It therefore seems likely that individuals who become blind after that age period have retained a developmentally acquired system of visual imagery that is independent of their visual-perceptual capabilities, which makes it possible for them to create visual dream images of people they met after they became blind (Kerr, 1993, pp. 30–35). Although there are no developmental studies of the ability to generate auditory, tactual, and olfactory mental imagery, the best conjecture, based on adult studies of these other types of sensory mental imagery, is that these imagery abilities develop in roughly the same time period (Lacey & Lawson, 2013).

As for narrative skills, developmental studies of waking children find only half of young children's statements about an event are narratives by age 3, and they are limited in length. By age 5 or 6, many children can tell a story containing a beginning, middle, and end (Reese, 2013, pp. 197–198; Taylor, 2013, p. 803). In a waking cross-sectional study of children ages 7 and 11, the 7-year-olds included only three of the eight basic elements considered to be part of a well-developed narrative, whereas children's stories included six of the eight by age 11 (Bauer, Burch, Scholin, & Güler, 2007). Paralleling these results, the children in the cross-sectional laboratory dream study were only able to produce simple narrative scenes without chronology or sequence at ages 5–7. By age 8, they were able to generate a narrative with continuity in two temporal units, along with evidence of causality (Foulkes et al., 1990, pp. 456, 461).

In terms of simulation and imaginative abilities, children's ability to engage in "pretend dramatic play is typically delayed until age 4 or 5 in preschool environments" (Nelson, 2007, p. 170). They only become proficient at imagining and in acting out complex play scenarios after age 5 (Nelson, 2007, pp. 170–171). Consistent with these findings, the children ages 5–7 in the cross-sectional study did not recall dreams very frequently and showed only limited ability to produce complex imaginative narratives in response to story prompts. At age 8, however, the correlation between recall frequency and the total score on the imaginative narrative test was .45 (Foulkes et al., 1990, p. 458).

Preschool children seem to lack the ability to simulate versions of past and future events (Atance & Metcalf, 2013; Taylor, 2013, p. 791). Consistent with these earlier conclusions, a cross-sectional study of 93 Turkish preschool children showed statistically significant improvements at ages 4 and 5 on a series of cognitive tests that assessed their ability to think about the past and the future (Ünal & Hohenberger, 2017, pp. 248–250). In a larger study of American children at ages 5–7, 7–9, and 9–11, which included an adult control group ($n = 157$ overall), the participants provided narratives of past and future events. The children had difficulties in simulating past episodic memories through age 7 and continuing difficulties in simulating future episodic memories through age 11, as compared to the adult control group (Coughlin, 2016, p. 22; Coughlin, Robins, & Ghetti, 2019).

The American children and adults who simulated episodic memories also were asked to provide narratives of a make-believe event. The results for this task are of even greater interest for the construction of a neurocognitive theory of dreaming. Children at age 5 had difficulties in creating make-believe narratives but not thereafter, and improved considerably between ages 7–9 (Coughlin, 2016, pp. 22, 45, fig. 3). These results align very well with the findings on how rarely preschool children dream. On the other hand, children do almost as well by age 9 as older children and adults in developing imaginative narratives, which is also consistent with the conclusions showing the default network can support complex dreaming at ages 9–11.

Turning to the final necessary cognitive capacity, an autobiographical self, personal (autobiographical) memories develop only gradually during the latter half of the preschool years (Eisbach, 2013b; Gopnik, 2009, chap. 5; Nelson, 2005; Tulving, 2005). More specifically, episodic memories for specific events, which develop a year or two earlier, only slowly evolve into more personal types of memories. These personal memories have a sense of subjectively experiencing and reexperiencing. At this point, the memories are "infused with a sense of personal involvement" (Bauer, 2013, p. 521). One developmental psychologist concluded that children do not have "the basics of autobiographical memory," along with an inner mental life and an "autobiographical self," until they are around the age of 6 (Gopnik, 2009, p. 156).

Once again paralleling the waking findings, the longitudinal laboratory dream study discovered there were no signs of "self-involvement" until ages 7 and older, and the regular appearance of self-involvement was not yet fully developed even at ages 7–8. Instead, the "simple dream actions" were usually carried out by other characters (see Foulkes, 2017, p. 4, for a further analysis of his original findings).

Further Evidence: Preschool Children Do Not Understand the Origins of Dreams

There is one final piece of evidence concerning the rarity of dreaming in preschool children. This evidence unexpectedly arises in studies concerning children's understanding of the origins of dreaming. Children understand mental states and pretense by age 3, and they can distinguish between the real and the imaginary in stories (Woolley & Nissel, 2020). However, they have difficulties in understanding and answering questions about the origin of dreams. Based on the waking development findings presented in the previous subsection, their inability to figure out the origins of dreams may be due to their lack of personal experience with dreams.

Work on children's understanding of dreaming suggests they are "quite confused about their origins" at ages 3–4. Some of the 3-year-olds "appeared to conceive of dreams as shared fantasies, claiming that dream content is shared between sleeping individuals" (Woolley, 1995, pp. 189, 195). In a further study designed to determine at what age preschool children understand dreaming as a mental event internal to the person (e.g., "in the mind," "from inside you," "in your head"), as opposed to a nonmental event external to the person (e.g., "from your pillow," "TV," "the sky," "God"), the "majority of 3-year-olds cited non-mental explanations (76%)." The 4-year-olds "gave mental and non-mental explanations equally often, and 5-year-olds offered significantly more mental than non-mental explanations (83%)" (Woolley & Boerger, 2002, p. 26).

Additional results on preschool children's limited and gradual understanding of dreaming come from an interview study of 32 children, ages 3–7, at a school for faculty and staff children at a midwestern university. The study adds further cognitive specificity in terms of what children do and do not understand. Rather strikingly, only 1 of 11 younger children (9.1%), but 7 of 21 in the older group (33.3%), understood dreams take place in their heads (S. Meyer & Shore, 2001, pp. 186–187). Moreover, less than half of 11 children ages 3.5 to 5 (45.4%) understood that dreams are imaginary events, as compared to 17 of 21 at ages 5–7(80.9%). In addition, the order in which 25 of the 32 children understood specific dimensions of dreaming—their imaginary nature, the fact they are private to the dreamer, and their internal origins—is consistent with the age sequence in understanding similar issues in waking thought. Children who grasp the distinction between appearance and reality, and who know that someone can have a different perspective on an object than they do, did not always understand that dreams have no material reality and are private to the dreamer (S. Meyer & Shore, 2001, pp. 186, 190–191). These findings are consistent with two further observations by Gopnik (2009, p. 152): preschool children "don't understand that your thoughts can be internally generated" and they "don't understand that thoughts can simply follow the logic of your internal experience instead of being triggered from the outside."

Preschool children not only lack an understanding of thoughts as internally generated; they do not "experience their lives as a single timeline stretching back into the past and forward into the future" or "feel immersed in a constant stream of changing thoughts and feelings" (Gopnik, 2009, p. 153). In another study, only 44% of children understood what mind-wandering is at ages 6–7, compared to 86% by ages 10–11 (Eisbach, 2013a, table 2). Based on these findings, children very likely need to have an autobiographical self in order to experience dreaming.

If the gradual independent development of visual mental imagery, narrative skills, imagination, and an autobiographical self in young children are considered in combination, they explain why preschool children seldom dream, if ever. This necessary combination of cognitive abilities also may explain why the dream reports of children ages 5–8 often lack a sense of sequence, complexity, visual mental imagery, and a central role for the dreamer. More generally, both dreaming and a waking autobiographical self are very likely the gradually emerging results of both neural and cognitive development between ages 5 and 8. Children do not understand the origins of dreams because they rarely dream and almost never include themselves as a character in the few dreams they do report.

Conclusions and Implications

The results presented in this chapter strongly suggest there is a developmental dimension to the capacity to dream. The findings on the frequency, length, and complexity of dream reports in the cross-sectional and longitudinal laboratory studies of children between the ages of 3 and 15 are consistent with, and fully supported by, the findings on the gradual maturation of the default network. They are also consistent with the gradual development of waking cognitive capacities. The results seem all the stronger because the two longitudinal dream studies involving older children and adolescents were carried out by two different researchers in two different countries in two different decades (Foulkes, 1982; Strauch, 2004, 2005). Then, too, the findings on the Male/Female Percent and the Animal Percent in the dream reports of preschool children, and in the stories they tell, add new evidence on dreaming-waking continuity at a young age (Domhoff, 1996, pp, 89–94; Hall, 1984, p. 115).

Similarly, the studies of the maturation of the default network, and of the development of cognitive capacities, were carried out by still other independent investigators in different countries. Every empirical generalization for the years between ages 3 and 15 has been replicated at least once, with the exception of the work on dreaming with preschool children. Even in the case of the one exception, the fact that the same 14 children were studied at ages 3–5, 5–7, and 7–9, and showed an overall progression in the frequency, length, and complexity of their dream reports, provides good evidence for the robustness of the results with preschoolers.

The findings in this chapter concerning the maturation of the default network, along with the gradual development of cognitive capacities, make it possible to add the two remaining conditions to the list of six conditions necessary for dreaming to occur. First, the relevant neural substrates of the brain not only have to be intact, they also have to be mature. Second, the waking cognitive capacities for generating mental imagery, narration, imagination, and an autobiographical self have to be fully developed for adult-like dreaming to occur. In that regard, the differences in the frequency and complexity of dreaming between children and young adolescents therefore can be understood as another type of cognitive insufficiency.

Finally, to the degree that readers agree there is a need for a developmental dimension in order to understand dreaming and dream content, they may be more inclined to consider the claims made for the neurocognitive theory of dreaming in chapters 8–11. Before turning to those chapters, however, it is necessary to add a content dimension to the findings on the development of dreaming.

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The Where, How, When, What, and Why of Dreams

By: G. William Domhoff

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