This is a chapter excerpt from Guilford Publications.
Neuroscience for the Mental Health Clinician, Third Edition, by Steven R. Pliszka.
Copyright © 2027. **Purchase this book now:** www.guilford.com/p/pliszka2

Copyright © 2027 The Guilford Press

CHAPTER 8

Brain Networks II

Language and Executive Function

The cerebral cortex is the seat of the many complex cognitive functions that humans display, including language, music, art and mentalizing. In his book, *A Brief History of Intelligence*, Bennett (2023) discussed five breakthroughs in evolution that led to the human brain. The first was the development of a bilateral, symmetrical body plan that made steering through the environment possible, and the second was learning by reinforcement (Chapter 5). The next three breakthroughs were (1) the ability of mammals to simulate in their minds what might happen in the near future, (2) primates' ability to predict the thoughts of others in their group, and (3) language (humans only). While humans are symmetrical creatures, brains are asymmetrical in intriguing ways (Kong et al., 2022). The brain has a torque or twist where the right hemisphere is slightly warped forward relative to the left. The left cortex is thicker than the right in the frontal cortex, as well as in the primary sensory, superior parietal, and medial temporal cortices. The right cortex is thicker than the left in the posterior cortex, including in the lateral and medial regions of the temporal, parietal, and occipital cortices. There is a fronto-occipital gradient of cortical thickness asymmetry, with the left cortex thicker in the front and thinner toward the back compared with the right. The planum temporale, a region of the temporal lobe that is highly associated with language, shows one of the greatest left–right size asymmetries in the brain (Karlsson & Ocklenburg, 2025). Ninety percent of right handers show left language dominance in the brain compared with 70% of left handers. Differences in brain asymmetry between left and right handers, between men and women, and between those with and without mental disorders are very small and not likely to be of functional significance (Ocklenburg et al., 2024; Zelco, Wapeesittipan, & Joshi, 2023).

Figure 8.1 is an overview of the classic localization of cortical functions. The predominant functions of the right and left hemispheres are shown. The adjectives

Copyright © 2027 The Guilford Press

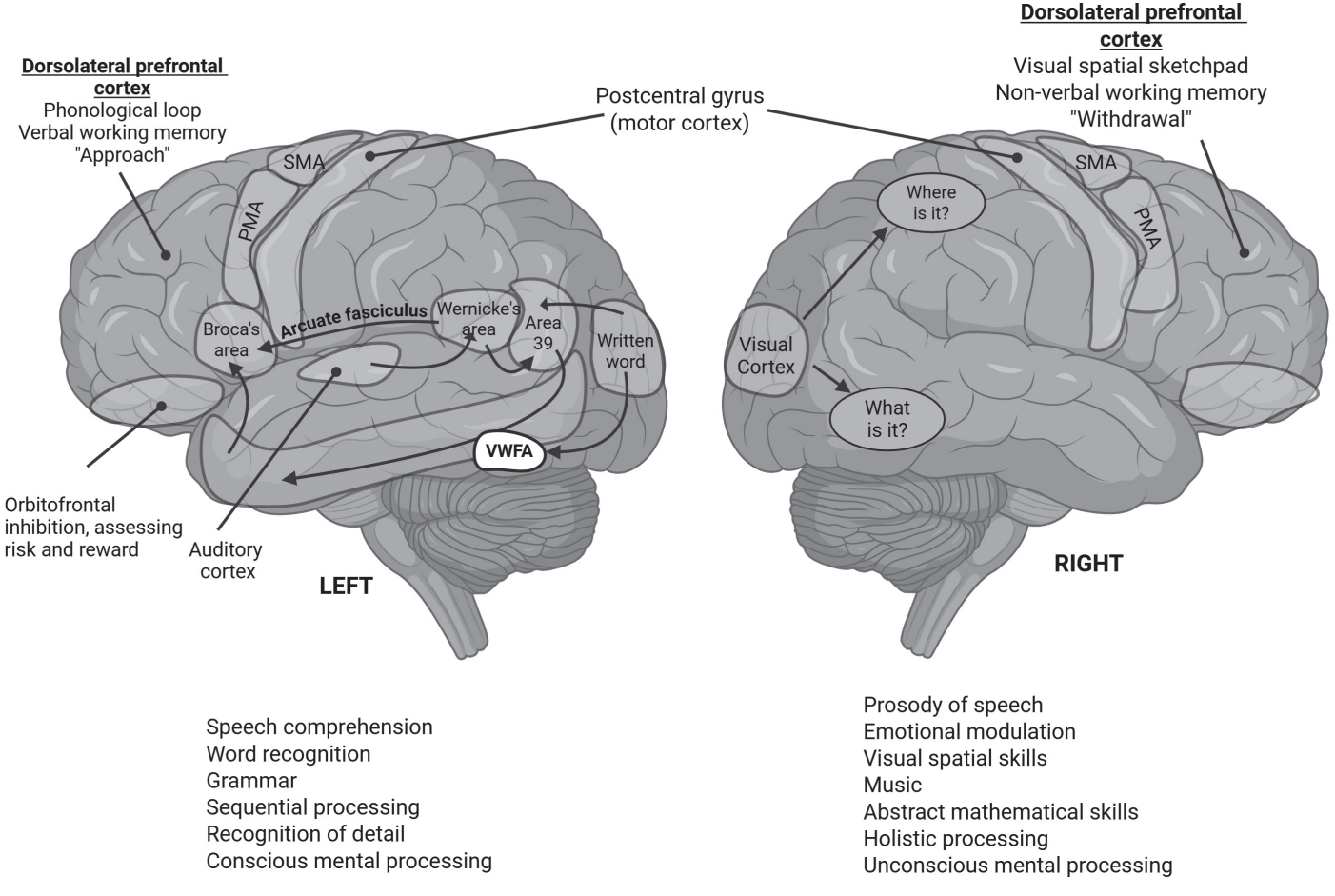


FIGURE 8.1. Psychological functions located predominantly in the right and left cerebral hemisphere. Created in BioRender. Pliszka, S. (2025). *https://BioRender.com/edzid3v*.

"left-brain" and "right-brain" have found their way into popular culture, with left designating verbal, highly logical pursuits and right indicating artistic, intuitive behavior. This distinction, although overly simplistic in many ways, is nonetheless backed up by a significant body of work in both pathology and neuroimaging. We now examine cortical functions in terms of language, visual–spatial skills, and executive functions.

LANGUAGE

Figure 8.1 (left hemisphere) shows the language network. If we hear the word "baby," it consists of two sounds, or "phonemes": "ba" and "bee" (see Box 8.1 for a definition of language terms). Wernicke's area, which lies within the angular gyrus and supramarginal gyrus, recognizes those phonemes that are part of the languages we speak. Once Wernicke's area recognizes these sounds as speech, the information flows in both a dorsal stream through the arcuate fasciculus and a ventral stream to area 39 and beyond (Specht, 2014). Area 39, in the angular gyrus of the inferior parietal lobule, integrates language sounds into words and sends this information to the ventral language stream. The ventral flow proceeds to the middle and inferior temporal gyri, where the word sound is attached to meaning (semantics), but the meaning of words is distributed throughout the brain as we shall see. The dorsal stream appears to be more concerned with grammar (syntax) and motor action. Broca's area receives input both from the anterior temporal lobe and Wernicke's area.

BOX 8.1. Building Blocks of Language

Phoneme: The smallest sound that can be a unit of language and combined into words. The sounds "ba" and "bee" can be combined to form the English word "baby." "Ooo" and "baa" can form the Spanish word "ova" (grape). Both English and Spanish speakers would experience activation of Wernicke's area with spoken presentation of "baby" and "ova," since they represent language sounds.

Lexicon (semantics): Recognizing a combination of phonemes as a word with meaning. In the previous example, only Spanish speakers would have a connection between the sound "ova" to the entity (a small green or purple sweet fruit). Human beings maintain a large mental dictionary, which includes not only a one-to-one correspondence between a word and its meaning, but also the ability to use context to assign meaning. For instance, "He's cool because he is in a band" and "He's cool because it is a chilly spring day" require the listener to assign very different meanings to the word "cool."

Morpheme: The smallest unit of a word that can convey meaning. "Ju," "mmmm," and "p" are phonemes. When they are combined into "jump," the result is one morpheme that has meaning. The word "jumped" has two morphemes because the "ed" conveys past tense.

Syntax (grammar): The language's rules for arranging subject, verb, object, and adjectives/adverbs. Broca's area appears to be key for understanding verbs and the grammatical relationship ("The boy hit the girl" and "The girl was hit by the boy" are equivalent statements).

Copyright © 2027 The Guilford Press

Pragmatics: Integration of nonverbal cues (tone of voice, facial expression) into language for successful social communication, including the use of slang or understanding hidden meaning. For example, if you ask your spouse if they would like to see a movie and they reply, "I'm tired tonight," you implicitly know that the answer is negative. Pragmatics is frequently impaired in autism spectrum disorders.

How does the brain access the meaning of the roughly 40,000 words that a typical adult uses? The circuit we have described so far should be viewed as mainly the input and output parts of our language network. Huth, de Heer, Griffiths, Theunissen, & Gallant (2016) recruited adult volunteers to undergo functional magnetic resonance imaging (fMRI) while they passively listened to hours of stories. They examined how each word activated a particular area of the brain. Surprisingly, word meanings were not limited to the language network or even to the left hemisphere. Words activated locations all over both hemispheres of the cortex and throughout the frontal, temporal, parietal, and occipital lobes (see the Nature Video at *www.youtube.com/watch?v=k61nJkx5aDQ*). Words tended to be clustered together in areas of the brain based on their category and the context in which they were used. For instance, words that describe the *appearance* of things such as "stripes" were stored in the visual cortex along with words like "color" or "long." Verbs were mapped to the frontal lobe motor areas. Thus, a word like "trunk" might activate several different regions, depending on whether it referred to an elephant's nose, a box to store clothes for a trip, or the storage space in the back of a car. Certain areas of the brain responded to social and emotional words such as "wife," "pregnant," and "suffering." For words with complex social and emotional meaning, the language network connects to the default mode network. This is especially true if we are using pragmatic language (See Box 8.1) or seeking to understand a narrative or use language to reason about a situation (Fedorenko, Ivanova, & Regev, 2024).

The process of reading is shown in Figure 8.1 as well. The written word is first processed by the visual cortex and then forwarded to area 39 and Wernicke's area. The letter symbols ("b," "be," "ka") must be mapped onto the sounds they represent, a process referred to as phonemic analysis. The phonemes must be assembled into words, then words must access the respective language stream (noun-ventral or verb-dorsal) in order to be assigned meaning. As we read, the dorsal stream and Broca's area process the grammar (syntax) of the evolving sentence.

Figure 8.2, which shows the brain from underneath, introduces the fusiform cortex of the ventral temporal lobe. The light gray areas represent the view of the ventral temporal lobe after the brain stem and cerebellum have been removed. Separate from language, the temporal lobe processes the shape of things in the environment. There is a discrete region in the right hemisphere that specifically processes human faces, the fusiform face area (FFA). In Chapter 14, we focus on the FFA when discussing how people with autism process facial information. The corresponding area on the left temporal lobe is the visual word form area (VWFA), which specifically responds to words and letters. Humans have only been reading for about the last 6,000 years; thus, the brain did not evolve a new neurological system for written language, but likely utilized

Copyright © 2027 The Guilford Press

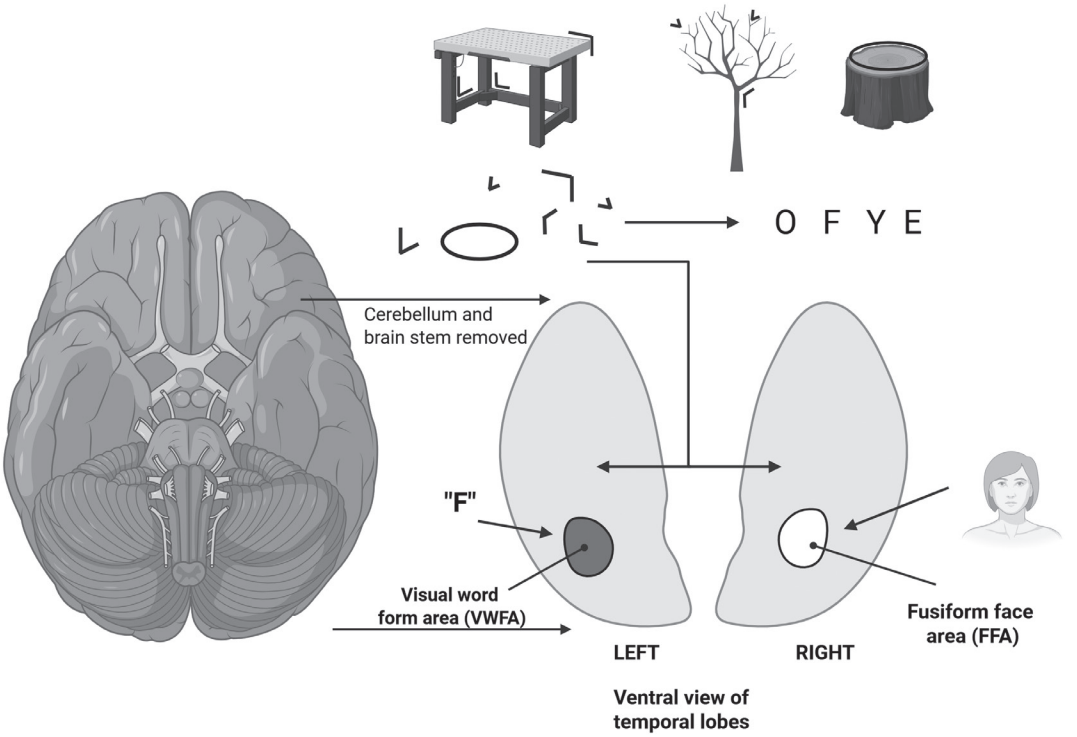


FIGURE 8.2. Fusiform face and visual word form areas of the ventral temporal cortex. Created in BioRender. Pliszka, S. (2025). *https://BioRender.com/13vc34g*.

the FFA for this purpose. Examine the table, tree, and tree trunk in the top of Figure 8.2. The small black line, angles, and circles are part of the object. The brain takes each of these precepts from the visual cortex and adds them to create the whole. These random shapes can be assigned a meaning by the brain. At some point, people determined that a circle can represent the sound "Oooo." As people are taught to read, the brain changes, reserving the left fusiform area for letters and words and linking the VWFA to the language network. Illiterate adults who never learned to read use both the right and left fusiform areas for faces (Dehaene, 2013). For young children just learning to read, their VWFA emerges after phonics training (Brem et al., 2010). This illustrates how the brain is not always hardwired for certain tasks, but changes its connectivity based on experience and learning.

PSYCHOLOGY OF HEMISPHERIC ASYMMETRY

The right hemisphere plays a greater role in nonverbal, visual–spatial functions. Returning to Figure 8.1, note that two "streams" of information flow in the right cortical hemisphere from the occipital (visual) cortex. The ventral stream flows into the

Copyright © 2027 The Guilford Press

temporal lobe, in which representation of objects is the principal function. Assemblies of neurons activate when certain objects, animals, or people are present. Unlike the left hemisphere, the right hemisphere produces primarily nonverbal, conceptual representations of the object or persons. Patients with right-sided lesions are more likely to exhibit "agnosia" (lack of knowing) about many objects, whereas patients with left-sided lesions tend to exhibit "anomia" (inability to name the object). A patient with a right temporal lesion, when shown a hammer, may state that they do not know what it is; when asked to demonstrate how to use it, they will fail to do so accurately. In contrast, the patient with a left temporal lesion will make pounding motions with their hands but be unable to access the correct word for the item. Patients in whom strokes have damaged the right temporal lobe are also more likely than those with left temporal lesions to experience "prosopagnosia," that is, an inability to recognize faces due to damage or disconnection of the FFA. Perception and the recognition of faces depend on a network of brain regions (FFA, amygdala, superior temporal gyrus, and inferior occipital gyrus), which is bilateral but nonetheless has a right-sided bias.

The dorsal stream feeds visual information into the parietal lobe, where it is integrated with other data (principally auditory) to determine where the object is in space. The parietal area deals both with the position of objects in space and the sense of our own bodies. Right–left discrimination is a critical part of this ability. Patients with right parietal strokes develop an array of interesting deficits. They often lose their sense of geography and are no longer able to navigate around their home or city. In severe cases, they may develop "hemineglect," a failure to recognize the left side of their bodies or the left side of their world. Asked to draw a picture of a clock, they draw only a semicircle, on the right side of the clock. They may fail to wash their left hand or comb their hair on the left side. The right hemisphere appears predominant for a wide variety of visual–spatial functions. Whereas rote arithmetic is the province of the left hemisphere, the right hemisphere may handle more complex mathematical concepts, such as geometry and algebra.

Right-hemisphere mechanisms control "prosody," the changes in intonation and emphasis in speech that conveys emotion or meaning. For instance, the difference in the meaning of the sentences "Joe got a raise" and "Joe got a raise?" are conveyed by tone of voice. In the former, the tone of voice is even throughout the sentence, but in the latter, the voice rises at the end to indicate a question rather than a statement. Patients with damage to the right hemisphere have difficulties making such distinctions, and their speech takes on a flat, nonemotional tone. More broadly, the right and left hemispheres have different styles of processing information (Harmon-Jones, Gable, & Petersen, 2010). The left hemisphere is more language based, uses conscious processing, and is logical and rule based. In contrast, the right hemisphere is more abstract in its functioning, and its processing is unconscious. The left hemisphere concerns itself with details of stimuli in the world; the right interprets the global pattern.

R. J. Davidson and Nathan Fox (Davidson, 1992, 1994; Davidson & Fox, 1982, 1989; Fox, 1989; Fox & Davidson, 1986, 1988) performed a series of studies in the

Copyright © 2027 The Guilford Press

1990s examining the amount of alpha-wave activity in the frontal leads of subjects' electroencephalograms (EEGs). While somewhat of a simplification, greater alpha power may represent lower activity of the cortical hemisphere. These studies suggest that (1) people activate (produce less alpha) in the right frontal region when they experience a negative emotion, (2) people with higher baseline right frontal activity tend to be pessimistic and withdrawn, (3) infants with more right frontal activity cry more intensely in response to separation, and (4) temperamentally inhibited preschool children have greater right frontal activity. While these effects are small, they have been validated in more recent studies (Gander & Buchheim, 2015; Light et al., 2009).

Interestingly, right-sided frontal-lobe tumors are more likely to result in mania (disinhibition) than are left-sided tumors, which are more likely to result in depression (Braun, Larocque, Daigneault, & Montour-Proulx, 1999; Starkstein et al., 1989). This suggests that the right hemisphere governs withdrawal and negative emotions (anxiety, fear, depression), whereas the left hemisphere is concerned with approach functions and positive emotions (elation). Aggression (particularly proactive aggression) is viewed as falling into the approach category (Harmon-Jones, Gable, & Peterson, 2010). This model may be of use in interpreting some neuroimaging studies of anger/depression, which often have lateralized findings in terms of brain activity.

EXECUTIVE FUNCTION

The occipital, temporal and parietal cortices are principally concerned with building a picture of the *present* world using visual, auditory, somatosensory (touch), and taste/smell data that they receive from sensory organs. The salience network, involving the amygdala and insula, judges the biological significance of the present world and whether it has that which meets our needs. The posterior memory system (Chapter 7) and default mode network help us summon the *past* world and compare it to the present world. The frontal lobes are not just concerned with executing motion; we must plan our action, and to do this, we need to *imagine* the future. As Bennett (2023) noted, mammals were the first animals to simulate the future. A small mammal 65 million years ago could be under a rock and see a needed piece of food. A predatory bird might be near, however. If the mammal can think, "If I go now, the bird will eat me. But if I wait until it flies away, I have a better chance," it can choose the most optimal of the possible future outcomes. For social mammals living in groups (primates), we must interact with members of our species in a sophisticated manner, requiring us to be able to understand what others are thinking and feeling (mentalizing, or theory of mind).

It is important to understand how some parts of the frontal cortex differ from the other parts of the brain (Barrett & Simmons, 2015; Beul & Hilgetag, 2014). Figure 8.3A shows the difference between the agranular and granular aspects of the cortex. Previously, we discussed the six layers of cerebral cortex, with the first being closest to

Copyright © 2027 The Guilford Press

the skull and the sixth being the deepest. "Agranular cortex" refers to those areas of the cortex that do not have a layer IV. In the "granular cortex," layer IV is the principal layer in which sensory information from the outside world enters the brain. The granular cortex does the computations that lead us to perceive the present world, which it shares with the agranular cortex. Figure 8.3B shows those areas of the motor cortex, premotor, and anterior cingulate cortex (part of the salience network) that are agranular. The agranular cortex is specialized for generating motor commands and higher-level cognitive functions related to action. *It is related to imagining and simulating the future* and is most developed in primates.

We will now look at executive function in terms of how it is distributed among three major areas of the frontal lobe: the dorsolateral prefrontal cortex (DLPFC), the orbitofrontal cortex (OFC), the ventrolateral prefrontal cortex (VLPFC), and the medial prefrontal cortex (MPFC). O'Reilly (2010) integrated information about the function of the prefrontal cortex (PFC) in a wide variety of tasks to develop a "What, How, Abstract, Cold/Hot" (WHACH) model of its functioning, which is illustrated in Figure 8.3B. In the anterior view, parts of a mental task that are related to the "how" function activate the more dorsal aspect of the PFC, such as thoughts that relate to action. In contrast, the ventral aspect of the PFC deals with the "what" function. "Hot" versus "cold" is distributed along the medial–lateral axis and refers to the emotional valence of the task. A simple arithmetic problem is neutral from an emotional perspective; thus, medial areas of the PFC are not likely to play a role in this task. Trying to figure out when is a good time to ask a friend on a romantic date, however, would surely activate these medial regions. These lateral regions also integrate information from the immediate environment that is relevant to the problem, while medial areas of the PFC allow internal information about the self (e.g., personal history, current emotional state) to influence the task. Finally, the lower panel shows the brain from a lateral view, illustrating the anterior–posterior gradient. The posterior aspect of the PFC deals with concrete concepts (count the apples), while the anterior pole is engaged as the task becomes more complex or abstract ("All men are created equal" does not mean that all men are of the same physical size, but that they have equal political rights). The OFC plays a role in determining the value of rewards (medial OFC) or punishments (lateral OFC). While the anterior aspect of the OFC deals with learned reward, more instinctive rewards are processed in the posterior OFC.

Let's examine some of the "cold" executive functions supported by the DLPFC (Figure 8.1). Suppose that you are presented with the following problem. How would you go about solving it?

> "Sally was walking down the street, carrying five apples. She walked five blocks north and met her friend. She gave her friend two apples, then walked four blocks west. She ate an apple and then walked one block south to her home. How many apples did she have left?"

Copyright © 2027 The Guilford Press

Copyright © 2027 The Guilford Press

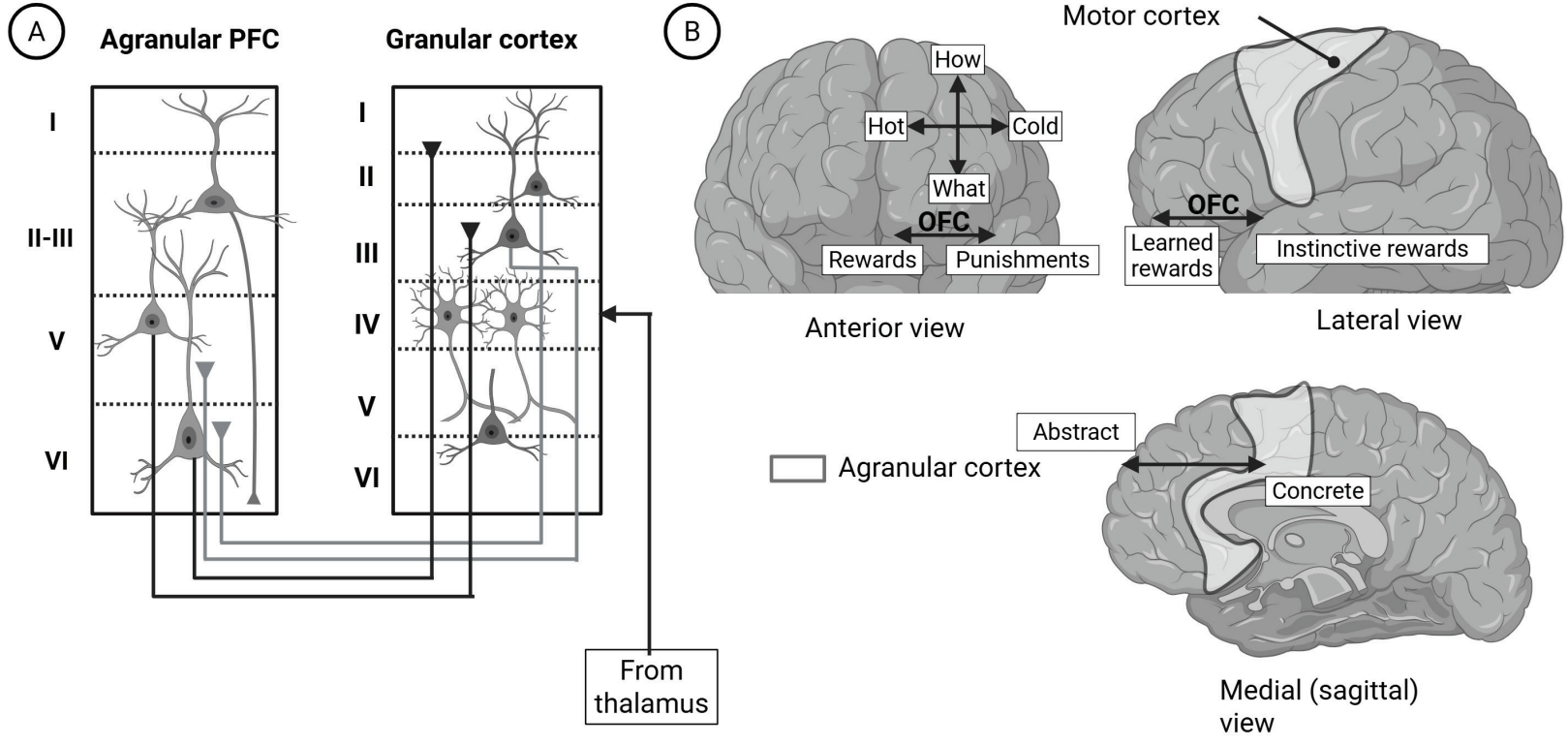


FIGURE 8.3. Agranular versus granular cortex in the cerebral hemispheres. Created in BioRender. Pliszka, S. (2025). *https://BioRender.com/h02dn70.*

Several cognitive functions are critical for solving this problem. Most obviously, language areas must be intact to understand all the elements of the problem; arithmetic skills are required as well. More than this is required to be successful, however. As you listen, you must keep track of the number of apples exchanging hands, and you must realize that the number of blocks walked is not relevant to the problem. This active, mental manipulation of information is done in *working memory*, in which the DLPFC plays a key role. Goldman-Rakic (1992) illustrated this process in monkeys doing a simple task. A monkey is shown a morsel of food, which is then placed in one of two wells. Both wells are covered, then a screen is lowered in front of the wells. After a delay, the screen is lifted, and the monkey must lift the cover of the well to find the food. Monkeys with DLPFC lesions have great difficulty doing this task. Goldman-Rakic then had the monkeys do a slightly different task. The covers of the wells had different symbols on them (a circle and a cross), and the food morsel was always placed under one of the symbols. After several trials, the monkeys learned which cover to lift. DLPFC lesions did not affect this skill. This finding tells us that long-term memory (associating the correct well with the symbol) was not impaired by frontal lobe damage. When the monkeys must hold the *location* of the well in their minds, however, the DLPFC is critical. The same task can be performed with monkeys who have indwelling electrodes in their frontal lobes. When the screen was lowered, particular DLPFC neurons fired during the delay, but they stopped once the response was made. Thus, the DLPFC is critical for "online" processing of information.

In Figure 8.1, somewhat different executive functions are ascribed to the right and left DLPFC (Brodal, 2016; White, Makhoul, Teferi, Sheline, & Balderston, 2023). The left DLPFC controls verbal working memory, which includes the "phonological loop" between Broca's and Wernicke's areas (Baddeley, 2010; Baddeley & Hitch, 1974). In this loop, language information, such as the word problem previously presented, is placed into a "mental buffer" and manipulated. The right DLPFC contains the "visual–spatial sketchpad," which manipulates objects in space. This area would be active when a person is thinking about a geometry problem or, more practically, trying to remember the directions to a place they have not been often. Patients with lesions in the DLPFC are quite different from those with lesions in the temporal or parietal lobes. They rarely exhibit overt language problems, and they recognize objects easily; indeed, in an initial conversation, they may appear quite normal. When tested, however, subtle impairments are detected. If given the problem described previously, they confuse the number of blocks with the number of apples. If a patient with a right parietal lesion and one with a DLPFC lesion are given a maze to complete, they both have difficulties, but for different reasons. The patient with the parietal lesion, having lost their geographic sense, will fail to comprehend the task altogether. Instead of guiding the pencil through the maze, they make stray marks on the paper that bear no relationship to the path. The patient finally just gives up, saying, "I can't do it, I don't understand." The patient with the DLPFC lesion will voice understanding, eagerly grab the pencil, and plow through the maze, taking the first path instead of taking time to consider routes that might be more

Copyright © 2027 The Guilford Press

successful. When at a dead end in the maze, they may simply keep drawing, ignoring the rule to stay within the walls.

Figure 8.4 shows two of the networks (salience and default mode) that have already been described. The lower right of Figure 8.4 shows the frontoparietal executive control network (CEN). It includes anterior nodes in the DLPFC as well as the posterior parietal cortex (PPC). (Do not confuse the posterior cingulate cortex [PCC] of the default mode network with the PPC of the executive control network.) How do the two areas of the CEN work together? As it is situated in the parietal lobe, the PPC is involved in sensory processing (the present world). There is a back and forth between the DLPFC and PPC, with the DLPFC acting as "CEO" for abstract motor behavior ("What and why I will do it") and the PPC acting as an interface for putting motor planning into actional motor commands, particularly for navigating in space (Bai, Liu, & Guan,

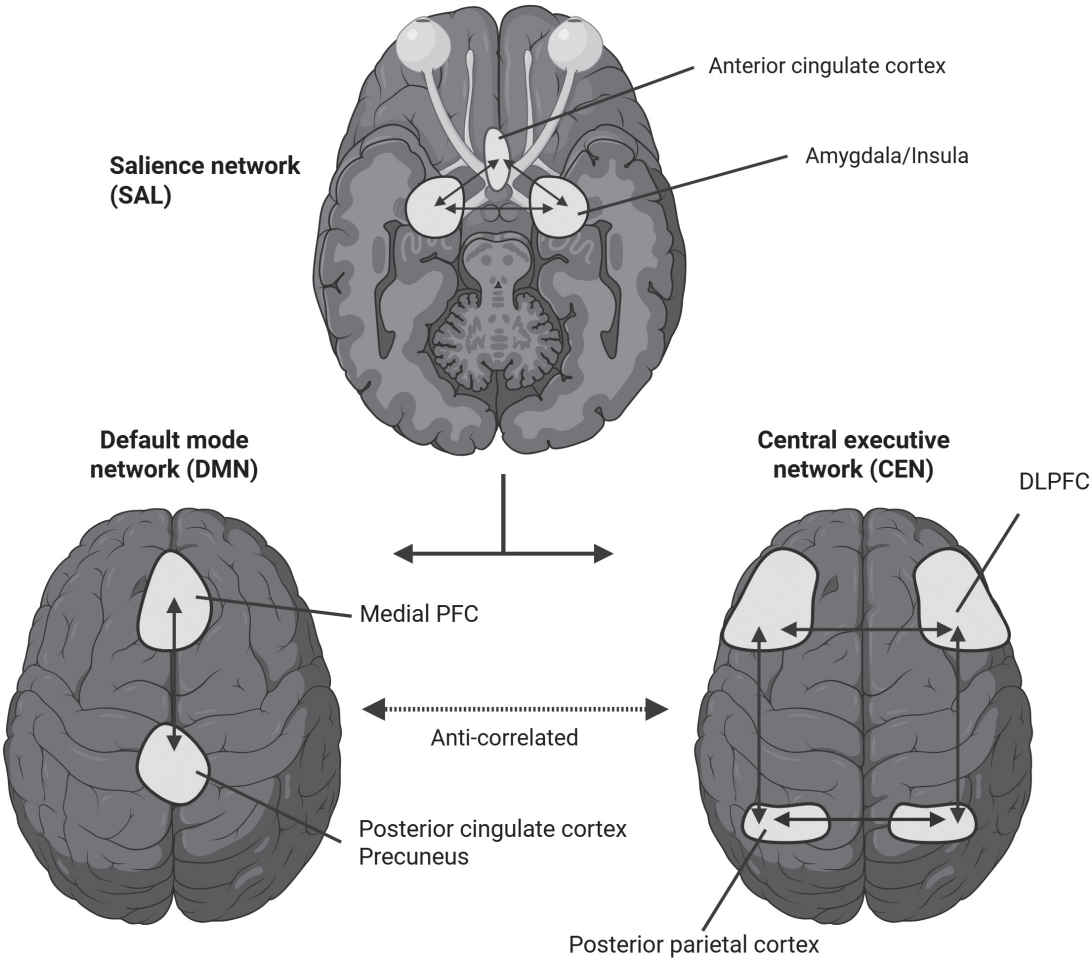


FIGURE 8.4. The tripartite networks. Created in BioRender. Pliszka, S. (2025). *https://BioRender.com/ftb72l2*.

Copyright © 2027 The Guilford Press

2021; Berryhill, 2012; Zhou & Freedman, 2019). Note again the key role of the salience network in modulating the anti-correlation in activity between the executive control and the default mode networks (Menon & Uddin, 2010).

The VLPFC and OFC play key roles in decision making and social behavior. Like the more dorsal part of the PFC, the OFC is also organized along two axes. The lateral part of the OFC codes the value of *punishments*, while the medial OFC is concerned with the value of *rewards* (Rolls, 2019; Rolls, Cheng, & Feng, 2020). The OFC can both inhibit and activate the amygdala. While the amygdala reacts to the current situation (physical needs, presence of rewards), the OFC contains information about *long-term* rewards and punishments. Rolls (2023) summarized the role of the OFC as follows:

> Recent evidence on the connectivity of human brain systems involved in emotion and motivation indicates that the orbitofrontal cortex is involved in reward value and experienced emotion with outputs to cortical regions including those involved in language and is a key brain region involved in depression and the associated changes in motivation. (p. 1201)

The OFC is strongly activated when subjects engage in tasks in which risk must be assessed, such as gambling games. Patients with OFC lesions have difficulty assessing risk and continue to take excessive risks, even when they are losing. This is not due to a lack of awareness that they are doing poorly, but to an inability to assess risk anew on the next trial, even though they lost on the prior trial. Such patients are described as impulsive, but it is due not to an inability to withhold a response per se, but rather to an inability to assess the risk and appropriateness of the response. Antonio Damasio (1994) described a patient—a well-adjusted professional in his 30s who developed a brain tumor (a meningioma) that damaged his OFC. The tumor was removed, but the orbitofrontal areas did not recover. The patient could no longer hold a job, he spent money foolishly, and he began to collect meaningless pieces of junk. He divorced his wife of many years and remarried impulsively. This patient became a modern Phineas Gage, the 19th-century railway worker whose OFC was damaged when an explosion drove a metal rod through it and who also became impulsive and irresponsible.

The posterior part of the OFC plays a role in rewards/punishments that are inborn or instinctive (sugar, sex, pain, social humiliation), while the anterior OFC is engaged for higher-level, learned rewards (Rolls, 2019). The OFC also plays a pronounced role in modulating emotion, particularly anger. In one of the early neuroimaging studies examining the functioning of the OFC, 15 healthy volunteers listened to a script while cortical glucose metabolism was measured by positron emission tomography (PET) scan (Dougherty et al., 1999). In the opening scenario, they heard about riding an elevator with their mothers. Next came three other scenarios in which their mothers were attacked physically by other men in the elevator. These scenarios differed in the following ways: (1) They could do nothing to help their mothers; (2) they tried to respond but were prevented from doing so by the other men in the elevator, and (3) they physically

Copyright © 2027 The Guilford Press

responded to the attackers. In all three of these aggressive scenarios, the activation of the OFC was *decreased* relative to the neutral condition, with the greatest deactivation occurring in the third (retaliation) condition. During the condition when aggression was restrained, other, more dorsal, frontal regions showed increases in activity.

Beyer, Münte, Göttlich, and Krämer (2014) used fMRI to assess OFC activity in 41 individuals who played a game against an opponent while in the scanner. They viewed the opponent as punishing them (delivering a loud noise into the scanner) for a losing response. The opponent would have either an angry or neutral expression. When the opponent had an angry expression, the OFC was more activated relative to the neutral expression. Subjects then had an opportunity to punish their opponent. Interestingly, those subjects who had the *greatest* difference in OFC activity between the angry and neutral faces delivered the *less* intense punishment, such that *decreased* OFC activity correlated with *more* aggressive behavior. The amygdala *recognizes* the threat (angry threat), whereas the OFC *assesses* the threat and weighs options (based on long-term assessment of risk/reward). If a decision is made to act aggressively, OFC activity decreases. In less aggressive individuals, OFC activity jumps to a higher level at presentation of the threat and does not drop as sharply at the decision point to act aggressively. In contrast, aggressive individuals tend to have less OFC activation in response to the threat; this may lead to a greater likelihood that they will trigger an aggressive response. OFC function is highly involved in disorders of anger and aggression and will figure prominently in disorders of mood regulation (Chapter 11).

The VLPFC (Figure 2.2, item 6) performs functions that greatly overlap with the DLPFC, OFC, and MPFC (Cheng et al., 2022). The VLPFC is also involved in the response to rewards along with the lateral OFC. As discussed in Chapter 7, the right VLPFC overlaps with the right inferior frontal cortex, which is part of the ventral attention system (VAN), particularly with regard to inhibition. The right VLPFC plays a role in downregulating negative emotions and thoughts. In contrast, the left VLPFC overlaps with Broca's area and is responsible for the linguistic processes, particularly using language for emotional control (re-appraisal). The VLPFC more broadly integrates the value of the reward assigned by the OFC with external sensory information and with motor planning in the DLPFC to achieve a broader goal (Segal & Elkana, 2023).

THE SELF AND OTHERS

As humans, we can mentalize, that is, we have a remarkable ability to be aware of others' feelings and understand their actions. This understanding is referred to as theory of mind or social cognition (Azarias, Almeida, de Melo, Rici, & Maria, 2025). If we observe someone else performing an action (e.g., waving), "mirror neurons" in our brain are activated, even if we do not overtly perform the action (Bonini, Rotunno, Arcuri, & Gallese, 2022). These areas include the motor cortex, the premotor cortex,

Copyright © 2027 The Guilford Press

the inferior parietal sulcus, the superior temporal sulcus, and parts of the VLPFC. It is debated as to whether Broca's area is part of the mirror neuron system. In monkeys, an area of the ventral premotor cortex responds when a monkey observes other monkeys eating or making communicative gestures with their mouths (Ferrari, Gallese, Rizzolatti, & Fogassi, 2003). Broca's area can be activated by watching others speaking (Callan, Jones, & Callan, 2014). Newborn infants may imitate their caregiver's mouth movements; such movements correlate with language development (Heiser, Iacoboni, Maeda, Marcus, & Mazziotta, 2003; Simpson, Murray, Paukner, & Ferrari, 2014).

The default mode network (Chapter 7) is active in imaging studies in which we must be introspective. In addition to tasks where the participant must take another's point of view, the medial PFC is activated in fMRI when subjects must form impressions of others' personalities based on their actions (Mitchell, Macrae, & Banaji, 2004). The default mode network is key in any task that requires perceiving and understanding the emotions of others and developing empathy (Bzdok et al., 2013; Schilbach, Eickhoff, Rotarska-Jagiela, Fink, & Vogeley, 2008). As shown in Figure 8.4, the default mode network does not accomplish this on its own, but through its interactions with the salience, executive, and ventral attention networks in the "tripartite network" arrangement. In this model, the interior nodes of each of these networks are many (like the commuter airlines reaching out from a hub airport), and they have sparser but denser connections between the three networks (the direct flights between hubs in this analogy). We examine several disturbances to this tripartite network as we review each of the major mental disorders.

INTRODUCTION TO PART II

We are now ready to begin our review of the major mental disorders. The overall theme will be to combine, whenever the knowledge permits, data from genetics, neuroimaging, and environmental risks/protective factors to yield a better understanding of the nature and treatment of these conditions. This will be a transdiagnostic process, as while the major DSM-5 categories of illness have validity, they frequently share disease processes, with the boundaries between them not always clear. We also must take into account the high degree of comorbidity of the different mental disorders.

In recent years, studies such as the UK Biobank (*www.ukbiobank.ac.uk*), ENIGMA (*https://enigma.ini.usc.edu*), and the ABCD study (*https://abcdstudy.org*) have examined hundreds of thousands of participants with and without mental disorders using genetics, neuroimaging, and other measures. Color Plate 5 shows the ENIGMA results of cortical gray matter thickness in people with nine different mental disorders (Thompson et al., 2020). The colors represent the effect size (*d*) of how different each group is from typical controls (see Box 4.1 for a definition of effect size). Red represents areas of the brain with *less* gray matter thickness in affected persons relative to controls, while blue shows areas of the brain that have *greater* gray matter thickness in affected persons

Copyright © 2027 The Guilford Press

relative to controls. Even the largest effect sizes are around 0.4, not large enough to distinguish controls from affected persons at the level of an individual participant. These results represent average effects, and not every patient will fit the overall pattern. Nonetheless, interesting themes emerge, which we delve into in coming chapters.

Autism spectrum disorder (ASD) is the only disorder where cortical gray matter thickness is larger than controls. (22q11, or DiGeorge syndrome, in the lower right has markedly increased gray matter thickness and is associated with psychosis and developmental delay.) Bipolar disorder and schizophrenia show very similar patterns of reduced gray matter thickness, although the reduction is enhanced in the latter disorder. Epilepsy shows reduced gray matter thickness as well. Major depressive disorder (MDD) and obsessive–compulsive disorder (OCD) have much less reduction of gray matter thickness relative to bipolar disorder and schizophrenia, and the reduction is less global. We can see that no *one* pattern of cortical gray matter thickness clearly delineates one disorder from another. Thus, it is not surprising that for almost all patients with a mental health disorder, a structural MRI study would not be diagnostic. For each disorder, we will have to step through the genetic, imaging, and environmental data to make sense of it. H. L. Mencken once said, "For every complex problem there is a solution that is clear, simple, and wrong." To avoid this, the key is to think flexibly and transdiagnostically as we approach each condition.

Copyright © 2027 The Guilford Press

Copyright © 2027 The Guilford Press • info@guilford.com • www.guilford.com
No part of this text may be reproduced, translated, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording, or otherwise, without written permission from the publisher.
Purchase this book now: www.guilford.com/p/pliszka2