

Parietal

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Parietal Lobe

Primary Disciplinary Field(s): Neuroscience, Anatomy, Cognitive Psychology

1. Core Definition

The **parietal lobe** is one of the four major lobes of the cerebral cortex in the mammalian brain. Situated near the side and top of the skull, it occupies a crucial position superior to the occipital lobe (located at the back of the skull) and posterior to the frontal lobe. It also lies directly above the temporal lobe, which encompasses each side of the skull slightly above the ears. This strategic location enables the parietal lobe to serve as a primary hub for integrating sensory information from various modalities, including touch, temperature, pain, and proprioception, with spatial awareness and navigation.

Fundamentally, the parietal lobe is responsible for a diverse range of cognitive functions. One significant section, primarily the anterior part, is dedicated to processing sensations and perceptions, forming our understanding of the body in space and interaction with the environment. Another critical aspect, predominantly in its posterior regions, involves the integration of complex sensory input, particularly concerning spatial relationships within a person's visual field and the broader environment. This integration is vital for tasks requiring hand-eye coordination, object manipulation, and understanding the layout of surroundings.

The term "parietal" itself derives from the Latin word "paries," meaning "wall," referencing its position forming the upper side walls of the cranium. Its intricate neural networks connect extensively with other brain regions, including the frontal lobe for motor planning, the temporal lobe for memory and language, and the occipital lobe for visual processing. This widespread connectivity underscores its role as an executive integrator, synthesizing disparate streams of information into a coherent perception of reality and facilitating appropriate behavioral responses.

2. Etymology and Historical Context

The term **parietal** originates from the Latin word "paries," meaning "wall," which accurately describes its anatomical position forming the upper side walls of the cranium. Historically, the understanding of brain functions, including those of the parietal lobe, evolved gradually over centuries. Early anatomists, such as those in ancient Greece, identified different brain regions but lacked the tools and knowledge to precisely delineate their functions. During the Renaissance, advancements in anatomical dissection provided more detailed maps of the brain's macroscopic structures, yet the specific roles of these structures remained largely unknown.

The 19th century marked a significant turning point with the rise of phrenology, a pseudoscientific discipline that, despite its inaccuracies, spurred interest in localizing brain functions. While

phrenologists incorrectly mapped personality traits to skull bumps, their work laid foundational groundwork for the idea that specific brain regions might be responsible for particular functions. More scientifically rigorous investigations began to emerge with clinical observations of patients with localized brain injuries. Physicians noted that damage to certain areas consistently resulted in specific deficits, hinting at the functional specialization of different brain regions.

In the early 20th century, pioneering neurosurgeons like Wilder Penfield contributed immensely to mapping brain functions. Through direct electrical stimulation of the cortex during surgery, often performed on conscious patients, Penfield meticulously identified the primary somatosensory cortex located in the postcentral gyrus of the parietal lobe. His work provided definitive evidence that this region was responsible for processing tactile sensations and body position. Subsequent research, leveraging advancements in neuroimaging and neuropsychology, has continued to elaborate on the parietal lobe's complex contributions to spatial cognition, attention, and other higher-order functions, solidifying its status as a critical brain region for integrating sensory experiences into a coherent understanding of the self and the environment.

3. Anatomical Subdivisions and Connectivity

The **parietal lobe** is anatomically divided into several key regions, each contributing uniquely to its overarching functions. A prominent landmark is the central sulcus, which separates the parietal lobe from the frontal lobe anteriorly, and the parieto-occipital sulcus, which demarcates its boundary with the occipital lobe posteriorly. Inferiorly, the lateral sulcus (or Sylvian fissure) separates it from the temporal lobe. Within these boundaries, the parietal lobe is further subdivided by the intraparietal sulcus (IPS) into two main areas: the superior parietal lobule (SPL) and the inferior parietal lobule (IPL).

The **superior parietal lobule** is largely involved in spatial orientation, particularly in processing the location of objects in space and guiding movements towards them. It integrates visual and somatosensory information to create a comprehensive map of the body and its interaction with the environment. This region is critical for tasks such as reaching for objects, navigating complex spaces, and performing mental rotations. Damage to the SPL can lead to deficits in spatial awareness and visuospatial neglect, where individuals fail to attend to one side of their environment or body.

The **inferior parietal lobule**, located inferior to the IPS, is further divided into the supramarginal gyrus and the angular gyrus. This region is highly multimodal, meaning it integrates information from auditory, visual, and somatosensory systems. The supramarginal gyrus plays a crucial role in phonological and articulatory processing of words, contributing to language functions, while the angular gyrus is implicated in complex language tasks, numerical cognition, and metaphor comprehension. The IPL's extensive connectivity makes it a critical node in networks supporting

reading, writing, and mathematical reasoning, making it particularly vulnerable to a range of cognitive impairments when damaged.

4. Somatosensory Processing and Perception

One of the most well-established functions of the **parietal lobe** is its role in processing somatosensory information. The primary somatosensory cortex (S1), located in the postcentral gyrus, is the initial cortical receiving area for tactile, proprioceptive, temperature, and nociceptive (pain) stimuli originating from the contralateral side of the body. This region is organized somatotopically, meaning that specific areas of the cortex correspond to specific parts of the body, forming what is known as the somatosensory homunculus. Areas of the body with higher sensory acuity, such as the hands and face, occupy disproportionately larger cortical representations within S1.

Beyond the primary reception, the parietal lobe plays a pivotal role in the higher-order processing and interpretation of these sensations. Secondary somatosensory cortex (S2), located posterior to S1, further processes complex tactile information, contributing to object recognition through touch (stereognosis) and understanding the texture, shape, and size of objects. This hierarchical processing allows for a more nuanced and integrated perception of sensory inputs, transforming raw data into meaningful experiences. Without these processing stages, simple tactile stimuli would remain as isolated sensations rather than contributing to a holistic understanding of the environment and our interaction with it.

Furthermore, the parietal lobe integrates somatosensory information with proprioception, which is the sense of the relative position of one's own body parts. This integration is essential for maintaining a coherent body schema--a dynamic internal model of the body's physical and spatial characteristics. This body schema is crucial for motor planning, balance, and spatial awareness, enabling seamless interaction with the environment. Disorders affecting somatosensory processing in the parietal lobe can lead to conditions like astereognosis (inability to identify objects by touch), agraphesthesia (inability to recognize writing on the skin), or even more complex issues related to body image and spatial neglect, highlighting the lobe's indispensable role in our sensory world.

5. Spatial Cognition and Attention

The **parietal lobe** is absolutely critical for spatial cognition, encompassing our ability to understand and navigate the three-dimensional world, as well as our capacity to direct and maintain attention. Its posterior regions are particularly involved in processing spatial relationships, integrating visual, auditory, and somatosensory information to construct a coherent representation of the external environment and our position within it. This integrated spatial map is fundamental for complex tasks such as reading a map, driving a car, or even simply reaching for a cup of coffee without

bumping into obstacles.

A key aspect of parietal spatial function is its role in the dorsal stream of visual processing, often referred to as the "where" or "how" pathway. This pathway originates in the occipital lobe and projects to the parietal lobe, specializing in analyzing spatial location, motion, and guiding actions. It enables us to perceive the spatial layout of objects, track their movement, and transform visual information into motor commands. Damage to this pathway can result in various forms of apraxia (difficulty with skilled movements) or spatial disorientation, underscoring its importance for purposeful interaction with the environment.

Beyond spatial perception, the parietal lobe is also a primary orchestrator of attention, particularly spatial attention. It helps us select relevant information from the myriad of sensory inputs and focus our cognitive resources on specific locations or objects. Unilateral damage to the posterior parietal cortex, especially in the right hemisphere, often leads to hemispatial neglect, a profound disorder where individuals fail to attend to, or even acknowledge, stimuli presented on the contralateral side of space. This condition dramatically illustrates the parietal lobe's role in constructing a complete and attentive representation of the world, emphasizing that perception is not merely about sensing stimuli but also actively engaging with them.

6. Other Cognitive Functions

While somatosensory processing and spatial cognition are primary functions, the **parietal lobe** contributes to several other complex cognitive abilities, often through its extensive interactions with other brain regions. One such area is numerical cognition. Studies have consistently shown that the intraparietal sulcus (IPS), a key anatomical landmark within the parietal lobe, is actively involved in processing numerical quantities, performing calculations, and understanding mathematical concepts. Damage to this region can lead to acalculia, an acquired inability to perform arithmetic operations, highlighting its critical role in mathematical reasoning and abstract thought.

Furthermore, the parietal lobe plays a significant role in visual-motor integration, the complex process of combining visual information with motor commands to guide precise actions. This function is essential for tasks requiring fine motor skills, such as writing, drawing, or manipulating tools. It allows for the continuous adjustment of movements based on real-time visual feedback, ensuring accuracy and coordination. This capability is not merely about executing movements but also about planning and anticipating the sensory consequences of those actions, demonstrating a predictive element in parietal function.

The inferior parietal lobule, particularly the angular and supramarginal gyri, also contributes to various aspects of language processing. While generally associated with the temporal and frontal lobes, these parietal regions are crucial for integrating phonological, semantic, and syntactic

information, supporting reading, writing, and understanding complex linguistic structures. For instance, the angular gyrus is implicated in reading comprehension and metaphor processing, illustrating its role in higher-level semantic understanding. The extensive interconnections of the parietal lobe with frontal, temporal, and occipital areas underscore its position as a central hub for multimodal integration, enabling the rich tapestry of human cognition that extends far beyond simple sensory processing.

7. Clinical Significance and Disorders

Given its central role in sensory integration, spatial awareness, and attention, damage to the **parietal lobe** can result in a wide spectrum of neurological and cognitive deficits, profoundly impacting an individual's quality of life. The nature and severity of these deficits depend on the specific location and extent of the lesion, which can be caused by stroke, trauma, tumors, or neurodegenerative diseases. One of the most striking disorders associated with posterior parietal damage, especially to the right hemisphere, is hemispatial neglect, where patients fail to perceive or respond to stimuli in the contralateral (opposite) side of space, often behaving as if that half of the world simply does not exist. This can manifest as neglecting to eat food on one side of a plate, drawing only half of an object, or ignoring people on their left side.

Another complex cluster of symptoms resulting from damage to the dominant (usually left) inferior parietal lobule is Gerstmann Syndrome. This syndrome is characterized by four primary components: agraphia (difficulty with writing), acalculia (difficulty with arithmetic), finger agnosia (difficulty identifying or distinguishing fingers), and left-right disorientation. These deficits highlight the inferior parietal lobule's critical role in integrating diverse cognitive processes, including spatial mapping, numerical reasoning, and bodily awareness, all of which are essential for basic daily functions and academic skills.

Beyond these specific syndromes, parietal lobe damage can also lead to various forms of apraxia, such as ideomotor apraxia (difficulty performing learned motor acts on command) or ideational apraxia (difficulty in sequencing complex actions). Patients may also experience astereognosis (inability to identify objects by touch), anosognosia (lack of awareness of one's own neurological deficits), or optic ataxia (difficulty reaching for objects under visual guidance). The broad range of clinical presentations underscores the parietal lobe's extensive network of connections and its integrative function, making it a cornerstone for understanding the complex interplay between sensation, perception, cognition, and action in the human brain.

8. Modern Research Directions and Future Outlook

Contemporary research on the **parietal lobe** continues to delve deeper into its intricate functions, leveraging advanced neuroimaging techniques, electrophysiological recordings, and computational

modeling. Functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and electroencephalography (EEG) are routinely used to map brain activity during various cognitive tasks, providing unprecedented insights into the dynamic engagement of parietal subregions. These studies are illuminating the precise neural circuits underlying spatial attention, working memory, numerical processing, and even social cognition, revealing the parietal lobe's involvement in a broader array of functions than previously imagined.

One significant area of ongoing research focuses on the parietal lobe's role in the formation and maintenance of body schema and self-awareness. Researchers are investigating how parietal circuits integrate proprioceptive, visual, and tactile inputs to create a coherent sense of one's own body in space, and how this contributes to the experience of embodiment. This work has implications for understanding disorders like phantom limb syndrome, body integrity dysphoria, and conditions where individuals feel detached from parts of their body. Furthermore, studies on tool use and embodied cognition are exploring how the parietal lobe extends our body schema to incorporate external objects, effectively integrating them into our sense of self for skilled interaction with the environment.

The future outlook for parietal lobe research is highly promising, with increasing efforts to understand its connectivity patterns at a micro- and macro-level. Combining diffusion tensor imaging (DTI) with functional analyses is helping to map the intricate white matter tracts that link the parietal lobe to other cortical and subcortical structures, providing a clearer picture of its role within large-scale brain networks. This integrated approach is crucial for developing more targeted interventions for neurological conditions affecting parietal function, such as rehabilitation strategies for stroke patients with neglect or therapies for developmental dyscalculia. Ultimately, a deeper understanding of the parietal lobe promises to unlock fundamental insights into human perception, cognition, and our very interaction with the world around us.

Further Reading

[Parietal Lobe on Wikipedia](#)

[Somatosensory Cortex on Wikipedia](#)

[Hemispatial Neglect on Wikipedia](#)

[Gerstmann Syndrome on Wikipedia](#)

[Neuroscience on Wikipedia](#)