The Manual: Dialogues Between the Hands and the Brain

Dr. Sari Hannila

An artist's hands are their most indispensable tool. When we hear terms such as "handcrafted", "handmade", and "handwrought", we immediately associate them with quality, tradition, skill, and an intimacy with materials that can only result from human touch. Similarly, the word "manual" can refer to either a descriptive term for working with one's hands, or a guidebook that provides instructions for performing a task. These two definitions complement each other beautifully when we consider the role of the brain in creative work. The brain serves as a manual for motor and sensory function – planning, initiating, and directing every movement that we make, and interpreting every sensation that we feel through our skin. And within that manual, no part of the body has greater representation than the hands.

When neuroscientists examine the brain, we often refer to its "topography", and this geographical description is very fitting, as its outer surface covered with physical features reminiscent of hills and valleys, which are called gyri (singular: gyrus) and sulci (singular: sulcus), respectively. Valleys often serve as natural borders, and sulci serve the same purpose in the brain – dividing it into distinct functional regions not unlike countries on a map. These regions are called lobes, and in the very middle of the brain, there is an appropriately named central sulcus that separates the frontal and parietal lobes. On either side of this border lie two gyri: the precentral gyrus and postcentral gyrus (Figure 1). While they are located right next to each other, their functions could not be more different, with the precentral gyrus controlling voluntary movement and the postcentral gyrus serving as the site where sensations are perceived. Within these gyri, the human body is mapped out in its entirety, and this map is typically represented in a caricature-like diagram called a homunculus, from the Latin for "little person" (Figure 2).

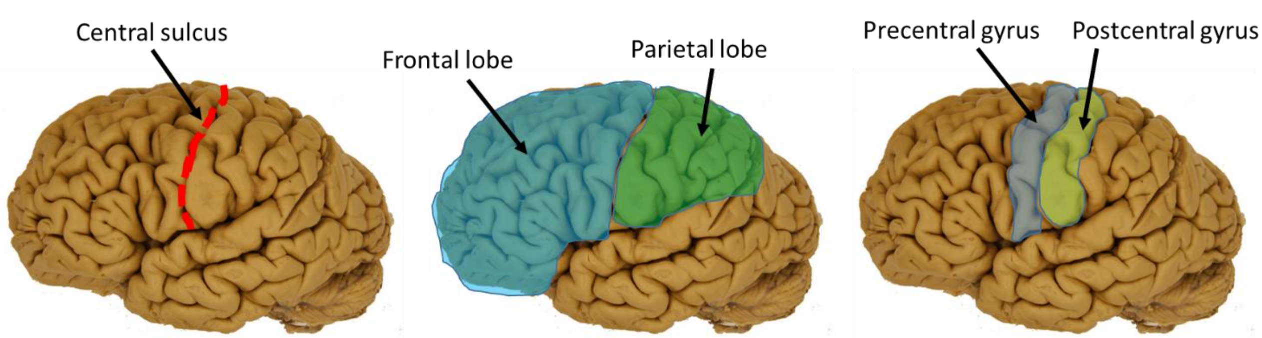

Figure 1: Locations of the frontal and parietal lobes, and precentral and postcentral gyri in the human brain.

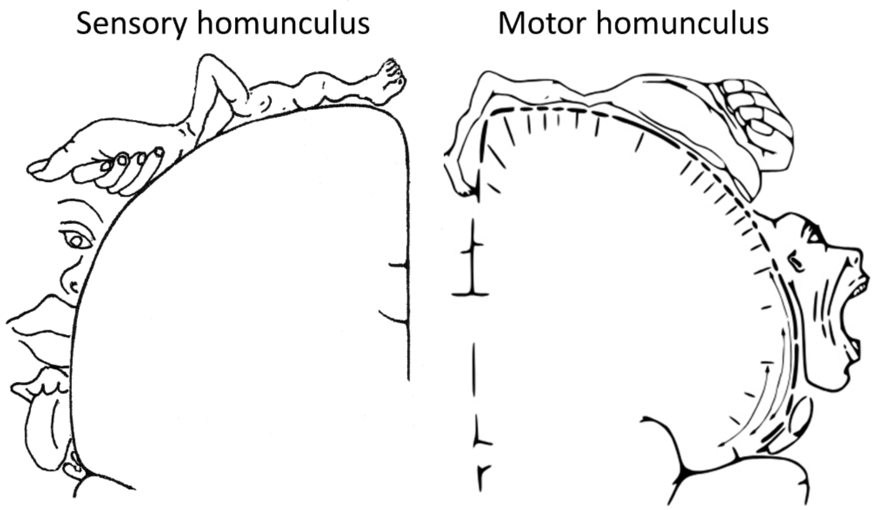

Figure 2: The sensory and motor homunculus. Attributions: Btarski at English Wikipedia, CC BY-SA 3.0 <http://creativecommons.org/licenses/by-sa/3.0/>, via Wikimedia Commons; mailto:ralf@ark.in-berlin.de, [CC BY-SA 4.0](CC BY-SA 4.0), via Wikimedia Commons.

The exaggerated features of the homunculus are not a fanciful creation, but rather, a scientifically-derived depiction of the amount of brain tissue devoted to a particular part of the body. The over-representation of the hands in the motor homunculus reflects the dexterity and fine motor control that characterize the human hand, and this is precisely what allows artists to perform the intricate movements that are essential for creating detail and nuance. The hand also features prominently in the sensory homunculus, and in this case, its disproportionate size denotes the hand's exquisite sensitivity to subtle changes in texture and temperature. The high degree of functionality that our hands possess is what enables us to interact with our surroundings in meaningful and enriching ways, and it is the very foundation of fine craft.

Motor Function: The Benefits of Going Through the Motions

A needle pierces rhythmically through hide, carrying beads and thread behind it. In and out. Up and down. Over and over. Hands slide along a spinning mass of clay, each movement measured and precise. Press just hard enough. Not too much. Not too little. A brush is gripped and dipped into paint. A broad stroke here. A small dot there. Blend the colours together.

Any visual artist will tell you that repeating actions like the ones described above has helped them to hone their skills, and that achieving mastery of their craft requires many years of dedication and practice. An accomplished artisan can make the difficult appear effortless, and this is not just a perception – it is well-established that the repetition inherent in artistic practice has a profound impact on motor learning and the structure of the brain. When a movement is made, neurons in the precentral gyrus that correspond to the appropriate region of the body are activated, sending signals to the spinal cord, which in turn stimulates contraction of the muscles. For intricate learned movements involving the hands, such as playing a musical instrument or tatting lace, this process is more complex and it extends all the way to the cellular level. The neurons that carry motor signals communicate with each other through chemical connections called synapses, which are formed by processes called axons and dendrites. As a movement is learned and repeated, dendrites grow small, mushroom-like projections called spines, which allow new synapses to be formed (Figure 3). This strengthens the connections between neurons, forming a functional circuit, and allowing the brain to construct a program specifically designed for executing that particular movement. These motor programs are stored in a region of the brain called the supplementary motor cortex, which is found just in front of the precentral gyrus. Over time, motor programs are refined to the point where activation of the supplementary motor cortex leads to execution of movements without the need for conscious effort. This is the scientific basis for what is called kinesthetic learning, or more commonly, “muscle memory”. It is therefore not hyperbole to say that there are “beading neurons” or “knitting circuits” within the brain of an artist. Practice does indeed make perfect.

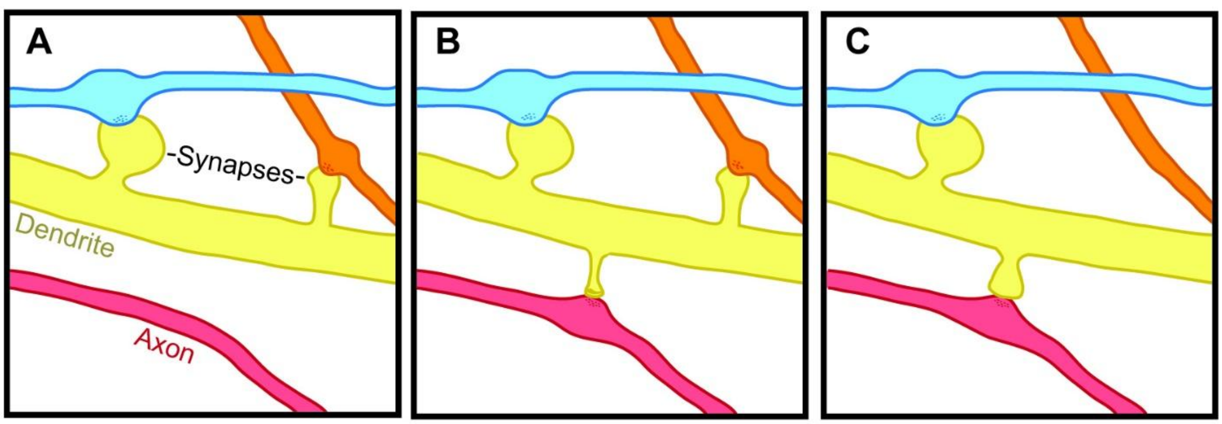

Figure 3: The formation of dendritic spines and synapses. Modified from: [Mrazadazdazz](), [CC BY-SA 3.0](), via Wikimedia Commons.

Sensory Function: The Fine Line Between Pleasure and Pain

Silk is embroidered onto linen. Their textures transition from smooth to coarse. A needle slips unexpectedly, piercing skin and drawing blood. Clay is molded into forms, cool and wet to the touch. The heat of the kiln intensifies as wood is added. A rogue ember singes a finger. Bars of *steel are carried to the forge. Hands feel the weight and muscles tense in response. Vibrations ripple through the skin as metal strikes metal, sending a shock through the body.*

The phrase "Do not touch" is posted in every museum and gallery in the world, and this immediately creates physical and psychological distance between the artwork and the viewer. Our relationship with craft pieces, however, is notably different, and often intensely personal. With its focus on functional objects and use of familiar materials, both maker and user are drawn to the tactile nature of craft, and our hands therefore serve as one of the primary means of interacting with these works. Embedded in our skin are a variety of specialized receptors that detect all manner of sensations (Figure 4). Onion-like structures called Pacinian corpuscles are activated by the vibrations of the potter's wheel. Ruffini endings, Meissner's corpuscles, and Merkel's discs respond to the stretch and pressure exerted on the skin as we run our fingers over beadwork or twist strands of silver into jewelry. Pain and temperature are carried by shared receptors called free nerve endings that are reminiscent of a bare electrical wire, allowing us to immediately sense the threshold that separates pleasant warmth from burning heat.

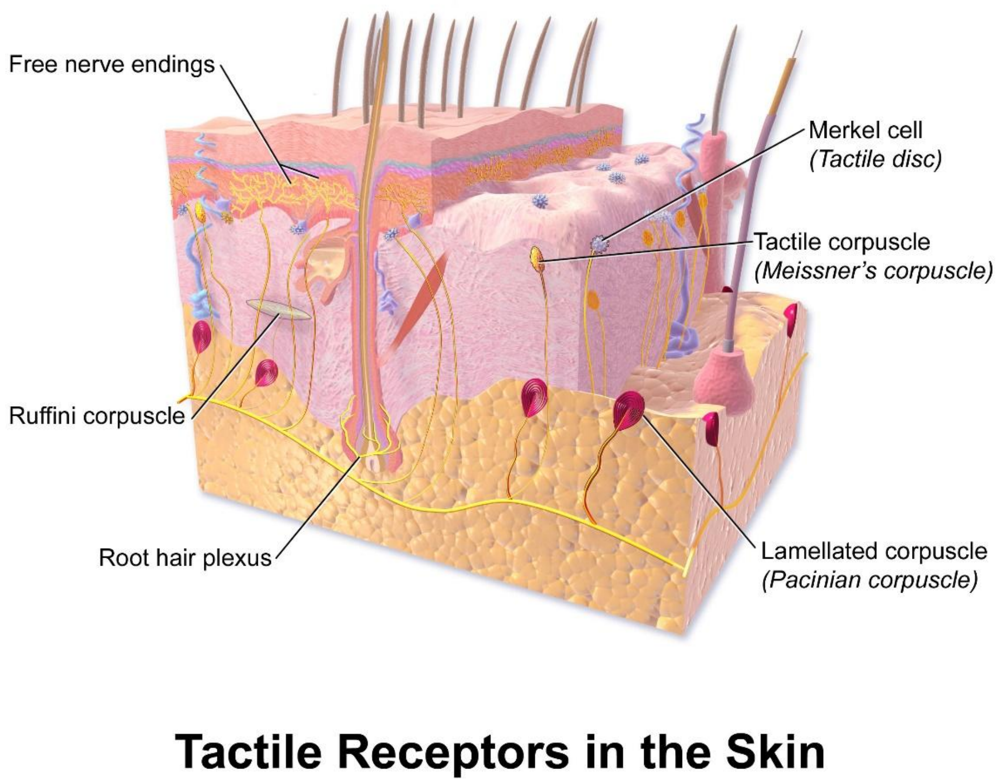

Figure 4: Sensory receptors in the skin. Attribution: BruceBlaus. Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436., CC BY 3.0 <https://creativecommons.org/licenses/by/3.0>, via Wikimedia Commons

The palms and fingers are densely innervated with these receptors, which allows us to gather vast amounts of information through the sense of touch. When the receptors are activated, sensations are transmitted to the postcentral gyrus of the brain, where they are perceived at a conscious level. As depicted in the homunculus, the detailed representation of the hand in the postcentral gyrus enables us to place these sensations with remarkable precision. As anyone who has had a paper cut can attest, we immediately know the location of even the smallest nick in the skin of our hands. The remainder of the parietal lobe will then take this sensory information and place it in a broader context, connecting it to past experiences and feelings both positive and negative. It also facilitates a unique function called stereognosis, which is the ability to recognize objects simply by touch. It enables us to find our keys in the bottom of a crowded purse, and more importantly, helps individuals with a visual impairment to identify different denominations of coins. For artists, the sensitivity of the skin converges with memory and stereognosis in the making process. As a piece is fashioned and completed, makers can feel minute variations and imperfections on its surface – a bubble of glaze on a newly-fired pot, the contrast of warp and weft in a woven textile – and draw on their experience to either make corrections or come to the satisfying conclusion that it feels just right. In many ways, the hands of the artist see more than the eyes ever could.

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About the author

Dr. Hannila received her Bachelor of Science degree in life sciences from Queen's University in 1999 followed by a PhD in anatomy and cell biology at Queen's under the supervision of Dr. Michael Kawaja.

Prior to joining UM in 2010, Dr. Hannila worked as a postdoctoral fellow in the laboratory of Dr. Marie T. Filbin at Hunter College in New York City.

She is currently an associate professor of human anatomy and cell science at UM and an associate member of the Spinal Cord Research Centre. She also serves as director of outreach for the Manitoba Neuroscience Network and was nominated for CBC Manitoba's Future 40 in 2017 in recognition of her outreach activities. Research themes include Neuroscience and neurobiology, secretory leukocyte protease inhibitor (SLPI) – roles in gene expression and neurodegenerative diseases; and spinal cord injury and axonal regeneration – roles of myelin-associated inhibitors.

Her work has been published in journals such as the Neuroscientist, Experimental Neurology, the Journal of Biological Chemistry, and the Journal of Neuroscience.

Her research is currently funded by the Natural Sciences and Engineering Research Council of Canada, and she has also held funding from the Canadian Paraplegic Association and the Wings for Life Spinal Cord Research Foundation (Austria).

Along with a respected research practise, Dr. Hannila is been active in the arts community, working closely with MAWA (Mentoring Artists for Women's Art) and other institutions. Dr. Hannila initiated the Neurocraft project with the Manitoba Craft Council and was pivotal in the Dura Mater program at MAWA, which resulted in an exhibition at the Buhler Gallery in 2021. She is currently opening her neuroscience lab for artists wishing to apply to do residencies with her.