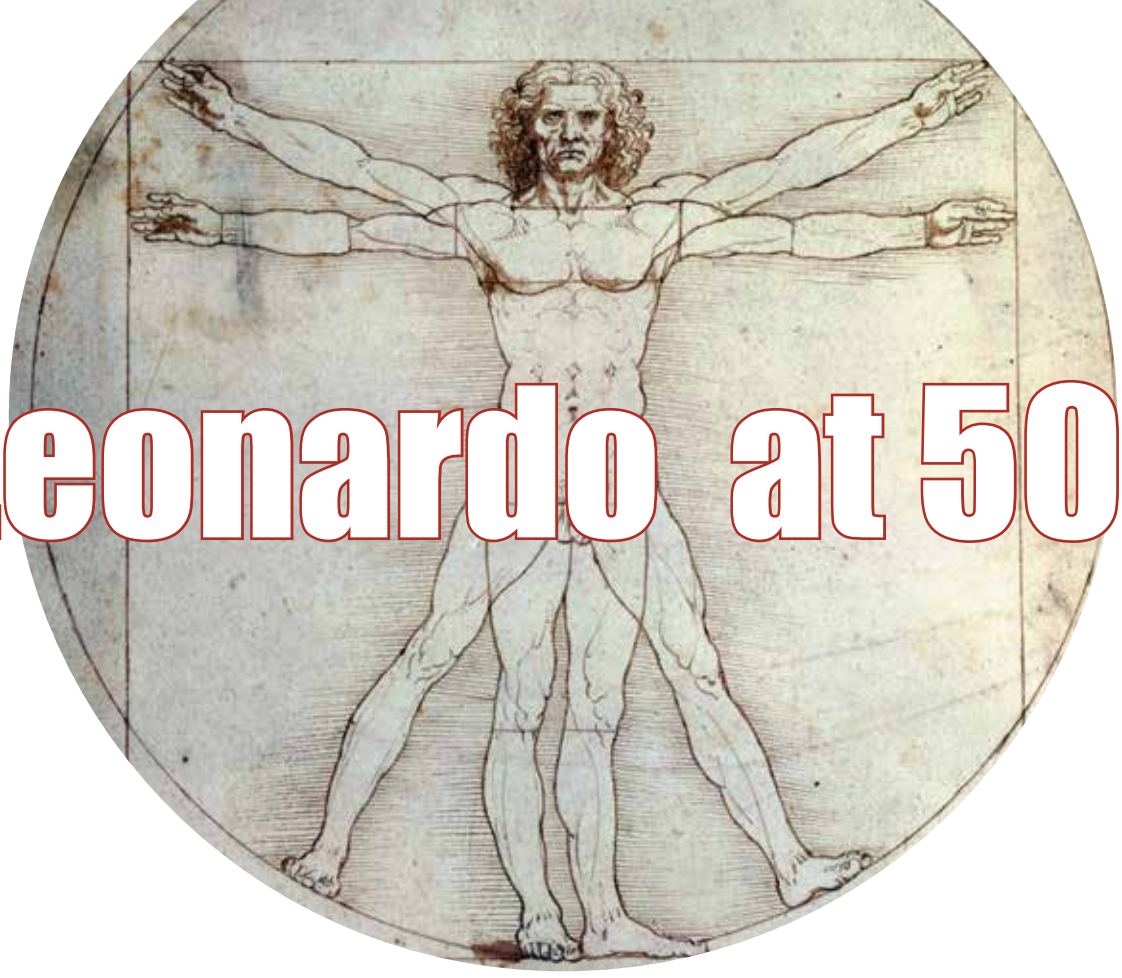

Leonardo at 500

A lesson in creativity

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> The acquisition of any knowledge is always of use to the intellect.[1]
>
> —Leonardo da Vinci

Leonardo da Vinci was exquisitely gifted in both the arts and science, and he practiced them as a "scientist of art and an artist of science."[1] Five hundred years after his death, his anatomical drawings remain testimony to his unique way of engaging the world both artistically and scientifically. From pioneering the injection of molten wax into ventricles, to multiple views of specimens, to the recurrent use of cross-sections and cutouts, his drawings remind us of a brain that always thought in pictures. They also challenge us to understand what made Leonardo so creative. This may be especially worthwhile in times when medical education has been accused of hindering creativity.

Barred by the church from entering the Ospedale di Santo Spirito under accusations of "heresy and cynical dissection of cadavers,"[2] Leonardo quit his studies in 1516, left Italy and retired to France. He would never dissect again. Within a year, he would suffer a disabling stroke, and within three days he died. He was 67 years old.

Five hundred years later, there is still much that medicine can learn from this extraordinary man. His 40-year-long exploration of the "*meravigliosa macchina umana*," the wonderful human machine, provided hundreds of anatomical drawings that are not only breathtakingly beautiful, but also scientifically sound. From the groundbreaking idea of exploded views, to the reliance on guidelines to demonstrate the three-dimensional location of various parts, and the frequent use of strings and wires

to mimic the function and position of muscles, Leonardo consistently mesmerizes us with his unique visual-spatial perception of reality.

As art historian Kenneth Clark said, "It is often said that Leonardo drew so well because he knew about things; it is truer to say that he knew about things because he drew so well."[3] Artist and surgeon Frederick Franck agreed, "What I have not drawn, I have never really seen."[4]

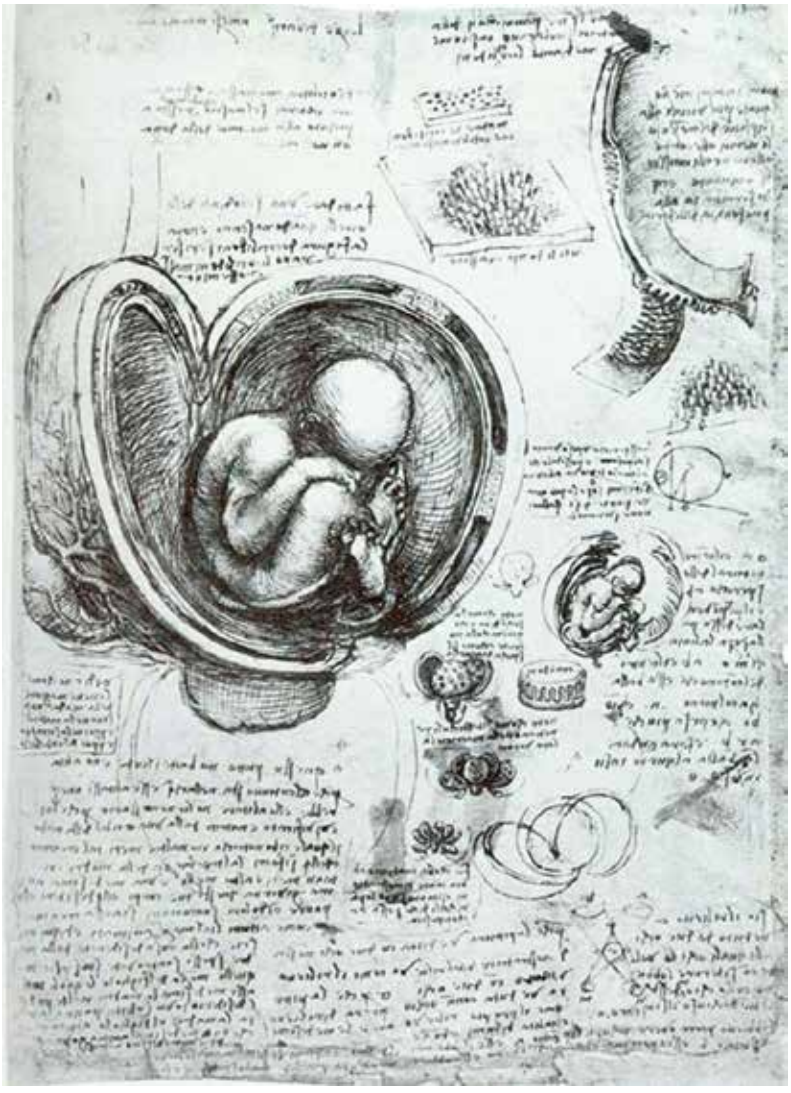
Many physical findings were first described by artists, and many great physicians were artists. Jean-Martin Charcot, who invented neurology,[5] drew and sketched throughout his life to the point that, "Charcot the artist is inseparable from Charcot the physician."[6]

Leonardo's drawings challenge the viewer to understand his mind. What was so special about it? Was he a unique genetic fluke, or was it all in his upbringing? If we could unlock his secrets and nurture those traits in educational practices, we might be able to produce more creative physicians.[7,8,9]

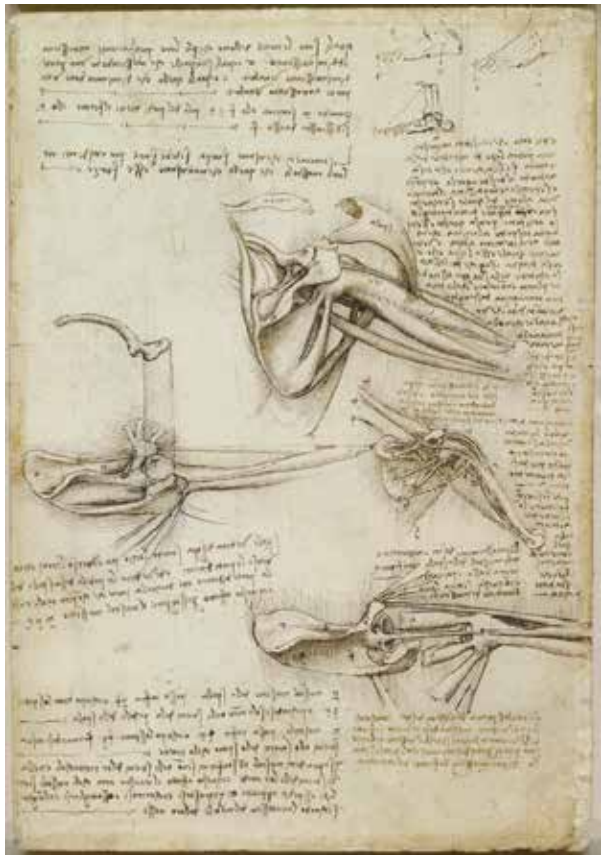
The outsider

From a genetic standpoint, there was nothing in Leonardo's family that predicted genius. The son of a peasant girl and a young notary, Leonardo was born out of wedlock, taken from his mother, and raised as a bastard child. He was discriminated against by his legitimate siblings, and cut out of the paternal inheritance.

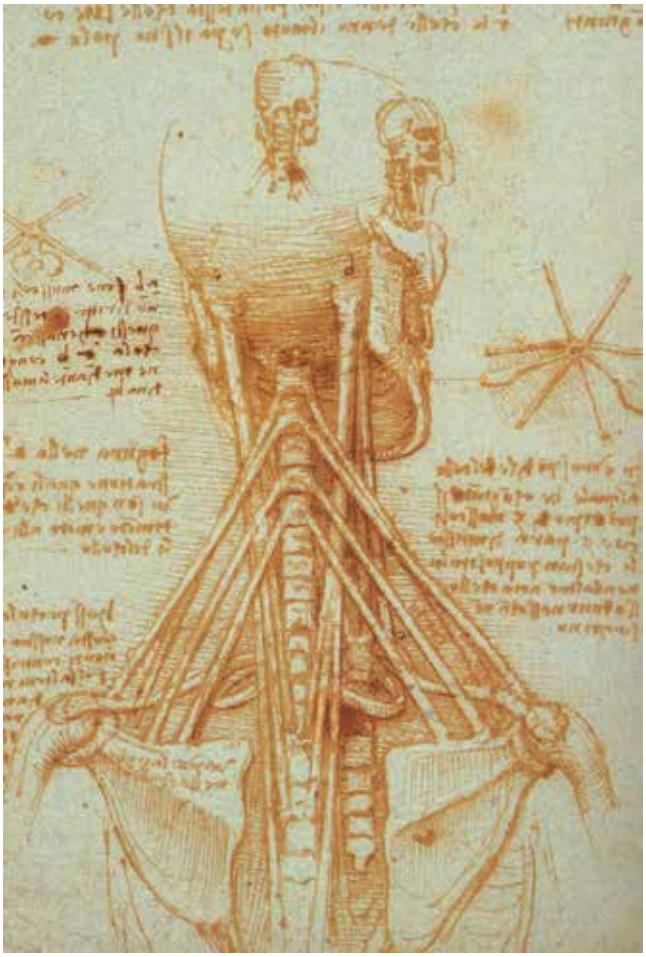
Major adversities are not uncommon in the life of geniuses,[10] yet, for Leonardo they might



Leonardo da Vinci, *The Foetus in the Womb*. Pen and ink over red chalk, circa 1510-1513.
Royal Collection, The Windsor Castle



Leonardo da Vinci, *The Bones and Muscles of the Shoulder.* Pen and ink with wash over black chalk, circa 1510-1511.
Royal Collection, The Windsor Castle



Leonardo da Vinci, *Anatomy of the Neck.* Pen and ink on blue paper, circa 1512-1513.
Royal Collection, The Windsor Castle

have contributed to much more than character—they might have made him an outsider. Leonardo considered it a strength. He wrote, "While you are alone you are entirely your own…if you have one companion you are but half your own,"[1] and "*salvadego è colui che si salva,*"[11] only the loner survives.

He was a bastard in a culture that favored legitimate sons; a left-handed man in a nation that believed that the left is the hand of the devil; a self-educated know-nothing shunned by the intelligentsia for his limited knowledge of Latin and lack of Greek knowledge; a vegetarian in a country of gluttons; and a gay man in a macho culture. Yet, alienation probably increased Leonardo's creativity.

As intuited by Colin Wilson,[12] and recently tested,[13] social rejection may lead to independent-thinking. Or, as the lay press put it, "don't get mad, get creative!"[14] Another creative mind that relished being a "lone traveler"[15] was Albert Einstein, who wrote in *The World as I See It*, "I have never belonged to my country, my home, my friends, or even my immediate family, with my whole heart."[15]

The rebel

Creativity is, by definition, rebellious. The old must be torn down before the new can be created. Creators defy dogma and shift paradigms which requires daring. "Creativity," said Matisse, "takes courage."[13] Leonardo relished going against the grain. When mainstream painters were relying on egg tempera, he had moved to oil. When mainstream medicine was following Galen, he was paying attention to what he actually saw.

He met resistance, and inevitably, he resented it. "I am fully conscious that, not being a literary man, certain presumptuous persons will think that they may reasonably blame me; alleging that I am not a man of letters. Fools!"[1]

William Manchester wrote, "of all the great Renaissance artists, Da Vinci alone was destined to fall from Papal grace…like Copernicus [he] threatened the certitude that knowledge had been forever fixed by God, the rigid mindset that left no role for curiosity or innovation."[16]

Nobel laureate Rita Levi-Montalcini (ΑΩΑ, 1970, Honorary) said, "We need to nurture the courage to rebel."[17] That may be difficult in today's medicine, where algorithms, guidelines, and electronic medical records provide a procrustean bed that seems cunningly designed to curtail both rebellion and independent thinking.[18]

The self-educated

Leonardo had very little formal education. Like Benjamin Franklin and Thomas Edison, he was self-educated, which often translates into an omnivorous curiosity. He was "the most relentlessly curious man in history,"[19] and he saw that as an asset.[1]

Creativity means taking seemingly disconnected pieces of information from fields as far apart as possible and repackaging them into new and better forms.[20] This requires a multifaceted mind, and a broad, self-directed education—not necessarily what is encouraged in today's hyperspecialized and regimented medicine.[21] Nobel laureates in science are often polymaths: 22 times more likely to perform as actors, dancers or magicians; 12 times more likely to write poetry, plays or novels; seven times more likely to dabble in arts and crafts; and twice as likely to play an instrument or compose music.[22,23]

The musician

Leonardo loved music. He played a horsehead-shaped silver lyre, composed songs, built instruments, and sang beautifully. Art historian Giorgio Vasari described him as an excellent musician.[24] One of his portraits may even represent him as musician.[25]

Einstein also loved music because it helped him professionally. As his son, Hans, reported, "Whenever he felt that he had come to the end of the road or into a difficult situation in his work he would take refuge in music, and that would usually resolve all his difficulties."[26] His sister, Maja, said that after playing the piano he would often get up saying, "There, now I've got it!"[27] And, Einstein told the great pioneer of musical education Shinichi Suzuki, "The theory of relativity occurred to me by intuition, and music is the driving force behind this intuition."[28]

Playing a musical instrument prompts a reorganization of the brain,[29] which, in turn, might help creativity. For instance, the corpus callosum of musicians is larger and more complex, thus allowing for greater inter-hemispheric exchange.[30] Einstein's brain sported a larger and richer corpus callosum.[31]

Well-known musician-physicians have included Theodor Billroth, Alexander Borodin, and Albert Schweitzer.

German schools used to encourage medical students to play a musical instrument, and lamented music's demise.[32] Should that encouragement be reinstated? Would it spark creativity?

Leonardo da Vinci, *Portrait of Unknown Musician.* Oil on wood panel, circa 1490.

The visual thinker

Leonardo was a visual thinker, a trait that has been linked to innovation.[33] Visualization was also key for Einstein, who relied on "thought experiments:" ideas that twirled around his head rather than in a lab. The centerpiece of these *Gedankenexperimente* was visual imagination—daydreaming.[34]

Rote memorization is anathema to this way of thinking, and Einstein hated it. He wrote about his experience in German schools, "One had to cram all this stuff into one's mind for the examinations, whether one liked it or not. This coercion had such a deterring effect [on me] that, after I had passed the final examination I found the consideration of any scientific problems distasteful to me for an entire year."[35] It was visualization of the unseen that allowed him to unlock the secrets of relativity: he imagined himself as a light beam. He said, "Imagination is more important than knowledge."[34]

Leonardo was also convinced of the superiority of the visual. Next to a magnificent picture of the heart, he wrote, "Writer, what kinds of words will you fetch to awkwardly describe what drawing can instead perfectly represent? Don't bother with words unless you are speaking to the blind…you will always be overruled by the painter."[36]

Seeing with a better eye is crucial in medicine. "The whole art of medicine," remarked Sir William Osler, "is in observation."[37] He added, there is "no more difficult art to acquire than the art of observation."[38] This is becoming ever more difficult when physicians spend 12 percent of their time observing patients, and 40 percent observing computers.[18]

The comedian

"Laughter is good for thinking," said the Dalai Lama, "because when people laugh it is easier for them to admit new ideas into their minds."[39] Creativity is a playful way of engaging the world, one that is more right-brained and less linear, more visual and less verbal, and a fresh shortcut to new associations and ideas.

In a brainstorming study of professional designers and improvisational comedians, the comedians generated 20 percent more ideas, and were rated 25 percent more creative.[40] Like wisdom, humor thrives on paradox, and Leonardo loved humor, especially paradoxes, puns, and pranks.[24] He created 171 rebus puzzles;[41] devoted an entire section of his notebooks to jokes and pleasantries, *facezie;*[42] and crafted tongue-in-cheek essays that could bring down the house in today's stand-up comedy (his ruminations on the penis as a "creature with a mind of its own" serves as good example.)[43] One of his responsibilities in Milan was to entertain the court.

Leonardo also had a fascination with the grotesque, which eventually led him to pioneer caricatures. As Vasari reports, "Leonardo was so delighted when he saw curious heads, whether bearded or hairy, that he would follow anyone who had thus attracted his attention for a whole day, acquiring such a clear idea of him that when he went home he would draw the head as well as if the man had been present."[24] Once again, it was his penchant for paradox: the pursuit of the beautiful through the ugly.[44,45]

Humor is creative since it takes seemingly extraneous material and forges it into a new reality, thus providing a new way to see the world. Sudden bursts of laughter imply recognition. Hence, humor can prompt creative solutions by making it easier to think more broadly and by fostering new associations and relationships.[46] Humor can also serve as a balm against hardship. Osler, whose sense of humor famously delighted patients, was known to quip that he whistled so that he might not weep.[47] Thus, as a tool for catharsis and wisdom, humor is a fundamental component of the physician's skillset.[48,49] It may even be a sort of cure-it-all elixir. There is an entire body of literature supporting its role as promoter of well-being and even healing.[50] Many Hippocratic Greek centers mandated patients to watch comedies as part of their therapeutic regimen, and Norman Cousins wrote a book on his own healing via humor.[51]

Adults seem to lose their capacity for mirth,[52] and in medicine, humor may actually be discouraged.[53] As the five-year-old said to her family doctor, "You're too funny to be a doctor."[49] This is unfortunate since it may impact not only on physicians' well-being, but also on their creativity.

The idler

Leonardo writes, "men of lofty genius when they are doing the least work are most active."[54] Agatha Christie agreed, "Invention, in my opinion, arises directly from idleness."[55] And, Virginia Woolf put it well, "It is in our idleness, in our dreams, that the submerged truth sometimes comes to the top."[56] Insights may appear in dreams like Mendeleev's table, Kekulé's benzene ring, and Coleridge's poem of Kubla Khan.[10] They appear like accidental flashes, but are not. As Leonardo put it, the creative mind is always subliminally churning before an idea finally sparks. It just takes time. To paraphrase Nathaniel Hawthorne, creativity is a butterfly, which "when pursued, is always just beyond your grasp, but which, if you will sit down quietly, may alight upon you."[55]

Easy to say in times when physicians are always pressed for time, and relative value units determine how they get compensated.

The nuancer

A follower of no dogmas, even spiritual, Leonardo was comfortable in a nuanced world. From pioneering his hallmark *sfumato* in landscapes he typically portrayed at twilight, to his distaste for sharp lines and stark black-and-white contrasts, he loved the ambiguous. He was fascinated by androgyny, almost as if he believed the soul to be both male and female. The two paintings he had at his bedside when he died were the androgynous figures of a woman and a man—both sporting perplexing smiles, and both challenging the viewer to accept the gray. And, his preparatory drawing for the Saint John portrayed him as a hermaphrodite.[57]

Tolerance for the nuanced might have been important for Leonardo's creativity. Individuals who are comfortable with ambiguity are typically more receptive to new ideas, can look at concepts from different perspectives, and often cope better with difficult situations.[58,59]

Tolerance for ambiguity is a desirable trait in physicians, since it translates to an open mind, greater empathy, less authoritarianism, and conservation of resources.[60,61,62] Yet, many physicians experience anxiety when confronted with the inevitable uncertainties of daily practice.[63] Since intolerance for ambiguity may worsen as a result of training, it has been suggested to screen for it, and then protect against it, in medical school.[64] There may be an additional benefit from nurturing the nuanced: it might help creativity.

Leonardo da Vinci, *Mona Lisa.* Oil on poplar wood, circa 1503–1506.

The dyslexic/adhd'er

Leonardo's peculiar orthography along with his unique right-to-left mirror writing have prompted scholars to suggest he was dyslexic.[65,66] Others have theorized that this was his way to protect his thoughts, or simply the ruse of a left-handed man trying to prevent ink-smearing.

Mirror writing has been reported in dyslexia,[67] and dyslexics are typically intelligent, creative visual thinkers.[68,69,70] Several are artists,[71] although one wonders how many dyslexics would do well on the Medical College Admission Test.

If not dyslexic, Leonardo might have had attention deficit hyperactivity disorder. His restlessness was legendary, forcing him to move through many cities and many pursuits, and he had problems with deadlines. Vasari states, "he began many things, but never finished one of them."[24] Part of the reason was possibly the breadth of his interests, which caused him to always carry more than one project at a time. Another might have been his need for "incubating," since some degree of delay can foster creativity.[72] As screenwriter Aaron Sorkin put it, "You call it procrastination, I call it thinking."[73]

Art and science can coexist

In the end, the most important lesson Leonardo teaches is that art and science can coexist: scientific creativity is not any different from artistic creativity.[74] Leonardo would have laughed at the idea of an art/science split since he considered himself a humanist who happened to be both an artist and a scientist. Curiously, what mostly impressed the people who met Leonardo was his wisdom. He was invited by the King to visit France for the pleasure of his conversation and philosophy.[75]

Rekindling philosophy and other humanities, a growing movement in medical schools, might help to return some wisdom to medicine.[76] A recent survey of five medical schools found that interest in the humanities is strongly associated with wisdom.[77]

If medical schools aspire to develop new Leonardos, they should admit more artists, musicians, dyslexics, and visual thinkers; nurture a sense of rebellion and distrust for authority; encourage visualization over rote memorization; avoid medicating restless and day-dreaming students; stop relying on single answer black-and-white multiple-choice tests; encourage breadth rather than depth of knowledge; foster humor and the humanities; and allow for downtime.

In the meantime, we can derive great pleasure from reacquainting ourselves with Leonardo da Vinci. He makes us proud of belonging to the same animal species. Yet, Leonardo might not have returned the compliment, since he was known to quip that most human beings are only "transit for food and fillers of toilets".[78]

Leonardo da Vinci, *St. John the Baptist.* Oil on walnut wood, circa 1513–1516. Royal Collection, The Windsor Castle

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Endnote

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