Abstract: This paper addresses the timely issue of human specificity in a multidisciplinary perspective. It starts with a brief description of the relationships between science and theology during the last few decades, and notes how the situation has been changing since the beginning of the 21st century. We then suggest how recent scientific developments open up fresh and concrete approaches to human specificity in science and theology, especially when the real import of human cultural complexion is taken into account. In a following section, two fundamental topics are addressed - neural learning and gene-culture co-evolution. We will then discuss the importance of these topics for human uniqueness and culture (as well as their potential limits in supporting the specificity of the human being). Furthermore, we will propose a novel approach, based on the notion of cultural neural reuse (i.e., cultural processes affecting brain anatomy). This approach acknowledges an irreducible role of cultural dynamics in human overall constitution. Cultural neural reuse suggests that one way in which humans are unique is that they are able to shape and transcend themselves. Finally, the implications of this approach will be drawn for theological topics such as the *imago Dei* doctrine, the notion of self-transcendence, and the integral view of the human being emerging from Biblical and early Christian anthropology.

Keywords: cultural neural reuse, gene-culture co-evolution, human specificity, *imago Dei*, neural learning, self-transcendence.

Introduction

The theological reception of recent developments in science has created concern affecting the Christian faith. Nevertheless, a deeper engagement between science and theology could overcome such a ‘suspicious attitude’ in view of a more collaborative stance. Nowadays, theologians discover how science, rightly interpreted, can help nourish mature faith in secular contexts. In our opinion, this might be the most serious and fruitful challenge for the 21st-century cognitive enterprise of humanity.

Science may offer multiple opportunities for strengthening the credibility of theological doctrines beyond the vagaries of time and cultural changes. This has already occurred in the past with the reception of Aristotelian ideas by medieval Christian thinkers. That was a critical moment in which a new worldview emerged from the contact with Muslim and Jewish medieval masters, who helped reframe many Christian doctrines. Nowadays, the dialogue between science and theology still needs to become a diffused and sustained interaction, capable of assuming scientific achievements as inputs that will distil and justify traditionally held viewpoints of Christianity as well as other religions.

Science is becoming increasingly diverse in its methods and research paths. At the beginning of the 20th century, science appeared as a quite unified field in which the findings acknowledged as true would have offered a unique view, complete and exhaustive. The steadily maintained conviction was that science would have soon
grasped the “unique representation” of how things are, the “right way” to understand reality. However, things soon changed, e.g., with the development of quantum mechanics in the domain of physics. Something similar is happening in the field of biological sciences, in neurosciences, and other scientific fields: pluralism seems to be the ‘state of the art’ and not just a transitory stage soon to be overcome. Furthermore, reductive evolutionary theories that integrate different kinds of organismal teleology have been developed. For example, in the field of neuroscience, the attempts at eliminating the conscious dimension are now counterbalanced by the acknowledgment of top-down forms of causation and the effective role of conscious, reflective processes. In the recently emerged “cognitive science of religion,” theories intended to debunk religious faith are now challenged by alternative views for understanding religion as a symbolic system of meaning.

Such a novel trend calls for a different research program in the area of science and theology for the 21st century. Theology should attentively scrutinize scientific developments to help reformulate and update traditional views. This paper assumes such a stance. Our aim is to show how recent progress in the scientific anthropological research provides valuable insights needed to maintain a core claim of Christian anthropology: the idea that humans have been created in the image of God, and that they bear a defining specificity and a “unique” character. After a succinct overview of recent proposals about the quest for human uniqueness, this work will focus on a potentially new idea: the possibility that genuinely cultural dynamics may affect human brain anatomy and functionality even without passing through strictly biological evolutionary processes and in ways not entirely reducible to (local) neural learning. This idea might be summarized under the label of ‘cultural neural reuse’. Cultural neural reuse is regarded as another item in the list of features possibly grounding human uniqueness in the interdisciplinary perspective. Finally, we will hint at some of the detailed theological consequences of such a notion, thus also prompting a new way to integrate theological and scientific anthropology.

A More Complex View of Human Beings: Nature and Culture

Human specificity has been a central motive in several theological essays during the last decade. The 2006 book by Wentzel van Huyssteen, Alone in the World? Human Uniqueness in Science and Theology can be regarded as one of the first attempts to deal systematically with such an issue in the contemporary context, and to reflect on the relevance of recent scientific anthropological research on the theological understanding of humanity. In this book, topics in current paleoanthropology are closely analyzed in search for arguments that could make the case for human specificity. Van Huyssteen’s point was to demonstrate that the divine roots of human uniqueness would be better grasped through a deep engagement with scientific anthropology. “Cognitive fluidity” appears as one specific trait potentially capable of explaining the emergence of the human conscious and reflective mind. This capacity paves the way for symbolic representation and language, and sustains higher forms of consciousness and self-transcendence. Interestingly, the author manages to provide new content and offer new insights into the traditional doctrine of imago Dei, thus reinforcing the anthropological implications of Christian faith.

After the landmark essay of van Huyssteen a broad panorama has opened for a fruitful contact between Christian and scientific anthropologies. These developments questioned the general direction in which so many publications have pointed since the seventies: the assimilation of human beings to strict bio-evolutionary programs, the understanding of the mind in terms of mere computational models, and the systematic elimination of what could be deemed human ‘superior conscious features’. The reaction against this trend has prompted a better assessment of the true nature of human beings and its complexity.

Interestingly, novel approaches to human uniqueness come for several scientific research areas and topics, which are worth mentioning here briefly:

- Cognitive studies on the characters of the human mind and those specific human processes that can hardly be traced back to algorithmic, computational performance, for example, the entrenchment of emotion and cognition in human perceiving and thinking.

1 See Oviedo and Colagè, “Human specificity and recent science” for a review of recent books on the matter.
- Studies on “dual forms of cognition” emphasizing the mind as employing a double strategy characterized by both a fast, intuitive component and a slow, reflective or conscious one. The relevance of the reflective component for decision-making in structured social contexts debunks strict reductive views.
- Studies on intentionality, enduring self-identity, morality and aesthetics show that these aspects cannot be neglected without facing deeper problems in explaining an array of human behaviours, attitudes, and convictions.
- Studies on symbolic capacities, language, generation of beliefs, and religious sensibility, regarded as human-specific emergent properties closely connected to cultural aggregation and mutual relatedness.
- Altruism and prosocial behaviour have been unveiled as something embedded in a truly cultural milieu and not entirely explainable in terms of sheer biological traits.
- Studies on culture and its key role in the overall human constitution. Humanity appears as the more ‘culture-driven’ species, and the interaction between genes and culture seems to be a fundamental factor in human evolution.
- Neurological studies inquiring into the neural underpinnings of all the above mentioned traits. Insights into human distinctiveness coming from this level of inquiry might turn out to be the more convincing to the scientists’ mind.

It will be worth pointing out some of the most recent and authoritative studies explicitly addressing the issue of human uniqueness in relation to the topics just sketched.

The book of the leading neuroscientist Michael S. Gazzaniga – Human: The Science Behind What Makes Us Unique – explores evolutionary and neurological clues of human distinctiveness and focuses on the relevance of sociality for language, art, and consciousness. The collective book edited by Rösska-Hardy and Neumann-Held – Learning from Animals? Examining the Nature of Human Uniqueness – lends several insights into human uniqueness drawn from comparative studies. Andrey Vyshedskiy’s On The Origin of the Human Mind describes the traits that would better characterize human uniqueness integrating evolutionary and comparative studies. V. S. Ramachandran offers a new attempt at explaining human properties in The Tell-Tale Brain: A Neuroscientist’s Quest for What Makes Us Human. This book addresses interesting neurological case studies to learn more about consciousness, language and creativity. Philip Lieberman’s The Unpredictable Species: What Makes Humans Unique is another insightful essay where evolutionary biology and neuroscience keep central stage. The core idea is that humans are unique because of the “supercharged” cortex-to-basal-ganglia circuitries that enhance executive control, cognitive flexibility, and creativity, thus making humanity capable of shaping its own destiny.

Both Neil Cummins’ Is the Human Species Special? and Peter Price’s Human Specialness stress aspects of human peculiarity focusing on the historical dimension. Daniel Cloud has published The Domestication of Language: Cultural Evolution and the Uniqueness of the Human Animal, according to which the unique feature would be the special way in which human beings steer language through a sort of historical ‘artificial selection’ of words and meanings. Dereck Bickerton’s More than Nature Needs emphasizes how thinking and language grow together allowing for new broader ways of communication and how human language is the result of a dual process of biological evolution and cultural development. Perhaps even more to the point is the book by Thomas Suddendorf’s The Gap: The Science of What Separates Us from Other Animals, the gap being our open-ended ability to imagine and reflect on possible scenarios and our insatiable drive to link our minds together.

An interesting recent development about the issue of human uniqueness focuses on processes of ‘emergence’ and gives rise to less reductive and more-than-physicalist understandings of the human being. Philip Clayton’s Mind and Emergence can be considered a reference-point in this research line. The recent book by Terrence Deacon, Incomplete Nature, puts even more flesh into the emergence approach to human uniqueness, also offering a concrete view about the mechanisms through which emergence could work. The author attempts to develop a model capable of accounting for – without eliminating – human features, such as consciousness, intentionality and purpose.
All this leads one to perceive the anthropological field as proceeding beyond some of the strictures it has suffered in recent decades. On this background, new research in neuroscience suggesting a greater integration of the cultural dimension in human biological constitution may be conveniently framed. We will see how these advancements add up fresh implications for traditional Christian belief about the human being.

**Culture Between Neural Learning and Evolution**

In this section, we focus on two issues that show both some human peculiarities at a rather fundamental level and interesting connections with the human cultural complexion: neural learning and gene-culture co-evolution. This will also provide the background against which a further alternative may be assessed.

*Neural learning* (and related brain plasticity). Human individuals learn many things from the time of birth; what they learn spans, for example, from learning to walk and holding a fork for eating to playing the piano, typing on a laptop, or sewing a garment, from speaking a mother-tongue to arithmetic or a second language, from social norms to physics or philosophy. When individuals acquire skills of any kind, what happens in the brain is the refinement of synaptic connections. During the early stages of brain development, a large number of neurons and synaptic connections are produced; each neuron becomes connected with a huge array of other neurons throughout the whole cortex (and beyond). As life goes on, experiences accumulate, and more and more skills are acquired and honed, a significant number of the synaptic connections produced earlier are eliminated (about 50% of connections are pruned back in the human brain throughout life), and a relevant part of the neurons die. At the same time, the surviving neurons strengthen connections with only some of the other neurons with which were originally connected, withdrawing other ones. It is important to note that the synapses that are preserved and strengthened are those that are more often and intensely activated by the stimuli, experiences, and activities constituting the individual’s concrete life in its natural and social environment. This is what has been referred to as learning by synaptic selection and strengthening, and represents a model of neural learning rooted in the so-called ‘Hebbian rule’, stating that neurons that fire together (i.e., that are activated concomitantly during some process), wire together (i.e., strengthen their synaptic connections). The human brain has peculiarities from this point of view: the potential for neural learning in humans is exalted with respect to any other species. Human newborns, indeed, are extremely neotenic. This means that, at birth, human infants are underdeveloped with respect to any other living being: they are absolutely incapable to survive without deep and long-lasting parental and social care. Neoteny mainly concerns the brain, and seems specifically high at the synaptic level. The fragility of neotenic newborns poses serious problems for the survival of new generations, and thus of the species. Therefore, for this trait to be conserved (and even augmented along primate and hominid evolution), it has to offer advantages that at least compensate for its costs. These advantages essentially consist in the fact that neotenic newborns undergo a significant part of their neural development being already immersed in a highly social, cultural, and linguistic environment. This ensures that the array of skills and fine details that have to be learned for an individual to become an active and reliable part of its (social, cultural, and linguistic) group can indeed be learned by the new generations. Neoteny and the protraction of a high plasticity at the synaptic level all along human lifespan are, therefore, fundamental elements allowing for the instantiation of highly elaborated social, cultural and linguistic dimensions that would be prevented otherwise and that have conferred significant advantages in facing survival challenges and in evolution. (To be clear, these are likely necessary factors for culture and language to develop, but we are not claiming that they are sufficient as well.) Thus, evolution has endowed our species with some developmental, anatomical, and physiological characters that make culture, language and exalted sociality possible; the actual implementation, invention, and fostering of

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2 Changeux, *The Physiology of Truth*, 184-210; Changeux, “Synaptic Epigenesis”.
3 Hebb, *The Organization of Behaviour*.
4 Petanjek et al., “Extraordinary neoteny”.
5 Manzi, *Il grande raccont dell’evoluzione umana*; Colagè, “Sociality, brain, evolution and culture”.

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social, cultural, and linguistic practices influence the brain’s fine structural details virtually all along the lifespan of human beings.

*Gene-culture co-evolution.* This approach—developed since the late seventies of the 20th century⁶—states that information transmitted through genetic means interacts with culturally transmitted information⁷. In other words, culturally implemented strategies are able to affect genetic evolution as they impose specific selective pressures on the traits (i.e., allele frequencies) transmitted from generation to generation. The best investigated case is that of adult lactose tolerance⁸ (i.e., the possibility to digest milk also in adulthood). This characteristic is frequently found in northern European populations and in peoples of Africa and Middle East. It depends on genetic variations near the lactase gene (which allow for the possibility to express this gene also in adulthood, thus, increasing the incidence of adult lactose tolerance). However, it is virtually absent in human populations living in different geographical areas. The crucial point is that the populations displaying high frequency of the genetic variation responsible for adult lactose tolerance are those with a history of farming and dairying, and thus of adult milk drinking. The idea, therefore, is that a culturally implemented and transmitted habit (dairying and drinking milk) influenced the frequency of specific genetic variation responsible for adult lactose tolerance in populations possessing that habit. There are other examples of such a process that deal with micro-evolutionary modifications occurring within our species *Homo sapiens*.

Now, what do the cases of exalted learning capability and gene-culture co-evolution tell us about human uniqueness? We think that both cases tell us something interesting to the extent to which they are connected with the issue of human culture. Some of the proponents of the approach in terms of gene-culture co-evolution, claim that this may be the dominant mode of human evolution.⁹ This approach suggests that culture indeed shapes human genetic constitution, so that the human being is capable of influencing its own evolutionary trajectories through invention and transmission of novel cultural strategies. Neoteny, and the related outstanding and enduring capacity for neural learning, is indispensable for true culture to be preserved and improved over time and across groups, populations, or even humanity as a whole. Indeed, if children were unable to undergo those forms of imitative learning that have been labeled ‘cultural learning,’¹⁰ human culture, along with its cumulative and innovative power, would likely be impossible.

Therefore, both gene-culture co-evolution and the exalted capacity for learning point to rather fundamental human-specific characters, without which human life, as we know it, would be very hard to conceive. These are fundamental characters upon which several other peculiarities distinguishing humans from other species are built, preserved and spread, as well as potentiated, improved and refined. However, as far as the quest for human uniqueness is concerned in the multidisciplinary context, both gene-culture co-evolution and the exalted capacity for neural learning may face a subtle objection. Such an objection would claim that these seemingly peculiar characters of the human being are not, after all, so peculiar.

Neural learning is something which has characterized and endowed the central nervous system of the species with such a system. Mechanisms of synaptic selection and strengthening following sensory, motor, and even social experience are widespread in the animal kingdom.¹¹ Moreover, the so-called late phase of the long-term potentiation (a process by which both implicit and explicit memories are consolidated and steadily stored in neural connections) likely implies the production of structural changes at the synaptic connections among the involved neurons. These structural changes have been proposed to happen in several, very distant species: from sea molluscs like *Aplysia*, to insects such as the fruit fly *Drosophila* and mammals such as the mouse.¹²

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⁶ E.g. Feldman and Cavalli-Sforza, “Cultural and biological evolutionary processes”.
⁷ Laland *et al.*, “How culture shaped the human genome”.
⁸ Swallow, “Genetics of lactase persistence”; Itan *et al.*, “The origin of lactase persistence”.
⁹ Richardson and Boyd, *Not by Genes Alone*; Laland, “Exploring gene-culture interactions”.
¹² Ibid., 1247-79.
Gene-culture co-evolution resorts to ‘classical’ mechanisms of population genetics and, under several respects, can be regarded as a case of niche construction. Niche-construction theory\textsuperscript{13} is a recent development in evolutionary biology focusing on the actions that the organisms of a certain species exert on their environment, thus modifying the latter in order to modify, at the same time, the selective pressures that the environment exerts on the organisms’ population and progeny (as well as on organisms of other species inhabiting that environment). In this way, any organism plays an active and not-negligible role in the evolution of its own population. Niche construction involves virtually every existing life form: from bacteria and plants, to algae, reptiles, birds and mammals. Any organism causes changes in its environment, and such changes influence evolution. From this viewpoint, in spite of the peculiarities introduced by the cultural dimension, gene-culture co-evolution may be understood as “just” one from of niche construction, as its effects depend on evolutionary mechanisms common to population genetics and niche construction.

To be clear, we feel that both the exalted neural learning and gene-culture co-evolution lend significant support to the complex issue of human uniqueness, and that this support mainly comes from the relevance that they have for the human \textit{cultural} dimension. For this reason, we would like to propose, in the next section, a further argument in favour of the idea that human specificity is indeed to be found in culture and its neural underpinnings. Our argument might also contribute to further strengthening the relevance of what we have seen so far.

\section*{Cultural Neural Reuse: Culture Beyond Learning and Evolution}

In this section, we will focus on some recent findings in cognitive neuroscience regarding the neural basis of reading. We will see how this research is promising as far as human uniqueness is concerned both at the scientific and at the more interdisciplinary level\textsuperscript{14}.

In 2000, S. Dehaene, L. Cohen and colleagues isolated a brain region in the left fusiform gyrus, approximately at the lateral occipito-temporal sulcus, that is responsible for the first stages of processing visual orthographic stimuli. They named it the Visual Word Form Area (VWFA).\textsuperscript{15} The VWFA responds specifically to written language in literate individuals\textsuperscript{16}, and its proper functioning is indispensable for an individual to be able to read (i.e., to process and decode orthographic stimuli).\textsuperscript{17} Therefore, the specification of the VWFA as an area dedicated to orthographic stimuli seems to be a necessary (although not sufficient) condition for the ability to read. We will argue that the specification of the VWFA in the human brain allows individuals to learn to read. However, this cannot be considered a direct outcome of strictly biological evolutionary processes (and thus cannot be traced back to gene-culture co-evolution). Moreover, it might be not entirely reduced to local neural (Hebbian) learning mechanisms.\textsuperscript{18}

Written language was invented approximately 6,000 years ago, and literacy was not common in human populations until a few centuries ago. Moreover, the VWFA specifies itself as an area for reading independently of the age at which one learns to read, thus demonstrating the absence of any developmental critical periods. Finally, in individuals that do not learn to read at all (or that have not yet learned to read), this brain region subserves other functions such as the processing of high-resolution, sharp-edged shapes or face recognition (i.e., functions for which it is possible to acknowledge selective pressures along the evolutionary history of primates which eventually brought to our own species). Taken together, these points suggest that the specification of the VWFA cannot be regarded as the direct outcome of biological evolutionary processes. In other words, it cannot be the direct consequence of \textit{changes} in the genetic-epigenetic program responsible for species-specific traits.

\textsuperscript{13} Odling-Smee \textit{et al.}, \textit{Niche Constriction}; Laland \textit{et al.}, “Evolutionary consequences of niche construction”.
\textsuperscript{14} Colagè, “Prospective Fruitfulness”.
\textsuperscript{15} Cohen \textit{et al.}, “The visual word form area”; Dehaene \textit{et al.}, “The visual word form area”; Dehaene and Cohen “Cultural recycling of cortical maps”.
\textsuperscript{16} Vinckier \textit{et al.}, “Hierarchical coding of letter strings”.
\textsuperscript{17} Cohen \textit{et al.}, “The visual word form area”.
\textsuperscript{18} See also Colagè, “Human specificity”.
Does the specification of the VWFA represent nothing more than local neural learning (of the same kind, e.g., as when we learn to recognize edible mushrooms or to cook them appropriately)? Clearly, since this kind of mechanisms are involved in our learning to read, the brain region coming to host the VWFA in literate subjects must be refined and fine tuned locally. There is evidence, however, possibly suggesting that something more occurs when humans learn to read. In particular, recent findings may make the case for the specification of the VWFA implying structural changes beyond the local level of synaptic strengthening, specifically at the level of inter-regional white-matter anatomical connectivity (which does not seem to be something usually occurring with neural learning).

In the first place, two cytoarchitectonic areas have recently been identified in the human posterior fusiform gyrus and labelled FG1 and FG2. The anatomical location of area FG2 has been acknowledged to correspond largely to the so-called fusiform face area (FFA) and to overlap significantly with the VWFA. The interesting fact is that left and right FG2 have a different pattern of co-activation with other brain areas. Specifically, left FG2 displayed a stronger co-activation with other language areas in the left hemisphere (inferior frontal, pre-motor and middle temporal areas), whereas right FG2 displayed a more pronounced co-activation with the left amygdala, thus suggesting its involvement in processing emotional face expression crucial for social interactions. This implies that the cytoarchitectonically-defined area FG2 shows a hemispheric-specific involvement in two different functions: emotional face processing in the right hemisphere (so that right FG2 would constitute the functional area FFA) and orthographic recognition and reading at left (so that left FG2 would coincide with VWFA). Co-activation is not a direct evidence for anatomical connectivity. However, the difference in the patterns of co-activation of left and right FG2, together with the fact that face recognition is much older than reading as a cognitive function (so that face recognition has likely driven the evolution of FG2 cytoarchitecture), is consistent with the idea that learning to read requires modifications at the level of long-range anatomical connectivity (and not only at the local level of neural learning).

Secondly, another recent study has revealed a significant correlation between the degree of proficiency in reading and an increase in the fractional anisotropy of the posterior, tempo-parietal portion of the left arcuate fasciculus (i.e., the white-matter fibre-tract anatomically connecting temporal and inferior parietal areas). As fractional anisotropy is an index of anatomical connectivity, these results suggest that learning to read implies a strengthening of the anatomical connectivity of ventral occipito-temporal areas (where the VWFA is located) with temporal, parietal and frontal language areas through the whole superior longitudinal fasciculus. It is furthermore important to stress that the increase in fractional anisotropy has been revealed not only in individuals that have learned to read at school age, but also in individuals acquiring this ability late in adulthood. In addition, these results are in line with the idea that the specification of the VWFA as an area for reading involves changes at the level of white matter connectivity.

Furthermore, it should be kept in mind that written language is always the visual/graphical instantiation of an existing spoken-language. In other words, a written language cannot exist without a relation with a spoken language. Therefore, it is not surprising that for the VWFA to become an area for reading it must “work together” with other spoken language areas. Indeed, it has been shown that within the VWFA, slightly distinct sub-regions may be identified with preferential connections to areas involved in grapheme-phoneme conversion and lexical access, respectively.

Finally, it is worth mentioning that the possibility of developing new axonal connectivity following acquisition of skills has been shown in the adult macaque brain. Specifically, the production of new intra-cortical axonal projections in the intra-parietal sulcus has been reported in adult monkeys exposed to 15-day intensive training in tool-use. Moreover, the production of these new axonal projections occurs in the same

19 Caspers et al., “Cytoarchitectonic analysis”.
20 Caspers et al., “Functional characterization and differential coactivation”.
21 Thiebaut de Schotten et al., “Atlasing location”, see also Thiebaut de Schotten et al., “Learning to read”.
22 See also Boughali et al., “Anatomical connections”.
23 Thiebaut de Schotten et al., “Atlasing location”.
24 Boughali et al., “Anatomical connections”.
25 Hihara et al., “Extension of corticocortical afferents”.
brain region where previous studies have shown increased expression of brain-derived neurotrophic factors (BDNF) – i.e., signalling molecules associated with many processes of neural growth – during the training period.\textsuperscript{26} This suggests that the acquisition of new, complex skills might require the production of new axonal branches. We suggest that something similar may be involved in learning to read. It should also be noted that the hypothesis according to which learning to read implies production of new anatomical connectivity would bear specificity even with respect to the just mentioned surprising findings in the monkey. Indeed, (1) learning to read would imply production of inter-regional changes in connectivity at the white-matter level (and not “just” intra-cortical modifications that do not involve white-matter), and (2) the acquired skill (i.e., reading) would be induced by conspecifics (e.g., school teachers) and not imposed by experimenters on members of a different species. Note that tool use is not something that macaques usually display in the wild.

Therefore, the specification of the VWFA in the human brain should not be considered as a direct consequence of truly biological evolutionary processes and, thus, not even as a result of gene-culture co-evolution as far as genetic variation and changes in allele frequencies seem unlikely to be involved. It might just require something more than ‘mere’ local neural learning. Such a situation could be labelled as an instance of \textit{cultural neural reuse}.\textsuperscript{27} This label is intended to stress some relevant points. First of all, it characterizes the related specification of the VWFA and the acquisition of reading competence as an instance of neural reuse. \textit{Neural reuse}\textsuperscript{28} conveys the general idea that to implement a novel cognitive function the production of new, specifically dedicated neural tissue is not needed as far as existing neural circuitry may be reused and put at the service of the novel function as well. Secondly, \textit{cultural} neural reuse emphasizes both that the reuse of neural tissue is induced by genuinely cultural dynamics, and that it is not a direct outcome of strictly biological evolutionary processes. Therefore, cultural neural reuse implies that genuinely cultural dynamics are able to affect brain anatomy at a level beyond that of local neural learning and without “passing through” truly biological evolutionary processes.

All this may actually provide a further element for human uniqueness and suggest that a human being has the peculiar capability of “shaping and transcending itself.” Indeed, the case of written language suggests how the human being has the power to \textit{transcend} itself, i.e., to implement radically new cultural strategies (such as written language) able to disclose and actualize hidden potentialities: it would be enough to think how present societies and life-styles would simply be inconceivable without written language. Moreover, the specification of the VWFA, understood in terms of cultural neural reuse, also shows how a human being has the capability of \textit{shaping} itself, the capability, that is, not only of enriching the array of available cultural strategies, but also of \textit{actively modifying its biological constitution} in harmony with cultural (and cognitive) advancements. From this standpoint, it is relevant to keep in mind that written language, and literacy more generally, is something that humanity has actively promoted, up to the point of instantiating formal schooling and compulsory education.

\section*{Back to Theology and the Issue of \textit{Imago Dei}}

What we have discussed in the previous two sections has, in our opinion, relevant theological implications, mainly related to the \textit{Imago Dei} doctrine (particularly the so-called relational and functional interpretations of this doctrine\textsuperscript{29}), the integral understanding of the human being emerging from Biblical and early Christian anthropology, and the notion of ‘self-transcendence.’

In the first place, the approach in terms of cultural neural reuse reveals the deep \textit{potentiality} and \textit{dynamism} of human natural constitution beyond any static and fixed anthropological model. Specifically, it not only conceives the human being as constantly able to advance and develop new cultural strategies and cognitive tools, but also to do this (a) \textit{beyond} what biological evolution has endowed \textit{Homo sapiens} with, and (b) \textit{jointly} at the mental/cultural and bodily/biological levels. The idea that human beings may progress jointly at the

\textsuperscript{26} Ishibashi \textit{et al.}, “Tool-use learning induces BDNF expression”;

\textsuperscript{27} Colagè and D’Ambrosio, “Exaptation and neural reuse”; see also Dehaene and Cohen, “Cultural recycling”.

\textsuperscript{28} Anderson, “Neural reuse”; see also Colagè, “Human specificity”.

\textsuperscript{29} Cf. Shults, \textit{Reforming Theological Anthropology}. 
mental/cultural and bodily/biological levels is in line with the integral anthropology emerging from the Bible and early Christian thought, where radical dualistic views are not a matter of course. Moreover, the so-called functional interpretation of the imago Dei doctrine – which primarily concerns the mission assigned by God to humanity, of stewarding and presiding over creation – provides richer implications. Human beings can be perceived as capable of prolonging and co-operating actively with the divine creative plan. What we have seen so far indeed suggests that humanity has an even more active mission, i.e. that of allowing the inner potentialities of the world and of humanity itself come out and develop.

This represents a further step with respect to recent approaches to the human being in science and theology similar to Philip Hefner’s well-known notion of the human being as ‘created co-creator’. Indeed, it is not just that humans spin out the divine creative work through technological development; it is rather about their own created capacity to implement new cultural strategies, to expand their biological and cognitive endowment, and to augment their range of knowledge, action, and interaction in a potentially limitless way. And it is not just about deploying such a creative and innovative power in view of outcomes and results related to specific needs or challenges posed by the natural and/or social environment; it is rather about applying this power to a human being’s own overall constitution.

Likewise, the recent scientific-anthropological developments addressed previously further substantiate the theological-anthropological notion of active self-transcendence – i.e., the real and concrete capability of human beings to “become more” and overcome their limitations by means of actively and intentionally pursued efforts. In other words, the invention of writing and literacy, and the concomitant cultural neural reuse, may be interpreted as scientifically addressable instances of human active self-transcendence.

The second most important consequence of the cultural-neural-reuse approach is the emphasis on the social basis of cultural dynamics. As we have just mentioned, writing and literacy can only hardly be understood as immediate responses to environmentally imposed survival challenges. They become rather useful (in terms of something actually to be preserved, spread, and promoted) only within a highly elaborated social and cultural milieu, and in view of new possibilities for storage, transmission and augmentation of information and knowledge beyond the limits of ‘on-line’ interactions among speakers. Such a solution, which we now take for granted, is linked to neural mechanisms and cognitive functionalities that were not entirely implied in the anatomy, physiology, and functioning of the human brain as it developed from the long and tortuous evolutionary path leading to our present day species. On the contrary, these mechanisms and functionalities are the result of a communal and creative effort, and are pursued for their intrinsic value and not merely for utilitarian reasons.

The unceasing striving of humans to improve, potentiate, and renovate communicative, social and cultural strategies may be regarded as a pale but concrete and dynamic reflex of God’s intrinsic relational attribute (as revealed by the Trinitarian dimension), as well as of God’s intended openness towards creation and humanity supremely manifested in God’s assuming human nature and entering creation and history with His Incarnation. This has clear links with the so-called relational interpretation of the imago Dei doctrine – i.e., the idea that human beings are created in the image of God because of their ability to entertain a personal relation with God. Such a relational and open character points to what Karl Rahner indicates as a transcendental structure of human beings that renders them absolutely culture-dependent and -driven, and much less self-referential or solipsistic. Wolfhart Pannenberg’s notion of “exocentricity” may also be relevant from this viewpoint. In other words, the point is in interpreting human intentional striving to develop widespread and effective social and cultural strategies (of which writing and literacy represent a key and recently devised element). It is also a sign of human openness beyond itself and, ultimately, toward communion with God. In a sense, these might be regarded as “signals of transcendence within the empirically given human situation.”

30 Hefner, The Human Factor.
31 Rahner, “Christianity and the ‘new man’”; Rahner, “Christology in an evolutionary view of the world”.
32 Rahner, Hearers of the World.
33 Cf. Van Huyssteen, Alone in the World?, 140.
34 Berger, A Rumor of Angels, 52-53.
We have hinted at just a few core theological notions that may be put in fruitful dialogue with the implications of recent scientific findings. This approach may well be extended to other topics and conceptual frameworks. The real challenge, at the methodological level, is to practice the science-and-theology debate at the level of specific theological tenets and detailed consequences of recent scientific advances. New scientific inputs could clearly help in updating and extending the scope and meaning of theological notions, facilitating new ways to integrate science and theology in the 21st century.

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