The Evolution of *Homo Discens*—Natural Selection and Human Learning

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ABSTRACT

This article takes an evolutionary "reverse engineering" standpoint on *Homo discens,* learning man, to track down the (learning) mechanisms that played a pivotal role in the natural selection of human being. The approach is "evolutionary sociological"—as opposed to gene-centred or psychologising—and utilises notions of co-evolutionary organism–environment transactions and niche construction. These are compatible with Deweyan theory of action which entails that in action one cannot but learn and one can only learn in action. Special attention is here paid to apprentice-like learning-by-doing peculiar to human socio-cultural niches since the Pleistocene, which has permitted each subsequent generation to learn massive amounts of habits and skills needed in utilising the affordances of action that constitute their ecological niche. Affordances and actions have changed over the history of human–environment transactions, but the core mechanisms of human learning have not changed much. It is increasingly important to appreciate these mechanisms now in the global age "knowledge society," which is in a way similar to the Pleistocene niche: characterised by uncertainty and life-determining problem-situations without any ready-made solutions, it calls for capacities to adapt to changing circumstances, and thus apprentice-like learning in action supported by savvy epistemological engineering of learning environments.

INTRODUCTION

Twenty-first century evolutionary biology involves more than the genes, being growingly appreciative of epigenetic mechanisms and co-evolutionary developments of organisms and their environments. For the social and human sciences, this means that bio-scientists and people engaged in evolution theoretical research, will be increasingly interested in research on social and cultural issues, which might give rise to new collaborations and cross-disciplinary studies. (See, e.g., Laland et al. 2010; Landecker and Panofsky 2013; Meloni and Testa 2014.) It also means that there are now on offer novel kinds of Darwinian standpoints on human sciences, alternatives to such nativist approaches as evolutionary psychology (e.g., Barkow et al. ed. 1992; Pinker 2002). These novel approaches are more social scientific than evolutionary psychological and less keen on supposing an innate, fixed human nature hardwired into the brain (Buller 2005).

In this paper we utilise a standpoint that Daniel Dennett (2017) calls "evolutionary reverse engineering" of human being—a standpoint that aims to track down some pivotal mechanisms of the evolution of *Homo discens*, learning man. Our specific application of the standpoint is best characterised as "evolutionary sociology," in contrast to evolutionary psychology.

The basic idea of taking into account the reciprocal interdependency of (human) organisms and their (socio-cultural) environment in evolution, was foreshadowed more than a hundred years ago already by John Dewey (1859–1952), for instance. American pragmatism, it has been said, was in many ways the first truly Darwinian philosophy (e.g., Goudge 1973; Menand 2001; Brandom 2004), and Dewey in particular was head and shoulders above others in developing evolutionary philosophy (see Popp 2007). Dewey's philosophy was Darwinian in that it was "action first"—not mind or comprehension first. To put action first meant that Dewey saw that, it all starts with life as constant activity, which our Darwinian world will most crucially judge as more or less successful coping with the environment—as more or less skilful or competent actions (see also Dennett 2017).

Social scientific standpoint of a Deweyan origin, such as our own approach, leaning on methodological relationalism (Kivinen & Piiroinen 2006, 2013), will apply Deweyan theory of action, which is compatible with some of the latest co-evolutionary ideas about natural selection. Among the key concepts will be Dewey's anti-dualistic notions of "habits" and organism–environment "transactions," both of which refer to both the organism and its environment, to their interdependence, and thereby overcome Subject–Object dualism (see Dewey [1922] MW 14, [1948] LW 16: esp. Ch. 4–5). These are Darwinian notions compatible with the turn of the millennium concepts of "coevolution" (Durham 1991) and "niche construction" (see Odling-Smee et al. 2003; also Kivinen and Piiroinen 2012, 2013). Niche construction in particular will be another key concept also in this paper. Dewey's notion of transaction already betokened this concept, though it remained very much underappreciated in mainline evolutionary theory up until the turn of the century. Today, however, we can draw on dozens of theories and research results on niche construction.

Being appreciative of the significance of niche construction in evolution means paying far more attention than evolutionary psychology does to socio-cultural, technological, institutional, and other social scientifically interesting developments (see, e.g., Buller 2005; Richerson and Boyd 2005; Kivinen and Piiroinen 2012; Yamagishi and Hashimoto 2016). However, the long Pleistocene period of early human evolution will not be irrelevant from our perspective either. We agree with evolutionary psychologists that the Pleistocene was an immensely important period in human evolution, but the way that we see it, the most important developments were related to the incremental construction of a socio-cultural niche that produced human "behavioural modernity" (Sterelny 2011). That is to say, we disagree with the evolutionary psychologists' suggestions that the most crucial evolutionary developments come down to specific genetic mutations that granted individual brains with some innate cognitive capacities essential to the human nature. From our standpoint, the most important developments making human beings the kind of species they are

were primarily social and cultural developments, whose importance was rooted in how they became pivotal parts of the ecological niche where early human populations transacted with their environment. (See Sterelny 2007, 2011, 2012a.)

The two arguably most important developments in the Pleistocene that contributed to human behavioural modernity were: first, the evolution of protolanguage and then full language, which we have discussed in more detail elsewhere (Kivinen and Piiroinen 2012); and second, the construction of a peculiar kind of social and cultural niche that would actively promote many of the vital activities of the community, in particular by allowing younger generations to learn the skills and habits of action needed in the environment. This latter arrangement, which Kim Sterelny (2012a) has called "apprentice learning" setup, will be a central topic of the present article.

Such socio-cultural arrangements for learning whereby inexperienced individuals (the next generation) get useful advice from more experienced ones, like apprentices would from a master, is a human speciality, which depended on many generations of epistemic engineering of the environment; and they were crucial for the emergence of human behavioural modernity (Sterelny 2011, 2012a). Apprentice learning is learning by doing, as all learning necessarily is, a Deweyan thinker would add, leaning on the basic notion that all life is action, and that in action one cannot but learn and one can only learn in action (Kivinen and Ristelä 2002, 421; see also Dewey [1916] MW 9: 192); but more specifically, apprentice learning is learning by doing in an environment seeded with social and cultural informational resources (Sterelny 2012a, 35). Apprentice learning differentiated humans from other species, and justifies the epithet *Homo discens*, learning man. It provided human individuals and their communities unprecedented chances of "growth"—in the Dewey's (MW 9: 4–6) evolutionary sense of improving adaptation, finding better ways to cope with or utilise the environment.

For Dewey, the primary evolutionary function of education is indeed to support the growth, further adaptation, of people and their communities, while he also appreciated that, by the same

token, education serves many sociological functions (for example, transferring customs and beliefs from generation to generation) (see MW 9: 5–7). The driving force of the development of educational institutions in particular lies with the society, as increasing division of labour has required ever new, more sophisticated forms of communication and cooperation.

Much of human evolution is cultural, and its pace has been accelerating over history. Many things have changed relatively quickly, including the institutions civilised societies establish to carry out their educational functions. Some of the changes in culture and technology have given humans new kinds of "tools of thinking"—various symbols, language in particular, books and maps, scientific methods, telescopes and radiocarbon dating, computers, the internet, etc.—which have elevated the human mind to a whole new grade of comprehension, allowing us to comprehend a vast variety of things more sharply, to have propositional knowledge-that about them, and to even think about our own thinking about them. Nevertheless, human knowledge-that and comprehension rest on—or, actually, consist of—knowing-how and competence, of apt nervous habits learnt in action: there simply could not be any separate; we join those who argue that there is no separate, supernatural mental life anywhere besides all natural activity (Dennett 2017, 94–101, 299–300, 388–9; also Dewey MW 14: 25–7, 48–53, 123 ff.). According to Dewey (MW 14), "habits are the means of knowledge and thought"—"habits formed in process of exercising biological aptitudes are the sole agents of observation, recollection, foresight and judgment: a mind or consciousness or soul in general which performs these operations is a myth" (p. 123). Even the most intellectualistic forms of "thinking cannot … escape the influence of habit, any more than anything else human," then, although they can become habits of their own kind, intellectual habits such that utilise and depend on a peculiarly intellectual "environment … [like] the study, library, laboratory and academy" (p. 50).

Accordingly, although educational institutions have changed a lot, the basic mechanisms of human (apprentice) learning have remained largely the same from the Pleistocene to the present-day

global "Knowledge Society." In that sense, perhaps, one could say that apprentice learning is a part of the human "nature"; but then human nature is conceived not as a mainly genetic or innate, but as a social and cultural affair thoroughly dependent on, and carried from generation to generation in, niche constructing transactions with the environment.

In order to fully understand the notions of transaction, habit, niche construction, and apprentice learning, we suggest, one needs to make use of the concept of "affordance," introduced by J. J. Gibson (1986) to capture the fact that certain kind of objects enable and invite certain kind of actions from of organisms with propensities to certain kinds of actions. Like transactions and habits (and the verb "to afford"), affordance is a relational concept, implying complementary relatedness of the organism and its environment (Gibson 1986, 127; also Dennett 2017, 79); it therefore fits very well to Dewey's (see, e.g., [1938] LW 12: 40) transactional view of organism–environment relationship. An ecological niche, in turn, could be said to consist of interconnected affordances, for the use of which the population has developed apt habits. And many of the affordances of a given niche are such that a human being will adopt the habits, knowing-how and competence required for their skilful use through apprentice learning mechanisms.

Over the course of human evolutionary history, it has been cultural affordances—among them many kinds of tools of communication, for example—that subsequent generations have most urgently needed to be trained to use. This may be more apparent than ever now in the present age of ubiquitous information and communication technology (ICT), as that rapidly developing technology is changing not only our affordances of action and hence our ecological niche, but at the same time also our socio-cultural networks and self-conception. Together with today's global market economy, ICT-based "knowledge society" can be seen as one ecological, socio-cultural, and especially communication technological niche, which is now setting its own parameters and challenges to people, their societies, and their educational aspirations.

We argue that, this now unfolding niche is in a way similar to that of the Pleistocene era hunter-gathering: as opposed to many historical era societies in between these periods, neither of them offers ready-made solutions to many possibly quite life-changing problem-situations that people could face. The uncertainties of today's global niche of all-out market economy and omnipresent ICT require people to adapt to novel situations and cope with unprecedented challenges. And that, we propose, calls for newfound respect for the Deweyan basic premise that in action one cannot but learn and one can only learn in action. These basic constituents of apprentice-learning mechanisms, revealed here from an evolutionary reverse engineering standpoint, have not changed since the Pleistocene—that knowledge and comprehension can only come from skilful action, the direction is indeed "competence first."

DOWN WITH NATIVISM! ARTICULATING GENE–CULTURE COEVOLUTION

Whereas the twentieth century was "the century of the gene," biology is now entering "the century beyond the gene," to investigate whole (epi)genetic systems where thoroughly relational or networked properties arise from dynamic interactions: twenty-first century biology will not be obsessed with linear reduction of wholes to their smallest components, but will be appreciative of the histories of interdependence and co-evolutionary developments of the parts in the light of the whole (Keller 2005).

In fact, John Dewey's pragmatist view of organism–environment transactions already foreshadowed the beyond-the-gene approach a hundred years ago. Due to his transactionalist thinking, Dewey was better able than most philosophers to see certain implications of the Darwinian fact that every living organism and every species (or, population) must by necessity cope with its environment, or perish and be replaced by others better adapted to that environment (MW

9: 4–5)—the fact that all life is most basically activity adapted to the environment (Dewey [1920] MW 12: 128).[1] Activity always transforms its environment, too, and these consequences of actions may call for changes in the organisms and their future activities:

> The organism acts in accordance with its own structure, simple or complex, upon its surroundings. As a consequence the changes produced in the environment react upon the organism and its activities. The living creature undergoes, suffers, the consequences of its own behavior. (Dewey MW 12: 129.)

Transactional relationships between organism and environment, as Dewey—here writing together with Arthur Bentley—pointed out seventy years ago, does not leave room for genes (or anything else) as the one ultimate explanation.[2] Genes do not hold "the secret of life": they are actually far from independent elements in themselves; a gene is "configurational within its setting" (LW 16: 118–9).

This Deweyan idea of transaction, organisms constantly acting and thereby changing their environment, which by the same token puts new kinds of (evolutionary) pressures on the (populations of) organisms, is akin to another old idea, the "Baldwin effect" (after James Mark Baldwin), as well as to the newer notions of coevolution and niche construction, and these have become quite well appreciated in the evolutionary theory over the past couple of decades.[3] "[T]he social aspect of evolution," in particular, "social relations and traditions", is seen as a part of the environment of evolutionary selection (Richards 1987, 484), especially in the human case, where it has become customary to speak of gene–culture coevolution and niche construction. Today, coevolution in ecological niches is pretty much an established fact about human evolutionary history, a crucial part of any adequate explanation of the evolution of language, for instance, or the capacity to altruism, or the human mind and body in general. (See, e.g., Durham 1991; Dennett

1995; Deacon 1997; Donald 2001; Odling-Smee et al. 2003, esp. Ch. 6; Weber and Depew ed. 2003; Buller 2005; Richerson and Boyd 2005; Bickerton 2009; Bowles and Gintis 2011; Sterelny 2012a.)

Niche construction has relevance in the human case in particular. As Dewey said, the "higher"—the more neurologically complex and phenotypically plastic—the organism, "the more important is the active reconstruction of the medium" (MW 12: 128). And humans, being the most complex organisms in this sense, are all the time engaging in activities that change the environment (both intentionally and unintentionally) in ways which call for changes in future activities, in potentially endless cycle (LW 12: 35), constructing and reconstructing a niche for themselves and for millions of other species. They are thereby creating new affordances (Gibson 1986) which the future members of their population can and sometimes need to learn to utilise.

Humans have proved themselves extraordinarily capable of learning, generation after generation, how to operate with a great variety of affordances, to develop more and more versatile sets of habits of utilising them. This justifies calling them *Homo discens*; humans are a species with an outstandingly plastic and malleable phenotype, capable of learning a vast majority of their behaviours, a social species alert and eager to adopt all kinds of habits, skills, ideas, and other clues to using affordances from others.

THE ROOTS OF *HOMO DISCENS*: BEHAVIOURAL MODERNITY AND STERELNY'S EVOLVED APPRENTICE

Kim Sterelny's *The Evolved Apprentice: How Evolution Made Humans Unique* (2012a), augmented by a series of articles by the same author (e.g., Sterelny 2007, 2011, 2012b, 2016),

constitutes a relatively rare piece of systematic scholarship into the evolutionary importance of learning, specifically in the context of niche construction.

In our reading, the key message of *The Evolved Apprentice* is that, human "behavioural modernity"—the cluster of behaviours shared by all modern humans and distinguishing them from all other hominins and even from physically indistinguishable early *Homo sapiens*—resulted from apprentice-like learning mechanisms underlain by lots of "epistemic engineering" of learning environments. These, and therefore the human minds and culture that depended on them, are a matter of niche construction—preceding generations constructing a cognitive niche, one nested in a broader ecological and socio-cultural niche, for the posterity. It is an emphatically "collective achievement and a collective legacy," whereby "we stand on the shoulders not of a few giants but of myriad of ordinary agents who have made and passed on intact the informational resources on which human lives depend." (Sterelny 2012a, xi–xii.)

So, according to Sterelny (2012a), apprentice learning is the main factor that distinguished human evolutionary lineage from those of other species; it enabled hominins to construct a niche of social, cooperative foraging which, strengthened by the positive feedback loop between this developing niche and the improving human capacities to learn from and train others, allowed our ancestors to prosper in a broad variety of rapidly changing environments. As cultural and social activity, apprentice learning is distinctly human: no other species has anything like the human and earlier hominin capacities to social learning. Chimpanzees, for example, are social animals capable of some communication and coordination of actions, but they only do individual, trial-and-error learning and do not intentionally teach other chimps (p. 173). Humans, in turn, go to great lengths in order to engineer educative environments that scaffold effective, broad bandwidth, high-fidelity flow of information from the older to the younger generations, encouraging and helping learning by doing, much like how an apprentice learns from the master (Sterelny 2011, 2012a, 2013; see also Richerson and Boyd 2005; Boyd et al. 2011; Gergely and Csibra 2005, 2006).

It is probable that human ancestors have been doing this at least from the introduction of the "Acheulian" stone tool culture (ca. 1.7 million years ago) onwards, because those tools were already too complicated to manufacture without the novices being actively trained in the necessary skills. The skills would have been too expensive (in terms of time and energy spent) to acquire by means of undirected trial-and-error learning. So in order to pass such tool-making skills from generation to generation, human ancestors engaged in guided learning. (Sterelny 2016.) This could then have been followed by social learning of customs and norms, once symbolically denotable behavioural regularities and a group identity began to emerge. Norms, like the whole niche of social foraging and capacity to adapt to and flourish in many different, sometimes quickly changing environments, all depended on learning of cultural affordances. (See Sterelny 2012a, e.g., 17–18, 48 ff., 151–71.) There are different affordances in different environments, and the members of local populations therefore need to learn different skills and habits, but the basic mechanisms of apprentice-like learning remain.

As Merlin Donald points out, this hominin peculiarity of being able to share knowledge with others in cultural networks greatly accelerated the pace of biological evolution in hominin species (making their brains go through a remarkably fast series of modifications that made it more and more a cultural organ). The speed of human evolution, the brain included, was much increased, then, by the extraordinary capacities to learn and share knowledge; cultural developments "hijacked the normally slow-moving process of natural selection and caused it to speed up." (Donald 2001, 259–60.) Indeed, although the early phases of cultural evolution may seem slow (for instance, the crude "Oldowan" stone tools, first created by *Homo habilis* or its relatives ca. 2.6 million years ago, show little progress for a staggering one million years), later cultural evolution proved orders of magnitude faster than biological evolution and capable of accelerating the latter, too, in gene–culture co-evolutionary loops.

Nevertheless it took thousands of generations—tens of thousands of years—of incrementally cumulating niche construction, before human behavioural modernity slowly emerged (Sterelny 2007, 2011, 2012a). That is to say: there is no "magic-moment, key-innovation" explanation of human evolution. Behavioural modernity could not appear suddenly, because it was produced by several factors that fed one another in co-evolutionary feedback loops. (Sterelny 2012a, xii.) Archaeological record supports this niche-constructionist, as opposed to genetic mutation- or other "happy accident"-based, view of behavioural modernity, showing as it does that it took way more than 100,000 years for the anatomically modern *Homo sapiens* to start behaving like modern humans. This proves that behavioural modernity was not a straightforward product of *sapiens*-size brains, or due to a lucky genetic mutation that suddenly installed language or other capacities into those brains. If behavioural modernity had a simple genetic-nativist explanation, it would have emerged sooner after anatomical modernity and spread more rapidly across human populations. Instead it evolved gradually and there were times of occasional regression in some places—the advance of behavioural modernity was incremental, sporadic, and periodic. (Sterelny 2011, 2012a, 45 ff.)

One important factor involved in the makings of behavioural modernity must have been the evolution of language. As Dewey understood, communication is a vital ingredient of distinctively human life in communities: people "live in a community [only] in virtue of the things which they have in common; and communication is the way in which they come to possess things in common" (MW 9: 7). Communication and community go hand in hand, and contribute to individual human minds. The evolution of full-scale language (from proto-languages that some of our ancestor species must have had already), was thus pivotal for the co-evolutionary loop between human body-minds and the socio-cultural niche that produced behavioural modernity. And this, Dewey [1925] (LW 1) argued, could not have happened inside–out, as if people came up with language as a new vehicle for expressing their pre-existing minds: language must have evolved to serve social needs, to

coordinate actions, and it only then created human mental life, consciousness of meanings and of one's own self (pp. 134–5, 198, 221–2; see Kivinen and Piiroinen 2012). Language evolved incrementally, coevolving with a slowly thickening, more complex growing, socio-cultural niche of collaborative scavenging or hunter-gathering and other and social life, tool- and symbol-use, and growing populations in relatively friendly interactions (see Dunbar 1996; Deacon 1997; Donald 2001; Bickerton 2009; also, e.g., Kivinen and Piiroinen 2012; Laland 2016; Sterelny 2016).[4]

So language evolution, or children's language learning, or very much of any skill learning actually, never was a solo performance: it was always supported by the community, and it was the community where the wisdom was stored in. One noteworthy part, both in the evolution of language and in the development of behavioural modernity, may have been played by mothers, who would spend more time than the men of the group with small children; and perhaps also, as argued by Sarah Hrdy (2009), by grandmothers, who may have been a precious source of wisdom and potential help in child-rearing in a group that could support elderly members even after they were no longer in reproductive age. Many of the interactions between young children and their mothers and grandmothers would certainly have been much like apprentice learning—the experienced members of the group at least subtly steering the learning of less experienced ones, in a sense intentionally training them, offering guidance or advice. These apprentice-like learning situations would also have created unique kind of communication demands, solvable by proto-language and then even better by full language (Sterelny 2012b, 2016; see also Gergely and Csibra 2005, 2006; Laland 2016).

The learning of the habitual lifeways and skills needed in the niches that humans have constructed for themselves and for future generations, have no doubt played an essential role in human evolution (also, e.g., Boyd et al. 2011), and apprentice-like learning has been a central mechanism in the evolutionary history producing humanity. But does this evolutionary view imply any noteworthy lessons for today's society? We think it does, although we should point out that

Sterelny's own response to those (e.g., Downes 2013) who have suggested that his apprentice learning model could be fruitfully applied to understanding some present-day issues, has been rather unenthusiastic at best: he warns against over-stretching the model and says it was only meant to describe the early stages of the process of evolving behavioural modernity (Sterelny 2013, 40–1). Indeed, Sterelny's apprentice learning model is mostly only about the hominin and early human hunter-gatherer life in the Pleistocene period, and—much like the bulk of evolutionary psychology—*The Evolved Apprentice* ends around the time of the Pleistocene–Holocene transition (the introduction of agriculture and town-like settlements).

That said, we argue that a Sterelnian and Deweyan, niche constructionist, apprentice-like model of learning by doing supported by socio-cultural environments, is worthy of serious consideration also in the present-day context; that the basic arrangement and mechanisms of such learning work as well today as they did in the Pleistocene. To be sure, there have been enormous changes in the human niche since those early days, including educational institutions set up by organized societies. But many of those institutions have actually been more hindrances than assets as regards human learning and real education—have not necessarily promoted the growth, in the Deweyan sense, of human beings and communities. However, an evolutionary sociological explanation of those institutions in terms of the functions they served, each in their own ecological, socio-cultural niche, could help understand how our educational system got to be the way that it is, and why it may not serve optimally in today's global niche of knowledge society.

SOME TURNING POINTS IN CHANGING CULTURAL TRANSACTIONS

Human behavioural modernity is said to have appeared between 50,000 and 100,000 years ago, when the record starts showing more concentrated traces of missile weapons and other

advanced equipment for hunting and fishing, artwork, burial ceremonies, etc.; it marks coming to a head of many gene–culture co-evolutionary processes which produced changes such that, although too incremental to be properly labeled a "revolution" (McBrearty and Brooks 2000; also Sterelny 2011, 2012a), at one point did cumulate into something very different from earlier lifeways and affordances. It was only the first big change in human culture and lifeways.[5]

An even more significant development took place 10,000–12,000 years ago: the advent of agriculture. Dewey also illustrated (what we now call) niche construction with the significance of agricultural turn, drawing a contrast between "savage" (hunter-gatherer) people who accommodate their activities to their environment more or less as they find it, and (agricultural) "civilized" people who dam streams, dig channels, cross-fertilise plants and breed animals, as well as work the soil with a variety of tools, purposefully transforming their physical environment (Dewey MW 12: 128–9). Indeed, for better or for worse, the shift to agriculture brought about pervasive, cumulating, niche-constructing changes to the local habitat which would become ever more consequential as agricultural populations grew in numbers. With agriculture there would also begin to be more surplus products to be traded, or to be collected as taxes for the local sovereign who would dictate laws for his subjects to follow, so agriculture led to the momentously significant technological-cum-cultural upheaval of the externalisation of memory by means of written symbols—what Donald (2001, 259–62) dubs the "theoretic" shift in the human culture and consciousness. This marked a huge step on the road toward more powerful means of niche construction, a road at the end of which we now, mere ten thousand years later—which in the evolutionary and global ecological time-scale is not much more than a blink of an eye—have fundamentally changed the ecosystem of this planet.[6]

Agriculture gave rise to stationary habitats, villages and towns, chiefdoms and states, which fostered new varieties of apprentice learning, including some that represent apprentice learning in the most literary sense of the term—learning in apprenticeship. Of these, artisans, artists, soldiers,

and some others who needed mainly manual skills, could still be trained somewhat similarly to hunter-gatherers. But gradually some new trades developed, a fraction of people in large enough societies would be taught new kind of "knowledge-work" skills—literacy, mathematics, the code of law, religious doctrines—and trained to do intellectual work that involved propositional knowledge. To educate those select few knowledge workers, a variation of master–apprentice system developed into a peculiar kind of tutoring method where a learned scholar, perhaps as a representative of some religious institution like a monastery school, would train a pupil or a few in these peculiarly intellectual skills, over a period of several years. Thus the "guild" of teachers emerged.

The case of agriculture also illuminates what niches on the whole are and are not: that the construction of niches and adaptation to them, even when in a sense more "developed" (or, complex) than previous ones, are by no means necessarily objective improvements in the sense of being more desirable or advantageous. For although the transition from hunter-gathering to agriculture is often hailed as a "victory over nature," a step "forward" toward more well-being and high culture, it has also had tragic unintended consequences: the populations of early farmers grew, meaning that from a narrow genetic-evolutionary point of view, the species *Homo sapiens* became successful, but the well-being and indeed the life-expectancy of most individuals actually sank with agriculture (which offered poorer diet than hunter-gathering, required hard work such that the human body was ill-adapted to, and exposed people to plagues in their densely populated towns with poor hygiene). (Diamond 1987; Harari 2015, Ch. 5.) Even today, when industrialisation and the consequent rise in living standards, with a little help from science of medicine, have allowed the global human population to grow to unprecedented over 7 billion, it is far from obvious that this marks a more developed state of the human environment.

Changing affordances change (habits of) action and hence the human being, already because affordance implies complementarity of organism and its environment and thus crosses the cranial boundary, calling for theories that allow weaving minds to their environment, individuals to their

socio-cultural fabric (see Dewey MW 14: Ch. 1–9, LW 1: Ch. 5–8, LW 12: Ch. 2–3, also LW 16; Gibson 1986, 127). After all, as the kind of "predictive engine" situated and embedded in an organism's stream of activity in its environment, trying to guess what happens next, our brains are tied to our environment (Clark 2015). There are evolutionary reasons for this; the very evolutionary function of the brain, as Dennett (2017, 169) points out, is "continuously to create 'forward models,' or probabilistic anticipations, and use the incoming signals to prune them for accuracy—if needed." The predictions will improve only in action, by forming habits of action, perception and thought well suited for coping with some particular kind of environment. "When the organism is on a roll, in deeply familiar territory, the inbound corrections diminish to trickle and the brain's guesses … give it a head start on what to do next" (Dennett 2017, 169). The familiarity of environment is important; as Dewey put it: "The sailor is intellectually at home on the sea, the hunter in the forest, the painter in his studio, the man of science in his laboratory" (MW 14: 123). As habit-formation involves the environment, Clark and other recent advocates of the "extended mind" hypothesis have a good reason to argue that in case some items that are physically outside the skull are actually inside the person's mind, a quintessential part of her cognitive processes (Clark and Chalmers 1998; Clark 2008, 2015; Noë 2009; see also Sterelny 2012a, 26–7). Dewey, too, already saw that any "living organism and its life processes involve a world or nature temporally and spatially 'external' to itself but 'internal' to its functions" (LW 1: 212). (His notions of habit and transaction were specifically designed to overcome Subject–Object dualism, especially in theory of action and in the philosophy of mind.)[7] That is why a pervasive change in a community's niche—in its affordances—cannot but mean that people will also change, as they have to adapt their activities and hence even deep-rooted habits and minds to the new affordances.

As to the shift from late middle age to early modern age, for example, there were several interconnected social, cultural and technological developments involved in it. However, as with agriculture, much of the retrospective significance of which is interlinked with the invention of

written symbols that externalised human memory and knowledge, there was one especially important change in the technologies of communication that took place around the time of the beginning of modern age and contributed to many other socio-cultural developments in that time: the invention of the printing press. It changed the society and minds by making book wisdom widely accessible to the masses, allowing ideas to spread faster, and also by transforming (giving book-form structure to) many important parts of culture and thought and thereby fuelling other (causally intertwined) developments—Reformation, overseas explorations, Renaissance, modern science, Enlightenment, the emergence of nation states and modern democracy, growing investments in entrepreneurship, and the eighteenth century industrial revolution. (Eisenstein 1979.)

Printing promoted more equal opportunities for people to get education, because it allowed books to be mass produced and become a growingly popular commodity in prospering enough households. A new distinction gained salience, separating the literate, with access to book wisdom, from the illiterate. It was this distinction (augmented by the Protestant notion that proper faith depended not so much on participation in physical rites as in belief in the words that one could read from the Bible) that, Neil Postman (1982, Ch. 2) believes, gave rise to what Ariès (1962) had argued is only a relatively recent, modern notion of "childhood"—as a special phase of life when one has not yet entered (intellectual) adulthood—and thereby to the idea that there was a need for public schools that would allow all populace to reach such adulthood. Nation state's municipalities' tax-funded and attendance-requiring schools were then introduced, first in Frederick the Great's Prussia in the 1760s; the institution of national elementary schools (as opposed to religious communities' and other private schools) and the practices of comprehensive public education (as opposed to educating only some aristocratic minority) got started.

Like agriculture and the beginnings of civilisation, modern culture and school education are usually seen as unquestionable improvements, steps forward on the road of humanity's progress; but as with the former, so with the latter, a niche-construction standpoint sheds better light on many

noteworthy aspects of the issue. Modernity, interlinked with industrialisation, brought us on the brink of ecocatastrophe and armed the human kind with nuclear weapons, among other things. And as to school education, insofar as the core of peculiarly human learning is, for evolutionary reasons, apprentice learning of new apt habits, then clearly there is no necessary connection between more schooling and more learning. Whether schools produce learning depends on what goes on inside the school building: are they offering appropriate action environments with ample opportunities for apprentice-like learning by doing that best encourage what Dewey (MW 9) called growth—learning of apt, clever and creative habits? Too often that has been overridden by the methods of rote learning of detached facts and teachers preaching their pupils "how things are."

Modern age, when the institution of nation states' public schools got started, was in some ways similar but in many ways also very different from our present-day world. The Enlightenment values have been (even naively) highly regarded, as were Protestant Christian doctrines, and both were referred to as justification for public schools in the late eighteenth, nineteenth, and early twentieth century.[8] Most importantly, these coincided with the modernity's nationalistic ethos and industrialising nation states' unscrupulously economic reasons. Large scale schooling was allowed most crucially by the industrial age accumulation of wealth and prosperity, the fact that industrialising nations could afford schools, and was encouraged by increasing competition between nation states (governments), many of which decided that it would be wise to invest in what would later be known as "human capital" by establishing educational institutions to prepare each generation for productive citizenship.

From an industrial society's (government's) viewpoint, schools could be seen as social factories, producing cohort after cohort of people who have some acceptable minimum of skills and knowledge, and who have been socialised into the prevailing social order, prepared for a life of law-abiding, productive citizen—not least through the "hidden curriculum" that instilled the youth with the industrial society's routines and practices, norms and values (of punctuality, for example, and

diligence and compliance), as well as with the space-time rituals that factory work, office hours for bureaucracy, and the newly invented timetables for public transport, all depended upon. Moreover, no matter what exactly was or was not being taught in school, the school institution would in any case benefit industrialising society already by offering a simple means to supervise and "contain" the immature age groups by providing a place where to put them for a certain number of hours per weekday, for a certain number of years; this arrangement enabled (both) parents to spend more of those days and years at salary work outside home.

Public schools therefore served useful, even necessary functions for industrialising nations all through the nineteenth and much of the twentieth century. However, so much of the technological and hence economic, socio-cultural, and political parameters have changed over the past fifty years as people have been reconstructing their—increasingly global—niches; and institutions, including educational institutions, will (need to) change with the niche.

THE AGE OF GLOBALIZATION AND DIGITALIZATION

The beginnings of the elementary school institution and national educational systems, like so many other modern-day institutions, were tied to the characteristically modern-age developments, especially the emergence of (the very idea of) nation state. Their fortunes also long went hand in hand with that of nation states. But even that may not be everlasting; it all depends on the niche, and recently there have been signs of national educational systems, like many other national institutions, losing ground with the rise of an increasingly global world.

Today's global community of billions of people involves an unprecedented amount of interactions, specialisation, and of course also options for co-operation. As this latest turn in human history, global digital age is only now unfolding, this niche being constructed or realised as the sum

of both intended and unintended outcomes of billions of transactions around the world, it is very hard to know how it will turn out. The full impact of digitalisation may be particularly hard to foretell because the powers of this technology have been roughly doubling (as the Moore's Law predicts) every couple years, so the pace of technological breakthroughs has been unprecedentedly exponential instead of merely linear, already producing many applications that only a decade earlier were thought impossible or to take several decades to accomplish (Brynjolfsson and McAfee 2011). Indeed, in a sense the digital tools and other affordances of the niche that people constructed over the past half-a-century have already taken over much of the driver's seat; the tail is wagging the dog—people, not just as individuals but also as the human kind altogether, have less and less say as regards how the reconstruction of this niche will unfold: the niche largely reconstructs itself. With ever bigger share of economy and society being not only globally interlinked but increasingly automatized, many parts of it ran by A.I., this adds whole new dimensions to the traditional social scientific problem of the unpredictability of large numbers of people's actions and their unintended consequences. But we do want to venture a couple of educated guesses here, focusing on the future of learning and educational systems in particular.

OECD and its Directorate for Education and Skills have been keen to monitor educational systems of the member countries and have also had a growing impact on them; their willful strategy has been to create international tests and global standards for education. They have been propagating for international large-scale assessments (ILSA), most famously the PISA test, pioneering for global human capital for global economy, and this has been a factor globalizing the field of education, which used to be an affair for domestic policy. The PISA test (for fifteen-year-olds, measuring the skills they are presumed to need in life outside school) today covers more than seventy countries, allowing standardized comparisons between them, thereby also guiding international companies in their decisions about where to establish their facilities and networks of contractors, or from where to recruit workforce. OECD's Director for Education and Skills,

Andreas Schleicher (2013) declares that, in this era of global economy the benchmark for success of educational system is no longer national improvement, but how well the system is performing in international comparison. This is seen to benefit the world market economy, as many private sector employers today are not very concerned with what diplomas a would-be employee may have, or whether they can reproduce from memory what they learnt in school, but only care about whether they have skills to benefit the company and are able to extrapolate from what they have learnt to apply knowledge in new situations, carry out tasks and use technology that may not have been even invented yet. As always, life will rarely ask what school lessons you have learnt, but will constantly test your abilities to adapt to and cope with changes in the environment, to solve whatever problems. (See Schleicher 2013.) This, per se, does not conflict Dewey's (e.g., MW 9: 55–6) Darwinian view of education.

In many ways the global niche implies diminishing significance for the nationalistic ideology that ruled from the late-eighteenth to the late-twentieth century. Surely there are occasional small-scale counter-reactions like Brexit or Trump presidency, but overall it is clear that nationality is becoming less significant as a component of people's identity; that the capacity of nation states to control the flows of capital, products, people, information and ideas across their borders has also been decreasing; and that along with developing technology and changing economy, working life has been transformed so that national educational systems have in fact become unable to offer ready-made solutions or even definite sets of alternative careers for life.

However, much of the discussion of the future of education is still done in nationalistic terms. A standard response to the changing working life—to the so-called "Knowledge Age" requirements—has been to say that nation states should try and improve the education of their youth with the eye on cumulating bigger labour pools of creative knowledge workers that can be hoped to generate national economic prosperity (e.g., Scardamalia and Bereiter 2005). Nation states are also advised to invest in higher education, which has in many countries already transformed from a

privilege of a few (largely male elite) to a right for the many (both genders, from the growing middle class), and looks soon to become almost a civic duty (see Trow 1972).

One often heard proposal is that, in order to produce creative knowledge workers able to cope with the changing working life in this era of digitalization, we need to start by introducing more advanced ICT to schools (e.g., Brynjolfsson and McAfee 2011, 60 ff.). This is compatible with a niche-construction standpoint emphasising apprentice-learning of affordances: ICT-skills, like thinking skills, even those learnt in higher education, are habitual matters, the learning of which takes place by doing (Kivinen and Ristelä 2002). ICT equipment and the data and interactions that can be engaged by means of them are certainly among the pivotal affordances of today's society, and schools should train young people's skills with such pertinent affordances of their niche. Children should learn, for example, digital literacy and skills of internet age inquiry, argumentation and communication (including the understanding of different points of view in the social media and other online social skills). But of course the introduction of ICT does not by itself guarantee apt learning (Hammond 2014). As a rule, any technology is educational only insofar as also educational practices have been developed such that the technology fits well to (Hakkarainen 2009). And of particular importance, as we have argued here, are apprentice-like opportunities to learn by doing with useful guidance available from an experienced master of the skills.

Educational practices for the global, digital age niche could be significantly improved by rediscovering the basic premises of the evolution of *Homo discens*, that one cannot act without learning or learn without action, the logic consistent with Deweyan theory of action where everything begins with continuous action, where action does not need any "spark" from the mind to get started. It is action first, not mind first, because to live is to act. Or, as Dennett (2017) puts it, first there is "*competence without comprehension*" (p. 94); "animals, plants, and even microorganisms are equipped with competences that permit them to deal appropriately with the affordances of their environments" (p. 101). Only from such competence can some (degrees of)

comprehension appear. So, "competence comes first. Comprehension is not the *source* of competence or the *active ingredient* of competence; comprehension is *composed* of competences." (p. 94.)

Human evolutionary history testifies to this, too, and clarifies the specific form that the distinctly human kind of learning took, the tried and tested apprentice-learning procedures to which the human body-mind adapted over its hundreds of thousands years evolutionary history in the Pleistocene. Much of those methods were at certain points in the history of civilisation replaced with other, medieval monastery or industrial age methods of purposeful teaching of knowledge contents detached from practical connections—the teacher addressing the whole class at the same time to teach them the day's lesson to be remembered, the pupils being told to copy text fragments from books to their notebooks, and earlier lessons being tested by requiring the pupils to reiterate memorized facts either orally or on paper. That kind of schooling served certain socialising functions in its societal niche, in medieval authoritarian societies and still in industrialising nation states—helped maintain discipline and power structures, for instance. (In pre-printing cultures, copying of texts and rote learning were also vital methods for transferring information from library to library and generation to generation.) But they never were apt methods for learning such that would encourage what Dewey (MW 9) called growth. And in today's global knowledge age people need to learn useful skills and clever and novel habits of thought and action, instead of being schooled primarily for the role of an obedient and productive citizen. In that sense today's niche is again closer to the Pleistocene era hunter-gathering, a rather unpredictable and often in many ways hostile environment where one needs to be prepared to—perhaps in collaboration with others, and utilising a number of affordances—come up with ways to cope with novel situations, find ways to deal with surprising new challenges and solve problems for which there might be no ready-made patent solution, be prepared to do extensive inquiry work, to move and re-network, learn new skills, even come up with a new livelihood if the old one disappears.

This is well in line with Dewey's Darwinian philosophy of education, and Deweyan pragmatism could point way to how best utilise the affordances of the global, digital age, most notably ICT, in school education, for example (Kivinen et al. 2016; also Chee 2014). For one thing, Dewey would stress that ICT like all affordances need to be sensibly tied to the learners' actions (and thus to their life-situations, actual interests and activities).[9] Dewey (e.g., MW 9, MW 14), like Sterelny later, saw that humans have evolved into organisms disposed to learn habits, skills and beliefs from others, and that they are hence susceptible to socialisation and education—through apprentice-like learning of habits, in particular.

That view is to be understood in the context of Dewey's (see LW 12) pragmatist and Darwinian, experimentalist outlook on inquiry and knowledge. Dewey (MW 9: esp. Ch. 4) appreciated how natural it is for human beings to learn by doing and to grow—improve their adaptation through curiosity, inquiry and experiment, leading to the forming of useful habits of thought and action—in appropriately stimulating, challenging and supporting action environments. This holds true also with respect to educating tomorrow's knowledge workers. For Dewey, knowledge is always tied to habitual knowing-how, skills and action, and can thus only be learnt by doing: "Only that which has been organized into our disposition so as to enable us to adapt the environment to our needs and to adapt our aims and desires to the situation … is really knowledge" (MW 9: 354).

Perhaps we should stress, however, that the Deweyan lesson is not to say that one cannot ever just tell the learner anything, without offering hands-on exemplification. No, Dewey would certainly not have belittled the educational value of linguistic propositions. However, as a Darwinian thinker he saw propositions as tools of action and coping, and intellectual skills of proposition-use as precisely that: skills—habits and knowing-how. Understanding of linguistic descriptions, reading and writing, reasoning etc., are methods for producing, handling, and acquiring propositional knowledge-that, but they do not work outside the framework of habitual

skills instilled into our nervous system through practice—one knows how to read and write, or to do math, and knows how to tell the difference between reliable and unreliable claims, how to argue for one's case, etc.; and the crucial method for acquiring skills, even the most intellectual and abstractly theoretical skills, is training and rehearsal. (Kivinen and Ristelä 2002; see Dewey MW 9, MW 12, LW 12; Kivinen and Piiroinen 2006.)

None of this implies any "undue emphasis upon drill and other devices which secure automatic skill at the expense of personal perception" (MW 9: 55). Rather, the idea is to understand also perception and intelligence as habitual affairs. Habits are anything but "mechanical," although they are ultimately based on mechanisms of nervous impulses. Some habits are rather routine-like, of course, but there is also flexibility, creativity, and intelligence to many habitual activities. (See MW 9: 51 ff., MW 14: 32, 48–53.) Present-day education in particular should emphasise those of the latter sort, precisely because the environment is constantly changing and it thus makes no sense for education to aim at some "static adjustment to a fixed environment" (a specific list of knowledge contents or skills). Instead, education can only aim at furthering growth, enabling people and their communities to continue coping with problems, adapting to the environment, learning from life itself. (MW 9: 55–6.) And for this, people could improve their skills of inquiry, thinking, and problem-solving; these are the kind of skills that best improve people's chances of successfully coping with any problems arising from the ever changing environments and to adapt to new affordances.

If anything, these Deweyan ideas are even more apt today in the globally networked information society of omnipresent ICT affordances, where there is no point in remembering lots of detached facts, but urgent need for skills to find and correctly evaluate knowledge relevant to one's activities. These twenty-first century skills, even the intellectual ones like digital literacy, inquiry and reasoning, are all about action and coping in the environment by means capable, habitual use of affordances. They can only be learnt by doing; and that is still best supported by apprentice-learning

mechanisms, not unlike how people learnt in the Pleistocene already. In fact, much like the first *Homo discens* in the Pleistocene period who learnt by guided doings to utilise the affordances of their niche, found ways to cope with their often versatile and unpredictable environment, the present-day society needs to allow each new generation to do much the same—to experiment, learn, and grow—adapting to the challenges of largely unpredictably (and often quickly) changing environment. From a Deweyan standpoint, there is no doubt that people can still cope with the problems of their (now global) niche, learning by doing, managing the continuing epistemic engineering of apprentice-like learning environments fertile for further growth.

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NOTES

[1] This basic Darwinian starting point explains why Deweyan theory of action starts with action and need not explain action with intentions of the mind—why it is action first, not mind first.

[2] Today, this much is already very much appreciated by most working scientists; even if they search for some part of explanation from the genes, they know they need to look for other parts from the environment. One recent example of such practical research related to learning is Minkov et al. (2016).

[3] The idea was first discussed already in the late-nineteenth century by Baldwin and a few others, like C. L. Morgan (from whom Baldwin may actually have gotten the idea) (Richards 1987, 480–93); but there was a long period around the middle of the twentieth century when it was very much disputed and largely discarded from the mainline modern synthesis of evolutionary theory (Depew 2003, 4). (It is possible that Dewey's views had been influenced by Baldwin; he did make some references to Baldwin, although, as Popp (2007, 107) notes, only as a social psychologist (which is what Baldwin was better known as at the time), not as a theorist of evolution.)

[4] The peculiarities of the niche of social life that brought about early language evolution have been speculated to have involved, for example, verbal grooming and gossiping, pair and group and meta-group bonding, and organization and

division of labour. But the sheer size of the population may also have been an important factor, especially when it exceeded the "Dunbar's number" (of ca. 150), which is roughly how many people can have mutual stable relationships on the basis of personal acquaintance alone (as opposed to rules, norms and institutional arrangements) (Dunbar 1993).

[5] To say that that was the first change implies that we are considering here only the (as the most recent findings suggest) 300,000-year reign of *H. sapiens*. There had been some significant technological-cultural and thus also social changes before that, in our predecessor hominin species, like the emergence of what Donald calls "mimetic" culture (gestures and other bodily communication) (ca. 2 million years ago); the shift from Oldowan tools to more sophisticated Acheleuan tools (1.7 million years ago); and the domestication and increasing use of fire (0.8 million years ago, if not earlier). The first appearance of spoken protolanguage and orally transmitted wisdom (starting perhaps 500,000 years ago) also predate our own (sub-)species of *H. sapiens*. (Donald 2001, 259 ff.; also Sterelny 2016.)

[6] It is good to bear in mind though that such steps never break out from the continuum of nature. There are no "gaps" in nature, and not even the momentous effects by agriculture or industrialisation removed culture from the rest of the nature (see Dewey LW 1).

[7] Habit involves both the organism and some relevant features of the environment, it is a function of the (often, socio-cultural) environment in the organism (Dewey MW 14).

[8] Another relevant cultural factor may have been the rise of modern individualism. With Dewey (e.g., LW 1: 136–7, see also MW 9: 300 ff., MW 12: 104–9, 190 ff.) and others, we can say "the Individual" was a modernity's child.

[9] Dewey saw that school education should be connected to the children's own world, their home and play. Today, these obviously include the internet environment and ICT, which also provide potent tools for creating learning environments such that can include pupils' own interests even when those interests involve fantasy elements, historical figures, or distant planets. (Kivinen et al. 2016, 384 ff.)