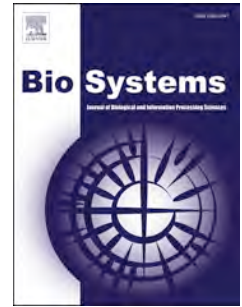


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**SOCIOTYPE AND CULTURAL EVOLUTION****The acceleration of cultural change alongside industrial revolutions****Pedro C. Marijuán\*<sup>1</sup> & Jorge Navarro\*<sup>2,3</sup>**

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**Abstract**

The present work explores, from the vantage point of the sociotype, the dramatic acceleration of cultural change alongside the successive industrial revolutions, particularly in the ongoing information era. Developed within the *genotype-phenotype-sociotype* conceptual triad, the sociotype means the average social environment that is adaptively demanded by the “social brain” of each individual. For there is a regularity of social interaction, centered on social bonding and talking time, which has been developed as an adaptive trait, evolutionarily rooted, related to the substantial size increase of human groups. A quantitative approach to the sociotype basic traits shows fundamental competitive interrelationships taking place within an overall “attention economy.” Approaching these figures via the Planckian Distribution Equation, they can be connected with many other competitive processes taking place in the biological, economic, and cultural realms. Concerning culture, the cognitive limits of the individual, which we consider commensurate with the sociotype general limitations, impose by themselves a strict boundary on the cultural items effectively handled by each individual, fostering the overall competition and decay. Further, the emergence of differentiated generations with ample discrepancy in styles of life, social aspirations, and dominant technologies would represent a systematic bias in the competition and replacement of cultural items. Intriguingly, the cultural acceleration detected in modern societies alongside the successive industrial revolutions, with an ostensible climax in the ongoing fourth industrial revolution –the information era– might be itself a paradoxical consequence of the sociotype’s dynamic constancy.

*Key words:* sociotype, social bonding, attention economy, cognitive limitations, generational bias, industrial revolutions, cultural acceleration.

### **1. Introduction: constancy of the “sociotype” versus acceleration of cultural change**

The main argument of the present work may be summarized as a paradox: that there is a constancy of our overall cognitive capability in relation with the external world, symbolized by and rooted in the “sociotype” limitations, that strongly conditions the dynamic processes of culture—underlying the general rhythms of maintenance, decay, and replacement of cultural items.

First, what do we mean by the sociotype? Recently coined from two independent sources (Marijuán et al., 2017; see also Berry, 2011; Berry and De Geest, 2012), the sociotype means both the bonding structures of the social environment and the dynamics of social interactions to which the individuals of our species would be evolutionary adapted. So, the sociotype refers to the regularity of our predispositions to social engagement, to establish social bonds, to talk. *Homo loquens* could aptly refer to the most conspicuous trait we may observe in human societies: we endlessly talk. But, *how much do we talk?* And, *with whom do we talk?* A quantitative response to these two interrelated questions, rarely formulated together, was recently attempted in the quest to delineate the sociotype’s core values (Marijuán et al., 2019). In the same way that the central size of human groups seems to oscillate around figures of 100-200 closely interrelated people (irrespective that other grouping sizes are also relevant, see Dunbar, 1996), the daily talking time would also oscillate around central figures, arguably of 3 – 8 hours (Mehl et al., 2007; Marijuán et al., 2019). The instinctive drive to talk on an almost regular basis would be useful to indirectly maintain the bonding relationships of the person and also to explore the possibility of new bonds. Social bonds (along the dimensions of family, friends, colleagues, and acquaintances) and talking time would appear as two different manifestations of the same unitary phenomenon: the sociotype (Marijuán et al., 2017). The sociotype captures the relative constancy of our species-typical social environment.

Evolutionarily, it can be argued that the general limits of our sociality have contributed to establish, at the same time, the overall limits of our cognition. For the mostly social use of our memory-space becomes one of the basic cognitive reserves which can be partially diverted to other endeavors—as an instance, how reading occupies brain space previously devoted to the analysis of natural scenes in the environment and in social interactions is discussed by S. Dehaene (2009). The different contents we may attribute to culture would piggyback on the enormous combinatory possibilities inherent of our sociality, of our sociotype—which are regularly expressed via the combinatory capabilities of language and the instinctive drive to use it.

As said, our main argument will be that this kind of shared relational/cognitive limitation, that we are symbolizing by the dynamic constancy of the sociotype, may

underlie the increasing acceleration of cultural change, so ostensible along the last two centuries. Our limited sociotype would act as a metronome, or better a 'ratchet', for the competition and replacement amongst cultural items and social customs. Importantly, a generational factor has to be considered, as it is via the aggregate interaction within generations that individuals promote – and suffer – cultural replacements and create new cultural equilibriums. Specifically during the last two centuries, the dynamics of creation, decay, and replacement of cultural items along the ensuing scientific and industrial revolutions has been steadily increasing, having reached a climax in the present information era. A series of economic data will be apportioned about that increase. A factor of capital importance along all historical epochs, and particularly in the present times, is the radical changes in the means of communication themselves. For many reasons, new media make possible the advent of the most profound cultural transformations (Hobart and Schiffman, 1998; Poe, 2011).

Several strands of thought will be interwoven in the present reflections: paleoanthropology, psychosociology, cultural philosophy, economic history, information science... All these heterogeneous strands should be brought together into a consistent thesis on the sociotype – and its intrinsic limitations – regarding cultural evolution and its acceleration along the successive industrial revolutions. That's the main goal of the present paper. But it will be a difficult multidisciplinary construction. The point is whether this effort might help us make better sense of new-fangled cultural phenomena that surround these times of globalization and accelerated obsolescence.

Along the sections which follow, we will discuss first, in some more depth, what we mean by the term *sociotype* and its evolutionary background, explaining its main contents and justifying its incorporation into the *genotype-phenotype-sociotype* conceptual triad (Section 2). We will be paying special attention to the different fieldwork data obtained on the quantitative sociotype (Marijuán et al., 2019). They will be approached (Section 3) by means of the "econophysics" of the Planckian Distribution Equation (PDE). From the sociotype point of view, it is like an *invisible hand*, an "attention economy", that adaptively distributes the limited capabilities of social bonding and talking time of each individual within the social scenario, optimizing his/her aggregate fitness under the existing social constraints. Recent work on the decay of cultural items (Candia et al., 2019) and on the decay of scientific publications (Pan et al., 2018; Parolo et al., 2018) will be connected with this discussion, contributing to build a tentative link between the collective "attention economy" and the individual limitations on memory and cognition (Section 4). And in this regard, we will come across the influence of the generational phenomenon, paying special attention to the different cultural imprints that surround the emergence of each generation and the resulting bias in the social maintenance of cultural items (Section 5). We will enter into a series of economic, technical, and scientific data that will buttress our main argument on the accelerating effects of the successive industrial

revolutions (Section 6). Then, the economic data of different countries and on a world scale will be examined with more detail, particularly looking for the growth trends during the last two centuries and discussing the ostensible consequences for the world of culture (Section 7). We will finally refer to the cultural inflationary dynamics of the Information Era and will argue about the unintended consequences of this Fourth Industrial Revolution (Section 8). And in the concluding comments section, we will summarize the fundamental points of our whole argumentation.

## 2. Evolutionary background

Sociality is an essential trait of the human species—as Aristotle put in *The Politics*, Book 1: “*man is by nature a political animal.*” Indeed a number of crucial novelties of our evolutionary and historical past revolve around the complexification of essential aspects of sociality: origins of language, emotional communication, in-group behavior, cooking and sharing of food, domestication of other species, cultural systems, morals and ethics, religious and legal codes, political institutions, knowledge accumulation, and so on (Diamond, 1998). So fluid and culturally diverse are the emerging structures of human sociality that, apparently, they defy any precise classification or quantitative specification. Traditionally, a number of schools of thought have followed culturally-oriented approaches to this open ended phenomenon of human sociality (Mead, 1964; Derridá, 1976; Lévi-Strauss, 1981), while some others have emphasized views closer to biological determinism (Lorenz, 1965; Wilson, 1977; Barash, 1986). More recently, however, some evolutionary, anthropological, and social science approaches have achieved an interesting degree of convergence about fundamentals of human sociality (Chapais 2008, 2011; Tomasello, 2010, 2019; Henrich, 2016). In particular, hypotheses such as the “Social Brain” have contributed to advance a new brain/communication perspective on the evolutionary emergence of human sociality. Other related approaches such as the “Cultural Brain Hypothesis” (Henrich, 2016) or the “Cumulative Cultural Brain Hypothesis” (Muthukrishna et al., 2018) have provided further explanation on the singular evolutionary pathways, culturally centered, that have propelled the fast expansion of human brains and the many original aspects of our societies and our psychology—including our extraordinary ontogenetic learning capabilities (Tomasello, 2019).

### 2.1. Brain size and group size: “bonds”

Actually, the idea of relating brain size with the demands of communication in social life was already hinted by C. Darwin in “*The Descent of Man*” (1871). More than a century later, Whiten and Byrne (1988) reconsidered the idea and framed it as a social hypothesis. Known as the Machiavellian intelligence hypothesis, it was more rigorously formulated as the “social brain” by J. Allman (1999), R. Dunbar (1996, 2004) and others, extending it into different mental and biomedical fields (Baron-Cohen et al., 1999; Badcock and Crespi 2008). Although the hypothesis has been criticized from

several grounds and cannot be extended to the generality of mammalian societies (Balter, 2012), nor can be neatly separated from ecological drivers (DeCasien et al., 2017; González-Forero and Gardner, 2018), it attempts a cogent evolutionary explanation of natural groups and bonding structures in human societies. At the very least it has contributed to the popularization of the topic beyond scientific circles: the famous “Dunbar’s number” of 150-200 ‘friends’ (or maybe acquaintances) found in numerous media reports. Critics of Dunbar’s number (Read, 2012; Dezechache, 2012) have pointed out the lack of empirically well authenticated studies about that figure, as well as the strange ‘variance’ usually provided ( $\pm 50$ ). Killworth and Bernard have given estimates close to 300 individuals (Killworth et al., 1990) following a power law, and in (Marijuán et al., 2019) the average number of total contacts is about 100 individuals, in this case following a Planckian distribution (a biexponential power law) that we will comment later on. In any extent, there seems to be emerging scientific consensus on an average of social networking, with very ample upper and lower limits, concerning the number and types of bonding relationships that an individual is able to maintain (Dunbar, 2004; Dunbar and Shultz, 2007; Fowler and Schreiber, 2008; Hill et al., 2011; Marijuán et al., 2017, 2019). And this ostensible limitation in the number of bonds, in the very extent of the sociotype, represents one of the basic tenets of the present approach.

Herein the emphasis will be put, not only in the size of social groups, but also in the communication practices that underlie the formation and maintenance of the individual’s bonding networks—conversation. In itself, every interpersonal bond is but a “shared memory”, consisting in specialized neural engrams that encode a variable number of ad hoc behavioral episodes – most often linguistic exchanges – in between the concerned individuals, positively or negatively finalized according to their valence (Collins and Marijuán, 1997). Distinguishing several classes of bonds (related to their strength and valence) is important in order to assess the main categories, or better dimensions, within the relational sociotype of the individual—family, friends, colleagues, and acquaintances appear as the basic sociotype dimensions (Marijuán et al., 2017). Depending on their preferences and temporary circumstances, individuals will variably distribute among these categories their relational capabilities and bonding potential. In all these cases, rather than static collections of recognition events, social bonds become dynamic memory constructs ensconced upon complex synaptic engrams that occupy an important quota of cortical space, presumably with each bond’s occupancy depending on its specific contents, valence, and strength. That these bond engrams rely on vast cortical spaces would be in accordance with the relevant multi-area activations produced by social interactions and social evaluations, as observed in different neuroimaging studies (Greene, 2001; Iacoboni 2004; Caccioppo and Patrick, 2008). Our social interactions have also shaped our whole perception systems, particularly the visual (Abassi and Pappeo, 2020), as well as the auditory, tactile, etc. Overall, the cortical conformation and capacity of our species, vastly enlarged regarding other Anthropeidea (Allman, 1999), have made possible the really

high number of bonds, the substantial sociotype, which comparatively human individuals can meaningfully sustain and renew via communication practices.

## 2.2. *'Languaging' as virtual grooming*

In many respects, language appears as the essential tool for bond-making in human societies, although not the only one (Benzon, 2001; Dessalles, 2007; Tomasello, 2010; Navarro et al., 2016). An important evolutionary aspect of language concerns its physiological effects on the practicing subjects. Could human language be a 'virtual' equivalent of the physical grooming of primates? It has been claimed that a variety of grooming practices (touching, scratching, tickling, chase playing, wrestling, massaging, etc.) are essential to maintain and restore the inter-individual bonds in primate groups and societies (Dunbar, 1996, 2004). The molecular cocktail involved in the grooming relationships activates the reward system in both groomer and groomee, with mutual effects in stress quenching, immune boosting, and learning consolidation, thus contributing to reinforce synaptic bond memories erased within the behavioral noise of those societies (Nelson and Geher, 2007; Shutt et al., 2007). Therefore, human 'languaging' could have been evolutionarily co-opted as a virtual system for social grooming, subsequently stimulating in our "social brain" the production of neuropeptides and neurohormones that relieve stress and boost both immune system and nervous system function (Dunbar, 2004). In addition, the fraction of daily time devoted to this virtual grooming exercise (about 3 - 8 hours) looks congruent with 20-25% of awake time for physical grooming in Anthrozoidea.

The repercussions in daily life cannot be overstated: talking becomes one of the preferred and most affordable types of mental stimulation. Counting with an appropriate network of relationships with people to talk with becomes a necessity for the individual. Having access to and participating in amusing conversations becomes an essential ingredient of our social, psychological, and physical wellbeing (Berkman, 2009; Klinenberg, 2012; Holt-Lunstad, 2017). The contents exchanged are not of much importance. Seemingly, rather than the exchange of functional information, it is trivial conversation, gossiping about common social acquaintances which represents the human equivalent of primate grooming (Dunbar, 1996; Dessalles, 2007). And of further interest, the distribution of our talking times would also reflect its intrinsic competitive background within our attention economy.

Taking into account the existing diversity of possible encounters (as well as the emergence of new communication channels), the daily conversation or communication budget of each individual has to be apportioned among the different bonding classes of his/her sociotype rather carefully, so that the talking exercise becomes sufficiently adaptive to 'fit' in the long term within the social niche around, and sufficiently rewarding in the short term, providing 'grooming' enough. There emerges, thus, a genuine competition and possible conflicting situations among all the possible communication targets that our "attention economy" has to continuously manage (Lanham, 2006) in order to advance individual fitness. Therefore, bonds compete with

each other for our attention, for the allocation of our limited communication time, and the signature of that competition appears in both the distribution of the number of bonds and in the distribution of talking times. The specific fieldwork supporting these relational distributions is described in (Marijuán et al., 2019). The competitive background and the Planckian fit are described in what follows.

### 3. Competitive “Planckian” nature of the quantitative sociotype

Two aspects of the sociotype results are relevant to our present concerns. First, the developmental or *ontogenetic arch* that can be appreciated in the age distribution of the sociotype results. And second, the *competitive processes* underlying the sociotype figures, which surface via the Planckian Distribution Equation.

That there is an ontogenetic arch described by the sociotype along the development of the individual is not difficult to visualize (Berry and De Geest, 2012). It looms under our different tables and figures. We may observe the influence of age segments in the number of contacts, showing the sociotype ‘in the making’, in its temporal evolution from childhood and adolescence towards adulthood, maturity, elderhood, and senescence—all along the course of ontogenetic development. The figures corresponding to family, friends, colleagues, and acquaintances evolve differently along the successive age segments; and similarly the total sociotype contacts and talking times expand, stabilize, and finally tend to collapse—reminding the general developmental trajectory of all dissipative structures (Salthe, 2018). This ontogenetic arch described by the sociotype along the life cycle stages should approximately parallel the neural development of the individual. Culturally, these developmental stages are recognized in the form of different rites of passage (often reflected in formalities and celebrations) that ostensibly place the individual in a different stance in front of all his/her social contacts when completely new phases of life begin—e.g., graduation, marriage, retirement, etc. Particularly, the cultural imprinting received during youth and early adulthood, as we will discuss later, is crucial for the emergence of the generational phenomenon. This imprinting will accompany and orientate the behavior of the individual in a very clear and distinguishable way. Thereafter, along the life course of the individual, the sociotype will form a developmental arch punctuated by irregular variations and by clear discontinuities; perhaps configuring another Planckian curve analogous to those depicted below.

Many considerations and influencing factors, such as personality type, gender, age, cultural background, socioeconomic conditions, etc., can be discussed in relation with the sociotype results (Marijuán et al., 2019). But, overall, like many other studies of social networks, they seem to be pointing at the emergence of a self-organizing landscape of social interrelationships grounded on competitive processes (Strogatz, 2001; Barabási, 2003; Hollstein, 2011; Christakis and Fowler, 2018). There is external competition for personal attention between social agents as well as internal neuronal



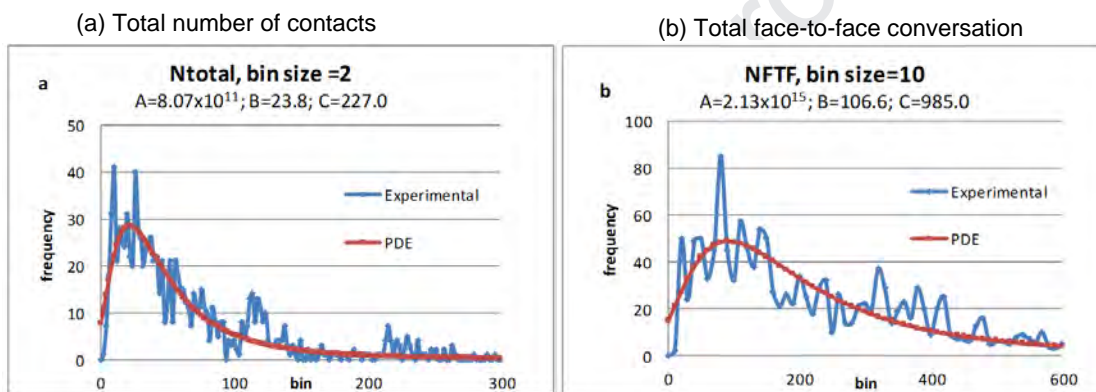
competition amongst inner memories vying for re-expression of their own engram content. These two competitions, internal and external, in fact a single attentional one, would underlie the communication phenomena of our social world in all epochs—and not only in nowadays information society.

As Lanham (2006) has posited, the “economics of attention” relates to the commodity in shortest supply in the present Age of Information: human attention itself. But herein we argue that such economics of attention would be inherent of all societies sufficiently complex, whenever the ‘natural size’ is achieved and the relational capability of the individual becomes overstretched. Insensibly, all our daily contacts and communicative interactions are caught within the general competition for attention. We optimize and we select with whom we want to talk and with whom we want to bond (or at least we try to do that). And we see our selections as spontaneous and natural within the different familiarity circles, paying differentiated attention along the specific valence and emotional overtones of the different relational domains. But the strength of some tight bonds does not mean that they are competition-free. For the sociotype is configured as an open and dynamic space, always involving a discrete – or not so discrete – exploration of new acquaintances, friendships, or even intimate partners. Old bonds may insensibly dissolve while new ones emerge. This extended competition for relational bonds configures an always changing scenario of social “partitions” that becomes a universal trait of human societies. Although it can be culturally modified and regimented in multiple ways, the competition is always there, providing each individual with relational potentialities for his/her social fitness leverage, for getting the own piece of the social tart. Nowadays it is easy to see this kind of extended competition as a characteristic of the virtual world or of the economic sphere, the latter apparently seen as the fundamental realm. But perhaps the opposite would be closer to the truth—the other competitive arenas would appear as derivatives of the fundamental one, the relational.

Looking for formal approaches to the number of social contacts and the communication times in the sociotype results, a power law could be considered as the most cogent fit, as is usually claimed in the social networks field—see for instance the multidisciplinary compilation by G. West (2017). These laws would appropriately cover the falling phase of these long-tailed histograms, but would fare not so well in the rising phase. Conversely, the Planckian distribution equation (PDE) developed by S. Ji (2017) becomes a suitable fit. See Figure 1. We think that the fits we have obtained for the different communication histograms in that figure are due to an underlying panorama of scarce cognitive resources that are optimized in a relentless competition for attention.

To reiterate, our social relationships mobilize an “attention economy” with mechanisms similar (actually prior) to our monetary economy and to other competitive domains, as already hinted by H. Simon (Simon, 1971; Gonçalves et al., 2011) and by other relevant authors (Kahneman, 1973; Pashler, 1998; Dukas, 2004).

This is precisely the sense of the Planckian competitive ‘econophysics’ or optimizing selection processes amongst competing distribution possibilities, as highlighted by (Ji, 2017), which is also present in a number of biological and social phenomena: protein folding, RNA metabolism, enzyme catalysis, T-cell receptor diversity, fMRI records, human decision making, econometric distributions, human communication, spoken and written language, etc. Derived from the resolution of the “econophysics” ultraviolet catastrophe, it represents the degree of organization (and hence of order) of a physical/biological/social system resulting from symmetry-breaking selection events applied to some randomly available (and hence symmetrically distributed) processes. In the case of social bonds, the randomness of possible interactions would be progressively selected and channeled into the different relational dynamic domains of the sociotype.



**Figure 1:** Graphical representation of the Planckian distribution equation (PDE) applied to the number of total contacts (a), and to the total face-to-face conversation time expressed in minutes daily (b). In both cases, the PDE was derived from the Planck's blackbody radiation formula by replacing its universal constants and temperature with three parameters, A, B and C, resulting in  $y = (A/(x + B)^5) / (\exp(C/(x + B)) - 1)$ , where  $x$  is the bin number of the histogram under analysis and  $y$  is the frequency. The numerical values of the PDE parameters were initially 'guessed' and the best-fitting parameter values were obtained using the Solver program in Excel. From (Marijuán et al., 2019), with permission.

#### 4. The decay of cultural items and the limits of cognition

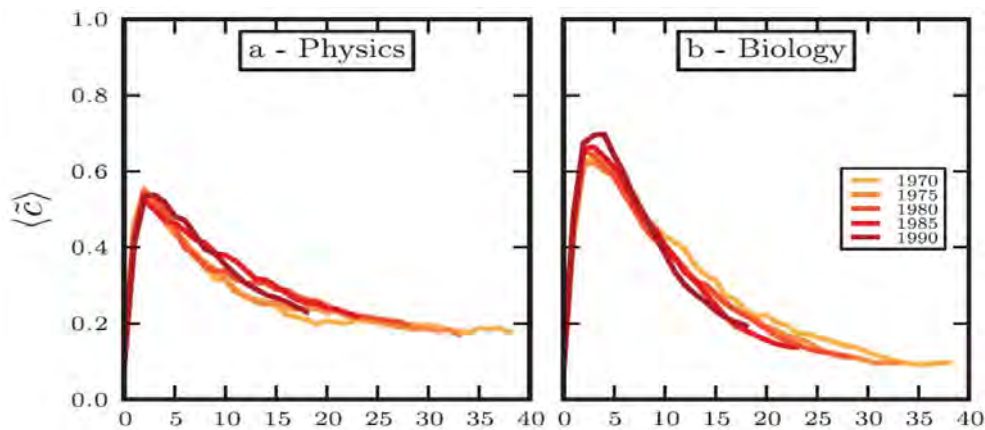
##### 4.1. Universal patterns of decay

In a recent approach, Candia et al. (2019) study the decay of attention and the collective memory in a variety of cultural products, using data on domains such as scientific publications, patents, songs, movies, and biographies. They test the hypothesis that the decay of the attention received by these cultural products involves interactions in two different domains: communicative memory and cultural memory.

The former relates to oral exchanges and the latter to records on material supports, both maintaining an asymmetrical relationship—with a regular flow from the former towards the latter, say, from conversations towards the written stuff. Subsequently a mathematical model is built that predicts a biexponential decay function, which is statistically better than the exponential and log-normal functions used in the previous literature. Three parameters of the biexponential function would adjust to the different rhythms of decay of the different classes of cultural products. Their suggestion is that, across the different cultural domains, the model captures a “universal feature” of the decay of human collective memory.

We argue that competition within an attention economy could be the underlying factor that manifests itself as a “universal feature”. This feature could be formally approachable via the biexponential functions developed by Candia et al. (2019), or alternatively via the PDE, which is also a biexponential function with three adjustable parameters as already noted in the quantitative sociotype’s distributions.

The “attention economy” is also invoked in other recent approaches to scientific production metrics (Pan et al., 2018; Parolo et al., 2018). Interestingly, these authors assume a finite capacity for individual knowledge, and they see the functionality of the science citation network as an infrastructure supporting the collective memory of science (Pan et al., 2018, p. 656). Currently, the overstretching of cognitive limits for researchers’ attention and expertise would force them to adapt by narrowing their breadth (range of expertise at the knowledge frontier) and depth (sector area reaching deep knowledge). There would also appear other deleterious consequences related to the imbalance between production and consumption in current scientific research and in the related citation inflation (Parolo et al., 2018). In Figure 2 we can see a highly representative item of the decay of publications: the average citations that a scientific paper receives over time in two scientific domains—physics and biology. Certainly these figures can be compared with the sociotype curves approached by the PDE in Figure 1. To emphasize the clear rising phase of this type of curves, so problematic for simple power laws.



**Figure 2:** Normalized number of citations per year received by papers in Physics and Biology after being published. Abscises represent the years passed. Normalization is done by dividing the number of citations by the peak value reached by the paper. For both disciplines, the averaged citation trajectories are calculated for papers in the top decile (top 10%) based on their total number of citations. Following (Parolo et al, 2018), modified, with permission.

In sum, like in the sociotype itself, the “universal feature” of decay, either in the short term or in the long-term, either in science or in cultural realms, would result from the competition for individuals’ limited attention – and limited brain capabilities – by a multitude of alternative cultural products within an overall attention economy. In the general decay of cultural items, the interactions between the oral communicative stuff and the different classes of recorded stuff look so tight and so numerous that separating these two categories along the multiplicity of processes involved becomes arduous, if not futile. A continuous, unitary competitive phenomenon, related to the vagaries of individual cognition, looks more cogent in spite of the endless kinds of bias that may intervene—or precisely because of that very biasing multiplicity.

#### 4.2. Forgetfulness and the limits of individual cognition

As stated, our argument on the “universal feature” focuses in the limited brain capability of each individual that fosters competitive processes—and forgetfulness. According to our discussion in Section 1, if sociality has been the great shaper of our brain growth, due to the management of social life within oversized groups finally limited by our cognitive capability, then the shared cultural repertoires effectively handled by individuals could hardly have an unlimited size. If natural social groups tend not to surpass 200 individuals (Dunbar’s number), and if languages tend to articulate a core of around 10,000 words, we have at least a little inkling on the limits of individual/social cognition—perhaps commensurate with the interactions of 100 x 100 individuals? Echoing the “*cognits*” term proposed by J. Fuster (2003), these are understood as consistent items of knowledge about the world (both external and

internal and their interaction) formed by multiple elementary sensory-motor constellations of memory that together work efficiently in some specific context. Cognits are neither “memes” nor “concepts”; they are closer to “schemas” as they integrate observation, action, and thought; and they can also be combined, integrated into hierarchies, projected, associated, etc. What matters is the efficient cognitive guidance that they should provide to the behaving individual and that they could be actively shared in the cultural niche. Leaving aside the many complexities surrounding our memories (Schacter et al., 2012), the question would be: How many cognits can individuals retain? Or in other words: What could be the average of individual cognits within a particular cultural niche? The term *personbyte* (Hidalgo, 2015) has been proposed to represent the maximum of personal knowledge, the human carrying capacity. Thereupon, the social strategy to overcome that universal cognitive barrier would consist in chopping down the overall knowledge problems into separate fragments and reuniting/recombining them via continuous communication in social networks. The social process of knowledge compartmentalization into separate ‘specialties’ and their multiple integration and recombination would be at the basis of all forms of social complexity.

But a complementary aspect is that, with the passing of time, inactive cognits, or inactive cognit complexes, suffer the decay process, the ominous fall into oblivion. Far from being negative, forgetfulness for lack of use turns out to be a very convenient process, as it liberates mental space for new generalizations and for potential newcomers. And the faster the arrival of such newcomers, the quicker will be the decay and oblivion. In that respect, Jorge Luis Borges’ character “Funes the memorious” (*Funes el memorioso*) achieves super-human powers of memory after an accident, but his world becomes one of intolerably uncountable details (Borges, 1944). Funes is incapable of crafting new ideas, generalities, or abstractions; his reasoning has become destroyed by his inability to forget (Quiroga, 2010): *“To think is to ignore (or forget) differences, to generalize, to abstract. In the teeming world of Ireneo Funes there was nothing but particulars.”* Borges was also linking forgetfulness to the general limits of memory. Seemingly he followed a classical estimate by G. Spiller (1902) on how many memories a person has from different stages in a lifetime: around 100 for the first 10 years, 3,600 until 20 years, 2,000 more memories between the ages of 20 and 25, reaching about 10,000 different memories in the first 35 years of life (Quiroga, 2010). These figures, congruent with the growing number of contacts in individual development, remind the ontogenetic arch of the sociotype, and perhaps also remind the 100 x 100 order of magnitude of individual interactions in a stereotypical natural group. In any event, according to these views, could 10,000-20,000 different cognits be an educated guess on the limits that could be accessed by the average individual? Needless to say, these considerations on memory require the customary *cum grano salis*.

In today’s complex societies, our cognizing limitations can be found almost everywhere: from specialized professions to the social division of work, from the usual

length of a book to the teaching contents of courses and programs, from the split of knowledge in separated disciplines to the branching of cultures and subcultures, from the information overload to the fantastic obsolescence of knowledge in this era. The limitation of knowledge appears at the root of all human behaviors. Unfortunately, new items are rather difficult to learn, but very easy to forget. Thus, as new items of knowledge and new social habits proliferate, “the battle for the cognits” becomes tougher and tougher.

The case is that whatever one learns has to pass through the existing rhythms of neuronal reorganization, of synaptic weakening and reinforcement, of synaptic creation and destruction (an amazing role is played by microglia: Wang et al., 2020). Any new learning has to compete with other pieces of learning in order to establish a temporary presence within the cognitive reserve mostly associated by evolutionary design to our most important niche, the social world (Allman, 1999; Dunbar, 2004; Dehaene, 2009; Berthoz, 2012), what we call sociotype—the limited sociotype, actually.

Thereupon, given the “conformity to peers” and the need to maintain social cohesion (Henrich, 2016), a brief glance on how collective dynamics of cultural change is superimposed upon the individual cognitive limitations becomes of utmost interest. In other words, how our powerful ontogenetic skills of social learning have been mastered – mobilized or immobilized – along the different epochs.

#### *4.3. The renewal of cultures*

In evolutionarily terms, stasis has marked the emerging cultures of our species during almost 99% of its existence. The survival of human groups was tied to very rigid social rules and slowly changing cultural products, and indeed it was so until the arrival of the Neolithic revolution. Once agrarian and husbandry production stabilized and cities could emerge (Diamond, 1997), cultures and civilizations broke with the immensely long period of stasis. Commerce, migrations, conquests, etc. lead to the historical interbreeding of cultures. The selection processes among competing ideas, products, customs, behaviors, etc. turned out to be more active and almost inevitable—and with them, the decay of outdated, discarded cultural products.

From the historical perspective of ‘modernity’, we may see more pungently the competition argument. The secular influence of ancient written works, for instance, was suffering a moderate, almost negligible, decay during medieval centuries. They were the model to follow, the genuine paradigm of learning... until the diffusion of a flood of new ideas and new works throughout the printing press that dramatically altered the panorama of intellectuals’ attention –and of many other social agents (Hobart and Schiffman, 1998; Poe, 2011; Wootton, 2015). Particular historical factors were at play in the different cultural areas, encouraging or suffocating the consequences and possibilities of the new, ‘modern’ intellectual order generated via the printing press (Huff, 2011). But in the aggregate and in the long term, the historical

consequences of the continuous competition of ideas and new written works were momentous: geographic discoveries, religious crisis, scientific revolution, political revolution, industrial revolution... Generation after generation, Western societies were caught in a continuous process of reinventing themselves.

That the renewal of societies along the ceaseless competition and universal decay of ideas, cultural products, material products, etc. could also be made “on a generational basis” represents an intriguing twist, an important additional factor to consider. If the subtle bonds emerging amongst people of a similar age turn out to be a relevant player in the dynamics of cultural change, the next question to examine in the present context is: What are “generations”? How do they play their influence in the decay and renewal of cultural items?

## 5. The idea of generations

Plutarch, in his biography of Lycurgus, cites three verses in which three generations of Spartans boast about their own might. The verses are supposed to be recited by each choir of warriors:

*The old ones:* We have been very strong warriors.

*The young:* We are: if you have won - look us in the face.

*The boys:* But we will be much stronger still.

The exchange appears in one of the emblematic texts of José Ortega y Gasset (1933) about the method of generations. Evidently, generations refer to the most fundamental fact of social life: birth and death, parents and children, life cycles in their continuity. Generations represent the different “ages of life” as separately grouped within the whole community. For the Ancients, life was composed of three ages: youth, adulthood, and senescence; or alternatively four: childhood, young adulthood, midlife, and old age. For Ortega y Gasset (1923, 1933), the usual interval in between parents and children, 30 years, becomes the basic generational granularity. Additionally, semi-generational periods or intervals of 15 years may appear either before and after the essential events or figures that mark the generation, or just at the middle of the whole period; they usually represent a distinguishable change of mood or cultural sensibility within the generation (forerunners vs. successors). The most formative period to internalize the new generational values and attitudes is adolescence; from 15 years old onwards there is a period of rejection of the traditional way of life and a frantic search of the new. The search culminates at the end of youth, from 25 to 30 years, when the individual starts his/her autonomous life project incorporating most of the new attitudes, cultural fashions, sexual mores, family ideals, political and societal values, etc.—the new life style that his/her generation purports.

Historically, the most formative events for crafting the new spirit of a generation have been wars and liberation events, or social crisis of utmost severity (plagues, famines,

catastrophes...); or waves of prosperity and abundance; or the appearance of a towering leader; or the emergence of a fundamental means of communication (e.g., printing press, TV, Internet). Looking at the historical succession of generations, one of the most popular theories on generations (Howe and Strauss, 1991, 1997) postulates the emergence of a curious sequence of very different “social persona” embedded in the peculiar spirit of each generation, alternating the collective moods within a complete period of around 90 years. It is the *saeculum*, a secular oscillation that seemingly dominates most of Western history (focusing in the US and the UK data) so that cyclical periods of crisis, high, awakening, and unraveling can be neatly distinguished, and with them the predominance of the respective personality archetypes (idealist, reactive, civic, and adaptive).

Influential works about the generational phenomenon are due to K. Mannheim (1928), J. Ortega y Gasset (1923, 1933), N. Howe and W. Strauss (1991, 1997), R. Putnam (2000), and many others. Although not strictly generational, the recent works by the Cliodynamics school of thought try to model the different cyclicities distinguishable within historical dynamics. Their models are based on combinations of a variety of data: historical, demographic, economic, political, cultural, technological, etc. (P. Turchin, A. Korotayev). One of their predictions is a severe instability peak in the 2020s due to declining well-being and elite overproduction and conflict (Turchin, 2016).

As stated, generations cannot be fixed beforehand: they emerge with a variable periodicity and with a variable degree of differentiation. In this respect, an intriguing panorama can be described in today’s societies. According to US sources (Cagle, 2018), five generations would be currently active in that country: *Generation Z* (26% population, born in between 2000-2018), *Millennials* (22% pop., b. 1976-1990), *Generation X* (21% pop., b. 1964-1982), *Baby Boomers* (25% pop., b. 1945-1963), *Silent Generation* (3% pop., b. 1926-1944). We may consider that most *Boomers* have already been replaced from power by the *Xers*, that the *Millennials* are actively engaged in their ascension, and that the *Zers* are just new comers to the social arena. To note that most of these recent generations have been attributed shorter durations, around 20 years each or less (so, closer to Ortega’s semi-generations), while historical generations of previous centuries were closer to 30 years.

From the point of view of the limited sociotype, the continuous mixing of generations is highly consequential. If we tried to identify the generational origin of the active cognits present in an individual, we would find, quite probably, a dense mixing. The main content would be biased towards the peers, of course, as peers, i.e. the closest individuals of the generational cohort (friends and colleagues in the sociotype dimensions), are clearly recognized by social psychologists as the main force driving the development of personality and life style (Pinker, 2009). But this would be accompanied by a series of decreasing influences from the preceding generations—in a nuanced degradation of the past. The non obvious point about that mixing is that the hypothetical stock of cognits available to the educated individual has to be adaptive,



efficiently linking to the existing social milieu. And this has to include not only the traditional contents of culture, but also the navigation in economic, educational, professional, technological, political, urban and –nowadays– digital spaces. What consequences may imply the overabundance of specialized new cognits regarding the maintenance and decay of cultural items?

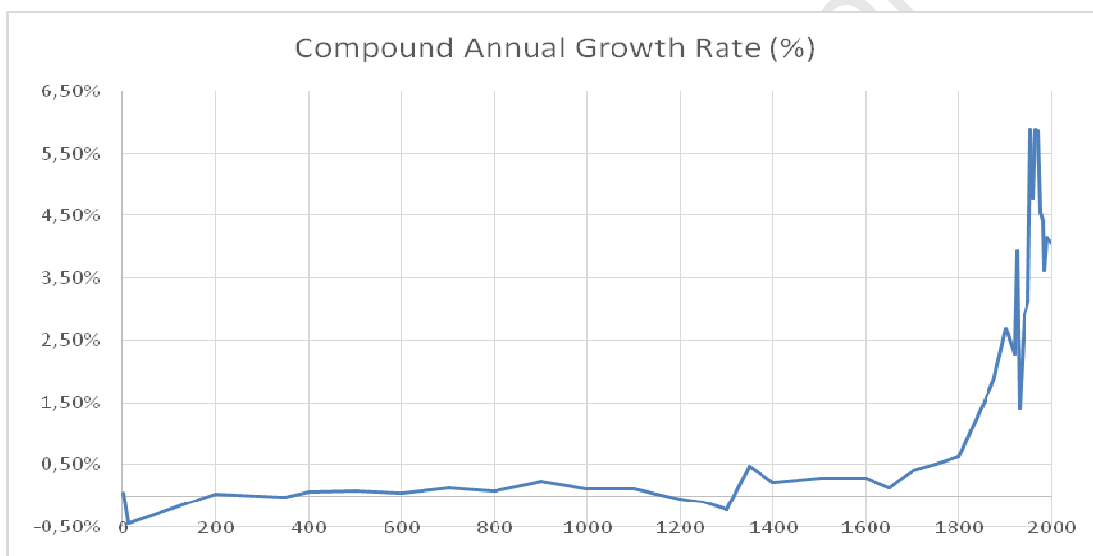
## 6. As the economy grows...

Fundamental economic factors have been often cited as the main movers of social evolution. The extent to which they directly contribute to accelerate the rhythms of replacement and decay of cultural items – becoming a *proxy* for intergenerational change – is an essential part of our argument.

For simplification, if we consider the ‘natural’ interval of 30 years for the successive generations, there is a striking fact to observe (partially commented in 4.3): that the deepest cultural and social changes occupy a tiny interval of less than 10 generations—from the onset of the industrial revolution to our times. Previously, there is another set of about 10 generations, from the Era of Discovery until the industrial revolution, in which the revolutionary intellectual order promoted by the printing press was developed (Wootton, 2015). And historically, there were around 400 previous generations, starting with the “Severing” age (Morton, 2017), that had passed with a comparatively modest although crucial legacy of civilization tools that were separating us from nature—plus another 10,000 human generations that had lived in an almost complete cultural stasis.

Then, after the onset of the industrial revolution something enthralling, really extraordinary, occurs. Approximately, with every passing generation the existing wealth increases systematically, almost geometrically (Landes, 1998; Pinker, 2018, Rosling et al., 2018). On average, every 30 years the whole wealth of the countries following the pathways of industrialization was increased at least by 50% —and in many periods above 100% or far more. We will see the economic data later. But that systematic growth means not only an enormous increase of wealth during the successive industrial revolutions; it also means the approximate duplication on a generational basis of other crucial correlates. We can witness the near doubling of strategic items such as: the number of engineering and technological inventions (Hughes, 2004; Arthur, 2009, Poe, 2011), the number of working scientists and engineers (Landes, 1998), the number of research fields (Marijuán et al., 2012), the inflation of scientific publications (Feist, 2006; Pan et al., 2018)), the global energy consumption (Smil, 2017; Rhodes, 2018), the population living in cities (Batty, 2013; Rhodes, 2018), and probably the same goes for buildings, factories, roads, infrastructures, civil servants, administration, sanitary and education personnel, and so on and so forth. In each generation, it is an entire world anew!

Formally, it can be argued that with the “Era of Discovery” some Western societies started a new, enhanced process of combinatorics of ideas. And that after 10 generations or so, the enhanced combinatorics finally percolated into the world of products and services. A threshold was crossed, then, regarding the “adjacent possible” (Kauffman, 2019) and an exponential course was initiated for the most essential aspects of economic and social life. See Figure 3, which reflects the global pace of economic development (world growth rate) during the last two millennia. Until circa 1700, there is no appreciable growth, with rates close to 0 or negative, or 0.5% in some rare positive peak. Clearly after 1800, growth rates steadily escalate and they achieve about 1900 the rate of 2.34 % that implies a complete intergenerational doubling of global wealth.



**Figure 3:** *Estimated annual growth rate for the whole world economy, over the last two thousand years. The data presented from 1990 onwards are from the World Bank: <http://data.worldbank.org/indicator/NY.GDP.MKTP.PP.KD> (accessed on April 16, 2017). Data earlier than 1990 are based on the growth rates implied by Maddison data. They are published in <https://www.rug.nl/ggdc/historicaldevelopment/maddison/> (accessed April 2020).*

The argument deserves more discussion—and data. In Table 1 we have put the economic achievement of different countries, the GDP ppp figures (gross domestic product in purchase power parity, expressed in international \$ of 2011) every 30 years, and in Table 2 we have calculated the corresponding growth rates for the same intervals. After the continuous stagnation of all the previous centuries, we observe in the period 1810-1840 a fast intergenerational growth above 50% for the UK, Germany and the USA, the latter with an amazing 180%; these are the early birds of industrial revolution, followed in the next period by France and Russia, and later on by Japan, Italy, and Spain. In the case of China and India, they achieved the growth rhythms of

the industrial revolution only well into the 20th Century and in the recent decades, when these two countries have reached fantastic intergenerational rates in the order of 1000% and 500% respectively. The case of Spain, with more than 400% of intergenerational growth in late 20th Century is also remarkable. Russia (during the USSR period) achieved close to a good 300%. This country, Italy and Japan have comparatively faltered during the last period analyzed (1990-2018).

**Table 1: GDP (ppp) per country during 1810-2018, every 30 years\***

<b>GDP (ppp) in Millions international \$</b>								
<b>Country/Year</b>	<b>1810</b>	<b>1840</b>	<b>1870</b>	<b>1900</b>	<b>1930</b>	<b>1960</b>	<b>1990</b>	<b>2018</b>
<b>CHINA</b>	342,317	404891	401,861	353065	515,817	603,134	1,760,886	22,566,550
<b>USA</b>	18,037	50,698	166,054	519,234	1,352,226	3,335,472	9,306,061	17,909,532
<b>INDIA</b>	180,384	198,801	225,103	286,928	354,887	442,379	1,499,808	9,136,965
<b>JAPAN</b>	32,520	35,076	41,982	79,066	175,673	430,222	3,717,842	4,969,486
<b>GERMANY</b>	41,564	64,695	112,006	246,827	454,049	1,044,079	2,505,592	3,712,598
<b>RUSSIA</b>	44,930	61,816	99,351	201,937	315,363	1,255,083	3,071,063	3,563,805
<b>UK</b>	47,339	83,927	165,372	304,738	404,222	707,098	1,526,097	2,663,825
<b>FRANCE</b>	55,049	72,967	126,807	173,400	289,619	515,805	1,667,824	2,541,113
<b>ITALY</b>	49,440	56,704	72,668	116,443	236,555	499,499	1,766,399	2,085,390
<b>SPAIN</b>	17,989	22,161	29,618	50,082	104,189	173,350	919,508	1,609,048

(\*) The Gross Domestic Product by purchasing power parity (PPP) attends to the currencies' respective purchasing power, expressed in 2011 international \$. All these data have been extracted by the authors from the chart animation in: (<https://www.youtube.com/watch?v=4-2nqd6-ZXg>). Source: The Angus Maddison Project & World Bank, <https://www.rug.nl/ggdc/historicaldevelopment/maddison/maddison-project-board> (accessed April 2020).

**Table 2: Variation rate of GDP (ppp) per country during 1810-2018, every 30 years\***

<b>GDP Growth (annual %)</b>								
<b>Country/Year</b>	<b>1810-1840</b>	<b>1840-1870</b>	<b>1870-1900</b>	<b>1900-1930</b>	<b>1930-1960</b>	<b>1960-1990</b>	<b>1990-2018</b>	<b>TOTAL 1840-2018</b>
<b>CHINA</b>	18.28	-0.75	-12.14	46.10	16.93	191.96	1,181.55	1,441.91
<b>USA</b>	181.08	227.54	212.69	160.43	146.67	179.00	92.45	1,199.85
<b>INDIA</b>	10.21	13.23	27.47	23.69	24.65	239.03	509.21	847.49
<b>JAPAN</b>	7.86	19.69	88.33	122.19	144.90	764.17	33.67	1,180.80
<b>GERMANY</b>	55.65	73.13	120.37	83.95	129.95	139.98	48.17	651.21
<b>RUSSIA</b>	37.58	60.72	103.26	56.17	297.98	144.69	16.04	716.44
<b>UK</b>	77.29	97.04	84.27	32.65	74.93	115.83	74.55	556.56
<b>FRANCE</b>	32.55	73.79	36.74	67.02	78.10	223.34	52.36	563.91
<b>ITALY</b>	14.69	28.15	60.24	103.15	111.16	253.63	18.06	589.08
<b>SPAIN</b>	23.19	33.65	69.09	108.04	66.38	430.43	74.99	805.78

(\*) All these rates have been calculated by the authors from the figures of Table 1. Source: The Angus Maddison Project & World Bank, <https://www.rug.nl/ggdc/historicaldevelopment/maddison/maddison-project-board> (accessed April 2020).

The whole data of Table 1 and 2 could tell quite many stories about the struggle for world power and the geopolitical commotions occurred during the last two centuries. The expansion of the industrial revolution was far from smooth, as it was accompanied by deep social conflicts, political upheavals, and imperialistic confrontations (Ferguson, 2017; Rhodes, 2018); it emanated from the UK plus a few pioneering countries, those cited with the higher initial growth rates, and progressively arrived to more and more countries. Later on, the cornucopia of new technologies and products from the second and third industrial revolutions multiplied the whole combinatory effect of the “adjacent possible”. And there emerged: electricity, combustion engines, cars, aviation, electronics, communication, computers, and a great improvement in sanitation and general health. This powerful set made possible the onset of the present globalization period and the extension of the modern economies and the new ways of life – in just a couple of generations – to almost every country and every continent of the globe. The sheer contrast with the stagnation of previous centuries is almost unimaginable.

## **7. As the economy grows... the past recedes**

As the economy has fantastically expanded, what has happened with the world of culture, with the permanence and decay of cultural items and ways of life?

Looking in generational terms, the steady economic accumulation we are referring could be seen as if every successive generation had been able to build by itself a new material world of paramount size – often bigger – than the received one from the previous generation. Two physical worlds factually amalgamated into one: the old and the new coexisting, but with a competitive advantage for the latter. And this presumably has occurred in every relevant sense, including the world of culture and multiple aspects of social life. It has not been due merely to the material goods and the global wealth created. The biggest impact corresponds to technologies. As we create them, they change our lives in far more senses than we think.

The successive waves of technological inventions have inexorably changed social customs, ways of life, uses of time, and the different habits and pieces of learning necessary to navigate in economic, technical, educational, professional, recreational, legal, political, urban and –nowadays– digital spaces. All of them have been utterly changed. And with the successive waves of change, the steady maintenance of culture as seen in previous centuries has faltered, and even collapsed.

Thereafter, as our argument goes, with each passing generation the available cognit space to be shared in the mixing with the legacy of the previous generation has continued to be basically the same; and this has forced a substantial loss of that very legacy. It means that if the emerging youth culture has become very dissimilar, bluntly imprinted by the surge of physical and mental novelties invading most corners of life, the mixing will be highly asymmetric, and far from keeping a balance with the legacy of the main competing generation. An important part of the accumulated legacy will become inactive, then, relegated to relatively inane written records or visual archives, and far from having a vital influence in social customs. Reminding what Figure 2 was telling about the decay of scientific citations, those relegated items would be pushed towards the extreme in the long-tail of the curve. The ascending part of the curve will now be occupied by the fashionable new comers.

Thus, as industrial and postindustrial economies have imperviously grown, with their mounting retinue of cognitive, technical, material, and entertainment loads, the past has systematically receded at a similar speed. The fraction of the past which is effective, that can be seen as “*vigente*”, as active or valid, has diminished dramatically—close to being systematically halved with every passing generation. According to a recent empirical quest (Liu, 2019), the living memory of contemporary society would be anchored to foundational events spanning a few generations—just three. As the economy grows, the fraction of the past which is effectively kept in mind recedes.

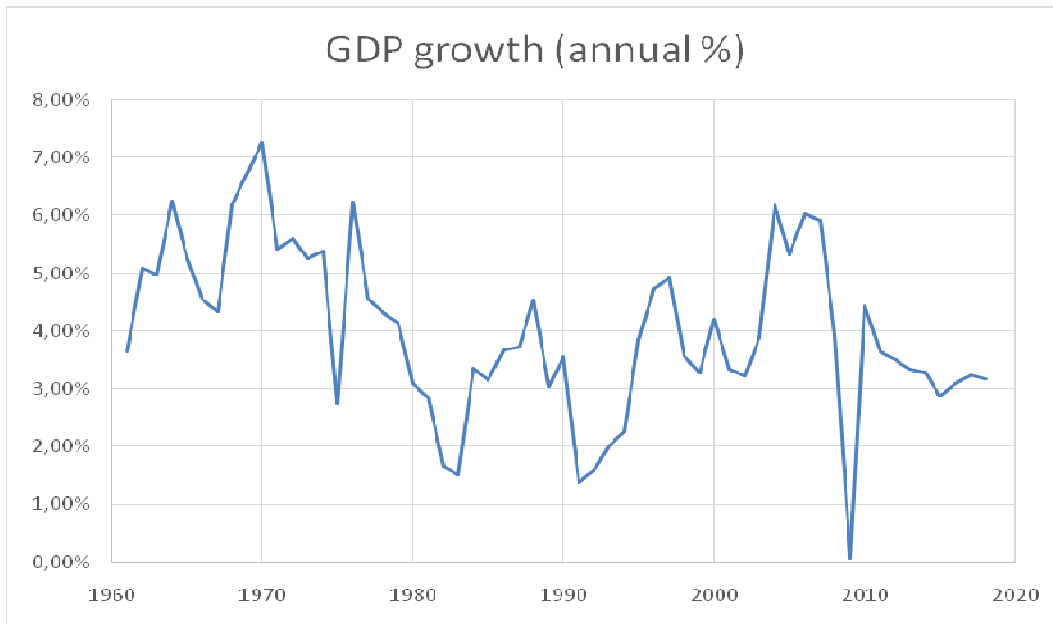
Which fractions of culture have been most affected by this generational decimation, by the approximate cutting in half of the intergenerational legacy? Possibly, the most salient fact of the last two centuries – apart of the revolution in science and technology – was the development of completely new ways of thinking and the exacerbation of social unrest. In fact, the new age of industrialism and social upheavals revolutionized all forms of cultural and social narratives—of storytelling. It was felt paradigmatically in novels, drama, opera, painting, cinema, music, and in all ways of entertainment (Booker, 2004). The changes in music, for instance, during last generations are enthralling (Benzon, 2001). Literature itself becomes a most revealing guide. In spite of their huge thematic diversity, Charles Dickens, Herman Melville, Thomas Hardy, Honoré Balzac, Emile Zola, Benito Pérez Galdós, Pío Baroja, and a number of other great novelists, would show a curious new trait. In many of their works they could not help but complain: for the fast disappearance of their own times; for the loss of their favorite cafes, theaters, and places; for the unstoppable “progress” and massification of their cities; for the advent of new impersonal and impolite styles; for the awful new fashions and tastes; for the ignorance and barbarianism of the young colleagues... Perhaps the most important novel of the 20<sup>th</sup> Century, “*A la recherche du temps perdu*,” of Marcel Proust, is an eloquent telling on the physical disappearance of the nobiliary and aristocratic world, replaced by a new business world congested of popularized inventions —trains, bicycles, cars, planes, etc. Along this much extended novel, the melancholy and remembrance of a luminous past in the first volumes gives

way to the amazing kineticism and destructuring of the last volumes, immersed in a new kind of life that the author ostensibly detests. A similar attitude transpires in the pungent criticisms and complaints of “The revolt of the masses” (*La rebelión de las masas*) from Ortega y Gasset (1929). Actually, this generalized sense of too fast change and disappearance was unseen in preindustrial centuries, when generations were following each other within similar economic and cultural frameworks and only separated by the emerging secular oscillations of collective personalities. The sense of loss continues to eloquently resonate in our own times: “*for a few short, dreamy years I was given a glimpse of a lost past, just before it vanished forever. And from then on I knew what I liked.*” (Hitchens, 2019).

## 8. The Fourth Industrial Revolution

An obvious continuation of the above is that along the periods of slow social change distinguishing between generations is difficult. Conversely, when social change is very fast, differences between generations are magnified (Kortti, 2011). Precisely we have called ‘revolutionary’ to those periods of economic and social upheaval when cultures and traditions are radically changed. About the so called “Fourth Industrial Revolution”, according to the proposer of the term (Schwab, 2015), it is a new era of machine and human augmentation and integration that represents a most fundamental change in the way individuals are living, working, and relating to each other. Enabled by its extraordinary technological advances, the new period would be commensurate with the first, second, and third industrial revolutions.

But following the proxy that each wealth-amplifying generation cuts a similar portion out from the cultural legacy of the antecedent generation, which contains in itself the whole decimated legacies of the previous generations, what would happen when the actual wealth has been more than doubled? Because that seems to be the aggregate economic success of the past 30 + 30 years (see discussions on world progress in Rosling et al., 2018, Pinker 2018). The fact is that beyond a sustained growth rate of 2,34%, as we have already stated, the GDP is doubled every 30 years or so. And Figure 4 shows that this has been the case of the world growth rates during the last 60 years. But there is an important difference between the two periods contained in the figure. In the first period (from 1960 to 1990), growth was concentrated in countries such as Japan, Spain, Italy, France (plus Korea, Brazil, Mexico...), while in the second period most of the world growth has been concentrated in the two most populated countries: China and India (with breathtaking figures of 1.100 % and 500 % respectively), with only a moderate growth in the previously industrialized countries. See Figure 4 below, and also Tables 1 and 2.



**Figure 4:** World GDP rate growth from 1960 to 2018. Source: The World Bank Data. <https://data.worldbank.org/indicator/ny.gdp.mktp.kd.zg> (accessed April 2020).

This is the amazing “globalization” phenomenon that started in the 1990s. But more important than the doubled GDP on a world scale is the powerful cultural punch of this economic boom. Cultural change has been amplified by the appearance of radically new communication media (Poe, 2011): computers, Internet, mobiles, social networks; with the addition of bioinformatics, robotics, and artificial intelligence. The overall result is that, probably, there has never been a comparable cultural change in history.

Too many new pieces of learning have been required; too many new automatisms have been learned and imprinted upon the new generation(s) involved. Indeed, the new habits and automatisms have provided unprecedented individual and social capabilities. Echoing Whitehead (1911, p. 42): “*Civilization advances by extending the number of important operations which we can perform without thinking about them.*” But the other side of the coin is that these new automatisms are taking their cognitive toll. Socially, we can only arrange the extra cognits necessary by means of enhanced forgetting. It is to say: “*civilizations evolve through strategic forgetting of what were once considered vital life skills*” (Tracy, 2019). And among these vital life skills, the first wave of casualties of forgetfulness occurs in the world of culture, in the legacy of traditions, stories, rules, and wisdoms linking the individual to the social collective.

In our times, the overwhelming arrival of new cultural items and the parallel acceleration of biased forgetfulness have reached fundamental strata of the collective identity—those which all education systems, religions, nations, and ideologies hardly struggle to maintain unchanged along time. Without any outstanding conflict, crucial traits of the shared past have been lost or relegated, and a fundamental cultural

disorientation has grown in both the ascending generation and the descending one. Traditional gatekeepers of the social information flows have been downsized if not eliminated; traditional intermediary economic structures have been disintegrated; the whole distribution of wealth has been dramatically altered; and the mounting ecological-climatic crisis has added a context of urgency and dramatism. Thereafter, the intergenerational gap in terms of economic change, technological change, cultural change, and communication change has never been so wide, and has far exceeded the potential for a balanced, approximately symmetric generational mixing. No wonder that disinformation, polarization, discord, social unrest, and turmoil are on the rise—tightly accompanied and stimulated by a formidable ignorance of the own cultural past.

There is another class of important consequences: the loss of face-to-face relations. It is the “*bowling alone*” phenomenon that was already detected by R. Putnam (2000). Technological surrogates are increasingly substituting for face-to-face relationships and social bonding structures (Turkley, 2011, 2015); nowadays the disruptions of algorithmic-decision systems are steadily advancing and touching every corner of our daily lives: shopping, communication, social networks, newsfeeds, travel & transportation, commercial advertising, medical treatments, loans and mortgages, insurance policing, bail and parole, and soon even self-driving cars (Benkler, 2019).

New machines, new ways of thought, and new ways of (more isolated) life... The extent to which the accelerated rhythms of technological and cultural change have also affected the inner rhythms of reflection, the substance and style of intellectual production, is hard to gauge (Lefebvre, 2017)—time will tell. Emotionally, an amazing prevalence of information-related disorders seems to be affecting individuals in the Information Society: epidemic of loneliness, depression, stress, collapse of ‘real’ sociotypes, etc. Depression is now the leading cause of disability worldwide (WHO, 2020), and mental illness accounts for up to 40% years lost to disability (Marijuán and Navarro, 2018). Another insidious epidemics, of obesity, is on the rise, coupled with an alarming growth of non-communicable diseases, prescription-drugs abuse (opioids, painkillers, and anti-inflammatories), plus widespread adolescent medicalization. Could it be related to the fact that adolescents are “almost constantly” in front of their cell phones screens? (Abi-Jaoude et al., 2010; Mak et al., 2014; Pipher and Gilliam, 2019). And to the fact that American adults spend at work and at home more than 11 hours per day – most of their waking hours – staring at screens in working, reading, watching, listening to or simply interacting with media? (Fottrell, 2018). Nevertheless, as happens when scientific research impinges on the vested interests of powerful industries and companies (Michaels, 2020), scientific opinions are apparently divided about the consequences of those new habits (Reeves et al., 2020).

In spite of the bounty of new products, inventions, and cultural creations, the previous industrial revolutions could not help but being involved in unrest and confrontation caused by the insidious growth of social imbalances. The thrilling technological and



cultural acceleration of our times, which is full of unintended consequences, probably cannot escape that fate. For some, ours is indeed becoming “The Age of Discords” (Turchin, 2016).

## 8. Concluding comments

It has been a dense conceptual excursion. From the sociotype term, a new construct that attempts the qualitative and quantitative description of the social niches to which humans are adapted, we have jumped to the attention economy present in our social interactions, to the competition underlying the decay of cultural items, to the emergence of the generational phenomenon, to the economic proxy of cultural change, and finally to the consequences of the explosive growth of industrial revolutions.

Although in the reporting of some sections the sociotype has apparently ended to be submerged to the subliminal, we should remind that the economy of attention is an outcome of the limited communication capabilities and the limited sociotype itself, that the necessary forgetfulness is also a children of our cognitive limitations, that culturally differentiated generations emerge due to the juvenile imprinting upon individuals caused mainly by two dimensions of their sociotype—friends and colleagues. Or that the very cognizing limits implied by the sociotype ultimately provoke the decimation of the received cultural items via myriad of individual preferences, biased choices, and involuntary actions. Indeed the sociotype characteristics have cast a long shadow on our cultural evolution. Nevertheless, the authors are aware that many of the assumptions are still speculative and would demand more careful a discussion than what is possible in the present work. Perhaps putting the central points in a condensed hypothetical form could help further discussion and stimulate comprobatation—or rejection.

1. *The genotype-phenotype-sociotype conceptual triad.* It indicates that our main evolutionary adaptation is to our species-typical social niche. The sociotype would form part of our own nature, with social bonds and ‘languaging’ as its central aspects. The approximate number of bonds (in different domains: family, friends, colleagues, acquaintances) and the corresponding amount of talking time become fundamental quantitative traits. Regularities such as the Dunbar number suggest the existence of a bonding average widely shared, implying the presence of cognitive constraints that limit the indefinite extension of the sociotype. Conversely, social isolation, the lack of social bonds and of a minimum daily conversation, represents one the most important risk factors for mental health and physical health.

2. *Inherent competitive nature of social communicative interrelationships.* The clear constraints in the sociotype quantitative distributions, to which the “econophysics” of the Planckian Distribution Equation (PDE) may be applied, represent an extra argument for considering our communicative interactions as immersed in an

“attention economy”. This seems to widely apply to the world of culture as well. Current approaches to the decay of scientific and cultural items are pointing in a similar direction, and this suggests that there might be a universal law of decay presumably based on a generalized competition stemming from the optimization of individual cognitive resources. The limited sociotype, actually our most important cognitive reserve, symbolizes the extent of such individual limitation.

3. *Cognitive limitation and forgetfulness underlie cultural dynamics.* Maintenance, decay, and replacement of cultural items are necessarily linked to forgetfulness and to the limited cognitive capability of individuals. As intuited by J.L. Borges (1944), there cannot be an unlimited capability for individual memory. The term *cognit*, crafted by J. Fuster (2003), is proposed in order to visualize an order of magnitude for such individual capability. What could be the average global cognits maintained by an educated individual? What kinds of cognits are needed to navigate in a cultural niche, or to follow a particular way of life? How could this cognitive limitation relate to the evolution and renewal of cultures?

4. *Emergence of differentiated generations.* The historical differentiation of generations ultimately relates to the imprinting of values, tastes, and styles of thinking taking place during youth and early adulthood along the ontogenetic development of the individual. Mostly produced out from two basic relational dimensions of the sociotype – friends and colleagues – this imprinting introduces a strong bias in the maintenance, decay, and replacement of cultural items. Each cohort would be attracted towards the new vision, tastes, and fashions upheld by the own generation.

5. *A new, astonishing fact in the succession of generations.* With the industrial revolution, a threshold was crossed regarding the “adjacent possible” and an exponential course was ignited for the economy, creating a higher number of new material and mental structures that have continued multiplying on an exponential basis. Each passing generation has been able to substantially and systematically increase the whole contents of its material world, adding up an entire new world to the received one. But the sheer amount of new habits necessary for social life in industrial and postindustrial societies has forced individuals to generationally absorb an almost duplicate amount of cultural presences, of cognits, in their inner mental spaces.

6. *As the economy grows, the past recedes.* The decay of cultural elements has been accelerated, and biased, with preference for much faster discarding the items of the previous generations, the contents of the received world. Factually, “doubling generations” become “halving generations,” systematically pruning the previous cultural legacy which already contains in itself the remains of previously decimated legacies. Like competing for writing on a vanishing palimpsest: each ascending generation brings its own new contents and relegates more and more of the distant past to oblivion, to increasingly outdated text books, archives, museums, etc. “As the economy grows, the past recedes”.

And finally, along the Fourth Industrial Revolution – the so called Information Age – the GDP has been doubling on a global world scale, and far more than tripling in some countries. And this is compounded with dramatic changes in new communication media and new interconnected systems of worldwide extension. What are the consequences? Let us leave this as an open question—only stating the formidable ignorance of the own cultural past in the ascending generations.

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