



## Article

# Economic Change and Cultural Evolution: The Ultimate Influence of Human Cognitive Limitations

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**Abstract:** How cognitive limitations of individuals may affect the dynamics of cultural evolution under the effects of economic and technological forces is explored here. In particular, the extraordinary economic growth during the industrial and scientific revolutions of the last two centuries has been accompanied by an extraordinary acceleration of cultural changes. We will propose that these changes are due to competition, decay and replacement processes among the different kinds of cultural contents, ultimately resulting from our cognitive limitations. Different laws have been proposed recently for the decay of individualized cultural items and for the underlying competition processes, which will be discussed herein. With respect to the informational/cognitive limitations of individuals, the cognitive psychology views will be complemented—and somehow quantified—from the angle of the “social brain” or “sociotype” hypothesis. The generational phenomenon also emerges, by which differentiated generations develop a remarkable divergence in ways of life, aspirations, ideals, values, and often in the use of communication technologies. It is in this interactive individual–generational context of competitive processes that the acceleration of cultural change during the few last decades might be investigated by considering the vastly increased economic output and the widespread use of new communication technologies.

**Keywords:** cognitive limitations; social bonding; generational bias; economic and technological change; cultural acceleration



Received: 27 November 2024

Revised: 4 January 2025

Accepted: 7 January 2025

Published: 9 January 2025

**Citation:** Bordonaba-Bosque, Daniel, María A. González-Álvarez, Pedro C. Marijuán, and Jorge Navarro. 2025. Economic Change and Cultural Evolution: The Ultimate Influence of Human Cognitive Limitations. *Social Sciences* 14: 24. <https://doi.org/10.3390/socsci14010024>

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## 1. Introduction: Economic Growth, Individual Limitations, and Cultural Change

The principal argument of this work can be summarized as follows: there is a relative constancy of our cognitive capacity—our individual informational limits—that configures the main processes of culture, underlying the different rhythms of preservation, decay, and replacement of cultural items (Marijuán and Navarro 2020). These very cognitive limitations, along the economic and technological forces unleashed by the successive industrial and technological revolutions of the last two centuries, have contributed to an unseen acceleration of cultural change and to an important transgenerational rejection of the shared cultural past (Marijuán and Navarro 2020). Thus, in the unending debates between the mutual interdependence of economy and culture, we propose a middle ground in between: it is cognition, or better its limitations, and what underlies their common ground in the social evolutionary process.

We will analyze first a historical anomaly. Specifically, during the last two centuries, economic output has increased steadily throughout the successive scientific and industrial revolutions that have taken place, reaching its peak in today's global and information age. This economic increase may be clearly seen in the various economic data that will be presented. A major factor in all periods of modern history, and above all in the present era, is the radical change in the media themselves. The social deployment of new media makes possible and accelerates the most profound cultural transformations (Hobart and Schiffman 1998; Poe 2011). We will provide economic, technical, and scientific data that will illustrate our central argument about the acceleration of the cultural world during the successive industrial revolutions. In particular, we will examine the economic data of representative countries and on a world scale, show the growth trends in these two centuries. One of our main inferences will be that, as the economy grows, culture is systematically renewed, even in an accelerated way. With a relevant consequence: a growing fraction of the past becomes effectively lost.

The most important consequences for the whole world of culture will be essentially attributed to the individual limits of cognition, but the emergence of differentiated generations will also play a very important part. It is a well-established evolutionary fact that the overall limits of our sociality have specifically established the limitations of our individual brains and of our cognition (Dunbar 2004, 2007). The memory-space of our brains devoted to sociality has become the basic cognitive staple which could be partially diverted toward other endeavors—for example, the practice of reading is based on brain space initially committed to processing natural scenes both in the environment and in social settings; see in S. Dehaene (Dehaene 2009) and J. Henrich (Henrich 2016).

This profound relational/cognitive constraint, symbolized by the relative constancy of the social networks that surround everyone (Dunbar 2004, 2007), or what the authors have called the “sociotype” (Marijuán et al. 2017, 2019), lies behind the ostensible acceleration seen in the cultural change of the last two centuries. The quantitatively limited sociotype of individuals (Marijuán et al. 2017), would be acting as a sort of metronome or “ratchet” in the overall competition, maintenance, and replacement of cultural elements and social habits. Then, it is obligated to consider the generational factor, since it is through close interaction within their respective generations that individuals uphold—and undergo—cultural replacements and provoke alternative cultural equilibriums (Howe and Strauss 1997; Pinker 2009, 2018).

The observed competition and decay processes of cultural items would apparently derive from the workings of an invisible hand that distributes in an adaptive way the limited informational resources of individuals within the aggregate social scenario. An “attention economy” emerges (Lanham 2006) that optimizes the aggregate individual utility under the established social constraints. So, the present approach could also be taken as a tentative bridge in between the cognitive and memory limitations of individuals and the emergence of a collective “attention economy”.

The rest of the paper will be organized as follows: in Section 2, ‘Methodology’, we will revise the economic data on world growth in aggregate, as well as the rates of GDP change in a series of representative countries during the last two centuries; the main innovation cycles will be chartered too. In Section 3, ‘Results’, we will see that the unprecedented economic growth data previously found have had an unexpected impact on social systems and in the whole world of culture; and we will arrive to an unexpected correlation: “while the economy grows the shared past withdraws”. In Section 4, ‘Discussion’, the individual limitations on cognition will be surveyed, trying to make cognitive sense of the nature of cultural change and the obsolescence of cultural items under the pressure of economic and technological forces that we have previously described; and we will link this process

with the overarching generational renewal. Finally, in the Conclusions Section, we will highlight the fundamental aspects derived from our whole argumentation, including a brief discussion of the study's limitations.

## 2. Methodology

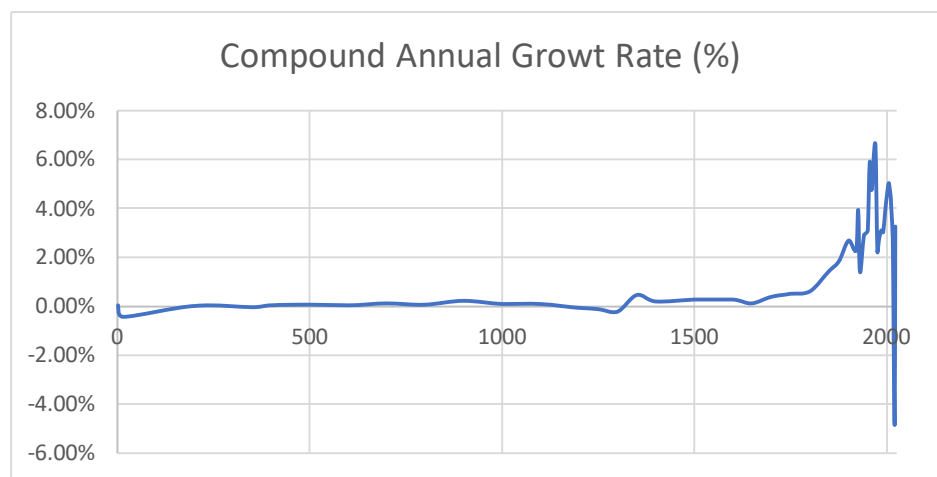
In this section, we apportion fundamental economic data about annual growth rates on a world global scale, followed by more detailed data on GDP ppp (Growth Domestic Product by purchasing power parity) from a few selected countries, a total of ten. Of these ten, three have been strategic in the onset of the industrial revolution (UK, US, Germany), another four countries with very important economies have had relatively recent industrialization processes (Japan, USSR/Russia, China, India), and another three have experienced periods of intense industrialization and economic growth (France, Italy, Spain). The main innovation cycles in the last two centuries propelling the successive industrial revolutions will be described too.

### 2.1. An Unusual Background of Economic Growth: Industrial Revolutions

Very often, economic factors have been considered as the essential shapers of social evolution, including cultural and intellectual aspects. Actually, the extent to which the influence of the economy, or “material life”, was felt on the world of thought and culture, on the “life of ideas”, or the vice versa influence of the world of ideas on the economy, became the great philosophical debate of the 19th century and most of the 20th. These debates on the relationships between economy and culture have come back in our own times ([Akerlof and Shiller 2009](#); [Hardin 2017](#); [Herrmann-Pillath 2010](#); [Kauffman 2019](#); [North 2005](#)). Herein we are proposing a different track.

Looking at the economic history, something enthralling and really extraordinary occurred after the onset of the industrial revolution. It had never happened that with every new generation, the overall wealth of industrializing countries increased systematically, almost geometrically doubling every 30 years or so ([Landes 1998](#); [Pinker 2018](#); [Rosling et al. 2018](#)). Never, ever in the history of mankind has the aggregate wealth of numerous countries increased on average by at least 50 percent every 30 years or so, and in most periods by more than 100% percent, or even much more. We can now see in [Figure 1](#) the overall world rate of economic development (growth rate) over the last two millennia (from 0 to 2023). Until about 1700, there is no noticeable growth, with a rate of about 0 or negative, or 0.5% in a few positive peaks. But after 1800, the growth rate increased steadily and reached annual rates of 2.14% or more in the decades around 1900. That sustained rate entails a complete doubling of world wealth from one generation to the next, every 30 years or so. See [Figure 1](#).

After the “Era of Discovery” in the 16th and 17th centuries, and with the ensuing scientific revolution, a few Western societies started new forms of management of economic, technical, and scientific activities. Very few generations later, that new management finally arrived at a mass of products, manufactures, and services—igniting the industrial revolution. An important threshold was crossed regarding what has been called in complexity science the “adjacent possible” ([Kauffman 2019](#)), basically thanks to mastering the discovery process itself via the “scientific method”. Subsequently, an exponential course was initiated and maintained for industrial production and for the whole economic output. In 2020, it experienced a notable decline of 4.86%, the highest in history, reflecting the severe impact of the COVID-19 pandemic on global economies.



**Figure 1.** The projected annual growth rate for the global economy over the past two millennia is presented, with data from 1960 onwards sourced from the World Bank (World Bank Group 2024). For periods prior to 1960, the growth rates are derived from the estimates provided by Maddison data (Maddison Historical Statistics 2024).

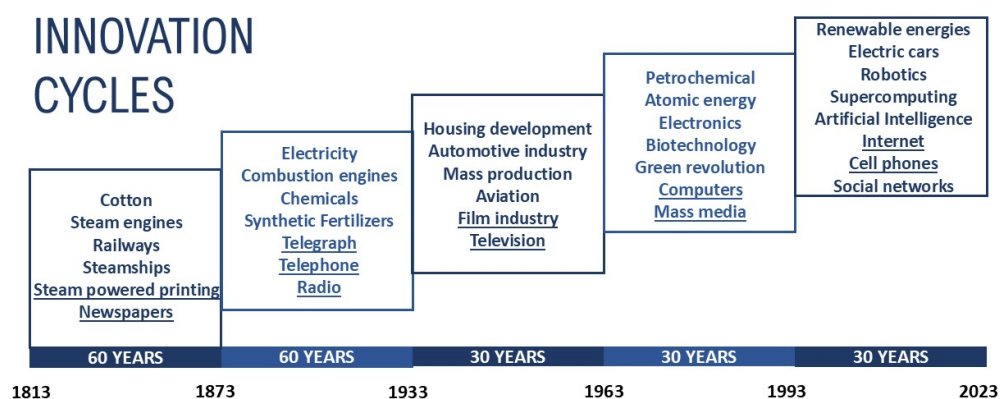
2.2. International Expansion of the Industrial Revolution

Our vision becomes more detailed when looking at the economic achievement of a few representative countries. In Figure 2 we have included the GDP ppp in millions international USD and variation rates (gross domestic product in purchase power parity) every 30 years. For clarity, we consider that the interval of 30 years is the ‘natural’ period for the emergence of successive generations. So, we have maintained this periodicity in Figure 2, starting in 1813 and counting from then a total of 7 generational periods spanning 210 years, until 2023 (last released figure). Therefore, after the long stagnation of all the preceding centuries, as shown in Figure 1, between 1813 and 1843, we see rapid intergenerational growth of over 72.69% in the United Kingdom, 55.32% in Germany and 161.75% in the United States, the latter country with a staggering 180%; these countries are the heralds of the industrial revolution, followed by France and Russia, then Japan, Italy, and Spain in the following period. In the economies of China and India, the growth rates of the industrial revolution were only achieved during the second half of the 20th century and especially in recent decades, when these two countries achieved extraordinary intergenerational growth rates of about 858.80% and 488.88%, respectively. The example of Spain, where intergenerational growth of more than 334.67% was achieved in the middle of the 20th century is also remarkable. Russia (at the time of the USSR) reached almost 301% during some periods of the 20th century. In the last reporting period (1993–2023), Germany, Italy, and Japan have relatively weakened.

Country/Year	1813	1843	1813-1843	1873	1843-1873	1903	1873-1903	1933	1903-1933	1963	1933-1963	1993	1963-1993	2023	1993-2023
CHINA	352,220	419,550	19.12%	292,277	-30.34%	373,415	27.76%	524,852	40.55%	434,117	-17.29%	2,467,252	468.34%	23,656,035	858.80%
USA	20,000	52,350	161.75%	184,337	252.12%	598,658	224.76%	1,002,990	67.54%	3,781,113	276.98%	9,782,599	158.72%	18,683,082	90.98%
INDIA	181,455	201,109	10.83%	229,721	14.23%	320,250	39.41%	346,201	8.10%	504,651	45.77%	1,685,806	234.05%	9,926,676	488.84%
RUSSIA	45,204	64,672	43.07%	103,544	60.11%	252,252	143.62%	343,806	36.29%	1,378,648	301.00%	2,319,466	68.24%	4,405,881	89.95%
JAPAN	32,800	35,335	7.73%	43,069	21.89%	80,143	86.08%	194,938	143.24%	593,085	204.24%	3,959,915	567.68%	4,268,801	7.80%
GERMANY	43,213	67,118	55.32%	122,177	82.03%	256,372	109.84%	411,719	60.59%	1,208,356	193.49%	2,623,056	117.08%	3,999,966	52.49%
FRANCE	56,399	73,836	30.92%	138,505	87.58%	165,789	19.70%	256,400	54.65%	648,810	153.05%	1,724,832	165.85%	2,846,800	65.05%
UK	48,754	84,191	72.69%	178,125	111.57%	315,948	77.37%	389,461	23.27%	616,074	58.19%	1,547,503	151.19%	2,749,270	77.66%
ITALY	46,540	59,489	27.82%	73,080	22.85%	126,107	72.56%	240,283	90.54%	243,150	1.19%	1,809,341	644.13%	2,357,502	30.30%
SPAIN	18,180	22,744	25.10%	38,054	67.31%	52,848	38.88%	101,773	92.58%	442,379	334.67%	955,524	116.00%	1,743,359	82.45%

**Figure 2.** The gross domestic product by purchasing power parity (PPP) in millions international USD and rates (all these rates have been calculated by the authors) attends to the currencies’ respective purchasing power, expressed in 2011 international USD. Source: The Angus Maddison Project (Maddison Historical Statistics 2024) and World Bank (World Bank Group 2024).

Far from being smooth, the expansion of the industrial revolution was accompanied by entrenched social conflict, political turmoil, and imperialist collisions (Ferguson 2018; Rhodes 2018). The data in Figures 1 and 2 could tell interesting stories about the global power struggles and geopolitical upheavals of the past two centuries. The further increase of growth rates along successive generations was due to the overlapping of scientific and industrial revolutions, igniting successive innovation cycles. See Figure 3. Actually, the abundance of new technologies and new products of the second and third industrial revolutions expanded the combinatorial effect of what has been termed the “adjacent possible” (Kauffman 2019). Thus, the following came: aviation, electronics, communications, computers, and very significant improvements in public health and hygiene, plus the new communication technologies. This powerful combination made possible the beginning of the current period of globalization, the spread of the modern economy and new ways of life. Within a few generations, just two, almost all continents and countries of the world have joined the multiplicative process. The contrast with the quiescence of the preceding millennia is almost unimaginable.



**Figure 3.** The main cycles of innovation. Approximate grouping of the main innovations in the last two centuries. The items mostly related to social communication have been underlined.

### 3. Results

Looking at the above economic data, what is the impact on the world of culture? And what results can we attribute to the innovation cycles and the new means of communication in the collective way of thinking of these historical periods?

#### 3.1. The Economic Impact on the Cultural World

While the economy has developed extraordinarily over the past two centuries, what has happened with the world of culture, with the maintenance and fading of cultural products, and with the ways of thinking and living associated with them? The sheer accumulation of cultural and social changes produced after the “Era of Discovery” opened the way to an even greater accumulation of cultural and social changes in the new period of the industrial revolution, but with an intriguing twist derived from the unseen economic growth.

Let us not forget that, in parallel with the sustained economic growth of industrial societies, we can point to the approximate duplication of a variety of relevant social items not too far away from the world of culture. Every 30 years or so, we might see the near doubling of the following:

- the number of engineering and technological inventions (Arthur 2009; Hughes 2004; Poe 2011),
- the number of working scientists and engineers (Landes 1998),



- the number of research fields (Marijuan et al. 2012),
- the number of scientific publications (Feist 2006; Pan et al. 2018),
- the global energy consumption (Rhodes 2018; Smil 2017),
- the population living in cities (Batty 2013; Rhodes 2018),
- and the same would go for buildings, factories, roads, infrastructures, civil servants, administration, sanitary and education personnel, and so on and so forth.

And this near doubling of societies was undoubtedly extended to the world of culture: printed books, newspapers, musical and theatrical works, decorative arts, film industry, media, etc. (Booker [2004] 2017). It is as if an entire 'extra' world would materialize in each generation, superimposed on the received world of the precedent generation.

It is to say, looking strictly on a generational level, the constant economic accumulation and the accompanying process of social change could be seen as if each successive generation was capable of building for itself a completely new material world of a size similar, often larger, than the received one from the precedent generation. Two physical worlds become merged into one: the old and the new would coexist, but with a competitive advantage for the second. And this has happened in every way, regarding the world of culture and many other facets of social life. It is not only a question about the quantity of material goods and global wealth just created. Rather, the most substantial cultural impact has corresponded to technology. When a bunch of new interconnected technologies are created, our lives are changed more than we realize. And that is particularly true concerning communication technologies. The psychological importance of new media and the social changes directly brought forward by new communication technologies was the *leit motif* of Marshall McLuhan's great work (McLuhan 1962, 1964). The chart showing the historical distribution of the waves of technological change in Figure 3 is highly revealing about the very relevant presence of new communication tools.

Successive waves of technological inventions, as seen in Figure 3, have been inevitably changing social habits, lifestyles, ways of using time, and the various practices and learning elements needed to navigate in a variety of spaces: economic, technical, educational, urban, legal, professional, recreational, and today's digital deluge. All the interrelated practices and habits become changed completely. And along successive waves of change, the maintenance of culture as practiced in previous centuries of relative immobility has been shaken or teetered on the brink of collapse.

### 3.2. Collision of Cultural Worlds: The Fading Legacy of the Past

According to our argument, with each successive generation, the cognitive load associated with the entire created world must mix with the cognitive load associated with the precedent generational world (Marijuán and Navarro 2020). But the available cognitive space of individuals involved in the intergenerational mix has remained the same, i.e., the basic cognition. And this has resulted in a significant loss of the legacy of the world of the previous generation. Thus, a significant part will stay dormant, inactive, relegated to relatively innocuous written records of libraries or to visual archives, but far from having a significant impact on social mores. These relegated elements will move away from the center, toward the end of the long tail of the curve of cultural presences. The novelty fashions, the new arriving cultural items, will be now occupying the ascending part of the curve, towards the central stage.

Thus, as the industrial and post-industrial economies have become bigger and bigger, providing an ever-growing package of technical, cultural, material and recreational products, the past has systematically receded at about the same pace. The proportion of the past that can be considered effective, that is still valid or influential, has shrunk dramatically: it is almost systematically halved with each new generation. Recent empirical research

(Liu 2019) shows that the living memory of modern society is associated with fundamental events that span a very small number of generations, only three. As the economy grows, the proportion of the past that is efficiently remembered decreases.

Which parts of culture have been most concerned by this intergenerational extermination, by the approximate division of the generational heritage in half? Perhaps the most significant development of the past two centuries—other than the scientific and technological revolutions—has been the emergence of radically new ways of thinking and the heightened social unrest. Indeed, the new era of industrialization and social unrest revolutionized all types of cultural and social narrative. Paradigmatically, this was seen in novels, drama, opera, painting, film, music, and all forms of entertainment (Booker [2004] 2017). The changes that, for example, have occurred in music over the last few generations are striking (Benzon 2001). Literature itself turns out to be a very revealing guide. The widespread sense of too quick change and disappearance was unknown in pre-industrial centuries, when generations succeeded each other in similar economic and cultural environments and were separated only by the age-old fluctuations of collective personality (Howe and Strauss 1997; Putnam 2000, 2020). The sense of loss and its attendant rebellion have strongly resonated in our times too, now amplified by the digital roller of new media.

#### 4. Discussion

Along this Section we will discuss the previous results, now considering the role played by individual limitations on cognition, in particular, paying attention to our evolutionary social nature. We will make cognitive sense of the processes of cultural change, looking at the obsolescence of cultural items under the pressure of economic and technological forces as previously described. We will also link this process with the overarching rhythm of generational renewal and will evidence an accelerated rate of cultural obsolescence in our times.

##### 4.1. *The Limitations of Individual Cognition: The 'Social' Human Agent*

An essential part of our argument revolves around the cognitive limitations of each individual, which seems to be directly related to sociality as an evolutionary determinant of human brain growth. Examining sociality could give us some preliminary insight into these cognitive limitations. But, first, we should mention some cognitive psychology studies on overall cognition limits.

The pioneer work of G.A. Miller (Miller 1956) about storage capacity limits in our memory, “the magical number seven plus or minus two...”, is one of the best-known articles in psychology. It was replicated in different ways in a number of studies, often following the “working memory model” (Baddeley and Hitch 1974), which proposed short-term memory as a collection of multiple stores actively processing different types of memory records; and forgetting processes would occur because these memory representations are decaying over time, unless countered by maintenance mechanisms (Baddeley and Hitch 1974; Barrouillet et al. 2011; Cowan 2012). We will refer below to the synaptic rhythms which seem to be involved in these decay and maintenance processes (Schacter et al. 2012). Along this line, the *Global Workspace Theory* is *nowadays* probably the most influential empirical *model* or framework for thinking about both consciousness and *working* memory (Baars et al. 2021), although it is not oriented to the kind of cognitive limitations we are looking for. The prestigious cognitive psychologist Steve Pinker, who has provided so many precious cognitive, social, and cultural insights (Pinker 2009, 2011, 2018; Pinker and Harrison 2005), has not addressed the present problem of overall cognitive limits. Regarding Miller’s pioneer finding of the “magical seven”, careful experimental work by

Ladislav Kovac (Kováč 2009) has reported that, empirically, most human reasoning about the causes of multifaceted phenomena is reduced to just ‘three factors’, irrespective of the nature or the complexity of the phenomenon. His explanatory argument revolves around the evolutionary history of our social communication, which has been the cradle, the fundamental maker of our cognition. This signifies the evolutionary importance of having configured parsimonious social cognitive interactions within small populations of hunter-gatherers in their natural niche—when our cognitive genetic endowment was crystalized.

Under the guidance of our evolutionary history of social communication, we are going to explore the possibility of an educated guess on the kind of limits we are searching for.

Following evolutionary psychologist Robin Dunbar, and the well-known Dunbar’s number about the ‘natural’ evolutionary size of social groups, which generally does not exceed 150–200 people, and which still is a most frequent size found in many human organizations and institutions, we may take this as an important quantitative limit. Then, if languages are related to the second great limiting factor, we may consider a kernel of about 10,000 words, and finally we could have a rough first idea on the fundamental limits of social cognition of individuals. Could it be somehow proportional to the interactions of  $100 \times 100$  people?

Let us adopt the term “cognit” proposed by Joaquín Fuster as a model of cortical representation (Fuster 2003). Cognits refer to basic sensorimotor memory aggregates that effectively drive adaptive actions in specific contexts, and which can be combined, integrated into hierarchies, associated, projected, etc. Cognits would be similar to “schemas” of cognitive science, and quite different from “memes” or “concepts”, as they combine observation, action, and thought. The effective cognitive directions that cognits and contextual associations of cognits provide are crucial to the behaving person within his/her cultural niche.

Then, how large a stock of cognits could an individual maintain? Or to use different words, what might be the average number of cognits per individual within a specific cultural niche? Too many neurophysiologic and contextual complexities are involved in the working of our memory (Schacter et al. 2012); for what we learn must go through different rhythms of neuronal mapping and reorganization, synaptic attenuation and amplification, synapse creation and destruction (Wang et al. 2020). As a proxy of these limitations, we may also consider the term “personbyte” (Hidalgo 2015) so to refer to the maximum personal cognition in labor environments, i.e., an individual’s capability to participate in the knowhow of complex technical works.

An important aspect to emphasize regarding the increase of technical and cultural cognits is that it always comes at the expense of ordinary social and natural cognitive abilities—the customary lack of social abilities in the literati is proverbial. Another important aspect of the cognit and personbyte limitation is that, as time passes, dormant cognits, or dormant cognit complexes, undergo a process of decay and progressive fall into oblivion. Forgetting will occur on several layers or levels of forgetfulness in working memory, or perhaps along a smooth continuum. Too many complexities are involved in the recording, the eroding, and the emotional imprinting of our memories (Schacter et al. 2012).

However, forgetting the dormant cognits becomes a very useful process, as it frees up mental space for new generalizations and learning of new items. A most likely circumstance is that the faster new items arrive, the faster the process of degradation and forgetting goes. In this sense, the great character of Jorge Luis Borges, “Funes the Memorious”, illustrates well the advantages of ‘healthy’ oblivion (Borges 1944). According to the story, Funes acquires superhuman memory powers after an accident, but his world becomes a world of unbearably countless details, and he cannot develop new ideas, generalizations, or abstractions. His reasoning is 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's there was nothing but particulars".

For Borges, forgetting was also associated with the general limits of memory. He seems to have followed G. Spiller's classic estimate of the number of memories a person possesses at different stages of life: about 100 during the first 10 years, 3600 before the age of 20, another 2000 memories between the ages of 20 and 25, reaching a maximum of about 10,000 different memories at 35 years of life (Quiroga 2010). Could, according to these views, 10,000 to 20,000 different cognits, or units of knowledge, be an estimate of the limits to which the average individual may have access? At this point we may remind the  $100 \times 100$  array of individual interactions in the stereotypical natural group.

Looking at the highly complex societies of today, the limits of our knowledge can be found almost ubiquitously: from the increasing specialization of professions to the vast division and coordination of labor; from the typical book size to the content of courses and programs; from the division of knowledge into separate disciplines to their integration into new interdisciplinary syntheses; from the homogenization of cultures to the ramification of subcultures; from the continuous information overload to the fantastic obsolescence of knowledge in this "knowledge age". Indeed, limited knowledge is at the heart of all human behavior because new specialized items of knowledge are very hard to absorb, but very easy to forget. Thus, as increasing loads of new knowledge and new social habits are piled on individuals, the "battle for the cognits" becomes even harder. And the parallel process of degradation of the other cultural elements will run faster and faster.

#### 4.2. *The Obsolescence of Cultural Items*

In this context, looking at the social obsolescence of cultural items, which finally is a recapitulation of quite many independent, individual acts of knowledge, the "attention economy" (Lanham 2006) becomes another representation of the cognit battlefield scenario. The attention economy is not only a recent conceptualization applicable to our time, but it is inherent in any sufficiently complex society—once the "natural size" is reached and the individual's capacity of interaction is overcome (Navarro and Marijuán 2022). Imperceptibly, all of our daily communicative contacts, interactions, and decisions become entangled into a common struggle for attention (Bissonnette 2016). We always optimize and choose with whom we want to talk to and with whom we want to connect (or at least we try to, in the extent of our needs and preferences).

Following the quest of these authors (Marijuán et al. 2019) about the number of social contacts and communication time within the sociotype research framework, the outcomes look congruent with the approach followed by (Ji 2017) on the spontaneous "universal" emergence of competition processes in economic, social, and biological contexts. Regarding the attention decay and collective memory of cultural products (Candia et al. 2019), the authors present data on scientific papers, patents, films, songs, and biographies. Their model would reflect a "universal feature" of the decline of human collective memory in all cultural domains. Competition in an attention economy would appear as the major constitutive factor of that "universal feature". The attention economy also appears in recent works devoted to measuring science outcomes (Pan et al. 2018; Parolo et al. 2015). These authors assume the limited knowledge capacity of individuals and view the main function of the scientific citation network as an infrastructure that supports the collective memory of science.

The "universal feature" of decay, either short-term or long-term, either scientific or cultural, is thought to be the result of competition for limited individual attention—and the concomitant limited brain capacity—within a multitude of other cultural products and alternatives within the global attention economy. We argue that all the lawful distributions

that emerge are the fingerprints of information competition processes in action, the ordering results of an invisible hand—both in culture and in the economy.

#### 4.3. *The Generational Factor*

Nevertheless, the world of culture contains several strata that are changing in very different ways. From the slow changing “identity” elements, whatever they are (Dalož 2008; Herrmann-Pillath 2010), to the most ephemeral fashions and consumer products. So, the tempo of the different cultural items will depend on the strata or behavioral realm to which they belong. And further, there is the generational phenomenon, which strongly biases the competition among cultural items. But what we do mean by the term generation?

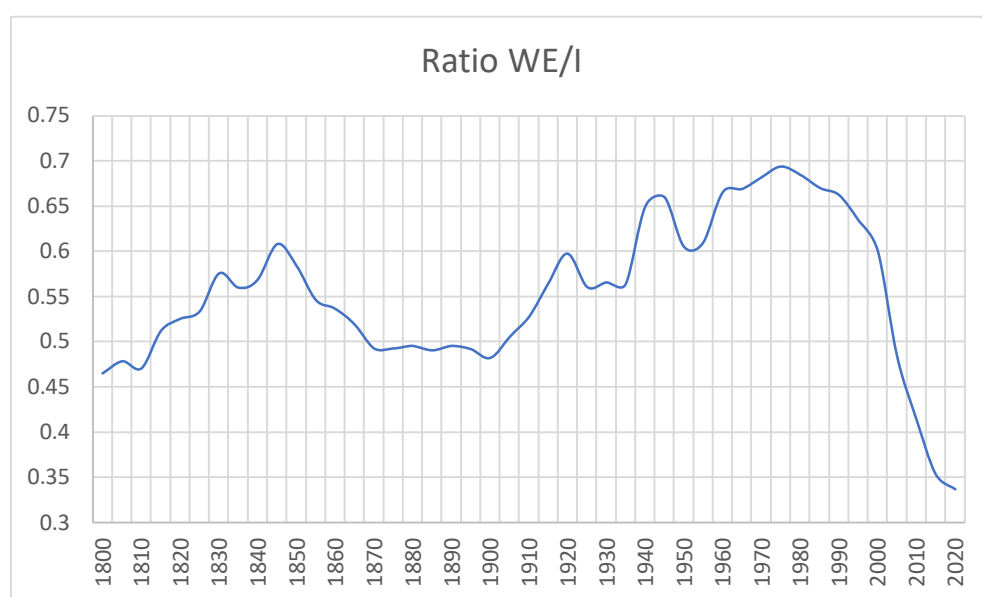
Generations refer to the most fundamental fact of social life: birth and death, parents and children, human life cycles in their overlapping and continuity. As stated, the usual interval between parents and children, 30 years, becomes the basic generational granularity. Additionally, semi-generational periods or intervals of 15 years may appear either before or after the essential events or social figures that mark the generation; 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 for a new identity. The search culminates at the end of youth, around 25 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 lifestyle that his/her generation purports.

Apart from social crisis of utmost severity (plagues, famines, catastrophes, wars, etc.), one of the most popular theories on generations (Howe and Strauss 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, so that cyclical periods of crisis, high, awakening, and unravelling 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 in our times are due to R. Putnam (Putnam 2000, 2020) and the Cliodynamics school of thought (Turchin 2016), which tries to rigorously model the different cyclicities distinguishable within historical dynamics. One of their outstanding predictions is a severe instability peak in the 2020s due to declining well-being and elite overproduction and conflict.

From the cognitive point of view, the continuous integration of generations is highly consequential. If we tried to identify the generational origin of the active cognits present in an individual, we would find, most likely, a dense mixing. The main content would be biased towards peers, i.e., the closest individuals of the generational cohort (friends and colleagues in the sociotype dimensions), who are clearly recognized by social psychologists as the main force driving the development of personality and lifestyle (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 must be adaptive, efficiently linking the individual to the existing social milieu. And this must 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? Accelerated obsolescence of the ‘dormant’ or

unused cognitions could be accompanied by strong changes in the social mood, amplifying the rejection side of the natural synthesis of the new elements with the received legacy.

As an instance, the inverted “U” curve that describes the whole socio-cultural process in the US during the 20th century (Putnam 2020), obtained as a composite of representations of very different social phenomena (economic, politic, labor unions, religious, cultural, etc.), has received widespread attention and commentary. A similar curve may be obtained directly from Google Books Ngram by just looking at the pronoun ratio “We/I” during the same secular period which becomes astonishing (see Figure 4). It means the continuous presence of a fundamental determinant of human behavior, the oscillation of which emerges as a faithful indicator of social mores and moods (trust vs. distrust, community vs. individualism, responsibility vs. rights, customary vs. unconventional, etc.), clearly influences the business cycle too (Lawson 2013). En passant, let us note the singular capability to uncover hidden cultural patterns by AI and big data methodologies.



**Figure 4.** Evolution of the ratio We/I during the 19th and 20th century and the last two decades. The peaks in the first half of the 19th century would correspond to the initial optimism after the onset of the industrial revolution. Later, the two bumps observed correspond to the “community surge” during WWI and WWII. The turning point is observed around 1975, it parallels data in many other social and cultural aspects. The “individualistic plunge” during the first decades of the 21st century is more than remarkable. The graphic has been built by the authors with data obtained from the Google Books Ngram website (Michel et al. 2011).

## 5. Concluding Comments: The Age of Discords?

The Era of Discovery charted a new path for Western societies. In a few generations, that path brought forth successive scientific, commercial, technological, and industrial “revolutions”. They represented a sustained boom of economic growth unseen during millennia. But at the same time, a fundamental change was occurring in the way Westerners were living, working, and relating to each other.

The basic idea herein developed implies a strong link between economic change and cultural change, via the cognitive limitations of individuals which force a generalized competition and decay processes among cultural items. There is an important generational component involved in these processes, as it is in the synchronized preferences, tastes, values, ideals, etc., of each generation that the decay processes become biased to accept/reject interrelated cultural items. We have lightly explored the limitations of individuals and

have mentioned some approaches that can illuminate some of the inner workings of the resulting “attention economy”.

In our time, cultural change has been exacerbated by two factors: on one side, the globalization period, with an amazing world growth rate, although with serious detrimental effects in Western economies and ways of life; and on the other side, the radical emergence of new means of communication (Hobart and Schiffman 1998; Poe 2011; Wright 2008). The progressive advent of computers, the Internet, laptops, cell phones, and social networks has contributed to a new social psychology in the (perhaps two?) generations affected. And the scientific change has been also comparable, with artificial intelligence, bioinformatics, robotics, advanced materials, quantum computation, etc. The overall result is that there has probably been no comparable impulse for cultural change in history. “Cancel culture” is an evident outcome of this new generation coming to terms with the cumulated legacy of precedent generations.

The resonant call of attention by Greg Lukianoff and Jonathan Haidt (Lukianoff and Haidt 2018) in their *“The Coddling of the American Mind”* might be understood, generationally, as the arrival into the social scenario of a new generation grown and socialized in a new way: via cell phones and social networks’ communication tools. Certainly, the cognitive, relational, and consensus habits formed in the daily use (mostly abuse) of the new media have molded the new wave of closed/distorted identities. The plethora of additional factors involved in the analysis of the new sociality may be fruitfully assessed in the vast work of Robert Putnam (Putnam 2020). Either at work scenarios (Turkle 2015; Zivnuska et al. 2019; Zuboff 2019) or in strategies for coping with loneliness (Hall 2024; Holt-Lunstad et al. 2017; Turkle 2011), the common abuse of social networks appears clearly deleterious. At a vast scale, the work by J. Bollen et al. (Bollen et al. 2021), analyzing the whole corpus of Google Books in three languages (14 million books in English, Spanish, and German) during the last 125 years, evidences the magnitude of the recent cultural change—an unprecedented societal shift toward language associated with cognitive distortions and internalizing disorders, which drives societal and political polarizations.

According to the cognitive terms of our own analysis, too many new learning elements were required for the new generation; too many new automatisms were learned and imprinted upon them in an unprecedented way, and by means of new ‘dissocializing’ channels. Subsequently, the collective rejection of previous cultural and social habits has also been unprecedented, to say the least. As, socially, we can only organize the additional cognits we need for the renewal of social life through reinforced forgetting: or in other words, “civilizations evolve through strategic forgetting of what were once considered life skills” (Tracy 2019). And among these vital skills, the first wave of victims of that forgetting, of ‘cancelation’, occurs in the world of culture, in the legacy of traditions, histories, norms, and wisdoms that bind the individual to the social collective.

The worlds of economy and culture are related in an unexpected, twisted way, unforeseen by social and political thinkers of past centuries. It is as if our limited brains would finally impose their “iron law” upon the imaginary constructions of the cultural world. It is ironic that despite the abundance of new products, inventions, and cultural creations, the successive industrial revolutions could not help but become bogged down in turmoil and confrontation caused by the insidious growth of social, political, and cultural imbalances. The spectacular technological and cultural acceleration of our age, full of unintended consequences, will probably not escape this fate. For some, our age is becoming “The Age of Discords” (Turchin 2016).

About the limitations of this work, the authors acknowledge the challenging multidisciplinary of the hypotheses presented regarding their accurate verification; nevertheless, the increasing availability of repositories of published materials during past centuries

provides many opportunities of partial or global quantitative verifications of the interrelationships between cultural change and economic change and the accelerated obsolescence of cultural items—at national and global scales. We think future works in these directions might contribute to a better understanding of the collective psychology of societies in response to the important challenges of all kinds ahead.

**Author Contributions:** Conceptualization, P.C.M., D.B.-B., M.A.G.-Á. and J.N.; writing—original draft preparation, J.N., D.B.-B., M.A.G.-Á. and P.C.M.; writing—review and editing, D.B.-B., M.A.G.-Á., J.N. and P.C.M. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research is partially financed by the Regional Government of Aragón and the FEDER project “Participación Ciudadana Cognitiva y Decisiones Públicas. Aplicaciones Sociosanitarias” (ref. LMP35-21); the Spanish Ministry of Science and Innovation project “Codecisión Cognitiva y Colaborativa. Aplicaciones en Salud” (ref. PID2022-139863OB-I00).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Data are contained within the article.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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