**Late Polymathy Emergence**

**J. Salzman**

**Technion – The Israel Institute of Technology**

**Abstract**

In this article we intend to provide a descriptive account of ***late polymathy emergence***among scientists and other highly specialized professionals. We expect that detailed studies will follow leading to theoretical models of life-span decision patterns between creative individuals with a broad range of interests. Inspired in the "four c-creativity model" (Kaufman and Beghetto, 2009), we contemplate multi-disciplinary experiences and propose categorizing individuals with expertise and interest in several diverse fields as "small-p polymath" and as "big-P polymaths" (p-polymaths and P-polymaths). We show paradigmatic examples of how personal and situational determinants may induce specialized professional individuals (mainly p-polymaths) to postpone expression of their diversified avocations until late in their professional lifespan. In many cases, late polymathy is expressed approaching retirement. We consider the plausibility that polymath professional researchers gravitate into active engagement in the arts.

1. **Introduction**

Works made by *homo sapiens* since the Upper Paleolithic times, such as Cave art as those found in Lascaux and Chauvet caves in France, have an uncontested art status (Davies, 2015). It seems then that already 40,000 years ago, there already were, among our human ancestors, artists (Curtis, 2007). Nobody cares whether these artists were professional or amateurs, educated or self-taught, their artefacts or images being the result of a serious or casual leisure activity. In fact, we tend to believe that art making was, over all times, one of the defining characteristics of human species (Morris-Kay, 2010).

Can one infer from that, that in our days wherever a human community exist there is somebody making art? Surely not. What is more compelling is the question of significance: Was really artmaking, in prehistoric times with very low life expectancy and demographic instability, essential for survival? In what sense? Survivability in the context of human species evolutionary history is understood today by account of the fact that engagement with *creativity* and particularly with the arts was (and is) an integral and necessary adaptive component of a common human nature (Dissanayake, 2008).

Generation of new ideas or concepts, implementation of novel artefacts, formulation of original and unknown processes, discovering rules and mechanisms in the dynamic evolution in nature, transforming objects, decorating, inventing stories, are just a few examples of human activity regarded as creative achievements. The three main scenes in which such activities developed are: art, science, and technology. To be considered "creative", the idea, artefact, process, or theory was always required to be *original* (novel), *appropriate*, and (except in the arts) *useful* (Sawyer, 2003).

A large number of studies were devoted to creativity during the last century, in particular after a seminal talk presented by Guilford at the American Psychological Association, in 1950 (Guilford, 1950). Early psychological studies focused on the mental processes (including sub-conscious and un-conscious experiences) of creative individuals. The *social context of the creativity process* was later incorporated into the modelling (Feldman, 1974).

More recently, creativity has been conceptualized as a ***system*** in which the process is not the result of a single creator, but of an *interaction between three elements: a domain of knowledge, an individual, and a field.* The individual creator draws from experiences, codes, traditions, emotions related to his cultural context (the domain) may use her imaginative skills to implement some novelty, to be appreciated, judged, or rejected by the social environment (the field) (Csikszentmihalyi, 1999).

From the psychological perspective, creativity, innovation, and invention processes, when being the result of integration of diversified pieces of knowledge, appear to be closely related to ***polymathy***.

A polymath is a person with expertise and capabilities spanning across a wide range of subject areas or disciplines. In modern times, its characteristics and behavior are regarded as an anti-thesis of the "expert" in the hyper-specialized system of knowledge. Many cultural historians state that the interdisciplinary approach of the polymath may be an important advantage for solving the hardest, extremely complex problems of contemporary world. In biographies of certain outstanding individuals, such as Herman von Helmholtz, or Thomas Young, they are described as "The last polymath", as if there will be no more people like that, and they constitute and endangered species. But in reality, are they?

1. **Demystifying prominence**

Since the early decades of the last century, Polymaths were discussed in relation to the controversy around the relative advantages of "generalists" versus "specialists" (see, for example Root-Bernstein, 1989, 2004, and references therein, Burke, 2020, Araki, 2018, Ahmed, 2018, and references therein). In most of these scholarly publications, polymaths were described as **cultural heroes**: Nobel prize laureates, great eminences, universal men, game changers, celebrity performers, extraordinary achievers, monsters of knowledge, inimitable humans. One may get the (wrong) impression that "normal people" are excluded from this trait.

Cultural heroes are needed in every human community. Every small town may have his local hero. Every academic institution admires and venerates some of his greatest past members. They provide inspiration, horizons to the aspirations of newcomers, and identification. Heroic narratives talk about doing something far beyond the normal scope of common people and become immortal after death. But heroes are short from representing the whole. The claim that human knowledge rides on the shoulders of heroes and only on them is difficult to defend.

On the contrary, the production of new knowledge entails a multi-layered complex system in which millions of people are continuously actively pursuing the validation, improvement, modification, development, and advancing the many fields of human knowledge (Ilkka, 2019, Mesoudi and Thornton, 2018). These people include scientists, artists, engineers, mathematicians, medical doctors, and other professionals and non-professionals. Some of them are highly creative, nobody has ever established how many of them are polymaths. Most of them are not necessarily celebrities, extraordinary achievers, or famous heroes. The cumulative evolution of knowledge could not have been developed by a single individual or by a handful of "prominent ones"(Dean et al. 2014).

The conclusion of the above is that if somebody intends to study the social behavior and psychological attributes of polymaths, she/he has to look for them among regular community members, not among heroes.

An important step in this direction was the model of "little-c and Big-C creativity" (Csikzentmihalyi, 1996), later enlarged to the "Four C Model of Creativity" (Kaufman and Beghetto, 2009). The main implication of this approach is that there is a continuum of creativity levels, and the legendary achievers (Big-C) are not the only ones that deserve recognition of being "creative individuals".

Inspired in the "litle-c and Big-C creativity" model, we propose to contemplate categorizing polymathy as "little-p and Big-P Polymathy" (p-polymaths and P-polymaths). The members of the "little-p" class being creative, polymathic individuals that, although at a professional level, have not achieved legendary status (paralleling the Pro-C creativity in the four-c model). Big-P would correspond to the exceptional, legendary Big-C creativity case. Kaufman and Beghetto already mentioned that conducting studies of living people with Big-C creativity is nearly impossible. Thus, we will deal in the rest of this paper with " p-polymaths".

A phenomenological field study of p-polymaths aimed at understanding the motivations for certain people to choose the generalist path, and their personal experiences was recently conducted. Personal interviews were conducted, focusing on personal life history, and meaning-making motivations. The participants’ narratives provided insights regarding how their experiences as polymaths have been like (Cotellesa, 2018).

Participants in Cotellesa's study are labelled here "little-p" since they achieved a recognized level of professional status, but not (yet) the legendary level of a cultural hero. Typical examples include a PhD. in neuroscience being also an accomplished photographer, a financial analyst with Bachelor of Arts degree in theater, a mathematician and accomplished pianist, a physics professor and professional magician (a main pre-condition to participate in the study was the active involvement in divergent fields, such as business, science, and the arts). The conclusions of the field study include identity issues (not fitting in the typical box), efficiency (juggle their many interests through effective time management), dedication (willingness to improve oneself through self-directed learning), and extra-curriculum determinants (family and financial resources impact the emergency of polymathy).

We may bring another paradigmatic example of p-polymaths engaged in advancement of human knowledge. Personal experience of the author draws from 30 years working in scientific-technological research at the Micro-nanoelectronics Research Center at the Technion, The Israel Institute of Technology. The center is the hub for about fifteen Faculty Members and more than fifty associated researchers, graduate students, post-Docs, and engineers devoted to the study of micro and nano-devices. As pre-requirement for the scientific characterization of these micro or nanodevices, one has to proceed in the process of nano-fabrication, plagued with many unknowns. Problem solving in such daily work relates regularly to chemistry, material science, optics, vacuum engineering, microlithography and more. Daily problem solving in the laboratories requires more often than not, a multi-disciplinary approach. Without a systematic study, I may recall that many individuals have shown creative problem solving using multi-disciplinary knowledge (without having reached eminent status). Nanotechnology and nano-science laboratories like the one described here exist in most developed countries around the world hosting thousands of researchers and engineering staff.

We must note that even in such inter-disciplinary Research Centers, not everyone attempts to solve her problems polymathically. Some prefer to consult or collaborate with "the expert" sitting in the neighboring office. Others, in a polymathic way, try to figure out the possible solutions based on experience in a distant discipline-related knowledge.

Pursuing an active exploratory search for the optimal solution in practical situations independently is a clear sign that *polymathy is an attitude, not necessarily a trait.* By that we mean that polymathy problem solving involves an *affective* component (enjoyment in confronting the challenge), a *behavioral* component (allocating personal resources on understanding the problem) and a *cognitive* component (utilization of interdisciplinary previous knowledge) (Rosenberg and Hovland, 1960).

We may extrapolate claiming that among many professionals (high school teachers, medical doctors, architects, large company engineers, nurses, start-up members, and many others), are p-polymaths to be found. They enjoy life, contribute, and flourish "under the radar". Unfortunately, their traits have not been studied with a social-psychologic approach.

1. **Professional life-course in a specialized, high technology society.**

Career patterns in present day western society went through drastic changes since conceptualized by Donald Super more than forty years ago (Super, 1980). One important trend in present day labor market is the increase in job mobility of the population. (Tikhonov and Novikov 2020). As an example for this trend, according to the US Department of Labor, the average number of jobs held by baby boomers in the U.S. between age of 18 and 38 is above 10. This may reflect an active negotiation of the young employees for a better matching between personal vocation (or expectations) and the actual job requirements, or the continuous seeking of a higher reward.

In the early professional career, job changes are often perceived as a normal process of finding the right match in the labor market (Oreopoulos et al., 2012). Mobility rate peaks around the age of 26 and decreases continuously along the working life cycle (Forsythe, 2018). This decrease with age may be interpreted as a combination of vocational satisfaction and situational and personal determinants, such as marriage, early parenthood, social status.

Let us focus, under this perspective, on the professional (just graduated) individual with a broad range of interests and capabilities. In the early stages of employment, she or he is mostly devoted to activating his expertise within her main (narrow) specialization. The tension between expectations and job opportunities (or job requirements) motivates her/him to invest her best resources aiming at success in her present role or in shopping for an alternative one. He/she is not in a position to risk or compromise his/her project with diversified thinking or with an unconventional approach. In addition to that, after-work time may be committed to family build-up (parenthood), imposing limitations on the leisure time priorities.

For the creative professional with a broad range of interests and a tendency of inter-disciplinary problem-solving approach, there is also an opportunity for sequential changes in job assignment within the same company. Mid-career professionals are likely to accumulate in their working history a large variety of specific specialized projects. However, it may take many years until the process of securing her/his job stability, recognition and success *within the narrow specialization* unfolds the inter-disciplinary potential.

A similar process is often found in academic careers. The young researcher may not be inclined to move to another research institute or department, but she/he may be continuously negotiating her/his position, visibility, creativity, and competitive achievements, expecting tenure, promotion, and international recognition.

The specific themes being treated and exposed as part of her/his "research personality" are likely to be successfully solved (or exhausted) and replaced by another ones (similarly to the case of lateral job mobility within the company in the industrial employment case). It may take two or three decades until her/his "body of public achievements" becomes widely recognized. By this way, one accumulates interdisciplinarity,

According to the "traditional" view of career stages proposed by Ronald Super, the lifelong working evolution is likely to include: 1. An exploration stage (age 15 to 24); 2. An establishment stage (age 26-44); 3. A maintenance stage (age 45-65) (Super, 1957).

In all cases we often find professionals working in the hyper-specialized society accumulating various themes, subjects, or even disciplines under their expertise. *They become inter-disciplinary experts.*

After work scenes for serious leisure projects, hobbies and social engagement become more accessible when the individual becomes "established" at work and more relaxed in his multiple duties. It is not uncommon to see engineers, scientists, medical doctors, and other professionals returning with aging to play their musical instruments, to get deeply engaged in certain competitive sport activity, or to enroll in evening courses in the arts.

Recent views and models of lifelong careers are more dynamic, complex, and multi-faceted due to the rapid changes in technology, political influences, fluctuating markets, and emerging opportunities. But the evolutional principles of individual career patterns remain valid.

Job mobility or shifts in a specific role within an organization are perceived by the individual as *career decision points.* These points reflect encounters with a variety of situational determinants, such as geographic, social, economic, and family condition. The outcome may be an increase in wage, a new technological challenge, a change in working environment, a better vocational satisfaction, and the need to add additional components in the already existing professional toolbox. These shifts are sometimes denoted *learning cycles* contributing to broaden the spectrum of expertise. New tools and concepts borrowed from remote disciplines need to be mastered and applied to the new problem at hand. Thus, shifts from one job to another or between assignements may contribute to the late formation of a multi-disciplinary expert.

One may summarize this rather general description of career patterns as follows:

1. *Every shift in a specific activity is a decision point. Decision points are critical for identity formation.*
2. *Movement to a new specific activity contributes to becoming multi-disciplinary.*
3. *Job security and other situational determinants may evolve into the potential to adopt a polymathic attitude.*

The schematic (and perhaps over-simplified) description presented here of a lifelong career pattern in a hyper-specialized society, may lead to an opportunity for a polymathic attitude. It is only an opportunity. The individual that is attracted to *divergent thinking* (unusual association of concepts, attempting different perspectives and approaches to problems) (Guilford, 1967) may find joy and satisfaction to implement this attitude. We do not embrace the vision of "Polymathy as a life project" (Araki, 2018). Neither we regard this as a "management issue" (benefits versus costs). Instead, we consider it as an evolution process embedded in the working dynamics of a high technology society.

This opportunity is what we denoted "Late polymathy emergence". It emerges probably late in the working trajectory after confronted diverse problems to be solved, novelties to be invented, concepts to be manipulated, secrets to be uncovered, and challenges to be met. The system composed by the domain, the individual, and the field may have to be concerted to turn this opportunity into a creativity greenhouse.

One outstanding exception to the lifelong career pattern described here is the case of young, creative, and bright professionals joining a highly aggressive start-up company. This is a working environment that combines specialization with openness to "crazy" ideas, inventiveness, and high risk moves. The employee here may have enough self-confidence to attempt from the beginning a polymathic attitude. We will address the social behavioral patterns of this group of people in a different publication.

1. **Late polymathy emergence and retirement**

Our description of mobility patterns of professionals uncovers a possibility that "specialists" in our technological society can be driven in a natural way to a broader, more interdisciplinary approach. The individual, finally armed with many experiences, having tasted several disciplines, and probably becoming more self-confident, is capable to return also to some of his old hobbies, sport activities, or artistic avocations, that were postponed or neglected during her/his career journey. This broadening of specialization focuses, and activation of avocations is what we denote "late polymathy emergence". At this stage one may start thinking about retirement. The retirement process starts then, when one starts thinking about that (Wang et al, 2018).

Decision points, learning cycles, and transient events along the past career may have affected the individual identity, and sometimes been associated to some degree of stress, but none of them was as profound and significant as the retirement process. Unlike the earlier decision points, the move into retirement implies learning to live with a new identity. This identity transition process entails necessarily a search for meaning (Wang et al, 2018).

The retiring professional, having acquired *some degree of polymathy* (Salzman, 2022), is likely to invest a significant amount of cognitive effort in planning and designing her/his retirement life-stile such as to find worth actions, projects, commitments, social connections, and values that will provide meaning to the years to come. In other words, the question being asked is "what do I really want to do, to make post-retirement life really worth living?". It has been suggested that the past history of engagement in a creative network encourages the retiree to adopt one of the three possible options: 1. a continued activity (and commitment) into her/his previous domain; 2. A change to a new domain; and 3. A broadening of focus within or beyond domains (Nakamura and Csikszentmihalyi, 2003).

The second and third options represent a more explicit avenue for adopting the *polymath attitude.* By that we refer, as examples, to the retiring chemist shifting into painting, the mechanical engineer into music composition, the mathematician starting to write poetry, or the physicist engaging in sculpture.

1. **Retiring professional researchers and the arts**

In some cases, when individuals have spent most of their adult years engaged in science, technology, engineering, or mathematical disciplines (STEM), they may reach the conclusion that, although the domain is still important, they no longer experience the profound personal engagement to these activities. Moving into a new domain is perceived in these cases as the best way to prevent the natural decay in creative productivity (Simonton, 1988). Changing domain has a social cost: the belonging to the previous community of action is weakened or eventually broken. On the other hand, an individual that changes domain may adopt in late life an identity of *explorer.*

In many western countries, academic and government related employment are subject of mandatory retirement at certain age (between 65 and 70). With present days life expectancy, one may expect in these cases, two to three decades of post-retirement activities. Thus, it is not uncommon for certain STEM-related individuals to start several years prior to formal retirement date, negotiating with themselves and planning their meaningful aging.

For these individuals, having certain degree of manual skills, willing embrace a humanistic approach, and with self-confidence of being capable to an extreme changefulness, active engagement with the arts is a viable option.

Transition from the STEM disciplines into the arts is perceived as a fresh revival of creativity. It provides a widening of the "universe of discourse". While producing visual artifacts (painting, sculptures), writing poetry, or composing musical pieces, one may attempt communicating expressively *any theme* of interest. A theme may comprise animals, landscapes, humans, objects and scenes, emotions, social criticism, historical events, gender issues, racial discrimination, technological threats, and more. For some, there is no need of a theme. The aged artist affords the opportunity to shift from the rigorous study of a definite domain separated from the whole reality, into a fuzzy mixture of fiction and reality, the subjective and the universal, affective, and cognitive, normative and defiance. His artwork may try to confer an aesthetic value, a message, an innovative form, or a combination of them. It may express a clear, sharp message or offer an open reading with multiple interpretations (Ecco, 1989).

These choices are not specifically concerning the aged newcomer to the art field. They are inherent to the very definition of the arts, intensively investigated in the past (see, for example: Hegel, 1975, Adorno, 1970, Carroll, 1999, Jimenez, 2002), and continuously debated in present days (e.g. Danto, 1981, 1989, Forsey, 2001, Adajian, 2018). However, for the aged polymath they may became a wonderful, authentic, meaning making endeavor. It is likely to provide a source of joy, wellbeing, and usefulness while acquiring his/her new identity.

But as much as it may look like a promising paradise, it is not free from obstacles, barriers, and challenges. The first one is learning a new symbolic language in which a visual or sound signifier may indicate multiple significations. Art symbols are likely to refer to other artworks, thus forming a complex associative network. Secondly, there is a need to master a set of techniques (a toolbox) for implementing artifacts. Third, one has to approach a diverse set of codes, cultural narratives, iconographic and immersed messages, traditions of works, genres, theories, conventions. We may denote all the above, *the language of art.* Mastering proficiency in *the language of art* could be challenging for retiring individuals. At their entry level, they may try enrolling in university-type, degree seeking art studies, or in the (less structured) Community Art Education Centers (e.g. Wallace Foundation Knowledge Center, 2007). Needless to say, these courses can only partially fulfil this expectation.

But there is a more compelling challenge: the social constrains or ambivalent response of the field. The "field" is the third component in the system model of human creativity (Csikszentmihalyi, 1999). It is the validating response to a piece of artwork, its approval and social recognition agent. This field may be naively considered to be "the audience", the beholders of the art piece, but it is not. The judgment and approval of the artistic activity of aged non-professional artist is being mostly performed by *Cultural Mediators and Gatekeepers.* These cultural mediators may be the curators, gallery owners, art critics, art dealers in the visual arts, or publishers, editors, cultural brokers in the literary publishing field. The term "gatekeepers" stems from the frequent role of these agents to evaluate, judge, and select the cultural works, and the corresponding creators, that deserve to be supported and distributed. Cultural mediators contribute to the formation of cultural tastes and consumption patterns.

The influence of mediators is decisive in fields characterized by lack of objective quality standards. However, art critics too, in certain cases, do not have a reliable instrument to assess aesthetic qualities in an unequivocal way and no objective agency can prove their evaluations true or false (Van Rees, 1989, Yogev, 2010). In such cases, gatekeepers rely on reputation, or on previous critical assessment of an artist work, on genre, technique, materials choices, etc. All the above said may be of disadvantage to the aged STEM professionals, that by becoming non-professional artists are frequently marginalized or regarded as *outsiders.*

One last obstacle for scientists to become artists frequently mentioned is the *commitment to rigorousness*. Such commitment is expressed in logical inference, attention to facts, unbiased recording experimental results, certainty ("truth *vs.* false") and detailed planning. This way of thinking and relating to the world may result in some rigidity, imposing limits to "wild creativity". We may quote in this respect Susan Langer (Langer, 1953):

*"…there are things which do not fit the grammatical scheme of expression, but they are not necessarily blind, inconceivable, mystical affairs; they are simply matters which require to be conceived through some symbolistic schema other than discursive language…"*

We denote these things "beyond certain knowledge", difficult to apprehend to people committed to rigorousness.

Obstacles, barriers, and challenges for the aged newcomer to the art world are plentiful. Nevertheless, long term commitment to this field may be, as pointed out by Jeanne Nakamura and Mihaly Csikszentmihalyi, a source of meaningfulness and vital engagement.

1. **A kind of summary**

* Artistic creativity in Paleolithic times is being interpreted as rooted in *survival* needs. In modern times, artmaking it is a viable option for the aged (retired) polymath as a source of *meaningfulness*. We suggest that these two motivations are closely related.
* Polymaths were identified by many scholars as an extraordinary class of *cultural heroes.* We have proposed to consider the existence of two groups: the P-Polymaths and the p-polymath. The later is a group of versatile, interdisciplinary, modest, creative individuals. Their behavioral traits could be of great interest for research in social psychology and cultural sociology*.*
* The role of heroes and others in advancing cumulative culture has been briefly touched upon (who rides on the shoulders of whom?).
* In a hyper-specialized society, polymaths are not necessarily opposites to specialists. We have seen that in certain scenes (job mobility, sequential research themes), the specialist may gravitate into being a multi-disciplinary expert. Eventually, this can be the source of *late polymathy emergence.*
* Late polymaths from the STEM disciplines in retirement may rejuvenate their creativity by engagement in the arts. This could become an interesting, enjoyable, valuable, and difficult time for them.

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