EMERGENT COMPLEXITY

Article

Form Is Never Final: Second-Order Nature and Capillary Selection

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Abstract

This essay argues that the human form is not final: : natural selection continues within a second-order natural environment, technogenic in nature, which the species itself fabricates. Understanding "form" as an integrated configuration (body, cognitive and relational dispositions, technical-symbolic couplings), it shows how the displacement of risk from early mortality to effective reproductive fitness re-parameterises evolution. In the technogenic niche, informational mediation of encounter (metric proximity, catalogue–algorithmic hierarchisation–filter) favours assortativity and quantile pairing; functional externalisation redistributes cognitive costs; and mental health operates as a selective channel, from extreme cut to chronic friction that delays parenthood. A verification programme is proposed with comparable indicators (childlessness, age at first child, assortativity coefficients, prevalences of sexual inactivity), defending that data operate as philosophical operators that make capillary selection measurable. The conclusion is that, by reconfiguring the environment, we reconfigure the pressures that shape us: the evolutionary future of the human is the multigenerational resultant of the ecologies we construct.

Keywords: second-order natural environment; capillary selection; effective reproductive fitness; metric proximity; quantile pairing; functional externalisation.

Initial Delimitation

What we call the human form— bodily, psychic, relational and technical-symbolic—is neither a static given nor a teleological endpoint. It is a local functional stability of the species, always negotiated with its milieu. This essay focuses on the evolutionary dynamics of the species under second-order selective forces—technically mediated forces that integrate the continuity of the natural. Here, "form" designates the integrated configuration of the body, neurocognitive and affective processes, relational patterns, and technical-symbolic couplings that sustain reproduction and common life. We avoid digressions on generic "unfinishedness" or ethical-political implications: the point is to describe, with material precision, how certain mechanisms of pairing, effective reproductive fitness and technical mediation re-parameterise the evolution of the species. These dimensions are not compartments but reciprocal couplings: variations in the body reorganise the psychic and relational circuit; alterations in technical-symbolic mediation re-parameterise cognitive dispositions and patterns of encounter.

It is crucial to distinguish two regimes of milieu: the first-order natural environment—physical-biological—in which the species configured itself over most of its evolutionary history; and the second-

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order natural environment—the technogenic—which thickens progressively and today co-determines the conditions of life. It is not "outside" nature, but a stratum fabricated by us, with its own rhythms, signals and accesses that rewrite opportunities for pairing and care, demanding new forms of attention, coordination and maintenance.

We call this technogenic milieu a second-order natural environment—and not "artificial"—because it remains entirely within the material order: it is produced by natural agents (us), operates through the same physical, chemical and biological causalities, and preserves the requisites of selection (variation, inheritance and differential reproduction). What changes is not the principle but the configurations: new gradients of risk, access and pairing. Hence, natural selection continues, now upon fabricated conditions that coevolve with us.

This reading finds support in contemporary research lines: Leroi-Gourhan (1964; 1965) on technical exteriorisation and gesture–language coupling; Simondon (1958; 1989) on technical individuation and "associated milieus"; the vehicle externalism of Clark and Chalmers (1998) and Malafouris's Material Engagement Theory (2013), which treat cognition as a body–thing–sign system; and, at the evolutionary level, niche construction (Odling-Smee, Laland and Feldman 2003; Laland 2017) and gene–culture coevolution (Richerson and Boyd 2005). All converge on the idea that technique integrates the continuity of the natural and reconfigures the conditions of selection.

The Non-Finality of the Human Form

By fabricating its own environment today, the species alters the pressures that select it. The development of a global technogenic niche reconfigures the selective landscape: the force of selection shifts chiefly from early mortality to differences in effective reproductive fitness—that is, to variations in the probability, timing, and number of viable offspring. This shift explains why we place differential reproduction at the centre: in evolution, differences that do not translate into viable descendants die with the individual. Only when variation, inheritance and differential reproduction converge does selection alter distributions (both biological and technical-symbolic) across generations. It is therefore in how, when and with whom one pairs that much of the species' evolutionary course is decided today.

This non-finality has firm backing both in philosophy of biology and in contemporary biology. Philosophically, processual proposals (Dupré and Nicholson 2018) reject the idea of fixed forms and conceive living beings as open processes, continually maintained and transformed by material and informational flows. Empirically, population genomics identifies extensive signals of recent and ongoing selection in humans (Akey 2009; Hawks et al. 2007), while demographic and longitudinal studies show selection at work in contemporary populations: direct estimates in cohorts such as Framingham (Byars et al. 2010), evidence of microevolutionary change in age at first birth in a historical context (Milot et al. 2011), and relations between reproductive patterns and polygenic profiles (Beauchamp 2016; Kong et al. 2017). Taken together, these lines sustain that human evolution continues, without teleology, and that "form"—understood here as an integrated configuration—remains open to selective reconfigurations imposed by an increasingly technogenic milieu.

In this essay, "form" is more than morphology: it includes cognitive and relational dispositions that emerge from material couplings with the milieu and with artefacts.

Second-Order Forces and the Technogenic Niche

Before mapping these forces, a historical cut matters: the species has not always fabricated its milieu systematically. For most of its evolutionary history, the relevant environment was primarily first-order. Regular milieu-fabrication by the species thickens with agriculture and sedentarisation (control of cycles, storage, division of labour) and then accelerates with industry and modern technical networks. This is what prepares the second-order natural environment in which contemporary selective pressures operate. In this key, the epidemiological/demographic transition (Omran 1971) and niche-construction perspectives clarify that selection did not stop: it reconfigured as the milieu became fabricated.

Technique is not external to life: it is a secondary level of the natural, a material continuity that co-determines the milieu. Under this light, we can distinguish four families of forces that together re-parameterise the costs and benefits of survival and reproduction.

Biotechnical forces include vaccination, advanced obstetrics and neonatology, assisted reproduction, and genetic screening/editing. Their clearest effect has been to drastically reduce pre-reproductive mortality, shifting selection to traits that favour pairing and parental care and altering reproductive ages and trajectories. This is the classical terrain of evolutionary medicine (Nesse 2010; Stearns 1999) and recent population genomics, where selection is estimated to be ongoing even in contexts with strong medical intervention; the demographic transition (Omran 1971) describes precisely this displacement of risks that re-parameterises fitness.

Techno-ecological forces derive from urbanisation, chronic pollutants, controlled micro-environments, and anthropogenic climate change. They produce low-intensity, persistent pressures that demand distinct immuno-endocrine and metabolic coordination and decouple physical effort from survival, favouring profiles capable of persisting in materially complex environments. Concepts such as the exposome (Wild 2005) and urban metabolism (Wolman 1965; Bettencourt 2013) help name this web of exposures and artificial flows that compose the second order of the milieu; the planetary health agenda (Whitmee et al. 2015) shows how these fabricated conditions return as biological constraints.

Info-symbolic forces act directly on encounter: pairing platforms and catalogue–algorithmic hierarchisation–filter systems convert physical proximity into metric proximity. The apparent abundance of options, imagetic idealisation and niche segmentation raise acceptance thresholds, generating choice overload and enlarged assortativity. The typical outcome is a densification of intra-quantile pairings (by education/status, markers of attractiveness, height), with effects on timing and stability of reproductive bonds. Here, cultural evolution (Henrich 2016) provides the frame for understanding learning biases and preferences; studies of online pairing and homogamy (Rosenfeld, Thomas and Hausen 2019; Kalmijn 1998; Schwartz 2013) show how filters amplify homophily; and the literature on choice overload (Iyengar and Lepper 2000) helps read delay and indecision as products of saturated catalogues and permanent algorithmic hierarchisations.

Within the info-symbolic family, language and image function as operators of signalling and triage: discursive and imagetic patterns stabilised by recommendation algorithms modulate attention, expectation and acceptance. By converting preferences into comparable signals, the semiotic ecology of encounter reconfigures search costs, raises acceptance thresholds and thickens assortativity—without breaking the material continuity of the process.

Cyborganic forces encompass prostheses, implants, psychopharmaceuticals, brain–computer interfaces (BCI) and exoskeletons. They create performance differentials that translate into indirect effects on income, social networks and longevity, influencing reproductive contribution across the life course. Philosophy of mind and of technique has here a precise formulation: Natural-Born Cyborgs (Clark 2003) and Simondon's technical individuation describe these couplings as stable operational extensions, not adornments; research on BCI and neuro-prostheses shows how such extensions can crystallise new functional margins.

How the Fabricated Environment Translates into Selection

With the decline in infant and juvenile mortality, selection acts chiefly in adulthood (Omran 1971). Operatively, this shifts the relevant variation to traits affecting who manages to form reproductive pairs, when this occurs, and with what stability—precisely what evolutionary demography has sought to measure via constraints in fertility and survival schedules.

Put differently: selection now increasingly targets the capacity to operate in the second-order natural environment. On average, profiles with greater resistance to stress, tolerance of social pressures, and competence for sustained cognitive effort tend to persist—those able to sustain divided attention, working memory, and decision-making under permanent comparison without operational breakdown. In parallel, robust affect regulation is required in the face of evaluation anxieties and scales of social comparison which, when persistent, erode the margin of self-modulation and reduce effective reproductive fitness. What changes in depth is the structure of pairing: from local encounter we move to encounter by measured affinities. Online encounter displaces traditional intermediaries and becomes a dominant route (Rosenfeld, Thomas and Hausen 2019), while revealing hierarchies of desirability and steep response gradients, with a marked drop in probability of reply as the algorithmic-hierarchy distance between pursuer and pursued increases (Bruch and Newman 2018). In saturated catalogues, choice overload and permanent algorithmic comparison raise acceptance thresholds and favour postponement (Iyengar and Lepper 2000).

From this emerges a trend towards quantile pairing, which increases covariance of traits within couples and stratifies the distribution of resources and cultural capital among descendants. In quantitative-genetic terms, phenotypic assortativity increases additive variance and reinforces intergenerational similarities (Lynch and Walsh 1998). However, recombination and regression to the mean function as statistical brakes in the short- and medium-term, maintaining porosity between sub-populations (Lynch and Walsh 1998). Hence the image of a reproductive archipelago: panmixia is diluted into global subnetworks with soft barriers to gene flow, without implying speciation.

Functional externalisation of memory, orientation and coordination outside the biosoma reorients the costs of what the body must maintain internally and shifts capacities to artefacts, routines and coordinated environments—this is the lesson of distributed cognition (Hutchins 1995) and cognitive artefacts (Norman 1991), compatible with vehicle externalism (Clark and Chalmers 1998). These technical-symbolic couplings are not adornments: they condition performance, support networks and, thereby, reproductive trajectories.

Mental health functions here as a decisive channel at two levels: in the extreme cut, suicide implies zero fitness; in chronic friction, persistent depression reduces the probability of conception and delays

the first child, with recent findings in couple samples and population registers (Liao 2024; Golovina 2023). These are capillary, cumulative effects, without moral teleology, yet with measurable evolutionary impact if they persist over time.

Empirical Anchors and Horizon of Verification

Recent empirical patterns strengthen the reading that the fabricated milieu reconfigures effective reproductive fitness through capillary pathways. In highly digitalised populations, consistent increases in sexual inactivity and reproductive postponement are observed. In the United States, sexual inactivity rose between 2000 and 2018, especially among men aged 18–24 and 25–34, with about one in three men aged 18–24 reporting no sexual activity in the previous year (Ueda et al. 2020), converging with declines in sexual frequency documented in GSS series (Twenge, Sherman and Wells 2017). In Japan, successive analyses of the National Fertility Survey show high and rising levels of sexual inexperience among those aged 18–39, and among never-married 18–34-year-olds more than 40% without heterosexual experience in 2015 (Ghaznavi et al. 2019); the 2021 round confirms objective barriers to encounter and declining marriage (NIPSSR 2022). These patterns are compatible with the displacement of intermediaries and the dominance of online encounter (Rosenfeld, Thomas and Hausen 2019), suggesting that metric proximity and filters reinforce postponement and assortativity.

Mental health emerges as a measurable selective channel. In general-population couple cohorts, pre-conception depression is associated with longer time-to-conception and higher risk of infertility (Liao et al. 2024). In national registers, depression treated in secondary care is associated with a lower probability of having children and lower completed fertility, with differences by sex and socioeconomic status (Golovina et al. 2023); similar results appear when modelling one's own depression, partner's depression and childlessness (Kailaheimo-Lönnqvist et al. 2024). These findings do not institute fatalisms; they indicate chronic frictions with reproductive effects when persistent.

Thus, the thesis is verifiable through a programme of indicators and comparable series: — Cohort childlessness, and by subgroups of exposure to the technogenic niche (education, income, urbanisation), using standardised sources (Human Fertility Database 2025; see also Jasilioniene et al. 2016). — Age at first child by status/education quantiles and the distribution of the interval to first child, to detect timing frictions (Human Fertility Database 2025). — Assortativity coefficients in couples (education/status), tracking strengthened homophily in digitalised ecologies (Kalmijn 1998; Schwartz 2013) and its covariance with the mediation of encounter (Rosenfeld, Thomas and Hausen 2019). — Prevalences of sexual inactivity/inexperience by age and sex in national surveys (Ueda et al. 2020; Ghaznavi et al. 2019) and their relation to indicators of digital mediation. — Mental health and parenthood: relative risk of childlessness and time-to-conception by profiles of one's own and partner's depression (Liao et al. 2024; Golovina et al. 2023; Kailaheimo-Lönnqvist et al. 2024).

Environmental contingency is part of the philosophical and empirical test: if policies that reduce the material costs of parenthood and infrastructures that facilitate non-metric encounters reduce involuntary celibacy or anticipate the first child, then selection is operating through the milieu we fabricate—not by immutable essences. It is this differential response, measured over decades and compared across cohorts, that would confirm second-order selection.

These indicators are philosophical operators, not mere illustrations: they function as materialist proxies of reproductive costs and benefits under the technogenic niche. Their reading requires causal caution (context, cohorts, heterogeneity), but it is precisely this contingency that makes them probative for second-order selection.

Conclusion

What is established is simple and operative: the human form is not final because natural selection continues to act, today above all within the second-order natural environment, technogenic in nature, which the species itself fabricates. "Form," understood as an integrated configuration of the human, is therefore a local stability subject to re-parameterisations whenever the milieu changes.

The originality of this proposal does not lie in claiming an isolated discovery, but in articulating four strands that rarely appear together: a materialist ontology without nature/technique dualisms; the distinction between first- and second-order milieus; the centrality of differential reproduction as the criterion of effective change; and the translation of the effects of digital mediation into nameable mechanisms—metric proximity, funnel effect, quantile pairing, reproductive archipelago—with metrics that can be verified.

A practical consequence follows: there is no fixed destiny. By reorganising the milieu, we reorganise the selective pressures that shape us. Policies, infrastructures and habits can attenuate or intensify trajectories—and that is precisely what series and cohorts will allow us to measure.

Finally, a limit is acknowledged: these are slow tendencies, dependent on the stability of the technogenic niche and heterogeneous by context. The openness of the work lies in following the evidence and testing the predictions; the philosophical openness, in keeping thought vigilant regarding the compatibilities imposed by our own environment.

To think policies and infrastructures here is to describe ways of modulating the niche: material alterations of the milieu that redistribute reproductive costs and benefits. This is not moralising; it is making explicit the selective pragmatics of the ecologies we fabricate.

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