

HOW TO EVOLVE AN IRON CAGE: CONSEQUENCES OF COORDINATION BY CODE

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ABSTRACT: This paper examines a core topic in the evolution of human social systems. The central question is why the cultural knowledge of groups of humans shows such a high degree of narrowness and boundedness within the conceivable possibility space of sociocultural systems. This property is referred to here as the ‘iron cage’, echoing Weber’s famous terminology, but revising the concept critically. The paper focuses on the consequences, both on individual rational decision-making and higher-level social organization, of the fact that human social relations are conducted by means of codes.

INTRODUCTION

In his 1905 book *The Protestant Ethic and the Spirit of Capitalism*, sociologist Max Weber proposed that certain key aspects of capitalism and bureaucracy imposed an *iron cage* on modern populations (Weber’s original German phrase was *stahlhartes Gehäuse* “steel-hard casing”). His idea was that modern social movements toward instrumental rationality, technical efficiency, and impersonal rules created rigid and hard-to-escape social structures. In this way, the ruthless rationality of modern man gives rise to a system of impersonal rules and structures that create “a world of calculability, pure functionality, and the instrumental rationality of means” (Scaff 1989, 150), destroying “any heterogeneity of ends” (Andrew 1999, 9) and eliminating “spontaneity in favor of formal rules and procedures to guide thought, feeling, and behaviour” (Schwalbe 1996, 256). The iron cage is often taken to be emblematic of modernity (Baehr 2001, 153) and is synonymous with a critique of modern society and state as soulless and “disenchanted” in comparison to an idealized pre-modern world. Weber’s iron-cage vision is at once “pessimistic”, “despairing”, “nightmarish”, “dreary”, and “dark” (see e.g., Mitzman 1969; Scaff 1989; Ritzer 2019). But the iron-

cage story needs revisiting, for at least four reasons. The first is that there is nothing uniquely modern about being rational (Tyler 1969; Hutchins 1980; Cole 1996; Atran and Medin 2008; Pinker 2021, among many others) and so if the iron cage is a modern phenomenon, its cause must be something other than just a rational mindset. All societies display instrumental rationality and enforce social norms based on impersonal and limiting roles, whether those norms are grounded in kinship, bureaucratic function, or some other shared basis for expectations. Second, the iron cage is not a modern phenomenon anyway. All social orders impose heavy constraints on their members (Maryanski and Turner 1992), and indeed it has been argued that traditional societies are far more constraining than modern ones (Turner and Maryanski 2008).² Third, the “cage” framing is decidedly negative (and prone to hyperbole at that; is any society literally “soulless”?), so we must also consider in what ways social structures may also be empowering frameworks for action. And fourth, it is important to reconsider the argument in terms that are informed by evolutionary perspectives on social processes that have developed considerably since Weber’s time.

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This paper revisits the question of the iron cage and its causal underpinnings. We ask: What causes sociocultural systems to universally limit people's worlds of thought, action, and feeling? Our answer appeals to a foundational pillar of human sociality: the use of codes for coordination at scale. By "code", I mean any effectively fixed symbolic convention that may be used for achieving social coordination: most obviously, this includes the words and grammatical structures of our languages. The argument makes three contributions. First, it generalizes the concept of the iron cage, arguing that because the phenomenon occurs in all human sociocultural orders—and is not just a property of modern bureaucratic life—it demands a general explanation. Second, it generalizes the link between rationality and social order, given that our understanding of "rationality" has come a long way since Weber's assertions more than a century ago that the rational basis of bureaucracies distinguishes the cognition of those who follow "that path of rationalization which is peculiar to the Occident" (page xxxviii) from those who live in "the *status naturæ*", under "the power of irrational impulses" (p71). Third, this account offers causal mechanisms that explicate the long-suggested link between the micro-level of talk and the meso- and macro-level structures of organizations (Boden 1994), cultures (Sacks 1992), and social orders (Garfinkel 1967; Goffman 1983).

We proceed as follows. We first establish three key facts that will be important for the argument: selectivity of sociocultural systems, the universal rationality of humankind, and the centrality of social interaction to macro social systems. We then present the argument that codes are the key mediating mechanism that links human rationality and sociocultural systems. Beginning with the concept of action agendas in human affairs, we argue that the social *sharedness* of agendas leads

necessarily to an alignment of attention and a subsequent collective narrowing of sociocultural flow. The devices that allow us to coordinate effectively are symbolic entities, with functions ranging from simple (e.g., prices) to complex (e.g., languages). These devices allow social groups to be scaled up in size. The subsequent sections introduce the idea that organizations and institutions are scaling technologies and that codes and common ground are necessary for creating and operating such organizations and institutions. The investment costs of creating organizations and institutions by means of code bring about path-dependence effects, which are not only observed at the local level in organizations such as firms but also apply at the level of whole cultural and linguistic systems. We then consider the need for interoperability *between* social/linguistic groups, which leads to isomorphism of the cultures and languages used by neighbouring social groups who are in contact. This has implications for the generalizability of DiMaggio and Powell's argument for the causes of isomorphism in neighbouring social organizations within a social or economic realm of specialization. Combining the notions of initial investment costs of socialization and path-dependence in sociocultural structure, we define sociocultural systems as evolved platforms for sociocultural action, being both enabling and constraining, as all iron cages must be. We conclude with a summary discussion.

1. SELECTIVITY, RATIONALITY, INTERACTION

Three facts must first be established in advance of the argument below: (1) sociocultural systems are selective; (2) rationality is universal; (3) social interaction is central.

1.1 Selectivity of sociocultural systems

All sociocultural systems are radically *selective*; that is, their

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- 2 There is good reason to be critical of Weber's pessimistic and catastrophizing framing. While Weber contrasted modern "bureaucratic" life against an idealized pre-modern life of "enchantment", Maryanski and Turner make a strong case that ancient lifeways were constraining and oppressive, and indeed modern life's "cage of power" is an improvement on the old "cage of kinship". If modern society is a cage, it has "widely spaced bars and an open door" (Maryanski and Turner 1992, 170); post-industrialized, large-scale societies are "open, fluid, and individualistic" compared to earlier social systems such as those organized around unilineal descent: "contrary to Max Weber's great agonizing over the 'iron cage' of rational-legal authority ... industrialization produces a far less constraining cage than traditional agrarianism. And post-industrialization perhaps creates even more potentialities for lessening the constraints of power" (Maryanski and Turner 1992, 138; see also Turner and Maryanski 2008). Membership in any social system means being "encaged" in some sense, though the casing in question could be as empowering as it is limiting: "culture is not merely the path to self-recognition, but also the dwelling place of repressive order. In one sense culture suggests movement and possibility, in another rigidity and limitation" (Scaff 1989, 198). It's like wind for a sailboat: you may be a "slave" to the wind in that it dictates your speed and direction, but that wind is what allows you to move.

contents only fill a tiny part of the conceivable state space.³ “From a whole possible area of past and present, in a particular culture, certain meanings and practices are selected for emphasis and certain other meanings and practices are neglected or excluded” (Williams 1977, 115).⁴ “A culture” is of course far roomier than a bureaucracy or a firm, but even a complete socio-cultural system is a very limited enclosure relative to the full possibility space, that is, to all possible forms of value and practice. The shared conventions of a sociocultural system must be rich enough to flexibly support a great range of coordinative functions and to allow members of the group to interact “without serious misunderstanding and without needing to explain what their behavior means” (Peoples and Bailey 2000, 17).⁵ At the same time, those systems must be small enough to be learnable by individuals. This is one source of pressure to restrict their scope of content and function.

In language, for example, there are no languages with a hundred words, just as there are no languages with a hundred million words. All languages have a basic vocabulary of around five thousand words that will be known by all fully competent users of the language. Most individuals will know many more words than this, but these additional words will relate to specialized knowledge or practice that cannot be assumed to be shared by all language users. The core inventory is limited in size (Enfield 2023, 13-16).

The radical selectivity of sociocultural systems is, in part, what allows us to describe them as iron cages. Sociocultural systems restrict the range of signals available for use, and therefore the range of social actions that are possible in a group. In sociocultural systems, this is not caused by any physical barrier, but rather by a simple functional limitation of communication, namely: our social actions cannot function unless they are legible to others, and so their design is necessarily shaped by practical limits on how much common ground can be learned and shared in a community.

1.2 Rationality of humankind

The concept of *rationality* was key to Weber’s description of modernity as an iron cage. Exactly what he meant by rationality was unclear. Some authors feel that his usage of the word was “irredeemably opaque and shifting” (Lukes 1970, 207). Others have sought more constructively to unpack what was intended. Swidler discerns at least three distinct meanings in Weber’s use of *rationality*, which she labels *rationalism* (“efficient orientation of means to ends”), *rationalization* (“the systematization of ideas”), and *rationality* (“the control of action by ideas”) (Swidler 1973; see also Cockerham 2015, 124). Eisen’s (1978) list of ideas indexed by Weber’s rationality include means-ends calculus for efficiency, norms that define conscious expectations, deliberate forward planning, specialized training and disciplines, systematization of knowledge, impersonality in relation to roles, sobriety and discipline, increasing predictability, and more (Eisen 1978, 62–63).

This notion of rationality as a feature of modern organizations also framed it in contrast with the supposedly irrational or non-rational nature of “traditional” cultures. But thanks to a century of progress in our understanding of human cognition and our appreciation of human diversity, we now know that none of the concepts listed by commentators like Swidler and Eisen, cited in the last paragraph, are exclusive to “modern” populations. All people are rational in the sense that they set goals and pursue them, are able to represent, evaluate and select alternative means to those goals, coordinate decisions and actions with others, use language for social coordination and conveying information, systematize bodies of knowledge and practice, interpret actions in relation to roles, and demand and supply reasons for decisions and actions. Rationality is of course always culturally inflected, given that different social groups work with different premises and norms, but the underlying mechanisms of rationality are always there. And just as cultures are not as *irrational* as they are made out to be (Geertz

3 I use the term sociocultural system as a broad term that captures diverse kinds of system at levels from dyads and organizations to firms to entire cultures.

4 “Among the multitudes of mental representations that a human mind entertains in the course of ordinary behavior, only a minuscule proportion are similar to other individuals’ representations.” (Boyer 2018, 246) There are “islands of similarity in an ocean of unique content” (p. 248).

5 For brevity, I use culture here to mean a system of sociocultural conventions, that is, a set of knowledge, values, and practices shared by members of a group and used as a frame of reference both for interpreting others’ actions and for generating actions that are interpretable by others. I do not mean culture in a monolithic or vernacular sense, as in *The French Culture* or *The Japanese Culture*. In the sense used here, culture could include the sociocultural conventions in a mechanic shop, as shared and used by the team of people who work there (and who will, of course, in turn be embedded in other, often larger sociocultural systems).

1973), neither are organizations as *rational* as they are made out to be (Dobbin 1994, 118 and *passim*).

1.3 Centrality of social interaction

A causal account of sociocultural systems, from dyads to firms to cultures, begins from the observation that social order is sustained by *social interaction*, either in dyadic conversation or some scaled-up version thereof. Social interaction draws on three key resources: (1) a micro-level infrastructure for interpersonal coordination, through mutual orientation, participation, and sequence organization (Goffman 1983; Goodwin 2018); (2) symbolic codes that are learned and used locally, ranging from specialist terminology to entire languages; (3) common information, knowledge, and values that are assumed to be shared by members of defined groups, and that are therefore taken for granted, informing members' actions and interpretations without needing to be spelled out.

These three resources combine to enable practices of talk, which not only constitutes dyadic relationships but from a microsociological perspective is “the apotheosis of social organization”: talk is the “enabling institution” for “a substantial proportion of the conduct of which all the other major social institutions are composed” (Schegloff 1987, 208; see also Boden 1994, 8; Lawler, Ridgeway, and Markovsky 1993, 280). More broadly, from an ethological perspective, it is only through micro-level interaction that relationships, relationship types, and social structures can emerge at all (Hinde 1976). This argument has been made both for the meso-level of organizations and the macro-level of society and culture (Garfinkel 1967; Goffman 1983; Sacks 1992; Sidnell 2007; Floyd 2021). The implication is that the micro-conditions and micro-outcomes of talk are a causal link between macro-conditions (social structure) and macro-outcomes (social change), thus mediating between individuals and organizations (Coleman 1987; Raub, Buskens, and Van Assen 2011).

1.4 Preview

We have established three reference points for the argument that follows: (1) the selectivity of sociocultural systems, (2) the rationality of humankind, and (3) the centrality of social interaction in sociocultural systems. We can now turn to the argument that the iron cage—i.e., the constraining selectivity of sociocultural systems—emerges from the rational deployment of communicative codes, something that human society has been

predicated on since the beginning. The argument derives from three disparate kinds of causal force, which in combination cause sets of individuals to form ordered social groups, cause sets of knowledge and values to form ordered cultural systems, and cause those systems to be small relative to the possibility space. The three kinds of interconnected centripetal forces that shape cultural cohesion in this way are:

(1) economic: at the individual level, people must manage finite resources; we must ration the finite time and attention that social action necessarily consumes

(2) functional: at the interactional (usually, dyadic) level, people must design their actions to be interpretable by their intended recipients, demanding joint commitment in interaction and isomorphism in the codes and knowledge/value sets that individuals use for coordination

(3) infrastructural: at the group level, people's economic and functional use of codes and common ground for joint action leads to local narrowing of shared knowledge and practice under increasing returns from path-dependence in the development of sociocultural systems

These three forces impose constraints by mediating the connection between rationality and communication, leading to the constrained sociocultural infrastructures that we call iron cages. This paper argues for a theory of centripetal force based in the alignment and interaction of these three forces. I argue that, taken together, these centripetal forces create the conditions in which sociocultural orders become both constrained and constraining.

2. FROM RATIONALITY, THROUGH CODE, TO IRON CAGES

Causal accounts for iron-cage phenomena have tended to focus on macro-level trends in modernity, the most famous being Weber's theory that the Protestant “rational” mindset enabled the development of efficient bureaucracy and the historical rise of capitalism. DiMaggio and Powell's subsequent analysis of modern institutional fields found a constraining force not in rationality or even efficiency but in the emergence of isomorphism among modern organizations: that is, neighbouring groups in a functional field (such as competing firms in the same industry) come to resemble each other (DiMaggio and Powell 1983). And Mann's survey of the sources of social power leading up to the Industrial Revolution found that the historical process of modernization through territorial expansion brought

about “the closing of the escape route” for local inhabitants who were “constrained to accept civilization, social stratification, and the state” and were thus swept up into the economic, ideological, military, and political “cages” of modernity (Mann 1986, 75). While each of these treatments of the emergence of sociocultural cages is focused on distinctly modern developments, our view is that iron cages have been around for as long as humans have combined culture with rationality, that is, from the beginning.

2.1 Agendas and incentives

Because the cognitive capacity for individuals to collect and hold information is inherently bounded, we have no choice but to ration our attention (Simon 1956; 1971). We divide decision areas into three fields: (1) active, (2) monitored, and (3) passive (Arrow 1974). The *active* field takes up most of our attention and provides most of our incentives. The *monitored* field contains the things we allow to occupy our attention if needed. This field provides a mechanism for redirection of attention. When we detect departures from the expected, this can lead to change, innovation, and flexibility in sociocultural order. If something is in the monitored field now, it can potentially be moved into the active field later. Finally, the *passive* field is a large, presumably infinite area, which we overlook entirely. This is our blind spot: hypocognized, irrelevant, and invisible.⁶ Whatever occurs in this field is what Arrow calls “non-agenda”.

Viewed from this perspective, sociocultural systems define availability landscapes for decision-making, making certain reasons for action more obvious to agents and easier to reach for.⁷ This does not mean that there is a direct line from value to action (Swidler 1986). Culture is not like Weber’s switchmen (Weber 1946, 280), who “determine the tracks along which action has been pushed” as if our actions were inanimate railcars. Instead, culture is more suggestive, full of nudges, like traffic-directing infrastructure, choice architecture that in prin-

ciple lets the perceiver actively decide but that mostly relieves us of the need to constantly evaluate our decisions about where to go and how to get there (E. J. Johnson et al. 2012; Mertens et al. 2022). This does not mean that culture is purely regulative; it is also constitutive, shaping who we are and what we want (see below). Another problem with Weber’s switchmen image is that it assumes the tracks are laid in advance. It is better to think of sociocultural practices as “tracklaying vehicles” (Mann 1986, 28) that run on the tracks they lay, an image that echoes the *duality* by which sociocultural systems both shape, and are shaped by, social action (Giddens 1984). The next section turns to the social dynamic whereby decisions and actions contribute to shaping the landscape that, in turn, shapes the flow of future decisions and actions.

2.2 Social action shapes and funnels sociocultural flow

Because decision-making and action consume the finite resources of time and attention, our agendas have a saturation point. Saturation both limits the amount of information that can be contained in our *active* and *monitored* fields of attention and entrenches the set of cultural items that are in those fields for any given culture or organization. This helps to explain why an individual’s scope of decision and action is limited. But how is it that, in groups, different individual members are constrained to *the same* limited scope? To answer this, we move from the individual decision-maker by considering the essentially *social* nature of their agency. Two significant points arise.

The first point is that social action is other-dependent. If your target cannot interpret what you are trying to do, the intended social action will fail (Krebs and Dawkins 1984; Kockelman 2005). This fact sets causal constraints on how social actions are formulated. Because social action is necessarily coordinative, associates are subject to a *legibility criterion*, namely that a social agent must design their actions to be interpretable to, and actionable by, the other. This criterion places a centripetal

⁶ Actually, “blind spot” is misleading. The inverse would be more accurate. While a blind spot is a small area we cannot see in a large field of vision, our active and monitored attention is rather more like a spotlight, a small area we focus on in a large field that is dark, unperceived, and ignored. (The screen of a smart phone would also be an apt analogy: sometimes we focus on it so intently that the rest of the world falls away.)

⁷ Availability has a negative side. Because the availability landscape is finite, when one thing is available, other things are not (cf. availability bias; Tversky and Kahneman 1973). This gives rise to what behavioural economists call dark patterns (Luguri and Strahilevitz 2021; Sunstein 2022). An example is where an online service gives you a choice between a free sign-up and a paid subscription, where the free button is smaller, lighter in colour, and further from the centre of the screen than the paid button. Patterns like these create “preselection of default”, which is also a property necessary for the efficiency of organizations and cultures. Culture is like an online form with prechecked boxes. This makes it efficient but it also works to “obviate consent” (Luguri and Strahilevitz 2021, 97). Like language, culture becomes a collection of off-switches for the mind.

force on the shared pool of semiotic resources that circulate in a socially-interacting population.

The second point about the relationship between social action and higher-level social structure is that social actions are not just carried out by individuals but are distributed (Goffman 1981; Hutchins 1995; Kockelman 2007). Social coordination allows people to have shared goals, make shared decisions, and share accountability for actions. This creates a building-block for social structure—i.e., a relationship rather than an individual—that allows sociocultural systems to be scaled up almost indefinitely (Hinde 1976).

2.3 Coordinative mediating structures, or signs

Social coordination requires mediating structures, also known as signs (Kockelman 2005). A simple illustration is the price mechanism (Hayek 1945). Prices provide information that allows people to decide whether to engage in an economic exchange. In the terms introduced here, prices provide *reasons for action*, in relation to people's agendas. In theory,⁸ a price heavily reduces decision costs by obviating the need for individuals to know about the complex causal chains that have created it. This general picture applies to signs as coordination devices more generally, from prices to words, technologies, ideologies, value systems, and the rest of culture.

Coordination devices have both *direct* and *indirect* signaling functions. They signal directly through what we might think of as the basic meaning of the sign, e.g., the number on the price tag of a Gucci mini shoulder bag (answer: \$3000) or the dictionary meaning of the word *hematoma* (answer: a bad bruise). They signal *indirectly* through the meanings *given off* by the sign. This refers to what we may guess or infer about a person from their use of a sign. For example, if they buy a \$3000 bag we might draw conclusions about their status, means, and character. Or when they say the word *hematoma* we might draw conclusions about their profession or field of expertise.

2.4 The need for rational solutions at scale

Coordination devices appear to yield much while costing little, but as social systems scale up, there are costs associated with maintaining infrastructures for determining shared incentives, interpretations, and values. How do individuals at the micro-level navigate the costs of operating in ever-larger groups at the macro-level? The rational solution to this problem is to invent new sociocultural technologies. In the following sections, we look at the two key types: (1) meso-level social units such as organizations and institutions; (2) codes and the shared knowledge within which they operate.

3. SOCIOCULTURAL TECHNOLOGY, I: ORGANIZATIONS AND INSTITUTIONS

Organizations and institutions are network substructures that mediate between the micro-level of individuals and the macro-level of society/culture. They reconfigure networks and thereby impact the ways in which information and relationships are distributed. This in turn impacts the distribution of agency. It also retools social infrastructures for cultural and informational flow.

An example of a mediating institution is the firm. Why do we have firms? One explanation is that they evolved to counteract certain costs of leaving social coordination to wholly distributed and emergent devices such as the price mechanism (Coase 1937). Those costs include the costs of gathering and exchanging information and aligning incentives. Another reason why institutions more broadly have evolved is to counteract centrifugal forces caused by increasing population, including anonymity and non-reciprocity in interactions (North 1991, 97).

The mechanisms described by Coase (1937) and North (1991) are innovations of social technology in the modern era, developed under pressure from increases in population size. To understand this argument from scale in the modern era, we must see the problem of organizations as a far deeper issue in human sociocultural organization. We need to contextualize it in light of social innovations going back to the beginning of

⁸ Obviously, the free-market price mechanism is an abstraction. Prices and equivalency values are known to have been administered by authorities since the earliest records of debt and equivalency in ancient times. In the Neo-Sumerian economy (3rd millennium BC), the “value of barley relative to silver arguably varies for quite other reasons than those of abundance or shortage due to natural events, or because of changes in the market and therefore the demand for and supply of one or the other of these commodities.” (Cripps 2017, 30) See also (Englund 2012), <https://michael-hudson.com/2018/04/palatial-credit-origins-of-money-and-interest/>. But our key point here is that, from the decision-maker's perspective, a price is a public reason for action.

our species.

The diverse sociocultural systems known to humankind all evolved as adaptations to increasing population size and density (Turner and Maryanski 2008). Two foundational elements of sociality provide the most basic building blocks for adapting sociocultural order to population size. The first is *kinship*. Kinship creates core social networks and provides primordial incentives for mutual support and preferential association with known others. Kinship can set biases on, and furnish models for, higher-level social units. The second is the mechanism of *corporate agency*, which allows multiple individuals to fuse together and jointly inhabit single social statuses.⁹ This can be done at levels ranging from a dyad to a segmentary lineage to a nation state. Underlying corporate agency is the capacity for joint actions and joint commitments, underpinned by social-cognitive capacities that are universal among human groups despite our significant cultural diversity (Tomasello 2019).

The human capacity to form ad hoc groupings in flexible ways is what defines the last *major evolutionary transition*, as proposed by Maynard Smith and Szathmáry (1995). In a major evolutionary transition, what were once independent units combine to form a new higher-level unit, as in the transitions from prokaryotes to eukaryotes and from unicellular life forms to multicellular life forms. The emergence of human social groupings is the outcome of the first *psychological* major evolutionary transition, that is, the first transition in which the glue that holds the new individual together has a psychological component. Human groupings clearly form new evolutionary units in so far as their success benefits their smaller constituent units, that is, individual group members who are incentivised to cooperate and even act against their own individual interests (see Wilson and Sober 1994; see also Enfield and Planer 2026 for further discussion of the first psychological evolutionary transition).

Many researchers have sought to chart the development of social structures through human history, proposing types from kin groups to bands, tribes, chiefdoms, and states (Service

1975). These systems cohere around characteristic group sizes; e.g., bands and tribes at around 25 and 500 people, respectively (Kelly 2013, 167), social circles at around 150 (Dunbar), and so on.¹⁰ The same group sizes are reflected in modern organizations such as the military, with, for example, platoons at around 25, companies at around 150, and battalions at around 500. The logic and organization of these various structures is the subject of a major literature in social anthropology. In early work, matrilineal systems provided a mechanism for kin-based social organizations.¹¹ This led to predictable group-level patterns of residence and property rights, with implications for political organization and lifeways (Rivers 1924; Murdock 1949; Chapais 2008).

Political systems provide general solutions for achieving efficient function at the meso-level, as needed in groups such as clans or firms. They must in addition solve two key problems of maintaining social structures at scales larger than those that have pertained through most of human history (i.e., in groups of more than a few thousand). These two problems are (1) how to get old brains to function in new contexts and (2) how to maintain critical functions of society in networks of exponentially increasing size.

How is it possible to create and sustain order in modern societies' massive populations when the ancestrally-derived psychology of individual group members is calibrated to social groups of around 150 people (~11k dyads) in a network of regularly interacting individuals? Modern social systems use hierarchies to provide workarounds (Richerson and Boyd 1999), emulating a smaller-scale social experience for individuals despite their being functionally embedded in enormous populations (Richerson and Boyd 2005, 230). Precisely how this is done in different modern organizations and institutions varies widely and with uneven results.

The challenge of maintaining critical social-group functions arises when network and scale changes disrupt social dynamics that normally stabilize the distribution of information, loci

9 Here I mean status in the sense of Kockelman (2006): not prestige, but any functional bundle of rights and duties. This is a fission-fusion process (Aureli et al. 2008), but not only in the spatial realm. There is also fission and fusion in our membership of social groups.

10 If we define group size by the number of potential dyads, not the number of individuals, this both foregrounds the dyad as a primary functional unit and highlights the quadratic scaling relation between number of individuals and number of dyads in a population, following Metcalfe's Law; thus, the three groups just cited are 25, 150, and 500 if counting individuals but 300, ~11,000, and ~125,000 if counting possible unique dyads.

11 Matrilineal systems were argued to be historically prior to patrilineal systems because it is easier to be sure who is a person's mother than who is their father.

of decision-making, management of resources, punishment, control of personal biases such as those toward kinship and in-groups, and prevention of violence. In a conceptual analysis of scale-sensitive transitions in social arrangements, Heath (2022, Ch 1) argues that three broad types of organization are each optimal for different specific group sizes: *solitary group*, *tribal chieftainship*, and *state*. Transitions from one type to another occur when changes in group size affect the costs, risks, and returns associated with maintaining critical social-group functions.¹²

When group size increases, costs of information transfer increase. Only under relative homogeneity of knowledge, understanding, and expectation can a larger group function efficiently. A key function of organizations and institutions is to impose precisely this homogeneity. In turn, when multiple organizations co-exist within a related field (e.g., firms in the same line of business), the organizations will tend to show homogeneity, too: “powerful forces emerge that lead them to become more similar to one another” (DiMaggio and Powell 1983, 148). In part, this is simply because they are in the same business and therefore they coordinate around the same things. In addition, certain signals of “legitimacy” within that field will evolve,¹³ further cementing homogeneity:

As an innovation spreads, a threshold is reached beyond which adoption provides legitimacy rather than improves performance (Meyer and Rowan 1977). ... [A]fter a certain point in the structuration of an organizational field, the aggregate effect of individual change is to lessen the extent of diversity within the field. (DiMaggio and Powell 1983, 148–49)

This explanation for the homogeneity of competing *organizations in a field* in the modern context draws both on the need to coordinate around the same realms of activity and the

need to signal legitimacy in those realms. I submit that it also explains the relative homogeneity of *individuals in a group*. Like neighbouring organizations, neighbouring rational individuals will optimize their own performance by identifying goals (both instrumental and value/identity-oriented) and selecting means to meet those goals. Those means require the use of shared codes (see next section), which, by virtue of their sharedness, necessarily further cement homogeneity. Like organizations, individuals must not only act effectively but must also signal their own status as effective and legitimate actors.¹⁴

4. SOCIOCULTURAL TECHNOLOGY, II: CODES AND COMMON GROUND

Social networks provide distributional infrastructures for the flow of action, information, and relationships. This flow is only possible thanks to two socially-shared resources: *codes* and *common ground*.

Codes such as the vocabulary of a natural language are the symbolic systems we use for coordinating our beliefs and actions. What I call code includes shared devices with pre-established and conventional information-structural contents that enable people in a group to efficiently coordinate behaviour. Words are the quintessential examples of code. One defining property of a code is that it must be learned before it can be used (though it can be learned in use). Common ground is the knowledge we share as background for the interpretation of code in context. The interdependence of code and common ground is a core insight of the field of linguistics known as pragmatics (Levinson 1983). As a simple example, to know what is meant when a person says *You can't do that* (Austin 1962, 102), you need to know (1) the code we call English and (2) who ‘you’ refers to and what ‘that’ refers to in this context, drawing on the language users’ common ground (i.e., mutually assumed personal, contextual, and cultural background information). Or in a different kind of example, when a person says *Coffee would keep me awake*

12 I argue that these critical transitions are changes in system-wide flow regimes. See O'Connor (2025) for a discussion of transitions between “place-based local groups”, “connecting pathways”, “status competition”, and “mana-like ‘power’” in relation to the case study of mainland Southeast Asia. Also see Heath (2022) on his three social types, and Service’s distinctions between kin groups, bands, tribes, chiefdoms, and states (Service 1975).

13 The functions of achieving legitimacy and improving performance are not mutually exclusive. Both functions depend on meeting the legibility criterion.

14 Under a transmission-bias model, instrumental action and value-oriented action are associated with content biases and model biases, respectively (Boyd and Richerson 1985).

(Sperber and Wilson 1995, p11), information in the code conveys the surface meaning (literally, just ‘coffee would keep me awake’) while information in the common ground may enrich this information further, enabling an interpreter to understand what the speaker is really saying: thus, *Coffee would keep me awake* could be understood as accepting an offer of coffee, in a context where the speaker needs to stay up late studying, or it could be understood as declining the offer, in a context where the speaker is about to go to bed. An even starker example is the word *yes*. This single syllable has a coded meaning (something like ‘affirmative’), but what it actually conveys on any occasion will draw heavily on the context.

By relying on common ground to amplify the information we articulate with code, we can economize heavily and keep our use of code lean. In turn, to maintain that economy, we need to invest in acquiring and sharing that common ground across a social group. This idealized model of code as a stock of conventionalized mental representations is only part of the story, because codes are not purely static or mental but are necessarily grounded in dynamic sequences of coordinative behaviour in social interaction (Enfield 2022, 2027, Hayes et al 2001). To understand how code and common ground are both representational *and* behavioural, it helps to acknowledge that in meaning systems, diverse structures and processes are distributed across different temporal-causal frames. This approach adopts the spirit of multi-level schemes for understanding other complex phenomena: for example, in trying to understand vision, Marr (1982, p25 and passim) distinguished between solving questions at the level of computation (purpose, strategy, and logic of a functional system), representation and algorithm (the representation of inputs and outputs and the algorithm for transformation) and hardware implementation (the physical realization of the system and process); and in trying to understand behaviour, Tinbergen (1963) distinguished between the levels of history, development, function, and mechanism. With these kinds of multi-frame approach, one kind of process or mechanism can be posited without entailing that it is needed at every level or in every frame. Thus, seen through multiple frames, no linguistic or cultural system is purely static, representational, and individualized, nor is it purely dynamic, behavioural, and interactive. For sociocultural systems to operate, individuals must carry relatively stable representations, but those representations can only be evolved and learned in dynamic contexts of

linguistic behaviour.

Having established the complementary resources of code and common ground and their interplay in the social economy of information, we now turn to the relationship-network environments in which, and by means of which, cultural information becomes unevenly distributed in populations. This involves the codes used as mediums and infrastructures for the flow of cultural content (*mill*; i.e., the apparatus for conveying information) as well as the cultural content that flows (*grist*; i.e., the content conveyed; see Heyes 2012, 2018 for this grist/mill metaphor). Note that here I am using the grist/mill metaphor to refer not to two types of structure, but rather two types of *role* that a structure may play in the mechanics of culture-situated coordination. In Heyes’s grist/mill metaphor, grist is “what we do and make”, including behaviour, ideas, skills, and artifacts, while mill refers to the cognitive processes and mechanisms that process and produce grist. My point here is that any element of language or culture can serve *both* as grist and mill.

In language, consider the pronoun paradigm of French, with its options of *tu* and *vous* for second person reference (‘you’). The words *tu* and *vous* can each function as grist for saying ‘you’, but when one of these words is actually selected for usage, the other serves as part of the mill that supports the interpretation of the one: thus, when *tu* is used, French speakers understand not only that ‘you’ was meant but that that it was expressed by choosing *tu* instead of the alternative *vous*; this generates a richer meaning than simply ‘you’ (thus, *tu* means ‘you’ *and* implies that the relationship between speaker and hearer is relatively intimate and informal). So, a single element such as *vous* is both code (a sign with conventional symbolic meaning) and common ground (a part of the shared background against which the use of signs is interpreted). This is a Saussurean point whereby the system as a whole, which is made up of conventional coded symbols, provides the backdrop against which individual conventional coded symbols get their value. This is not a circular claim but a claim that emerges from the fact that language and cultural systems are by nature *reflexive*: that is, they can be about themselves.

A broader sense in which code and common ground overlap is in the fact that all conventionalized symbolic structures are in the common ground by definition: that is, they constitute knowledge that is openly shared, taken for granted, and non-deniable in the relevant group. Note that the reverse is not true: that is,

not all common ground is code. The key idea here is that while code carries or transmits culture, it also part of the very culture that it carries, and indeed it transmits itself. This illustrates the “duality” of sociocultural systems long noted by sociologists (e.g., Giddens 1984), who observe that people’s current actions create the contexts for their later actions. This reflexive causality is a hallmark of all forms of niche construction (Odling-Smee 2024).

The socially-constraining economics of codes can be illustrated with reference to Arrow’s account of the agenda of organizations (see earlier discussion). Codes reduce costs of repeated interactions, but they increase costs too, in three ways. First is the *initial cost of learning* the code. Codes “typically represent an irreversible investment” (Arrow 1974, 217). The more complex the code, the more time is needed for the initial investment. Second is the *opportunity cost* of such investment, given that time and attention are finite. The more steeped in one code you are, the less time you will have had to become steeped in other codes. “Once the investment has been made and an information channel acquired, it will be cheaper to keep on using it than to invest in new channels” (Arrow 1974, 219). The third is that *codes cater to limited audiences*: “the need to learn specialized codes constrains the scope of the organization” (Crémer, Garicano, and Prat 2007, 373). In these ways, a code creates an iron cage. When it becomes rigid this leads to problems communicating beyond the group of agents who have learned the code:

The essential trade-off determining the scope of the language chosen is thus one between specialization and coordination. An organization that wants to capture more synergies by expanding its scope must acquire a more vague and imprecise common language to facilitate coordination among its units. (Crémer, Garicano, and Prat 2007, 374)

This account of codes helps us understand an important causal factor in how iron cages evolve. “At any given moment an individual is a bundle of abilities and accumulated information. He may easily find it cheaper to open certain information channels rather than others in ways connected with these abilities and this knowledge.” (Arrow 1974, 219). And just as we may prefer information channels that are cheaper, so we may find ourselves preferring those people with whom we have codes in

common. This argument helps us refine the nature of homophily as a force for, and a consequence of, social cohesion and differentiation in populations.

Homophily can be understood either as a simple correlation (people who share culture tend to be similar) or as a specific causal claim (people share culture because they are or want to be similar). The account developed here suggests that there is a causal relation but it is not about wanting to be similar to others per se. “The need for codes mutually understandable within the organization imposes a *uniformity requirement* on the behavior of the participants.” (Arrow 1974, 227, emphasis added). Homophily is a functional requirement for code-mediated sociability at scale. Again, we see that the uniformity requirement among individuals at the micro-level is the same requirement observed by DiMaggio and Powell among organizations in a field, at a meso-level.

In this way, the cost-benefit trade-offs of codes are similar to those of firms and institutions. Just as firms relieve us of having to repeatedly negotiate coordinative arrangements (Coase 1937, 391), codes are inventories of tiny pre-made contracts for coordination (Lewis 1969). My goal here is to apply this thinking not to the limited domain of, say, the firm or institution, but to the quasi-universal domain of entire societies and cultures. People invest very significant initial costs in sociocultural membership, as the codes of language and the common ground of culture must be evolved by populations in historical time and learned by individuals in lifespan time. These are irreversible investments. After we have paid the costs of years-long socialization into a culture, the costs of leaving are great. And with the sunk-cost fallacy they are subjectively felt to be even greater. “[A] significant part of accumulation of human capital consists of training specific to the needs of a firm, an input of information to the worker which increases his value to the firm but not to other firms.” (Arrow 1974, 227) What Arrow says here about firms is true for societies and cultures. It is one explanation for why we conform: we want the benefits of social interaction and for that we must adapt and tune to our associates, becoming mutually dependent on a shared code and a shared set of values against which uses of the code will be understood. This leads necessarily to the evolution of iron cages.

5. FROM ISOMORPHISM TO INTEROPERABILITY

We noted that in theories of firms and organizations, codes reduce costs of information transfer inside the group but increase costs of information transfer outside it. This, again, is true of cultural systems more generally. This section shows that not only does convergence and homophily arise between associated individuals within a group, but also between associated groups within a higher-level field or social system. The need to minimize intra-group costs creates an incentive against diversity, with “steeply decreasing returns to dialect variety” (Crémer, Garicano, and Prat 2007, 385). This in turn makes portability between organizations a crucial challenge (Crémer, Garicano, and Prat 2007, 398) not only for individuals who need to function effectively in multiple firms or other modern organizations within a single field, but also for individuals navigating the highly diverse organizations that together make up the quasi-totalities of natural sociocultural systems. Human mobility requires being able to move between often highly unlike contexts, not only through the lifespan but through the course of a typical day. How is this portability achieved?

The answer is obvious when we zoom out from the codes specific to firms and organizations and consider the higher-level “matrix” codes in which they are embedded, namely natural languages and cultures, broadly conceived. Just as firm-specific codes allow us to coordinate efficiently with others in a firm, culture-wide codes allow us to coordinate efficiently with others in a sociocultural system. Firms and other organizations are always *embedded in* larger sociocultural systems, which provide rich scaffolding for portability.

What authors like Arrow call a code is usually a small set of technical terms and phrases. But these cannot be used without being embedded in the highly flexible society-wide codes we call languages. The functional core of a natural language, including its basic vocabulary and grammatical rules, provides an infrastructure for the codes of any given specialization. Thus, mechanics and cardiologists talking shop may be unintelligible to each other but are still recognizably “speaking English” (or whichever language). The matrix language is maximally flexible for usage across contexts and thus serves as an operating system for plugging in specialized vocabulary as well as for facilitating coordination in random dyads anywhere within the diverse ecology of a cultural system. A natural language pro-

vides portability across organizations ranging from families to firms to any of the hundreds of subcultures we move within. An English-speaking cardiologist needs their technical code terms while at work, but in the rest of their life they won’t and can’t use that code. Their code for everyday life is English. The society-wide language might feel “neutral” to its users, given its high flexibility, but it is still a code in precisely Arrow’s sense: it imposes high investment costs, demands isomorphism and uniformity, and creates both lock-in and lock-out. It is just that with languages, this all applies at a higher level of sociocultural scale.

Now, what about portability of individuals across groups *above* the level of languages? Just as organizations in a field should be ordered in ways that are readily translatable (DiMaggio and Powell 1983), so too are languages in a region of interacting populations. Just as a mechanic and a cardiologist can interact by relying on the shared matrix code of their natural language, neighbouring groups speaking entirely different languages also have recourse to commonality in shared infrastructure of their alternative codes. It is well known that where people have a history of mobility across language communities, the languages of those communities will tend to be organized similarly, leading to easy translatability of ideas and expressions (Thomason 2001; Aikhenvald and Dixon 2001; Muysken 2008). Sometimes this is because the multiple languages a person knows are related by ancestry, and so share vocabulary and other features (e.g., Dutch and German or Cantonese and Mandarin). But even when neighbouring languages come from different historical sources, they often converge closely in underlying structure (Ross 2001). This heavily lowers the costs of learning one language when you already know the other. And this is another example of duality from ecological feedback: what causes that lowering of costs is the history of past cost-lowering actions by language learners who made “errors” or short cuts or innovations, modelled on their first language, which have persisted and become norms. Thus, portability of expression across distinct languages both facilitates, and is facilitated by, homogeneity in the underlying structures of those codes.

As noted, DiMaggio and Powell (1983) point to homogenization and isomorphism across neighbouring organizations. When we need to move between organizations, portability can be achieved by ensuring that the codes used are similar enough

that moving from one “dialect” to another incurs minimal cost. This similarity constitutes the *interoperability* of codes and sociocultural systems. The more interoperable two codes are, the lower the cost of sociocultural portability across those codes.

Interoperability implies isomorphism. Here is the account of functional units in social systems from Amos Hawley’s 1968 survey of human ecology:

Units subject to the same environmental conditions, or to environmental conditions as mediated through a given key unit, acquire a similar form of organization. They must submit to standard terms of communication and to standard procedures in consequence of which they develop similar internal arrangements within limits imposed by their respective sizes. Each unit, then, tends to become a replica of every other unit and of the parent system in which it is a subsystem. (Hawley 1968, 334)

While I would say that “replica” is too strong, Hawley’s idea is right, and it aligns with subsequent sociological work. For DiMaggio and Powell, writing about the isomorphism of organizations, isomorphism is “a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions” (DiMaggio and Powell 1983, 149). (Note, though, that like any technology, the mechanism is both empowering and constraining.) The same is true for the units we call individuals: were we not “replicas” of each other, we would hardly be able to coordinate as efficiently as we do. But it is not that individuals become the same because their environments are the same. At least, that is not the proximal cause. Rather, people share the same sets of cultural representations *because they need to coordinate*. (Naturally, the common environment is what they coordinate around.) It doesn’t matter what shape the key is, it just has to fit the lock:

The key to my front door has a shape that is quite arbitrary within limits in relation to its function of opening my front door. Almost any shape would have done—provided that the lock on my door was adjusted accordingly. And it is in just this sense that almost any sound could have served the “dog” function—provided that the mechanisms

within hearers that respond to tokens of this sound were adjusted accordingly. (Millikan 1984, 1)

On DiMaggio and Powell’s account, isomorphism is created by three kinds of process: (1) coercive (pressure from outside; force or invitation), (2) mimetic (imitation under uncertainty; do what others do when you are unsure), and (3) normative pressures (e.g., rules taught during professionalization). When these processes apply in organizations, and in higher-level ecologies of organizations competing in the same fields, neighbouring organizations will have counterpart individuals in defined roles:

Such mechanisms create a pool of almost interchangeable individuals who occupy similar positions across a range of organizations and possess a similarity of orientation and disposition that may override variations in tradition and control that might otherwise shape organizational behavior (Perrow 1974). (DiMaggio and Powell 1983, 152).

This interchangeability is related to the “impersonality” that characterizes institutions and their constituent statuses and roles (North, Wallis, and Weingast 2009, 23) and that was central to Weber’s iron cage concept. Professional recruiting is a process of sifting using a standardized mesh, with the result that “individuals who make it to the top are virtually indistinguishable” (DiMaggio and Powell 1983, 153). In culture, similarly, social statuses are abstracted from concrete individuals and relationships, and thus become standardized and impersonal (Hinde 1976).

The concepts of isomorphism and interoperability are related to homophily, mentioned earlier (Lazarsfeld and Merton 1954; Mark 2003; McPherson and Smith-Lovin 1987; McPherson, Smith-Lovin, and Cook 2001). Homophily sometimes refers to people’s desire to be with people like themselves, and sometimes to the phenomenon of *network autocorrelation*: “the tendency for similar people to be linked and linked people to be similar” (Feld and Grofman 2009, 522). “In general, foci of activity (Feld 1981) bring people together in repeated interactions that tend to create personal relationships and further interaction between the individuals involved.” (Feld and Grofman 2009, 528) This involves positive feedback and path dependence. Culture, as a set of coordination devices, both presupposes and creates

homophily and thereby limits its own breadth (McPherson, Smith-Lovin, and Cook 2001).

My point is that isomorphism doesn't simply arise because homophily is an intrinsic human preference, but because coordination requires legibility of action, and for that, people in the same group must, so to speak, install the same software. Conformity's function is to maximize mutual legibility. We seek isomorphism and interoperability not *because* we want to be like others (though we may want to be), but because we need to coordinate with them in social action. Homophily in language runs on this principle: "sound like those you wish to cooperate with, and cooperate with those that sound like you" (Nettle 1999, 222). And this is not *because* shared bits of culture mark shared identity (though they may), rather it is because bits of culture are our common devices for coordination and cooperation. It is not (only) that homophily gives you entry into a market of cooperation, it's that one cannot function in that market without it. This is Millikan's Key. You can treat the key as an emblem of identity, but that is optional. What is obligatory is that the key must fit the lock.

With codes, the combination of increasing returns and irreversible investments creates a roach-motel attractor dynamic. Because culture trades on codes, it is easier to get in than out. The initial investment of learning the code leads to clear payoffs for the agent, and for the network, but it becomes increasingly difficult for the individual to operate outside of that network than inside it. Of course, a code is not *literally* a cage, so we must clarify the causal mechanism by which a code can resemble one. We are now going to explicitly confront a point that has only been mentioned in passing so far, by arguing the following. Codes such as languages and other cultural meaning systems create a form of lock-in caused by the centripetal and structure-narrowing mechanism known as *path-dependence*. This mechanism is driven by nonergodic dynamics of population-level convention combined with interdependence between individuals (as code-carriers) in a social network. We have already discussed the interdependence between code-carriers in a network. Let us now turn to the nonergodic dynamics of

path-dependence.

6. PATH DEPENDENCE AND PLATFORMS FOR ACTION

The concept of path-dependence has been applied in evolution (Blount et al 2018), sociology (Mahoney 2000), archaeology (Blake 2014), political science (Pierson 2004, Ch 1; David 1994), the history of technology (Arthur 1994; 2009; David 1985), and beyond. Path-dependence is what happens when the historical order of events in the development of a system closes off certain options for further development, creating a distinct inflexibility that makes a system difficult to change, even when the current state becomes inefficient or suboptimal on some measure. An example would be the track gauge used in a railway system. In the sociocultural realm, path dependence creates iron cages.

The causal basis of path-dependence is *nonergodicity*. This can be explained with the example of Pólya's Urn (N. L. Johnson and Kotz 1977). The urn contains two balls, one black and one white. Compare two procedures for filling the urn with 100 balls. In procedure 1, you flip a coin: heads means add a black ball to the urn, tails means add a white ball; repeat until there are a hundred balls in the urn. This procedure is ergodic, meaning that no matter how many times you repeat it, or the order of the moves, the outcome is basically the same: ~50/50 white/black.¹⁵ Other examples of ergodic processes are smoke filling a room or a drop of vermouth mixing with vodka in a martini glass. Procedure 2 is *nonergodic*: start by taking a ball from the urn at random; if it's white, take a new white ball and then place both white balls back in the urn. Same for black. This time, the output of one step changes the probabilities for the result of the next step. The first few steps are especially consequential for how the process plays out: if on the first move you pick black (50% chance) there are now three balls, two black one white, meaning the chance of picking black again is now higher (67%); if you do pick black again, the odds of black next are now 75%, and so on until an equilibrium is reached in which black dominates. Switching white for black in the first few moves in Scenario 2 would completely change the outcome. In this noner-

15 A clear diagnostic of ergodicity is when sampling one system at numerous times (the time average) gives the same result as sampling numerous systems at one time (the ensemble average). Take a system that flips a coin a hundred times. Sample a hundred different instances of the system at one time and you will see the same variance as when you sample a single instance of the system at a hundred different times. One hundred people lined up flipping a coin at once will produce the same ~50/50 distribution of heads and tails as when one person flips a hundred times. Because the system is ergodic, nothing about the history of the lone coin-flipper's series of a hundred tosses will change the overall outcome.

godic process, the possibility space is filled very differently depending on the order of events.¹⁶ This is the essence of path dependence and lock-in in the history of sociocultural systems, where increasing returns and irreversible commitment carve out one (usually very small) region of the possibility space.¹⁷

Now consider this more concretely in relation to our interest in codes as iron-cage creating devices. In the historical development of a cultural code, the force of path-dependence is applied twice: first in the process of establishing the semantics of the code at group level, second in the process of establishing shared pragmatic norms around the code's use. The semantics and norms of codes are clearly historical and thus nonergodic.

Multiple forces contribute to the nonergodic nature of the building up of codes. The first is that each piece of a code is a coordination device and users of the code are forced to be conservative because of the legibility criterion. If a code is going to serve its function, any randomly-chosen dyad within the group must be calibrated well enough around that code to facilitate efficient coordination. If I arbitrarily change the code I am using, my actions won't be legible to you. Changing the code is only possible with a gradual and incremental process at the population level, as occurs in organic language change (Campbell 2020). It requires keeping the bulk of shared knowledge constant, while innovating only at the margin.

The second feature contributing to the nonergodicity of code-based sociocultural systems is that the items that make up a system of code are often heavily interdependent. For example, they may modify each other's meanings, as when a grammati-

cal modifier narrows the meaning of a noun (e.g., *jungle cat* vs. *house cat*) or they may play off each other as alternative means to say similar things but with different semantic details or different frequency profiles (e.g., *tu* vs. *vous*, or *man* vs. *gentleman* vs. *fella*).

The example of Pólya's Urn again highlights the sociocultural property of duality, noted earlier. In this widely-acknowledged dynamic of self-dependence in social affairs, actions both *create* and *presuppose* contexts for action: "the rules and resources drawn upon in the production and reproduction of social action are at the same time the means of system reproduction" (Giddens 1984, 19).¹⁸ In other words, past actions shape our contexts for current action, a fact that can either be framed in terms of constraints (we live in iron cages) or in terms of possibilities for action (we wear powered exoskeletons).¹⁹

It is worth noting that in the duality of social structures, the two axes operate within different temporal-causal frames. Any action is interpreted against a presupposed context that has been created diachronically by the emergence of structure at a group level. At the same time, when an action changes the immediate context, this creative force comes from an individual agent and their design of actions in the moment. To illustrate again with language, on the context-presupposing side, an individual cannot randomly decide what code to use, nor can they decide what others say to them. On the context-creating side, an individual *can* decide what is said and how (though they are of course required to use the historically-acquired tools of the code).

16 A move may have the effect of reducing or biasing the possible moves that can happen in the next step, or in extreme cases, a move can shut down the process completely, as when a player dies in Russian Roulette and can no longer play, or when a species unable to adapt can no longer reproduce and goes extinct. These are known as *absorbing states*. As Holling puts it, "evolution is like a game, but a distinctive one in which the only payoff is to stay in the game" (Holling 1973, 18). On this point, Holling cites Slobodkin (1964).

17 A caveat. There is a key conceptual problem with applying the idea of nonergodic path-dependence in domains like language and culture. With Pólya's Urn, the beginning and end points of the process are clearly defined. That's not the case with languages and cultures. Identifying a "start" point for a social process is likely wholly arbitrary. The system is always already in a biased state due to its history. And because the world never ends, defining an "end" point is arbitrary too.

18 Along similar lines, Schutz referred to the axes of "because motives", which point back to causes, and "in order to motives", which point forward to effects (Schutz 1967). For Heritage, a social action is simultaneously "context-shaped" and "context-renewing" (Heritage 1984, 242), meaning that each move both emerges from a context and creates a new one. For Silverstein, signs are both "presupposing" (they make sense in terms of the established context) and "creative" (they create new contexts in which to make sense of further signs) (Silverstein 1976). And for Fleck: "The general structure of a thought collective entails that the communication of thoughts within a collective irrespective of content or logical justification, should lead for sociological reasons to the corroboration of the thought structure" (Fleck 1935, 106, emphasis in original).

19 The general point that path-dependent "cages" can be both enabling and constraining clearly has much broader application than just to sociocultural systems. For example, much of what is reviewed here about cultural systems would also apply to genetic inheritance systems, including self-organizing processes of development and path-dependence.

The path-dependence of cultural cumulation through code-mediated action is self-reinforcing and leads both to lock-in (the structure becomes fixed) and lock-out (outsiders lack access), caused by the combination of irreversible investment and increasing returns. It means that at any moment, agents find themselves on a platform of possibilities created by what has come before, where certain paths are open for creative action while other paths are effectively closed, either because people's attention is directed away from those other paths or because the costs of taking them are too high. This path-dependent dynamic is familiar in the history of technology (Arthur 2009; 1994) and in biological evolution, where the design improvements of undirected variation provide "platforms at which further innovation can occur" (Godfrey-Smith 2012, 2166).

In culture specifically, one feature of the ever-advancing nature of knowledge systems is their increasing "amenability to being understood" (Deutsch 1997, 17). Platforms for creative action are therefore not only path-dependent, but may also be self-improving. By evolving to become easier to learn, they become more stable. In evolutionary terms, the platform for action is a *niche* (Laland, Boogert, and Evans 2014, Odling-Smee 2024). In developmental terms, it is a *scaffold* (Caporael, Griesemer, and Wimsatt 2014). In sociocultural terms, it is either an *iron cage* or a *powered exoskeleton*, depending on your mindset. To avoid the inherently evaluative slant of those two labels, we could borrow the concept of *ergon* from Wilhelm von Humboldt's analysis of languages as platforms for *energeia*, or creative action (Humboldt 1988). Ergon is the historically-acquired scaffold that facilitates or constrains the locally-executed *energeia*. And ergon is of course nothing other than the accumulated *product* of past expressions of *energeia*.

7. CONCLUSION: HOW TO EVOLVE AN IRON CAGE

This paper began with Weber's famous idea that an exclusively modern form of rationality led to an exclusively modern form of lock-in. But we have seen that all sociocultural systems substantially constrain their members' worlds of possibility, and that this is due to the universal logic of using codes for social coordination. As individuals, we have agendas which we must pursue under limited time/energy budgets. Things being equal, we tend to choose lower-cost options, not only when deciding on how to get what we want but also when deciding what to want

in the first place. Cultures are inventories of ends and means, reasons for action, explanations and justifications. These are social technologies, embodied in coordination devices including symbols and norms.

Because populations of dyads are so enormous (recall that a village of 500 people contains ~125,000 unique dyads), the coordination devices of cultural convention must be impersonal and portable. They need to be mutually legible if they are to work. We have argued that given the practical and economic constraints of networked sociality, the legibility criterion causes our inventories of shared signs and symbols to converge and cohere, remain limited in size and relatively conservative in form and function.

When social groups increase in size, as has happened over and over in human history, meso-level organizations and institutions emerge as cost-reducing adaptations to scale. These social units can function because their members share codes for communication and common background knowledge and values for interpretation. But while codes and common ground save costs within an organization, they also increase costs of operating outside its boundaries, creating barriers to mobility and incentives to conform, and reconfiguring social networks in ways that apply centripetal, system-narrowing force.

The processes we have described create structure both in spatialized networks of social relations and in temporal sequences of social interaction. The nonergodic properties of both the spatial and temporal domains of socio-culture give rise to path-dependence and lock-in. This means that a sociocultural system is easier to get into than out of. And because the outputs of past social actions are inputs for future social actions, every action not only has a local purpose but also affects the frequency and value of its components at the population level. This dualism in social systems strengthens the centripetal, encaging forces we have reviewed. As a result, the cultural items that circulate in a population of dyads converge, cohere, and hold together to create a higher-level integrated system whose functional cohesion resembles that of organisms, ecosystems, or cities, to which cultures and languages are often compared.

Just as "the major factors that organizations must take into account are other organizations" (Aldrich 1979, 265), the major factors that individuals must take into account are other individuals. This is the key insight behind advances in our understanding of the evolution of higher social cognition in humans (Jolly

1966; Humphrey 1976; Dunbar 2003). The need for mutual anticipation and adaptation creates a need to reduce uncertainty (as well as any *sense of* uncertainty) under imperfect and partial information. A sociocultural system in the sense used here helps in two ways with reducing uncertainty: (1) it directs members' attention to common fields of information and away from everything else,²⁰ and (2) it fosters homophily through incentives for people to align their values and interpretations. The reason individuals are incentivized to follow convention is not to eradicate uncertainty. Uncertainty can be useful, as it triggers creativity and innovation in problem solving. Without uncertainty, "it is doubtful whether intelligence itself would exist" (Knight 1921, 268). But on balance, we prefer to minimize effort, especially in solving the higher-level problem of "deciding what to do and how to do it" (Knight 1921, 268). Culture is the solution to that problem. Like all institutions, sociocultural systems "provide the incentive structure of an economy" (North 1991, 97). When we need it, culture is there to tell us what to do and how to do it, and even what to want.

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20 This creates a division between hypercognized fields of knowledge and practice (what members of a culture are especially concerned with and attuned to) and hypocognized fields (what members of a culture oversee or ignore). Recall Arrow's active/monitored/passive scheme (Arrow 1974).

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