Till death do us part: The Intertwining of Fidelity, Mortality, and Identity.

Maximus Thaler, May 2014

Abstract

The relationships between three different forms of identity are explored: corporeal, genetic and symbolic. Cultural dual inheritance theory is examined in the context of the total four billion year history of life. Parallels are drawn between the evolution of DNA and the evolution of symbolic language. It is claimed that the increasing fidelity of symbolic replication in human society is having a transformative effect on classic notions of selfhood and death; high fidelity symbolic transmission is facilitating the emergence of an effectively immortal superorganismic identity. Examples from primitive cellular biology, as well as from the Jewish and Tibetan Buddhist traditions, are used to describe the process through which this transformation occurs.

Introduction

"Now there are selves. There was a time, thousands (or millions, or billions) of years ago, when there were none – at least none on this planet. So there has to be – as a matter of logic – a true story to be told about how there came to be creatures with selves." (Dennett, 1989)

Rocks do not have selves. Neither do the atoms that make them up. Yet atoms can also make up creatures, and creatures have selves. Bacteria have selves. So do chimpanzees, although the lived experience of a chimp is very different from that of an E. coli. And of course, people have selves which differ radically from all the other kinds of selfhoods on earth. This paper examines selfhood, in its many varieties.

Identity is notoriously difficult to define – its self-referential looping resists lexical confinement. Yet somewhat paradoxically, confinement is essential if any sort of self is to exist. Identities must have boundaries, a distinction between self and non-self, some sort of line that marks off where I end and the world begins. All living creatures possess such a boundary. Elimination of the boundary is equivalent to death; the boundary's accurate preservation is life's Sisyphean task. As life has complexified over the past four billion years, its various self-other distinctions have become increasingly abstract and immaterial. Correspondingly, the adaptations preserving these abstract boundaries have become

increasingly sophisticated. Information takes center stage in this evolving drama. Over the eons, the selves that best endured were not necessarily the ones with the toughest cell membranes or the thickest shells, but the ones that were best able to preserve high fidelity information about how to build and thus define self. Throughout the history of life, the final arbiter between life and death has been the ability to transmit information with high fidelity, and not any ability to temporarily protect a body. And so the concepts of fidelity, mortality and identity are tightly bound together. Identity cannot exist without the risk of mortality – rocks cannot die. Identity is fluid, and as it transmutes from one form to the next, the fidelity of its transmission is the ultimate determinant of its ability to persist amidst the constant threat of death.

This paper broadly describes how identity and mortality have changed in response to the different media that have evolved for preserving and transmitting life's essential information. There is an unbroken (although certainly not unchanged) line of identity running from our first universal common ancestor to us. There have been many major transitions along the way, but at its coarsest scale, the tree of life can be described with just two crucial branch points: The origin of DNA (maybe a hundred million years after the origin of life) and the origin of symbolic language (concurrent with the origin of *Homo sapiens*). Both of these developments did not just create new species, but fundamentally altered the landscape in which all life on earth evolves. This paper traces an isomorphism between those two innovations, and examines how they have each changed the nature of identity. Specifically, these new information media each provided avenues for aspects of identity that were previously only dynamically embodied (and thus difficult to preserve) to become statically stored in a crystalline structure. These identifying aperiodic crystals can be easily shared between individuals and can be transmitted down a lineage of selves with high fidelity. This ability to accurately replicate identifying information has had a dramatic effect on the nature of death and identity because it creates a kind of immortality. Ultimately, I will argue that symbolic language is facilitating the emergence of a new group level of human selfhood – an effectively immortal communal identity that is embodied by an entire tribe or nation. I will use religious examples of Judaism and Tibetan Buddhism to describe how this higher-order identity is established and maintained. However, in order to make the mechanics of the transition to higher-order self apparent, the narrative must first start with the origins of life, and the first selves.

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Birth

Before there was DNA, before there was RNA, before there were cells, there was still life. All life dates back to a single common ancestor, but what form that ancestor took is still a matter of debate. Often our Last Universal Common Ancestor, Luca for short, is often depicted as a single cell, a first mitotic divider that gave rise to all the rest. However, a close look at the root of the tree of life reveals that this depiction is overly simple. The deepest roots of the tree of life display a high amount of anastomosis, the fusing of branches. This indicates that horizontal inheritance played a major role in the evolutionary trajectory of early life, which makes tracking a distinct cellular lineage next to impossible. This has led some theorists, like Carle Woese, to propose that our Last Universal Common Ancestor wasn't a cell, but a community (Woese 1998)[1]. Luca was likely a diffuse collection of protocells – none of them autonomous, each of them dependent on the others, constantly interacting, swapping protogenes and body parts like bits of conversation over dinner. These protocells lived their lives without DNA as we know it. The mechanisms for translating triplet nucleotide codons into the amino acids they represented had not yet evolved. But despite the lack of true DNA, there was still representation. There was still identifying information to be replicated. But this information was distributed across many structures, mostly in the form of dynamic chemical reaction patterns rather than crystalline molecules. Because biological identity was so diffuse, because there was not yet a strict correspondence between codon and amino acid, there was no guarantee that any one of Luca's cells would replicate accurately. Replication was low fidelity, so information had to be distributed redundantly, over many bodies, to correct for errors. This makes our last universal common ancestor a communal entity. If we want something more distinct to call our universal ancestor, then we need to go back millions of years before Luca, to the origins of life: Fuca.

Our First Universal Common Ancestor, Fuca, was as simple as could be. A collection of molecules – not even really alive. But fuca was notable because it possessed and maintained a boundary separating it from the rest of the world – the first self-other distinction. Fuca was a macromolecular flask containing a dormant self-catalytic reaction network lying ready to patch any hole in the identifying boundary that entropy might create (Deacon, 2011)[2]. Sometimes, if the hole was large enough, Fuca would actually split in two – the first reproduction. Fuca begat Twuca, who begat Thruca, who begat

[1] Around the turn of the millennium, microbiologist Carl Woese wrote a series of papers detailing the evolutionary history of the first cells and protocells, describing their unique evolutionary dynamics using an annealing and crystallization metaphor. A good summary of those papers and a modern reassessment of his conjectures can be found in Koonin, 2014

[2] I am referring specifically to Deacon's theoretical construct, the autogen, which is used to exemplify the minimal criteria for life. See Incomplete Nature, Deacon 2011

Fouruca, and so on and so on for millions of years until Luca was born, a diffuse coalition of the billions of Fuca's descendants.

Fuca's descendants differed massively from one another. Without a static crystalline genetic code to ground identity in, the information that made Fuca who it was was embodied only in the dynamic constraints that kept its body together. These reciprocal constraints (the boundary, which protected the reaction network inside it, which in turn built the boundary) were both fragile and volatile – always moving and constantly mutating. When Fuca broke in two, perhaps it reformed with an extra phosphate group or amino acid. This random addition might change the tendencies of the reformed structure. The shell could become harder to break, or maybe easier. So mutation goes. But these mutations were of a radically different flavor than the point mutations that geneticists study today.

Fuca, and Fuca's early descendants, made no distinction between genotype and phenotype. They were not survival vehicles (a la Dawkins), ferrying their informational load around until it was safe to reproduce it. For early life, the medium was the message. An acquired change in the body of the father meant an inherited change in the body of the son. This exposed corporeal form of inheritance had its advantages. The pace of evolution then was much faster than it would ever be for the next four billion years. Many mutations were macromutations - hopeful monsters - odd concatenations of previous forms. The monumental adaptations of transcription, translation, and multiple forms of metabolism all evolved in the first few hundred million years of life, spurred by the incredible mutability of those early forms. But wearing your heart on your sleeve has its downside as well. It leaves you exposed to the elements, potentially ravaged by the slightest breeze. An undifferentiated pheno-genotype meant that any noise accrued during a lifetime was passed down directly to offspring. This made vertical transmission unreliable, so in those early years, horizontal transmission dominated. Reproduction occurred primarily through something like plasmid exchange, more like body part transfer, producing patterns of evolutionary progression that differed greatly from the modern patterns of change that a genome allows. Notably, without DNA, death is a more terrifying sort of specter.

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Death

There are many different ways to die. A cell can be eaten, or it might starve. It can be desiccated, key components oxidized, or rupture under osmotic pressure. These are all local forms of death. Life has evolved numerous adaptations to protect itself from these constant death threats –

spines, toxins, energy storage, dormancy. But the most important death-defying adaptation is not usually seen as such. DNA is often viewed as a primitive (as in first, axiomatic) vital compound – the magic catalyst which is responsible for imbuing a collection of molecules with the breath of life. But in actuality, DNA post-dates life. It evolved long after life was blooming in the seas, and proved to become the most ingenious trick ever developed for cheating death.

No matter how many spines or protective toxins you have, death always catches up to you in the end. Our corporeal forms exist in opposition to all the forces of nature around them. Eventually every body must submit to the ceaseless blows of entropy. Bodies degrade. DNA tacitly recognizes this fact of life and allows biological identity to bifurcate itself and dwell in two places at once. The locus of identity for an *E. coli* is not just within the dynamic self-perpetuating chemical synthesis of the cell, but also within a static DNA crystal that can withstand the sands of time much better than a mutable body. The creature contains itself. This dual identity effectively rebuffs the threats of death (that is, risk of identity cessation) from local sources, and forces death's specter to withdraw to a more global domain.

Predators, drought, and famine present much less of a threat to a modern *E. coli* than they did to one of Fuca's early descendants. The physical effect of these disasters has not changed, but the magnitude of their impact on identity has been greatly reduced. Each *E. coli* is an avatar, a single physical manifestation of a more ætherial microbial essence[3], which is redundantly embodied in the myriad *E. coli* forms that populate the planet. The cessation of one of those forms is only a local inconvenience, and has a marginal impact on the genetic *E. coli* identity. So for *E. coli*, the specter of death does not take the shape of lysis or desiccation or any other form of corporeal destruction. The angel of death for most life on earth is more cosmic than that. It takes the form of lineage annihilation – extinction.[4]

This was not the case for Fuca and its descendants. Replication was not of sufficient fidelity for anything avatar-like to exist in the early years of life. Cell membranes and intercellular anatomy were not nearly as sophisticated or integrated then as they are today, and components were often breaking away from one entity and attaching themselves to another. In such an environment there could be no semblance of a static self. Everything was in flux, and death was always near. As Woese notes, for each

[3] Of course, I use the words 'æther and 'essence' here not to refer to some sort of immaterial platonic ideal, but rather as summary words for the ill-defined bundle of characteristics that stays constant in a lineage over generations.

[4] This broader view of death comes from the writings of Lynn Margulis. For more on Margulian death, and its relationship to sex and multicellularity, see What is Sex? Margulis and Sagan 1997. For wider spiritual implications on this reconception of death see The Sacred Depths of Nature, Goodenough 1997

being there was a physical history for how its form came to be, but not a genetic one (Woese 1998). When one form disassociated, its unique assemblage of parts was lost forever, for there was nothing that could rightly be called offspring to carry on the lineage. This is not to say that there was no evolution. Darwin's three criteria of variability, heritability, and competition still held. Heritability was low fidelity, but not no fidelity, so evolution could occur. Still, vertical transmission of specific forms was so poor that high fidelity replication could only be accomplished obliquely, by relying on a large and redundant network. This is why it is better to consider Luca to be a communal organism. Luca had sub-networks that gradually differentiated and became more autonomous over time, and once they reached a certain level of autonomy (and accuracy of replication) they could be said to possess an identity of their own – Luca's children. But before translation evolved, before there could be a genotype-phenotype distinction, persistent biological identity could only exist in a redundantly distributed network. Each node in this network faced the constant threat of death, because its personal identity was too closely linked with its physical form to last for any significant length of time. Death for any one of Fuca's descendants was permanent and final. Not so for Luca's children. Luca's children, the first bacteria and archaea, each had genomes which persisted after the death of any individual. They were avatars. This means that Luca's children, and all their children after them, up to us, were in some sense *immortal*.

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Immortality

The idea of immortality is a uniquely human construction, but our myths of death and rebirth mirror cycles that have been persisting for eons. Life is ancient, and it is ceaseless. So here is one form of immortality: When we zoom out from the individual thrivings and perishings of all the countless identities that have populated the globe we see a single multidimensional being – the tree of life – that has been growing since our first ancestor and shows no signs of withering any time soon.

But, this cosmic view of immortality is of little comfort to most people living their individual experiences. The immortality that captivates humanity is not that of Gaia but of ourselves. Each of us is acutely aware that our body has an expiration date, and that the narrative surrounding it will someday come to an end. And so we artificially extend these narratives. Our first recorded mythical hero, Gilgamesh, sought immortality at the bottom of the sea (Tablet 11). The pharaohs built pyramids covered in hieroglyphs depicting their lives so that they would never be forgotten. We have a deep intuition that by projecting ourselves into some crystalline media – by symbolically representing parts of

our identity in clay tablets and stone monoliths, we will be able to live forever. And the story of Fuca and Luca suggests that this intuition may not be incorrect. The pharaohs have yet to be forgotten, after all. So here is another form of immortality – an artifactual immortality, although only one of degrees.

Some of us, some special few, are remembered long after we are gone. Often it is because of some marked contribution to the rest of society. Do we remember Newton or Confucius because they increased humanities fitness? Perhaps. Nonetheless, immortality through artifacts, through monuments or books or public admiration, is clearly a limited form of immortality. No amount of knowledge *about* Newton, no increased degree of public internalization of his ideas, will be a sufficient facsimile of the lived experience of Newton the man. As Woody Allen put it, "I don't want to achieve immortality through my work; I want to achieve immortality through not dying. I don't want to live on in the hearts of my countrymen; I want to live on in my apartment." The idea of living on through artifacts, or by changing the world - by being re-membered - is older than the pharaohs. But it has never come close to quenching our fear of death. There is simply too much of each of us, too many facets of our identity, to ever be fully captured by a series of artifacts or memories. When we die, most of who we are, all our hopes, our loves, our fears, our fleeting desires and subconscious dreams, our experience of being, is lost. Only our most salient and clearly articulated ideas remain, if we are lucky. We take this state of affairs for granted, without realizing how deeply unusual it is, from a biological perspective, that this kind of loss of identity should be the case. No other species loses as much of its biological identity with the passing of each generation as humans do.

Luca's children possessed an artifact, an aperiodic crystal, that effectively preserved their identity when their bodies withered away. DNA allows for a complete transmission of self from one generation to the next. No aspect of an *E. coli* cell, no idiosyncrasy of behavior, no quirk of temperament, fails to be transferred from mother to daughter. Of course, this is not strictly true – mutation must produce some level of variation for evolution to occur. But the amount of behavioral variation between two *E. coli* cells is minuscule compared to the variation between two human siblings, or for that matter, between two of Fuca's early children.

Remarkable similarity between generations exists in life forms of all levels of complexity. What is lost when an amoeba dies? How similar or different are mother cells from daughter cells? What about a fruit fly, or an oak tree? Oak trees exhibit a decent amount of phenotypic plasticity. No two trees will ever branch alike, so clearly some identifying information is lost upon death. But how much? Geneticists are acutely aware of the spread of alleles in *drosophila* populations. Some mothers have red eyes, some

daughters have white eyes. So something unique about them is lost when they die, but how important is it? Evolutionary biologists are trained to focus on variation in a population. Understand the variation and you will understand how the population evolves. But this focus on evolutionary change often leads us to forget the more hum drum biological fact that life is incredibly constant. A horseshoe crab fossil from 445 million years ago is almost indistinguishable from creatures living today (Rudkin et al. 2008). Individual horseshoe crabs come and go, but something, something essential, remains.

This consistency of biological identity breaks down slightly in the social vertebrates. Big brains confer a form of identity which is not easily preserved. We are unsurprised to observe that dogs or chimps have personality – personality which stops existing when the animal dies with very little of it passed on to offspring. But large, long lived, communal mammals like primates and canines are the exception that proves the rule. They all show some degree of social learning. That is, they all possess adaptive information that is not passed down through the germ line. This information must be acquired from conspecifics and is not present at birth. Although the amount of information transmitted socially is minimal in most animals (compared to the genetic information transmitted) the fact that it occurs at all is a notable exception to the nearly ubiquitous germ line monopoly on identity in plants, animals, fungi, protists, bacteria and archaea, and it has striking consequences.

Social inheritance may actually be a relatively old transmission stream – perhaps dinosaurs or even some fish have passed down minimal parts of themselves extra-genomically through traditions. However, this mode of inheritance only began to show its real potential once its bandwidth was symbolically expanded by humans. My claim is that symbolic culture allows for a splitting of biological identity that is analogous to the first bifurcation facilitated by the origin of the genetic code. The fidelity of this new channel is imperfect, but evolving rapidly, faster than any time since that chaotic period before translation solidified. During this current intermediate period, the relationship between phenotype and memeotype remains undifferentiated, although diverse replicator dynamics are becoming more and more apparent. A new kind of identity is emerging, facilitated by this new symbolic information medium, but the level of organismality of this new sort of self is unclear. Do symbolic language and culture augment individual human identity? Or do they create a societal superorganism? Perhaps they are virus-like, dependent on their human hosts but with an organismal autonomy all of their own? All are likely, and not mutually exclusive. These hybrid selves deserve much further exploration. Analysis of their different forms shows how symbols have radically altered the transmission of human identity, and in doing so, have also revolutionized death.

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Symbols

The genetic code is at least 3.5 billion years old. Symbolic language is far younger, and by no means has it reached the same level of canalization as DNA. Generous theories put the origin of primitive symbolic communication at around 2.5 million years ago, but a fully articulated spoken language evolved extremely recently, no more than 200,000 years ago (Deacon 1997). Physical evidence for symbolic communication is even more recent. The Chauvet cave depicts a woman with a bulls head, showing that the motif of Theseus and the Minotaur is at least 30,000 years old (Herzog 2010). But, it is only after the advent of writing, about 6,000 years ago, that an analogy between symbolic and genetic information can be rigorously justified.

Writing allowed for the crystallization of cultural identity. Its effect was to make a static backup copy of the cultural information previously only dynamically held in human minds. But not only did writing provide redundancy, and thus increased heritability of cultural information, it also introduced a strong stabilizing force on cultural identity. Information that was loosely distributed among many minds became centralized in one place and could provide a touchstone of continuity. Formerly disparate or marginally connected peoples could now be unified by this collective font of information that they could presume each other shared. These unifying information sources were by no means a complete cultural genome, but by stabilizing even a fraction of a cultures identity, our first holy texts provided an accretion disk around which the more dynamic and less easily crystalized aspects of culture could orbit. The past several thousand years have seen the rise and fall of thousands of cultures. Nations are conquered; groups blend together and mutate into new forms. After one or many inevitable social upheavals, any culture which was unusually effective at translating aspects of itself into more stable symbolic media would stand a better chance of reforming than would the groups that did not so strongly emphasize symbolic preservation. This is precisely the same sort of selective pressure that led to the evolution of DNA, manifested this time on a cultural rather than cellular level.

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Judaism

Writing has been used all over the world at all points in history to stabilize cultures, from the Code of Hammurabi to the Bill of Rights. Religious traditions are particularly good examples of this pattern because of their tendency to dominate every aspect of believers' lives. And many religious texts

show some awareness of their own stabilizing function. The Jewish tradition is particularly notable in this regard.

Judaism puts extraordinary emphasis on the Hebrew language. Biblical Hebrew has been called Leshon Hakodesh, (לשון הקודש), the sacred language, since some of the earliest commentaries (Mishna, Tractate Sotah, 7a). This sanctification of language serves an adaptive function. It is no coincidence that a religion that puts such numenosity into the preservation of historical texts is also one of the world's oldest, despite repeated persecution. Replication of scripture is built into the scripture itself in a self-referential feedback loop. The Torah states, *"And now, write for yourselves this song, and teach it to the Children of Israel. Place it into their mouths, in order that this song will be for Me as a witness for the children of Israel."* (Deuteronomy 31:19, translation from chabad.org) One of the doctrines of the Torah was the memorization of its laws, so that the entire community was accountable for upholding canonized norms and morals. The replication of these norms through text is even more explicit elsewhere in Deuteronomy. *"And it will be, when he sits upon his royal throne, that he shall write for himself two copies of this Torah on a scroll from [that Torah which is] before the Levitic kohanim. And it shall be with him, and he shall read it all the days of his life, so that he may learn to fear the Lord, his God, to keep all the words of this Torah and these statutes, to perform them."* (Deuteronomy 17:18-19). This urging for not only preservation but actually proliferation (*two copies!)* of the Torah has evolved fantastical complexity and specificity since the days of Deuteronomy. Consider these excerpts from the twelfth century rabbinic scholar Maimonides,

> *...Should [a scribe] have to write a word with five letters [at the end of a line, and there not be sufficient space for them all], he should not write two within the column and three beyond its margins. Rather, he should write three within the column, and two beyond its margins. If there is no room on the line to write [at least] three letters, he should leave an empty space and continue at the beginning of the [next] line...*
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> *...There are other practices which, although they are not mentioned in the Talmud, have been followed by scribes as tradition, transferred from generation to generation. They include that: a) the number of lines in each column not be less than 48 nor greater than 60; b) there is a space of approximately nine letters left empty between each passage, so that one could write the word* אשר *three times...*
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> *(Mishneh Torah: Sefer Ahavah: Tefillin, Mezuzah, and Sefer Torah: Chapter 7: Halacha 5,10. translation from chabad.org)*

Similar rules extend for many more pages. They are not unlike adaptations for DNA proofreading to keep mutation rates down. But this reverence for the holy word does much more than simply ensure the high fidelity transmission of texts. The idea of Leshon Hakodesh actually facilitates the articulation, and then the perpetuation, of Jewish identity. The majority of the Torah and its associated commentaries is not dedicated to just defining textual replication rules, but to defining other (phenotypic) aspects of society. Proscriptions surrounding diet, or marriage, or animal husbandry were all dictated in Leshon Hakodesh and were all scrupulously copied. And as Maimonides notes, explicitly defined rules were often augmented by unwritten traditions. These unwritten traditions, although not explicitly codified, also took on the same sacred aura due to their reflexive association with explicitly sacred commandments. Thus the central Jewish tradition of textual sanctification, reproduction, and commentary served as the eye of a vortex, swirling up unarticulated cultural items and codifying them into a reflective network. From the Torah came the Talmud, and from the Talmud commentators like Maimonides. With each generation more and more cultural information accreted around the center and crystalized in symbolic form.

As cultural traditions became canonized, they gain the additional function of becoming identifiers. No longer was a kosher diet followed out of habit, or convenience, or health benefits. Kosher laws became identifying markers, facilitating a group level self-other distinction (Wilson 2002). Thus a codified system for perpetuating the norms of the Jewish culture also served as an abstract boundary isolating it from surrounding society. Jewish diet, circumcision, Sabbath, and dress, especially in the more orthodox traditions, serve this isolating-identifying function. And over many generations, an isolating symbolic identity actually has the capacity to influence the genome. Jewish communities from all over the world are more genetically related to each other, and to the Middle Eastern population they originated from, than they are to any of the foreign populations they reside within, even though the diaspora occurred millennia ago (Hammer et al. 2000). This empirical result shows remarkable continuity of the Jewish identity, stabilized by reverent replication of cultural artifacts. But just what exactly this identity is is not yet clear.

The Judaism that has perpetuated itself since early history has undergone many changes. It is not the same religion that it was 4000 years ago. It has spilt into hundreds of sects, and contains a lot of junk DNA – proscriptions relevant to militant pastoral nomads that have no bearing on the life of any living Jew, although those proscriptions are dutifully copied along with everything else. Furthermore, we can speak of a Jewish 'identity,' but clearly this identity is very different from the lived identity of Isaac

Newton or Woody Allen. But it is a kind of identity none the less. While no one person can embody all of Judaism, there are many Jews, and some aspect of each Jew's personal identity is taken from the more nebulous corpus of Judaism. We have all heard stories of someone's kvetching Jewish mother. How is it that distinct suites of character traits like this seem to be passed down, generation after generation, with remarkable accuracy?

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Identity

Identity exists on multiple levels. At the lowest level, the simplest bacterial cell displays two distinct kinds of identity, genetic and corporeal. Protists display a higher-order identity than this because they were formed by an endosymbiotic merger of archaea and bacteria (Margulis 1970). And multicellular creatures possess an even more extended identity, which emerges from the processes of their component cells. As individual identities become subsumed by a larger collective, they do not get completely eliminated; mitochondria and somatic cells still possess some degree of autonomy. Rather, evolution has fine-tuned domains of influence, producing hierarchically nested identities with an intricate internal balance between autonomy and dominance. These evolutionary transitions have had millions of years to develop their well-defined boundaries. In contrast, symbolically defined group level human identities are brand new on an evolutionary time scale, and it will be some time before they achieve the same level of differentiability. Group level identity is stored and transmitted through a new symbolic information medium, and in order to understand its properties, it is helpful to look back to an earlier time in the history of life when a new information medium was emerging – back to Luca.

The distributed identity of the Jewish people, or any other cultural group, is similar to Luca in many ways. In both cases there is a complex interaction of vertical and horizontal transmission modes. Identity can be most cleanly defined when it is transmitted vertically, but in cases where vertical transmission is of insufficient fidelity, horizontal transmission must redundantly take up the slack.[5] The biological identity of any single proto-avatar (either proto-cell or human being) can only be incompletely replicated because much of it cannot be crystalized inside a static medium (either DNA or symbols). Much of biological identity must then be replicated dynamically, but this is limited and difficult to track because there is no germ/soma or genotype/phenotype distinction[6]. In both cases, the limited parts of

[5] For more on redundancy and its role in stabilizing cultural information, see The Evolved Apprentice. Sterelny, 2012

[6] It could be noted here that even creatures with a well-defined selfhood still transmit some of their biological identity dynamically – this transmission mode is studied, if not explicitly, by evolutionary developmental biologists. Here is a simple example of information being

biological identity that can actually be transmitted through a proto-germ line (the information that can be stored in codified cultural texts or in DNA with an ambiguous codon code) serves as a stable attractive center around which the more volatile aspects of identity can gather. In this way, the entire distributed system achieves a primitive kind of immortality. While individual proto-avatars are still mortal, as many of their unique features are lost upon death, the entire group is able to perpetuate itself indefinitely. This kind of immortality is restricted because the communal creature may lose large chunks of its identity over time (those parts that resist crystallization). But nonetheless, here is kind of immortality. Not the cosmic immortality of the tree of life, nor incomplete personal immortality through artifacts, but a communal immortality. Members of the community may come and go, but some core aspect remains constant, impervious to the sands of time.

Once a group level identity is established, selective pressure arises which pushes the group to become less distributed and more organismic – which makes the self more readily distinguishable from the environment. As Luca aged, her distributed network became smaller and more tightly integrated. The vocabulary and bandwidth of DNA increased significantly, allowing for an increasingly diverse array of adaptations to be centralized. Most components of identity that could not be crystalized in this manner were eventually lost. Sometime before the origin of the first true-breeding cells, Luca's network split into two, forming distributed Achaea and Bacteria networks with independent genome replication mechanisms (Woese 2002). Horizontal transfer between and then eventually within these networks became restricted as vertical inheritance evolved to be more specific, complex, and canalized. Eventually, the first true avatars evolved – individual autonomous cells which on their own were capable of embodying and replicating most of the identifying information that was formerly distributed across a vast network. These avatar cells had a dual, bifurcated identity. One aspect was corporeal, with reciprocally arranged parts that catalyzed and recreated each other. The other aspect was genetic, a crystalline representation (and component) of that reciprocal catalysis. DNA allowed for lineages of avatars to persist for long stretches of time – billions of years – each avatar an independent embodiment of a more universal identity. Do we see anything like this identity split leading to avatar development in human communities? Consider the myth of reincarnation.

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transmitted dynamically: In a vertebrate blastula, cells receive instructions dictating which body part to specialize into not from 'head' or 'leg' genes, but from their location. Cells at the top of the blastula develop into dorsal structures, bottom cells develop into ventral structures. Thus some of the identifying information of the new organism comes not from its DNA, but from the spatial relationships between different cells, and between those cells and the environment in which they are developing.

Avatars

The word avatar comes from the Sanskrit word 'avatara', अवतार, which literally translates as 'descent' (Darwin added the 'with modification' later). The word is typically used to refer to reincarnations of Gods, or extremely holy people who take on a divine aspect. This idea is taken to its zenith in Tibetan Buddhism, because of that tradition's unique merging of spiritual and political authority. The post of the Dalai Lama bears intriguing similarities to the first cellular avatars.

The first Dalai Lama, Gendun Drub, was born in 1391. Soon after his death in 1474, a young boy, Gendun Gyatso, was proclaimed to be his reincarnation. It was not until the next reincarnation in 1543 that this lineage of priests was given the title of Dalai Lama (Brauen and McCormick 2005). And it was not until the ascension of the fifth Dalai Lama in 1642 that the position assumed political control of Tibet. Yet despite the changing nature of the post, "for more than 600 years since Gedun Drub, a series of unmistaken reincarnations has been recognized in the lineage of the Dalai Lama."(Dalai Lama 2011). After the thirteenth Dalai Lama died in 1933, a high lama meditated and received a vision indicating where the next avatar would be found, as was customary. A search party was dispatched in 1936, and when they found the farmhouse indicated by the vision, the leader of the search party disguised himself as a servant, so that he could observe the two year old child that lived there without his prestige biasing the interaction. The boy crawled into the supposed servant's lap, and found a rosary in his robes. The child insisted that the beads, which had formerly belonged to the thirteenth Dalai Lama, were his. This seemed auspicious, so three weeks later the search party returned, this time bearing a number of the thirteenth's belongings, as well as duplicate items that he had not owned – two rosaries, two small drums, and two walking sticks (Marcello 2003). The biography on the Dalai Lama's website recounts "In every case, the infant correctly identified those belonging to the thirteenth Dalai Lama saying, 'It's mine. It's mine.'" This display was considered sufficient evidence that reincarnation had occurred. While from a western perspective the veracity of this method seems dubious, what is important to note about the episode is the way the monks used redundant checks of key pieces of information to ensure that the transmission of identity had occurred. After the new Dalai Lama passed these initial tests, the transferred identity was strongly enforced by Buddhist training at the capital palace in Lhasa. He was given the thirteenth Dalai Lama's living quarters and old possessions, and was generally treated as if his life were a linear continuation of the former spiritual and political leader of Tibet.

Training to be a lama is intense. For several decades every day is spent in mediation and study. The current Dalai Lama was trained by monks who knew his predecessor intimately, and who were likely

even trained by him. Given their nearly identical rigid upbringing, how similar might the personalities of these two men be? Similar enough to consider them avatars of each other, in an evolutionary sense? Over the past 600 years, fourteen men have been trained from birth to occupy the same post. They studied the same texts, memorized the same prayers, lived in the same buildings, with the same daily schedule. Their social world contained a remarkably static geometry, as other high lamas occupying complimentary social posts were also reincarnated and trained from birth to fulfill their designated social roles. It is as if there were a pre-defined social niche carved out for each lama, and as they develop they strive to fill it with exacting precision. Thus there is a continuous symbolic entity that has passed through fourteen men over the last 600 years – reincarnation.

The Tibetan Buddhist tradition embodies a system that replicates symbolic identity with remarkable fidelity. It differs from most biological replication methods in that much of the reproduction of individual identities is facilitated by a suite of adaptations that exists outside of the individual – a palace, a social hierarchy, hundreds of overlapping lamas that shuttle bits of identity from one mind to the next. Indeed, without this array of environmental factors, it is not clear what the identity of the Dalai Lama would be. Symbolic identity is inexorably tied to the network. But this is what we should expect from a channel of inheritance that has not yet evolved a vocabulary large enough to represent a complete cultural genome. Information that cannot be translated to fit within a single individual must be embodied by the network or be lost. So the apparent immortality of the personal Dalai Lama identity is likely better viewed as a component of the group level immortality of Tibetan Buddhism. The Dalai Lama is a highly specialized organ that can be partially differentiated from the network, somewhat akin to deer antlers – a figurehead that falls away and is regrown with each passing season. Viewing the leader-priest caste as a group level adaptation also reveals the function of some of the more enigmatic aspects of the reincarnation process. Rather than viewing the complex ritual that went into the Dalai Lama's selection as a case of institutionalized confirmation bias, it can be seen as an adaptation that prevents abusive concentrations of power. The celibacy of monks prevents the inheritance of cultural position to be coupled with genetic inheritance, as it is in most other societies. This produces a surprisingly egalitarian system of representation because leaders are chosen from the entire population. [7]

The fact that Tibetan Buddhism effectively decouples genetic inheritance from cultural inheritance is indicative of a much larger trend. Identity splits and interpenetrates itself as life

[7] Darwin's Cathedral (Wilson 2002) takes an organismal perspective on religious organizations to provide a number of examples like this one of adaptive explanations for otherwise enigmatic religious traditions.

complexifies. Luca experienced the first bifurcation of identity. In Luca's children, information that had previously been distributed across many cells in many forms came to be concentrated in single cells in two forms – one genetic, one corporeal. Modern cells all embody precisely two copies of themselves, whereas Fuca embodied exactly one copy, and Luca embodied somewhere between one and two copies, with lots of redundant pieces. All creatures with complex brains embody more than two copies of themselves – they also possess some degree of mental self-representation. With the advent of symbolic language, humans robustly enforced and expanded this second splitting of identity. We creatures contain ourselves three times: in our bodies, in our DNA, and in our minds.

Our genetic identities have achieved a certain degree of immortality. Corporeal forms may come and go, but something common and highly similar to all of them remains. In contrast, our mental identity is not so easily preserved, and so we die. Despite our intuition that symbols like hieroglyphics or Torah scrolls might somehow preserve us, we still experience death to be a profound and permanent loss. For all of human history our societies have been dealing with these inevitable losses, and evolving more and more sophisticated ways of preserving information. Religious societies like Judaism and Tibetan Buddhism possess particularly notable adaptations in this regard. The relationship between the Torah and the Jewish people seems like a primitive genotype phenotype relationship. And the position of the Dalai Lama hints at how an entire cultural identity could be compressed into a single avatar.

However, we need not look exclusively to religious traditions for adaptations that preserve symbolic identity. Indeed, the most high fidelity developments to date in this regard are the incredible advances in information technology produced in the past fifty years[8]. Through Google, Facebook and other media, the children of a child born today will have access to tens of thousands of photographs, status updates and other microevents of their predecessors' lives. Everything from marriages to breakfast menus are meticulously documented. This has a dramatic impact on the heritability of identity, as we are able to crystalize more diverse kinds of information than ever before. The kind of death that humans experience is a biological anomaly, and there is constant selective pressure to

[8] This paper has focused on the information theoretic definition of fidelity, but the other definition hinted at in the title deserves comment. The word fidelity comes from the Latin fidelis, faithful, most often considered as faithfulness to a spouse rather than to an information source. But these two meanings of the word may be more than tangentially related to each other. The Symbolic Species (Deacon 1997) proposes that symbolic thought could have originated through marriage rituals guaranteeing sexual fidelity. This proposal is an elaboration of what is generally known as the social intelligence hypothesis – that the human mind emerged from intense selection pressure for social competence. This conjecture on the origin of language is compelling because it epitomizes the expansion of self that symbols provide. A marriage ritual is not simply a contract of sexual access, but a recognition of mutual codependence – symbiotic merger. The ritual allows for abstract identification of each spouse with the other, empathy, a merging of two selves into one. Such a symbolically enforced relationship would have been fitness enhancing, as couples bonded in this way likely made better parents than those that were not. The relationship would also have been vertically heritable as children learned by example from their parents what the union represented. Thus a faithful marriage could have been one of the first aspects of cultural identity to be transferred with high fidelity.

minimize it. In a few million years, and maybe much sooner, death as we know it will be a thing of the past. But the nature of identity will never be the same.

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Conclusion

Living forms are often characterized as discrete ships of order amidst a sea of chaos. The irony of this metaphor is that despite the myriad evolved adaptations for enforcing unity and self-continuity, no self-other distinction can be perfect, because an impermeable boundary means stasis, and stasis means death. Symbolic language has made the boundaries of identity more permeable than any other development in the past four billion years. But it has also expanded them. Every conversation is a tiny act of reproduction. When we empathize with one another, we are effectively recreating the form of the other within ourselves. A provocative book can alter how you perceive the world – can even change who you are. Form on the page becomes form in the mind. And so language allows parts of selfhood to become detachable, modular, easy to exchange and distribute across an entire population. And as our personal identities mix and fuse, a new higher-order self is emerging. The self-other distinction of this group level identity transcends corporeal and genetic boundaries, for it is not made up of one body, or even one genome. Humans, artifacts, crops and livestock are becoming integrated into a single organism. The dermal boundary of this global organism is far from being complete, but it is clear that it will not consist of any sort of physical barrier. Rather, the boundary will be made up of symbols – a symbolic structure which can outlast any of its material components. Identity and mortality transform as higher and higher fidelity methods of replicating symbols evolve. And this new branch on the tree of life is just beginning to grow.

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