

## A Filmstrip: The Evolution of Emotions

by R. Salvador Reyes [Excerpted from “Narrative Complexity: A Consciousness Hypothesis,”  
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...Let me pull the screen down over the board, switch off the lights, and roll out one of those old filmstrip projectors (kids, imagine an ancient PowerPoint presentation with *way better* analog-ish ambience). And don't put your head down on your desk—you're gonna wanna see this...

It is 700 million years before humans ambled onto the evolutionary stage. A little roundworm with an unfortunate first name—Caenorhabditis elegans—is squiggling along in the muck. And little *C. elegans* has something in common with us: he likes to eat. Not only does he like to eat, he *expresses* this desire using clever devices that we also make heavy use of in the expression of our desires: *neurotransmitters*.

In particular, *C. elegans* is using serotonin and dopamine, which play significant roles in our own brain mechanics (they are key players in producing & manipulating our pleasure/pain responses). When Mr. Roundworm encounters positive stimuli, like food or a mate, serotonin is released—helping to enact motor scripts like bacteria ingestion. In addition, when his worminess rubs up against that yummy bacteria, dopamine is released. The dopamine helps to inhibit the creature's locomotion motor scripts—

slowing him down & allowing him to spend more time in the presence of the food. And if he's really hungry, more serotonin is released—this dose helping to inhibit his locomotion even further, ensuring he eats every last bacterial bite.<sup>7</sup>

I know what you're thinking: *this C. elegans guy sounds like an uncle of mine*. And, yes, from a broad universal perspective, we're not all that different from our wormy planet-mate. But 700 million years is a long time. And our use of these neurotransmitters is so much more diverse & complex than *C. elegans'* that it's like comparing an abacus with an iPad. Sure, they both calculate stuff with similarly clever efficiency, but an iPad can calculate *a whole lot more stuff*. And, not to make *C. elegans* feel worse about himself, but plenty of tinier & earlier creatures were using neurotransmitters to affect behavior (even lowly paramecium use serotonin when swimming).

Nonetheless, in *C. elegans* scientists have found some of the specific kinds of serotonin receptors that humans use today.<sup>8</sup> And in his simple existence we can see the early sparks of those relationships between resources (*food*), “feeling” (*neurotransmitters*) & behavior

(*stay here*) that are at the root of our own complex emotions.

As we said, 700 million years is a long time. And in the epochs between roundworms & humans, those simple neurotransmitter-fueled commands "*stay here & eat*" and "*stay here & reproduce*" evolved into more complexly regulated—but still very basic—resources, feeling & behavior relationships. (Thanks to more robust & diverse neural structures & neurotransmitter mechanisms.)

The result was likely a system of primitive *proto-emotional* pairs that initially helped vertebrates to manage: *hunger(thirst)/satiation, lust/repulsion & strength/fatigue*. Those would cover all of an early creature's basic needs (and probably composed an average evening in the cave: eat, drink, screw, sleep). *C. elegans* politely raises his tail: "*Hey, I basically do all of that stuff too!*" Which is true, but post-roundworm creatures began to require resource-acquisition strategies more complicated than *squirm toward that chemical marker & hope I squiggle over something to eat*. Thus, the neurotransmitter-fueled behavior signaled by proto-emotions such as hunger & lust also grew more complicated.

Now, in the blink of a celestial eye, 700 million years have passed (cue Terence Malick's "*Tree of Life*"). Here, humans have gotten the long end of the stick. Their brains are *awesome*. Those simple implements like

hunger/satiation, lust/repulsion & strength/fatigue have morphed into an entire toolbox of fancy gadgets. And those gadgets have a name: emotions. Those same neurotransmitter-based signals that forced *C. elegans* to eat all his spinach are now signaling all sorts of crazy & unbelievable things. And they're doing it mile-a-minute. If a roundworm's simple signaling system woke up inside a human brain, it would feel like a previously perpetually-recluse hydrogen atom suddenly transported to the center of a blazing sun.

And yet, it was *C. elegans* who begat those proto-emotions—and those proto-emotions likely begat our complex (& *very* complex) emotions. Look closely at the value gain/loss judgements that are at the heart of so many primary emotional pairs. What was the original *object of value*, the one that hunger & satiation managed? *Food*. Hunger. Pain. Value loss. / Satiation. Pleasure. Value gain. *Rodney saved the yummy and felt pleasure—even before eating the rescued yummy*. (Interestingly, the vast majority of our brain's pleasure-producing serotonin comes from one location: our *stomach*—and the serotonin's commute to the brain is signaled by a specially-designated nerve that connects the two organs. Coincidence? Doubt it.)

In addition, these *other entities* we are always judging, Agents of Value—what was the original *other entity* that early animal brains

were most interested in evaluating? *Our mate. Lust. Affection. Agent of Gain. / Repulsion. Animosity. Agent of Loss. Rodney was angry at the wanderer for causing the loss of his yummy.*

The emotional “bonding” that is triggered by Agent of Gain judgements (which are involved in many emotions beyond affection—like generosity & magnanimity) is likely aided by the specific use of the hormone/neuromodulator *oxytocin*. Research has shown that this neuromodulator is involved in many “empathetic” (aiding/sharing)<sup>9</sup> or affectionate behaviors (it’s sometimes called the “love hormone”).<sup>10</sup> And the use of oxytocin by our modern Agent of Gain emotions (to aid in bonding with those dynamically-determined Agents) probably has its roots in that less dynamic proto-emotion *lust*.

As in humans, oxytocin appears to be used by earlier mammals to aid in bonding with mates & offspring, thus its expanded (but similar) use in our modern *Agent-of-Gain-related* emotions seems likely. (And this kind of bonding works in combination with belief-based mechanics like *admiration*—and other predictive patterns/assumptions drawn from accumulated or high-impact experiences—in helping to cognitively define individuals & entities as reliable or “trustworthy.”)

Decision-making about all of these resource gains & other entities began getting more complicated when—in the middle of that 700 million year blink—advancing creatures got a cool new (but still primal) neurotransmitter-fueled prediction tool & signaling gadget: *fight or flight*. This little device provided a super-useful survival skill—a method for choosing the most appropriate response to immediate danger. *I can take him! Let's do this! or No way, man! Run! Whaddaya know...a validity judgement—assessing which one of two predictions is more likely to either achieve a gain or avoid a loss. Fight. Confidence. Prediction success. / Flight. Anxiety. Prediction failure. Rodney hesitated before reaching into the fire for his possibly-pooppy yummy.*

Keep in mind, exercising *fight or flight* is not the same as identifying a possibly-edible fruit and feeling compelled to eat it. That’s simple value gain recognition & signaling. You know *exactly* what to do: eat the fruit. But *fight/flight* is likely tied to our ancestral validity systems because it involved assessing two possibilities that might be best. *If I fight, I might win & live. If I run, I might get away & live. You don't know exactly what to do, you're weighing your choices—measuring the validity or likelihood of each prediction.*

Another primitive feeling—one that also seems to be tethered to a modern emotional

mechanism—emerged during the heart of that 700 million year blink: strength/fatigue. Is this category a little too imprecise? Probably—inasmuch as it doesn't distinguish between an overall state of fitness & simply feeling rested/unrested. But at its core, strength/fatigue represents a more fundamental, action-specific judgement: *am I able to keep going or must I stop?* This judgement is most vital at times when a creature's survival depends on its ability to squeeze every last bit of life-saving action out of whatever physical resources remain—which can be hindered by things like pain & fatigue (feelings creatures typically experience in these survival-challenged moments).

Once again, nervous systems around the globe went back to that oh-so-reliable tool for a little help in these situations: neurotransmitters. Vertebrates got a gift—*endorphins*, which are released during moments of pain, excitement, exercise & fatigue (and others, like orgasm, but let's stay focused). These endorphins are known to inhibit pain, create feelings associated with pleasure, and to be released in moments when we're trying to squeeze the most out of our resources (injury, exhaustion, sex).

Thus, it seems likely that—as the modern human brain emerged—mechanisms rooted in that primitive strength/fatigue

feeling & involving endorphins evolved into what we think of as *willpower*: the attempt to "consciously" bolster one of those aforementioned struggling or difficult (or *extra-resource-requiring*) efforts. Science has, indeed, shown that these endorphins can play a key role when we experience both very open & very guarded states<sup>11</sup> (highly-excited & highly-fearful) generated by our primary (*narratively-based*) emotional pairs—making us more capable of taking effective action in each state. And the roots of this kind of willpower mechanism were probably heavily-intertwined with that validity-based proto-emotion we just described: *fight/flight*.

To understand why, first consider that the validity judgements necessary to take the most-beneficial dynamic & contextually-based action appear to have actually *preceded* the development of true *fight/flight* (even though we shamelessly gave *fight/flight* all the credit on the previous page). This validity-based precursor to *fight/flight* is something we might think of as a *fight/cower* response.

An example of this in early reptiles: *turtles*. (Humans, of course, didn't evolve from turtles, but reptiles & mammals both emerged from the earliest amniotes. Thus, those first versions of reptile brains likely shared many fundamental mechanisms with those first versions of mammalian

brains—and similar basic fight/flight responses are demonstrated by both reptiles & mammals.) When certain land turtles dynamically *choose* to respond to a unique new potential threat by either biting or retracting their heads <sup>12</sup> (some are not capable of both) they are making one of those contextual *this-or-that* validity judgements that's the basis of fight/flight.

But, as described, turtles don't typically *flee*—instead, they essentially *cower*. If we consider that, according to our theory, all emotions (proto & modern) are part of an encourage/inhibit pairing, then fight's *encourage* response would naturally be countered by a pure *inhibit* response. This is what cowering represents: *inaction* & *guarding behavior* in response to a perceived threat instead of active & open behavior (biting).

In order for this creature to overcome its inhibitory cowering response and actually *flee*, they would likely need to begin getting injured while cowering & suffer pain. This is because, among these earlier vertebrates, pain or fatigue were required to generate an endorphin response, which is what ultimately helps them to neurally overcome the inhibitory cowering and actually engage in some life-saving fleeing.

One of the interesting things about fight/flight is that it contradicts that seemingly

fundamental action/inaction pairing of emotional responses—fight/flight is actually *action/action*. How did advancing vertebrate brains likely achieve this paradoxical pairing? *Endorphins*. Evolution seems to have sorted out the fact that—if you've already determined a threat is *un-fightable*—it's often better to engage in any necessary fleeing *before* you begin to get that endorphin rush from being pummeled while cowering (especially if you're a *post-turtle* vertebrate whose *cowering effectiveness* isn't enhanced by a shell). Thus, in the development of fight/flight, the brain likely began to repurpose those original endorphin-based strength/fatigue mechanisms & use those neurotransmitters to help counteract that *initial* inhibition response generated by fight/cower.

Basically, this means that creatures with more evolved fight/flight responses would've been the first to generate endorphins based on cognitive analysis of externally-perceived threats (those *this-or-that* validity judgements) as opposed to producing endorphins purely based on internally-detected pain or fatigue stimulus. (This kind of development seems to be one of the primary drivers of evolutionary advancement in vertebrate cognition: the growing integration of neural systems that were originally solely devoted to either external or internal sensory input.)

The neurotransmitter/hormone most commonly associated with fight/flight is epinephrine (aka *adrenaline*, like our body's version of speed) which is typically released in heavy doses when stressed or otherwise physically-aroused by a situation. But epinephrine doesn't appear to help us to *choose* to act or overcome some inhibitory behavior. Rather, it seems to be released once we've *already chosen* to act or simply upon *encountering* the stressful stimuli—essentially temporarily juicing our whole system, allowing us to perform *whatever* act with greater efficiency, robustness, stamina or effectiveness.

Endorphins, on the other hand, were first designed to be pain-blockers (like our brain's version of opiates) and thus naturally work in *direct opposition* to inhibitory instructions and primal urges. Endorphins aren't just there to provide pleasure that enhances performance, but pleasure that also specifically helps overcome inhibitory or contradicting instructions. Thus, fight/cower likely generates only epinephrine in the creature (making it more effective in fighting or cowering, but still unable to flee) while the more-developed fight/flight response generates both epinephrine *and* endorphins. Similarly, endorphins likely play a key role in some of our “guarded” emotions that can require urgent action, like *anger* (which is probably why it can actually *feel good* to be angry sometimes).

These are the reasons why it's more probable that endorphins and *not* epinephrine are the foundation of our actual *willpower* mechanisms. (In fact, because it's juicing *everything* in the brain, epinephrine can sometimes make it *more* difficult for an urge to be controlled by our endorphin-based willpower.)

Why did the involvement of strength/fatigue's endorphins with fight/flight's validity judgements end up being so great for humans? Because this evolutionary development connected the release of endorphins to those early cognitive systems that would eventually generate validity-tested, emotion-producing, decision-making narratives. This is how it likely became the root of *willpower*—that attempt to “consciously” bolster a struggling or difficult effort. Once these systems—urge-overcoming endorphin-production & action-enhancing narrative motivations—were tied together, brains could (eventually, in humans) use these unique neurotransmitters to aid in choosing high-priority & sophisticatedly-arrived-at narrative options over powerful primal or emotional urges.

Unfortunately, endorphins are a fairly new discovery (only dating back to the 1970s) and there is not a wealth of broad research on their effects in different neural circumstances. But there is a small amount of endorphin research that provides an

interesting window into their willpower connection: research on endorphins & *sleep*. In one study, it was shown that disrupting endorphin input within the human brain while sleeping had no impact on the sleeping brain; it remained asleep & unperturbed<sup>13</sup> — suggesting that endorphins have no role in the sleeping brain.

In addition, a study on cats showed that the introduction of endorphins to the brain during sleep both inhibited lighter sleeping & entirely prevented deep REM sleep<sup>14</sup> — also suggesting that it is unlikely that mammalian brains are using endorphins while sleeping. Thus, those moments immediately after awakening or moments of semi-sleep (like sleep-walking) are likely brief windows into how our brains might behave *without* the benefit of narrative-action-enhancing, urge-inhibiting endorphins.

As someone with a lifetime of sleep issues (sleep-walking, difficulty sleeping long stretches, etc.) I happen to have a good deal of experience facing the world in either semi-sleeping or barely-awake states—in fact, as I've aged my sleepwalking has been replaced by the odd & disconcerting habit of sleep-*eating*. My experiences in both of these (likely endorphin-deficient) states are fairly common, and one thing seems to be particularly true about all of these experiences: I exhibit a significant decline in my ability to express *willpower* over my urges

(like eating half the box of cookies or flying off the handle at the slightest irritation, even though deep in my brain I can hear myself clearly saying *don't eat that* or *calm down*).

This willpower deficiency while barely-awake, as mentioned, is not uncommon. My guess is that nearly every reader of this essay has had similar experiences. And although some of the other primary neurotransmitters like serotonin & dopamine are typically less in evidence during sleep, they are still used in some small fashion or another during the whole process of sleeping and awakening, and their presence in the brain does not actually appear to inhibit sleep in the way endorphins do. Thus, endorphins appear to be one of the only primary neurotransmitters that's entirely absent during these episodes of sleep-induced willpower deficiency, also supporting its candidacy as willpower's main neural advocate.

Whenever a narratively-based cognitive desire (don't eat those cookies, don't get mad about that, *control yourself*) is powerfully contradicted by one of those strong emotional or urge-based impulses, endorphins are released and enlisted in aiding the “preferred” narrative desire. The higher the value you can generate for the preferred choice via your story, the stronger the production of endorphins in support of that narratively-reasoned option.

This is why when guys like Aron Ralston (the dude who cut off his own arm) finally muster up the willpower to slice away, they do so by thinking of all the people they love and want to return to, convince themselves that they will die otherwise and thus must act to see them again. This is a powerful & convincing story—the kind that helps maximize endorphin production & win the battle over the very strong primal urge *not* to cut off your own arm.

Another thing about Ralston, whose endorphin system and story were so amazing that he could cut off his own arm: he was one of those *thrill junkies*. In other words, he seemed to get extra-special and addictive pleasure from the endorphin-enhanced joys of risk-taking behavior and physical exertion. This is evidence that he likely possesses naturally-strong endorphin production or benefit, which is partly what saved his life—that and the aforementioned powerful, convincing & endorphin-maximizing *story* that aided him in winning the battle against *not wanting to cut off one's own arm*.

Which is not to say that *all* individuals with strong natural willpower mechanisms exhibit a *thrill-desire*—many other factors are also at play here, such as our ability to create & maintain those powerful narratives/reasoning that help *trigger* the endorphins. In fact, from our theory's perspective, many of the decision-making conflicts that are considered

to be mitigated primarily by “willpower” (such as resisting the urge to cheat on a test) are actually a result of our belief systems working in powerful *combination* with mechanisms like our endorphin-based willpower (a matter that will be explored in Essay #4).

Ultimately, the particular willpower device that we're identifying here can be described in very specific terms: “willpower” is a neural mechanic that (with the aid of endorphins) encourages humans to *consciously choose to endure* (& helps them to tolerate) predicted & ongoing pain/loss in the service of achieving a longer-term personal or broader societal (& often belief-based) gain. This neural mechanic is cognitively triggered when there is a *strong conflict* between a powerful narratively- or belief-based (consciously-considered) goal and a powerful pain-based/loss-avoidance urge or emotion—like hunger, fear, anxiety or anger. (For example, when the goal of saving your life by cutting off your arm *strongly conflicts* with that fear- & pain-based urge to *not* cut off your arm.)

Keep in mind: even when we use willpower to refuse an easily-available gain like secretly downing an extra piece of cake or swiping an unseen \$100 from the register (*or having sex with someone other than your spouse*) that willpower mechanic is still essentially helping us to overcome (& tolerate) the predicted (& ongoing) pain of

*not eating the delicious cake or not becoming \$100 bucks richer (or that devilish pain of not having sex with someone other than your spouse).*

Additionally, as we noted, the *effectiveness* of this mechanic in helping to achieve or choose the narratively- or belief-based goal is primarily determined by a combination of the strength of the emotional response generated by the narrative and an individual's capacity for endorphin production & benefit. This effectiveness can also be *hindered* by the kind of mental fatigue (aka, diminishing brain resources) that can result from being over-worked, under-rested or stressed-out—which likely makes it harder to maintain the cognitive focus necessary for effective (& willpower-inducing) narrative reasoning. (This mental-fatigue-based willpower hindrance does not, however, *totally disable* our human willpower mechanisms in the way that those *endorphin-deficient* sleeping or semi-sleeping states seem to.)

By viewing willpower in these terms, its connection to that endorphin-based *strength/fatigue* proto-emotion becomes even more clear. When those early creatures attempted to muster their quickly-waning resources in order to take that next *survival-aiding* step away from danger despite extreme fatigue or serious injury—which trigger endorphins—what those creatures

were really doing was choosing to endure (& being aided in tolerating) the *pain* that was an inevitable consequence of taking that *oh-so-difficult-but-survival-aiding* next step away from the danger. That *pain* is telling the creature: *Don't move, we're injured!* or *Don't move, we're almost out of resources!* But the endorphin-based (& primitively cognitive) response is saying: *We'll worry about that later, because if we don't move RIGHT NOW there probably WON'T BE any "later."*

And so, based on all of this, we can imagine how a complex, endorphin-based willpower system evolved from our ancient strength/fatigue mechanism—via millions of years of interactions with those fellow primitive mechanisms: hunger/satiation, lust/repulsion, and most-importantly, fight/flight. *Rodney was so angry with the wanderer that he nearly slugged him—he really wanted to, but knew it was a bad idea. Resisting the urge took all the willpower he could muster.*

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The next likely leap in vertebrates' emotional evolution reveals a truth that even Darwin had a hard time reconciling: everything isn't *always & entirely* about us, the individual. In some cases, it turned out that aiding one's own survival meant aiding *the group's* survival. And aiding the group often meant one specific kind of behavior: sharing resources. (It also meant helping out fellow

group members in a bind—i.e., helping free a trapped species-mate, which is ultimately a *sharing* or *donating* of personal resources like time, energy & risk-exposure; we're *literally* giving something of ourselves.)

This gearing of individual action toward benefitting a larger group by encouraging cooperative behavior (essentially, aiding & sharing behavior) was the beginning of social structures. (Keep in mind that in these social structures, individual actions that benefit the group also provide ultimate benefits for that *individual*, whose own survival is supported by the group.) And recently, researcher Alison Davis Rabosky discovered a rare group of desert-dwelling lizards who present the earliest evolutionary evidence of kin-based social behavior.<sup>15, 16</sup> These lizards work cooperatively to build the tunnel structures in which they live (for multiple generations) & share resources, and this openly cooperative behavior is built around kin-based social structures. In other words, these lizards appear to be among the first to share with other genetically "pre-defined" (by kin) Agents of Gain within their species.

In early mammals, there is actually evidence that this aid/share proto-emotion or instinct was applied species-wide. (To be more accurate & less positively-biased, this proto-emotion is better described via its root encourage/inhibit pair: Share/Hoard.)

Peggy Mason at the University of Chicago demonstrated that rats will help free a trapped (& unrelated) rat, and also share the yummy chocolate chips that both rats have access to (they will even free the trapped rat first, even if they have open access to the yummy chocolate chips).<sup>17</sup> Other recent research in rats has shown that they appear to use mirror neurons to empathically reflect/experience stress & pain observed in other rats.<sup>18</sup> Thus, it seems likely that the mirror-neuron-perceived distress in other trapped (or otherwise stressed) rats helps to trigger sharing's resource-donating twin: "aiding" behavior (a string of dynamic responses that continue to be tested & revised until no stress is empathically perceived in the other rat). All of this essentially represents indiscriminate "altruistic" behavior in which donating resources to any fellow species-member represents an overall survival benefit.

In later mammals (like pack animals & primates), this aid/share instinct mostly grew more discriminatory again—applied only to kin (like those lizards) or other members of tightly-knit social groups, thus allowing more intra-species competition for resources. With the exception of bonobos, who—as proven by Brian Hare at Duke—actually *prefer* to share with *strangers*.<sup>19</sup> It seems that ever-social bonobos value expanding their social circle above all else.

Hare's most recent (& brilliant) bonobo experiments also demonstrated something else very revealing: the sharing-inclined bonobos would *not* share with the stranger if an *actual* food loss wasn't *counterbalanced* by the gain of *actual* social contact.<sup>20</sup> I believe this loss/gain “counterbalancing” is still an essential element in modern human sharing—no matter how powerfully our relationships or beliefs may compel us to share, there is almost always some “maximized” level of loss that will inhibit that powerful urge to share or aid. (The *most-maximized* level of loss is, of course, losing *our lives*—which we're typically only willing to donate in the service of our most dear causes or in aiding our most profoundly-bonded Agents of Gain.)

Even though this kind of kin- or pack-based (or stranger-based) sharing was a more discriminatory application of this proto-emotion in mammals, it was still applied primarily according to genetically “pre-defined” Agent of Gain criteria. And sharing stayed that way (pre-defined) for a long time—until hominids (or likely until some of their closest primate relatives). Thanks to those newly-evolved, awesomely-modular & flexible neural systems, humans added a new trick to our judgements of other individuals/entities: that dynamic tagging of Agents of Gain or Loss (the descendant of Lust/Repulsion).

In other words, no matter *who* you are, if you help me or hurt me I'm going to *remember* that and tag you as a helpful or harmful entity for future reference. This individualistic, dynamic tagging of Agents of Gain also meant that our aiding/sharing behavior could be applied in a newly dynamic way—allowing humans to feel those modern emotions like *generosity* or *selfishness* toward entities that we have specifically categorized as helpful or harmful. Share. Generosity. Donate resources. / Hoard. Selfishness. Protect resources. *The wanderer promised to help Rodney hunt in the morning, and the offer made Rodney feel better about sharing his yummy with the wanderer.*

(Earlier mammals—like dogs—can also remember entity-related gain events that can *ultimately* affect future sharing behavior with that entity & help them make emotional judgements like anger & affection. But I believe those initial gain-providing interactions can actually allow that entity to obtain “pack member” status. And that pack status is still the “pre-defined” neural judgement that determines specific sharing behavior, which is a neural judgement that's different from anger & affection.)

It's important to understand, however, that a human's decision to *share* or *hoard* isn't all about our dynamic Agent of Gain/Loss tagging—because humans have those other

powerful behavioral calibrators: *beliefs*. In other words, we can have very specific & hierarchically-organized learned beliefs regarding sharing and apply those in combination with our more primal (but sophisticatedly-dynamic) Agent of Gain or Loss judgements when making decisions about sharing resources or providing aid.

Ironically, from Narrative Complexity's perspective, our human empathy mechanisms (which I do not believe are actually much different from the empathy mechanisms of other primates) only play a tertiary role in human aiding/sharing behavior—behind the roles of those beliefs & Agent of Gain/Loss mechanisms. Consider that "empathy" is ultimately the result of mirror neuron-based systems that reflect visually-perceived "other entity" physical movement & facial expressions from our parietal lobe to our pre-motor & somatosensory cortexes—which allows us to internally experience & interpret those "other entity" physical movements & feelings.

Thus, this empathy mechanic really only provides humans with the *capacity to better judge* (& feel for ourselves) how others are feeling, but empathy does not actually have much impact on how we choose to *respond* to that experience or judgement of their feelings. Our actual response to empathically-based emotions & judgements is mostly determined by

cognitive mechanisms like those Agent of Gain/Loss mechanics & belief systems. *Someone says something mean to you. You respond by saying something even meaner & it almost makes them cry. You visually & empathically—via mirror neurons—identify their sadness & reflexively, to some degree, feel their sadness. Do you apologize or walk away satisfied?* In both cases, you *empathically* perceived their pain—and this empathic perception might automatically trigger at least an *echo* of that primal "aiding" urge—but ultimately, your full behavioral *response* to that perception (& that echo) depends upon your beliefs about concepts like forgiveness, and judgements like whether or not you perceive them as a potential Agent of Loss or Gain.

Returning to the trail of emotion's evolution, although our earliest social mammalian ancestors did not possess this ability to respond to other group members in such diverse & complicated ways, their primitive-but-ever-advancing social structures did more than just foster basic aiding & sharing. These social structures also helped give value to a new commodity that those animal packs & communal groups allowed: *social status* (the acquisition of which provided myriad survival & reproductive advantages). And wherever there's value to be gained or lost (social or otherwise) emotions are bound to be found. Thus, mammalian brains developed a new proto-emotional mechanism that aided in managing &

responding to the gains & losses of this new, valuable *social status* commodity.

In the view of Narrative Complexity, advancing mammals who arranged themselves into more complex (non-purely-kin-based) social groups—i.e., pack animals like wolves—likely used this "social status" behavioral/emotional mechanism to accomplish two tasks that are crucial to forming complex social groups: 1) helping to determine "in-group" & "out-group" judgements of individuals, 2) helping to determine an hierarchical order within the group (aka, determine leaders & followers).

And, according to our theory, the proto-emotion that played the key role in those tasks was likely a primitive version of our purely-socially-based modern emotion: *Pride/Embarrassment* (an emotion that, as we noted earlier, *requires* an actual audience—or, at the very least, an *imagined* one). Viewed in its proto-form, we might think of this emotional pair as *Inclusion/Ostracization*.

Whenever a potential or current member of a social group (like a pack of wolves) engages in behavior that harms the group or its pursuit of a goal (like hoarding food or screwing up your role in a group hunt & allowing the escape of soon-to-be-food) the social group—usually following the example of the leader—will likely engage in some kind of "disciplinary behavior" toward the offending screw-up. This

"disciplinary behavior" is essentially a form of "shaming." And the result of this shaming is that the offender "feels" (at least temporary) *ostracization* from that group. The behavior that's triggered by this proto-emotion (behavior that's demonstrated, for example, when you scold your otherwise-beloved dog for pooping on the carpet) essentially leads the offending individual to "self-ostracize" or engage in behavior that distances themselves (physically and/or socially) from that group.

Conversely, when a potential or current group member engages in behavior that specifically aids the group or its pursuit of a goal (like impressively taking down the big & elusive target of a group hunt) that individual is likely to receive a positive response from other group members (essentially a form of "praise" combined with primitive expressions of gratitude). The result of this positive social response is that the individual experiences a powerful "feeling" of *inclusion* within that group. And the behavior that is triggered by this proto-emotion (which can be observed when you effusively praise your dog for a job well done) is something that we might think of as a desire or willingness to "take center stage" (at least temporarily or maybe even *momentarily*).

This kind of primitively prideful behavior essentially signals a stronger engagement

with or commitment to the group, which demonstrates to others that individual's capacity to be part of (or take on a greater role within) the group. This *inclusion-spurred* behavior can also trigger within that individual a *desire* to take on a greater role within that group (something that might ultimately lead a powerfully-prideful underling to challenge the reigning *alpha* for group dominance).

The evolutionary-fitness value of this emotional mechanic is that it both helps to sort out the most group-benefitting individuals from the least group-benefitting individuals, and it helps to determine an hierarchy within that group, which is crucial to highly-cooperative behavior like pack-based hunting (cooperative behavior that typically requires both a strong, proven, highly-skilled leader and competent, willing & well-disciplined followers). Despite the obvious evolutionary necessity for this distinct proto-emotion's existence in advancing social mammals, it expresses such a fundamental judgement about how we view ourselves (*part of or not part of*) that we barely think of this primitive pair as a true set of "feelings" by themselves.

And, in fact, I believe that our difficulty in identifying *Inclusion/Ostracization* as a distinct & separate proto-emotion that can be clearly differentiated from the experience of *Pride/Embarrassment* is because

this feeling has actually *barely evolved* from its primitive form into a distinctly modern one. Why have these particular emotional offspring stayed so uniquely close to their parents? According to our hypothesis, it's because a more complex, capable & modern emotional/social tool took on many of the tasks that *Pride/Embarrassment* (& its proto parents) originally handled: those ultra-useful & highly-flexible human belief systems.

We'll detail the evolution of our belief systems in a moment (& explain exactly how intricately *Pride/Embarrassment* are tied to that evolution) but we've already discussed the powerful role that belief-based emotions like admiration/resentment can play in making decisions about following or not following the lead of someone else. Additionally, in modern social groups an individual's in-group or out-group status is powerfully impacted by whether or not that individual has demonstrated or expressed that they share the group's most important & sacred beliefs.

Because our brain's belief systems are so complex & highly-evolved, they are ultimately much more effective & nuanced arbitrators of social groups & group hierarchies than those much simpler *Pride/Embarrassment* mechanics (which can be overly-prone to undesirable results like

simply allowing the biggest bully—aka, a disproportionately prideful & shaming-prone individual—to take over a group without necessarily demonstrating all of the skills best-suited for leading the group). Thus—having ceded the task of handling the more diverse & robust management of social groups to our beliefs—that nearly-proto-emotion Pride/Embarrassment was never evolutionarily driven to morph into something more distinctly complex. It's like the *Peter Pan* of modern emotions: *it just never really grew up.*

All of which means that—although there's still a distinct parental relationship between the proto & modern versions—the evolved pairings of Inclusion-Pride (*Gain of Social Status*) / Ostracization-Embarrassment (*Loss of Social Status*) still remain uniquely sibling-like (members of nearly the same "emotional generation"). *When Rodney explained to the wanderer that he was the first person in his tribe to discover this unique yummy—and then observed how much this impressed his new companion—Rodney's heart swelled with pride.*

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Those frequently-mentioned belief systems finally bring us to what might be the most crucial & pivotal development in the evolution of emotion, one that likely occurred alongside the emergence of social

structures in the heart of that 700 million year blink: disease avoidance behavior—essentially, primitive *disgust*. Early disease avoidance appears to be based on identifying a specific subset of olfactory data within a larger scent pattern. For example, rats could detect & identify a subset of disease-indicating olfactory data within the larger scent pattern of another rat, which triggered survival-aiding *avoidance behavior*.

(The unique neural mechanics & roots of primitive disgust are well-explored by Hanah Chapman & Adam Anderson in their 2012 paper “Understanding Disgust.” Additionally, as their paper notes, humans’ & other animals’ *distaste* response—primarily spurred by specific stimuli like bitterness, and intended to identify toxicity as opposed to a possible disease-source—is much more primitive & less sophisticated than disgust.<sup>21</sup>)

In the view of Narrative Complexity, this neural mechanic—applying a specific, but broadly-applicable subset of data to larger data patterns in order to determine avoidance behavior—is what unites *all* forms of disgust. This mechanic is demonstrated by advancing mammals’ capacity to specifically judge, for example, disgust-producing (& possibly-illness-causing) *rotteness* across a wide variety of unlike fruits & meats.

As mammals evolved, different species developed different levels of disease avoidance behavior—likely based on the species' specific natural disease-resistance. (Thus, species with greater natural disease-resistance, like dogs, would require less powerful & broadly-applied primitive disgust responses.) Hominids not only inherited this olfactory-based, disease-avoiding disgust, but they also seemed to possess a particularly powerful version of it—demonstrated in our strong, primal aversion to the scents & tastes of harmful resources like rotten food or feces (stimuli that don't seem to particularly bother the olfactory systems of mammals like those aforementioned dogs).

And since we've mentioned dogs, it seems fair to note the unique disgust response displayed by their cultural counterparts: *cats*. Felines appear to express this avoidance behavior by reflexively attempting to *bury* or *conceal* the offending material (and they even seem to reflexively seek out a burying-favorable location—a pile of sandy dirt or a litterbox—when depositing their own offending material). Disgust's cross-applied-data-subset mechanic is evident in this behavior too: cats will reflexively display this *paw-reach-&-pull* burying action when encountering a range of different kinds of novel (but powerfully-scented) stimuli. I've seen cats do this in response to items as diverse as ashtrays & coffee puddles—

despite the fact that these items' overall, complicated scents are much different from each other & from feces.

For early humans, these flexibly-applicable primitive disgust mechanics were so useful that they eventually made a spectacular & crucial leap: from the olfactory systems to our visual & cognitive systems. What spurred this leap? Narrative Complexity hypothesizes that the key event occurred long after hominid brains had already left all others in the dust, when our human ancestors finally did the deed: *making fire*. This discovery now allowed them to cook their food, which ultimately forced our ancestors to develop & nurture an unprecedented ability: eschewing the primal, *hardwired* desire to eat raw meat in favor of exercising the *learned* behavior to wait & eat the meat *after* it's been cooked (and eating the cooked meat offered a plethora of advantages in areas like digestive efficiency, food storage & general health—i.e., *avoiding food-borne disease*).

In his 1999 paper "The Raw and the Stolen," Harvard anthropologist Richard Wrangham hypothesizes that the advent of cooking by early *Homo erectus* populations played a significant role in the evolution of human social systems.<sup>22</sup> Wrangham theorizes that, initially, cooking was primarily used to take greater advantage of underground storage organs (essentially, root vegetables) during

periods of food scarcity. He also hypothesizes that the cooking of meat didn't emerge until *after* the cooking of these root vegetables had already made a significant impact on our evolving human social systems. (Although the earliest environmental evidence of cooking with fire—i.e., hearth-like structures in human-inhabited caves—only dates back to around 1 million years ago<sup>23</sup>, Wrangham believes that evidence derived from the *Homo erectus* fossil record suggests that the cooking of underground storage organs might've actually begun around 1.9 million years ago.)

In the view of Narrative Complexity, despite the powerful impact that cooking root vegetables had on the evolution of human *social* systems, this behavior would not have impacted the evolution of human *cognitive* systems in the same dramatic way that cooking meat would have. Essentially, from our theory's perspective, developing & nurturing a preference for those cooked underground storage organs over the raw versions of the same resources presented less of a *cognitive emotional challenge* than developing a preference for cooked meat vs. raw. This is because the cooking of underground storage organs likely made these less desirable (but in times of scarcity, *necessary*) food resources generally more desirable & palatable (i.e., making their consumption much easier & significantly

more pleasurable). In other words—when they were initially presented with the choice between immediately consuming raw storage organs and waiting to consume the new & improved cooked versions during periods of food scarcity—our human ancestors' brains did not have to work very hard to convince themselves (& their communal cohorts) that waiting to eat the cooked version was (for a variety of reasons) highly preferable.

In contrast, raw meat was a food resource that was commonly sought out & consumed by our human ancestors—even during periods of resource abundance. Simply put (although, as Wrangham suggests, those early humans probably didn't consume *large quantities* of raw meat) our ancestors actually *liked* eating raw meat, and chose to do so even when raw meat was not a *last-resort* food resource. Thus, unlike those raw underground storage organs—which were probably viewed as an *eat-it-or-die* food resource—raw meat was a food option that early hominids & their primate ancestors had instinctively *enjoyed & desired* for millions of years whenever the option presented itself.

How does all of this relate to those primitive mammalian disgust mechanisms making that spectacular leap from the olfactory systems to our visual & cognitive systems? Well, for starters, it helps to explain why

developing a strong *preference* for cooked meat over raw meat would've required more complicated cognitive gymnastics than simply choosing to eat those cooked underground storage organs instead of the raw versions. (And evidence of our modern disgust mechanisms' strong ties to meat-eating can be found in modern Homo sapiens innate *disgust* toward most raw meat, which is *not* something that most humans tend to display in response to those raw underground storage organs.)

Thus, when our human ancestors initially began to choose & prefer the consumption of cooked meat over raw, they likely needed to employ some of their more advanced cognitive powers—like their advanced version of *willpower*. In choosing to wait for cooked meat instead of simply eating the perfectly yummy & desirable raw meat, those early humans were demonstrating the ability to exercise their willpower in the service of a *learned & predicted long-term gain*—not just an in-the-moment, inhibition-overcoming, *get-up-&-run!* self-willed impulse. In addition—because these human ancestors did not yet possess those behavior-calibrating & socially-nurtured belief systems that ultimately emerged from this behavior—the primitive emotional mechanic that these early groups of humans likely used to help socially reinforce the advantageous, new *don't-eat-that-raw-yummy-wait-for-the-cooked*

behavior was that original emotional/social tool: Pride/Embarrassment, which enabled the effective *shaming* on non-conformers.

This suddenly-useful ability to develop a preference for cooked over raw meat was so advantageous that it quickly (in evolutionary terms) began to evolve into a hardwired, primal *avoidance* or *rejection of (disgust toward)* that raw meat. And the very close association between that socially-enforced *embarrassment* of eating raw meat & hominids' subsequently-evolving, hardwired *disgust* toward the raw meat likely accounts for the strong *overlap* between the modern emotional experiences of *socially-based Pride(in self)/Embarrassment* and avoidance behavior's *belief-based* descendent, Satisfaction/Guilt—and its *other-entity-judging* counterpart *Pride(in other)/Disgust*.

But there was something even more unique about humans' newly-evolved & hardwired *disgust* toward raw meat—this avoidance behavior was based on detecting & identifying a subset of *visual* data, *not* olfactory data. (Two systems that are—as we'll discuss in the next essay—uniquely isolated within vertebrate brains.)

Consider this: we are often repulsed by the *sight* of particularly bloody or "gory" raw meat, but there is nothing about the *scent* of raw meat that causes a similar repulsion

(that's how we can tell by *smell* if raw meat is rotten, because we aren't actually repulsed by the *scent* of raw meat unless it's gone bad). In other words, the thalamocortical loop that is at the heart of our consciousness (& whose cortex-based cognitive systems were primarily rooted in ever-growing visual systems) now had use of this *data subset/behavior avoidance* technique: disgust.

Consider that no other (or *non-cooking*) species seems to be *disgusted* by the *sight* or "thought" (essentially, the thalamocortical *perception*) of anything in particular. Even our near & dear primate relative, a Chimpanzee, nonchalantly *handles* their feces, even though the scent would likely prevent them from eating it. And it's quite clear that no animal other than humans is disgusted by the sights or textures of raw meat. Indeed, this visually-based application of a disgust response appears to be uniquely human.

Once this mechanic joined humans' thalamocortical cognitive toolbox, it began to do some truly amazing things. How? Let's look one more time at what this unique tool, disgust, really does: it uses a broadly-applicable, but rigidly-defined subset of data to evaluate a wide range of resources and determine which ones to accept or avoid/reject—an ability that was neurally-expanded via our learned capacity to resist a primally-motivated short-term

gain (raw meat) in exchange for a longer-term gain (cooked meat).

Doesn't all of that sound an awful lot like *beliefs*? And what's that feeling we have toward someone who has violated one of our beliefs? The same as raw & bloody or rotten meat: *disgust*.<sup>24</sup> Avoidance. Disgust. Belief violation. / Acceptance. Admiration. Belief compliance. *When Rodney saw that the yummy was poopy, he winced—and when he smelled the poop, he gagged. Then Rodney looked at the wanderer and shook his head, disgusted by the other man's violation of a solemn truth: Don't shit where you eat.*

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How amazing was this meat-cooking behavior—behavior that allowed the extraordinary evolutionary emergence of beliefs? Consider this: those early humans' closest ancestors had likely been eating raw meat for at least a few *million* years before the advent of cooking. This means that those first instances & traditions of consuming (& encouraging the consumption of) cooked meat would have gone against millions of years of *hardwired* urges & desires.

As simple as it seems to us now, this ability to *significantly* self-delay gratification was a profound leap of logic—a kind that no other earthbound creatures had truly made, a leap that I believe marks the real beginnings of

humanity as we know it. I've described this self-delayed gratification as *significant* because: a) fire-building & cooking involved the expenditure of additional resources—time, effort & actual physical resources—at a moment that likely often occurred not long after expending significant resources to *acquire* (hunt & butcher) the meat, and b) for most of those early humans that hard-earned raw meat was *already* perfectly yummy & desirable *exactly the way it was*. These kinds of factors help to distinguish our earliest ancestors' meat-cooking behavior from the behavior demonstrated in a very recent experiment that showed chimpanzees were willing to exchange a raw slice of sweet potato for a yummier cooked slice by placing the raw item into a simple device that produced a cooked slice after being shaken briefly—a process designed to mimic basic cooking.<sup>25</sup>

(Some might also point to behavior like *seed-caching* in birds as examples of non-human self-delayed gratification, but in these cases there is no current impulse to overcome, and therefore no gratification being delayed. When the bird caches the seeds, it's likely not very hungry *at that moment*. Thus, the cached resource is viewed as an excess—not as a very currently-desirable item whose value increases if the entity expends resources in order to help “improve” the item while self-delaying that current desire.)

And the powerful belief systems that ultimately emerged from this capacity to *significantly self-delay gratification* played an important role in our species' survival during a critical period of evolution. As the modern human came onto the scene 200,000–100,000 years ago, climate was fluctuating frequently & dramatically. In the regions of Africa where those modern humans lived, this climate instability resulted in environments that switched between lush & arid in mere thousands of years. These evolutionary pressures likely favored the selection & survival of human populations with the strongest ability to understand & dynamically adapt to the ever-changing environment by generationally passing-on these populations' ever-adapting knowledge & practices. Such abilities were based in their brains' complexly-modular, problem-solving, language-based capacities, which also allowed for the evolution of beliefs both within those brains *and* within the now-continuous, ever-sophisticating & emerging *cultures*.

And the human brains & cultures that demonstrated the strongest ability to learn & apply these newly-evolving belief systems would've been inherently better at dynamically adapting to the maddeningly-metamorphosing African landscape (we'll give an example of why in a moment). This process of Darwinian selection favoring the "believers" was likely accelerated significantly during the middle of this

100,000 year window via an event referred to as a “bottleneck” in human evolution. This bottleneck was a short period in which severe, sudden cooling of the planet reduced the human population to near extinction.

The plummeting population led to significant reduction in genetic diversity in our species—and recent analysis of the human genome has shown that *everyone alive today* is a descendant of that small pool of humans that stubbornly (& ingeniously) persisted along the South African coast during this bottleneck. One of the most provocative & compelling scenarios depicting this crucial moment in evolution is presented by paleoanthropologist Curtis Marean in his 2010 paper about the coastal adaptations that emerged in this tiny group of remaining humans.<sup>26</sup>

Marean hypothesizes that this prehistoric coastal community consisted of possibly only 600 people, and that the keys to their survival were abilities such as the sophisticated use of fire in tool-building, and exploiting the sea & other coastal resources for their primary survival needs. (Including behavior like *harvesting shellfish*, which was only efficient at the lowest tides—unless modern humans have since lost those coastal humans’ ability to *breath underwater*.) The tool-building & creative problem-solving skills were probably well-enabled by those modular cognitive systems. But some

of the other adaptations—such as planning (& relying on) that harvesting of shellfish during low tides—are the kinds of learned behaviors whose powerful predictions would have required that newly-developed & very specific cognitive tool: a belief system. (In Essay #4, we’ll explore in detail just how *uniquely* specific this cognitive system is.)

Consider that understanding tide cycles & correlating the movement of the moon to the harvesting of food is not the same as understanding how to build a tool or a fire, which involve direct causal relationships in their construction. These humans could not have understood *how* the moon makes the water move in the same way that they would’ve understood that striking two stones made a spark that ignited dry grasses—they could only observe and then come to *believe* that there was a correlation between the water & the moon. In addition, this period provides the earliest evidence of humans using red ocher (our inaugural art supply) in symbolic & ceremonial ways—which is more proof of a sophisticated belief system being present in these humans’ brains.

How exactly does this kind of belief (*whenever the moon has this appearance/position, the water will be very, very low the next morning*) correlate to that original *data subset/behavior avoidance* technique that it

evolved from? The "data subset" here is *the unique appearance/position of the moon that "causes" the water to be very, very low*—a data subset that is compared to the larger data set represented by the moon's & tide's "overall behavioral pattern" (their full yearly, lunar & daily cycles).

Even if these humans were making this prediction purely according to tide patterns instead of using the moon, this would still be a version of comparing a data subset (low tide periods) to a larger data set (the full tidal cycle). Although, because tides vary in a yearly & lunar pattern in addition to their daily patterns, it was likely actually easier & more reliable to recognize the *lowest-tides pattern subset* by using the moon than it would've been via the tracking of water level patterns alone.

Either way, if these humans *weren't* using *some* form of a belief to guide this behavior, then they would've simply been harvesting shellfish essentially randomly: whenever they noticed that the tides were low enough. This obviously wouldn't be a very reliable method for managing vital resource acquisition, and it doesn't seem to represent the kind of *advantageous* behavior that would be such a great way to survive *the world's greatest winnowing of humans*.

The *emotional* role of a belief like "*whenever the moon looks like this, the water will be very,*

*very low*" is exhibited during actual *behavior* when, for example, more-basic urges or desires come into conflict with that belief in choosing an action. Let's imagine, say, that on the morning of the lowest negative tide (which provides that lunar cycle's only opportunity to harvest the least-accessible & survival-aiding mollusks) our coastal human is very, very tired, and thus chooses to sleep late instead of harvesting mollusks at dawn.

When he puts his head back down on his grass mat & chooses to forego foraging, he might use as his lame excuse something like "I will collect shellfish later." And as he says this to himself, our coastal human likely feels a pang of *guilt*: "I cannot shellfish later, I should wake up now." (And this guilt is essentially being *disgusted* by one's own behavior.) Unfortunately for his *now-less-likely-to-be-reproduced* genes, this pang loses out to the pang of his comfy grass mat. This *guilt* is produced by violating his strong belief that "*whenever the moon looks like this, the water will be very, very low the next morning*." (And he saw the moon look *exactly* that way last night.) In other words, he is making a choice that his brain *believes* will likely lead to an ultimately undesirable result (based on a highly valid & valuable prediction trope built from experience & study).

Our coastal human would therefore likely feel this guilt even if he was only harvesting the

food *for himself*—eliminating other possible guilt sources, like failing to contribute to his social group or to fulfill a commitment to others. Consider that even if we are the only ones who will likely suffer the possibly negative consequences of our actions, we're still likely to feel at least *a little* guilt or inner-conflict if those actions represent the violation of a strongly-held belief.

The obvious evolutionary advantage of strong *belief-based emotions* in situations like our coastal human's *inner conflict* is that the most-likely-to-survive brains are those that feel enough *guilt* (& exhibit enough *willpower*, whose *endorphins* are unfortunately in short supply during this sleepy inner-conflict) to actually *get up & forage* instead of succumbing to the primal urge for more sleep (which is, again, a lot like waiting to eat a cooked steak instead of succumbing to the primal urge to eat the yummy bloody steak).

Exploring Marean's coastal scenario shows why human populations with the most evolved cognitive belief systems would've likely owned a key advantage in surviving this bottleneck, and it provides the perfect avenue for this essential human trait to emerge as one of the most powerful & fundamental aspects of modern humanity—because all subsequent human evolution sprang from this harshly-selected tiny population of our best "believers."

Making efficient, reliable predictions about our world based on learned (but not entirely *provable*) correlations between events that often have mysterious, but observable relationships—and the development of a specific cognitive system devoted to this mechanism—is at the root of what separates us from all other animals. Consider that *many* other creatures—birds, aquatic mammals like dolphins & whales, elephants, other primates—have the modular neural capacity for language, and can display the profound behaviors, emotions & even the learned, generationally-fluid *traditions* that can result from such a proto-linguistic capacity (however rudimentary). But they do not have *beliefs*. And I propose that it is our beliefs, and the emotions that they engender, that truly make us *human*.

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Interestingly, *all* of these aforementioned primitive emotional mechanisms are *still* a part of our emotional kingdom; these original systems remain almost fully intact. In fact, they are still the *rulers* of that kingdom. Most of the time, these proto-emotions (which we now think of as essentially *urges*) are the last obstacle that any narratively-based decision must confront before action is taken. And the highest level of any urge will almost always supersede *any* narrative desire.

If you are at any of the urge extremes—starving/parched, in the throes of lust, completely exhausted, repulsed by rottenness or in the grip of fight/flight—those primal desires will very likely be prioritized over your narrative goal (unless you've developed—or were born with—a *wicked* willpower mechanism). This dominance of our ancestral urges over their modern offspring offers unexpected proof of an age-old truism: *we'll always be your parents, and we'll always know what's best for you.*

### **Emotion, Meet Modularity**

How, then, did we develop our modern, complex emotions from these primitive proto-emotional pairs? Well, that requires some speculation *about* the speculation, but since we're already deep in our "what-if" rabbit hole, let's keep digging...

Our filmstrip slips into one last flashback from that 700 million year blink: the long stretch when early mammal brains were morphing into the human one. This is likely the time when all of those uniquely modular neural structures (discussed in the previous essay) began to evolve. And it was this modularization of basic data & larger "ideas" that lit the fuse that led to our emotional explosion.

Think of it this way—those early mammals were actually pretty smart critters. They

could *remember* stuff and make use of it later. *Check out that tiny-brained mouse memorizing the fancy maze that leads to the yummy.* And evolving emotions played a big part in this memory device. The *pleasure* of the yummy helps encode the *pattern* of the maze into the mouse's memory. But those mice-like early mammal minds had a flaw: non-modular data structures—a result of their neural limitations. In the mouse's brain, that memory of the maze isn't a collection of turns, it's one big pattern.

This is why, when Mr. Mouse encounters a similar-but-different maze—i.e., the same exact first half, but different thereafter—the mouse will not likely recognize that the mazes are *partly* the same. He'll either ultimately think of them as entirely different mazes, or exactly the same one (possibly leaving the mouse continually baffled whenever he reaches the different second half—at least until he finally starts thinking of it as *an entirely different maze*). This means that those pain/pleasure mechanics are still pretty broad in their application—always associating themselves with large, highly-detailed data patterns. But as mammals' neural structures evolved and data became more modular, emotions were able to associate with those modular & more specific pieces of data. These newly diversified associations between feelings & data likely allowed emotions to differentiate

as they grew more interwoven with specific kinds of data modules.

Thus, using these evolved modular systems, a dog can learn to *symbolically* associate the first step in a sequence with the *actual* pleasure derived from the last step. *Pavlov's dog*: ring the bell and the dog salivates excitedly in anticipation of the predicted food pleasure, *not because he wants to eat the bell*. (For the mouse, seeing & recognizing the entrance to the *previously-cheese-producing* maze makes him interested & engaged, but it likely doesn't give him *pleasure*—the actual pleasure is still reserved for successful navigation & yummy consumption.) Therefore, in those more-evolved mammals like dogs, anticipatory emotions are now possible: fear, excitement, confidence, anxiety. And these symbolic inanimate objects soon—or simultaneously—allow for symbolic *entities*: Agents of Value. *Viola!* Anger, gratitude, affection & animosity join the kingdom.

(And based upon my distinct childhood memories of our beloved family guinea pig, *Cupid*—who consistently demonstrated a *Pavlovian* & excited squeal merely upon *hearing* the plastic-crackling of the bag that contained her cherished parsley—it seems that the first examples of this emerging capacity for emotional/neural modularity &

rudimentary *symbolism* appeared rather early in mammalian evolution.)

By the time humans arrive in our story, this modularity has gone gonzo. We can do all of this symbolic, predictive & other entity stuff *way, way* better. A massive cerebral cortex allows far more data to be stored for reference, comparison & analysis.

Advanced neurons with more connections & more sophisticated associative powers enable data tagging & comparisons to be done with greater precision, and allow our predictions to become vastly more complicated. Emerging research suggests that these modern pattern & prediction mechanisms even involve our cerebellum (which brains originally employed purely to control motor function).

And our dizzyingly complex use of those age-old neurotransmitters—combined with our immaculately-tuned insula, amygdala, thalamus & basal ganglia—allow for complex new ways to use those pain & pleasure responses. Guilt, satisfaction, envy, admiration, greed, jealousy, melancholy, all the blends & hues—all are now possible. In addition, those long-evolving *mirror neurons* allow *empathy* to help our minds incorporate emotional data that is physically-expressed by others.

*The Mothership has arrived.* And she has a passenger: consciousness. Which probably means that Descartes' elegant definition of "being" (after all these centuries) is in need one small edit: I think *and feel*, therefore I am. It's a little less succinct, but maybe a little more true—after all, without *love*, what are we?

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