Contrasting Living-Being and Machine Metaphors:
Implications for Making Meaning of Human Experiences

Amanda B. Diekman

Heidi E. Williams

Heidi A. Vuletich

Department of Psychological and Brain Sciences, Indiana University

Joseph S. Vuletich

Department of English, Indiana University

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Abstract

We delineate a framework for considering the differential implications of understanding human experience when invoking metaphors based on living, biological beings versus metaphors based on machines/technology. We consider the origins and expressions of machine metaphors as culturally dominant in the United States and Western Europe. Machine metaphorical frames differ from living-being metaphorical frames in assumptions about transformation, development, and decline; in expectations about source of motion or change; and in whether environment or season are seen as integral to experience or action. These features then carry consequences for how individuals make sense of their and others' experiences. In particular, we highlight how understanding based on living, biological beings might result in different meanings attached to the purpose of activity, to pauses in activity or nonlinear growth, in variability across individuals, and in what discomfort signals. We close by considering the implications of these different metaphorical frames for system design, well-being, and group disparities in achievement. This review provides a framework for empirical research that examines the psychological consequences of these different frames.

Contrasting Living-Being and Machine Metaphors: Implications for Making Meaning of Human Experiences

The metaphors used to describe experiences matter for the meaning that people make of those experiences: Using an easily-understood concept to describe and explain a more ambiguous concept or experience is a key tool that people use to navigate the world (Lakoff & Johnson, 2008). In this paper, we examine the implications of understanding human experience by invoking metaphors based on living, biological beings versus metaphors based on machines/technology. We highlight how a dominant cultural frame in the United States and other Western countries leads to understanding motivation, performance, and goal attainment through mental models based on machines and mechanical systems, rather than mental models based on living beings rooted in particular ecologies. The assumption that human experience is machine-like reverberates through how individuals and organizations construct and construe experience.

What is the difference? Briefly, living beings possess an internal force to grow and develop; transformation from one qualitative state to another is part of a cycle encompassing life, death, decomposition, and contribution to new life. Biological beings are rooted in their local ecologies, sometimes literally and sometimes figuratively. For biological beings, nonlinear growth and dormancy/activity cycles are necessary; for machines, they are not. Certainly, we acknowledge that the lines are blurry (e.g., are factory farms more factory or more farm? What about plants that are engineered, or machines that learn?): Yet our point is not to argue that a particular element is exclusively akin to biological beings or machines, but that invoking either of these metaphorical frames will guide subjective meaning and, in turn, human experience.

Metaphors are key to understanding (Bowdle & Gentner, 2005; Lakoff & Johnson, 2008): They provide frames to interpret and explain experiences. An event is not simply an event; it is encoded, interpreted, and recalled in light of the cognitive structures in place already. The impact of different

frames for interpretation has been investigated through methods employing the *alternative source strategy* (Landau et al., 2010). In this strategy, researchers experimentally manipulate the metaphorical frame available to participants and examine resulting effects on cognition, attitudes, or behavior. For example, framing crime as a “beast” compared to a “virus” leads to different recommended solutions (Thibodeau & Boroditsky, 2011): Participants exposed to a “beast” metaphor tend to endorse law enforcement strategies focused on capturing and punishing, whereas participants exposed to a “virus” metaphor tend to endorse strategies focused on diagnosis, treatment, and prevention. The mental construction of the crime through different metaphors thus guides relevant cognitions and actions.

Metaphors are not only held by individuals; they are communicated and reinforced through cultural practices as well (Landau et al., 2010). Within scientific disciplines, for example, certain metaphorical frames gain traction and wield influence on how scientific phenomena are framed, explained, and investigated. For example, Weiner (1991) traces different metaphors through motivation science. Tetlock (2002) noted that research on judgement and decision making frequently assumes that individuals function as intuitive scientists (seeking knowledge) or intuitive economists (seeking utility), but that they might alternatively be seen as pragmatic politicians (balancing needs of different stakeholders), principled theologians (protecting core values), or prudent prosecutors (enforcing social norms). Morgan (2006) writes about metaphors that guide theories of organization and management, such as organizations as machines made up of interlocking parts; organisms belonging to different species; brains with capacity for learning; cultures with values, ideas, norms, and rituals; political systems with different sets of interests, conflicts, and power; etc. Each of these metaphorical roles carries with it different assumptions and different scientific questions, and thus influences the knowledge and theory within a field of study. We pose the questions in this paper in the tradition of examining conceptual domains for dominant metaphors and how they shape both scholarly and lay understanding (Gentner & Grudin, 1985; Weiner, 1991).

Origins and expression of machine metaphors

Origins. Explanations and understandings of the world are intertwined with observers' own experiences; cognition and language are not separable from culture (e.g., Uskul et al., 2008). As machines gained ubiquity in daily life - and as different types of machines gain or lose prominence - different aspects of machinery also become more salient as frames for understanding human experience. At the same time, capitalist economies that prioritized efficient and largescale production for profit amplified a way of viewing the world - and of value - that centered on machinery in different ways. As noted by Lakoff and Johnson (Johnson & Lakoff, 2002; Lakoff & Johnson, 2008), use of metaphors aligns with embodied experience in the world: What are people doing, and what are their activities and tools?. The move from agriculture to industrialization thus provides different daily experiences, and our language (and in turn conceptual understanding) draws from these experiences and surroundings.

Although comparisons of human performance to machine outputs can be traced back to ancient Greece, the systematic application of the metaphor can be traced to mid-seventeenth century Europe (Wolfe, 2004): Until this time, the machine metaphor could not be said to represent a consistent, "cohesive set of scientific theories" about the movements and motives of an organism. This mechanistic understanding was a pivot away from understanding human behavior in terms of spiritual explanations: No longer satisfied with (strictly) religious answers about what motivates human actions (i.e., soul or spirit) or what moves the heavens (i.e. God or Fate), philosophers and scientists began to turn to physical, Newtonian descriptions of "force." If humans are made of component materials subject to mechanical laws, then perhaps a study of those materials and mechanisms could yield a non-divine cause for actions. Understanding based on machines - that the whole can be understood in terms of separable component parts, that these relate to each other in a linear sequence - infiltrated a wide range of sciences, including evolutionary biology. One example is Pinker's (2009, p. 22) description of

human physiology: "we have understood the body as a wonderfully complex machine, an assembly of struts, ties, springs, pulleys, levers, joints, hinges, sockets, tanks, pipes, valves, sheaths, pumps, exchangers, and filters."

With advancements in computing in the 20th century, computers became a powerful metaphor for human cognition. Indeed, Alan Turing's seminal "Computing Machinery and Intelligence" (eponymously referred to as the "Turing Test") sought to define intelligence as a series of discrete, rule-bound operations right from the very inception of mechanical computing ("computer" being a title previously given only to humans). As detailed by Thagard (2002), the cognitive revolution in psychology (contrasted with behaviorism) benefitted from computer metaphors: Information was seen as something that could be processed by a person. Frameworks and language based on computing include mental representations, buffers, semantic networks, heuristics, depth of processing. This reconceptualization of the mind as an information processor had metaphysical as well as scientific importance:

Before the development of computers, behaviorists hounded cognitivists with the charge that use of mentalistic concepts was dualistic, implying a separation between mind and body, between the mental and the physical. This charge was fair against introspectionists like Angell, who indeed saw psychology as having a different subject matter from the natural sciences. But no one denies that computers are physical entities: if attribution of internal representations and processes to them is methodologically admissible, then so should be attribution of representations and processes to the brain. Cognitivism brings with it a coalescence of the concepts of mind and computer, using the new, higher concept of information processor. (Thagard, 2018, p. 238)

Coupled with the shift to industrialization and factory production in the late 19th century, the cognitive sciences have, broadly, developed in conjunction with computers and made great inroads into cognition because of them.

Yet, this increasing emphasis on industrialization and technology is accompanied by a simultaneous shift in the focus of cultural metaphors away from the natural world or organic growth. The decreased interaction and experience with the natural world, in turn, has implications for human

cognition and for understanding and interpretation. Experience with the natural world shapes categorization processes and environmental decision making: Individuals whose cultures have daily experience with natural kinds offer different groupings, different explanations, and enact different behaviors (Atran et al., 2005; Medin & Atran, 2004).

Expressions and examples of machine metaphors in lay and scientific discourse. In Table 1, we provide some examples of phrases common in contemporary English that reflect assumptions or understanding based on machinery. Many of these (e.g., hardwired, downtime) are so entrenched in commonly used language that they are used without considering their sources in machines or technology.

Table 1. Examples of machine and living-being metaphorical language

	Presence in cultural idioms and language
Machine frames	<i>Industrious, work like a machine, productivity, recharge, crank out, hardwired, cogs in a wheel, efficiency, well-oiled, running like clockwork, nuts and bolts, fix, wheels are turning, being a wreck, auto-pilot, downtime, maximize, optimize, programmed, inputs and outputs, rev up, amp up, pedal to the metal, shift gears, power down, push reset, update, running out of steam, burnout, recalibrate, grind</i>
Being/organism frames	<i>Growth, roots, fruitful, cultivate, weed out, nurture, fertile, blossom, mature, evolve, flourish, incubation, plagued, take root, thrive, lay fallow, hibernate, metamorphosis, rotten</i>

These expressions shift with technological advances in the machinery that is available. For example, as computer technology advanced over the 20th and 21st centuries, the term “hardwired” became much more prominent:

Figure 1. Frequency of “hardwired” over time

Note. Google ngram searching for frequency of “hardwired” in English 2019 corpus of books

The cultural emphasis on maximizing productivity lends itself to machine framing, which appears frequently in advice about how to “work like a machine” (Bryant, 2015; Engineer Calcs, 2020; Rajey, 2017). This emphasis may emerge because the goal of “producing” output itself can place individuals and organizations in the role of the apparatus to produce an outcome, rather than a being to experience events (see further discussion in section on “Meaning of Action or Development” below). The embeddedness of machine metaphor in organizational structure and philosophy is directly addressed in this essay by Dee W. Hock (2021), former CEO of Visa, Inc.:

We have, for more than three centuries, worked diligently to organize society in accordance with that concept, believing that with ever more reductionist, scientific knowledge, ever more specialization, ever more technology, ever more efficiency, ever more linear education, ever more rules and regulations, ever more command-and-control management, we could engineer societal organizations in which we could issue commands at one place and get precise results at another, and know with certainty which commands to issue for which results. Never mind that human beings must be made to behave as cogs and wheels in the process.

At an organizational level, understanding the function and purpose of a system as more machine-like has implications that reverberate throughout organizational policy and practice: Is there a central line of

power or control? Are schedules uniform? Are people replaceable? Are expectations and evaluations standardized?

Evidence of the cultural dominance of the machine metaphor emerges in individuals' own strategies or descriptions of experience - particularly with regard to how productivity is defined, attained, or measured. For example, computer scientist Cal Newport describes a "shutdown ritual" at the end of the workday that provides a clear signal that the work of the day is over (Newport, 2016). At times, workers describe themselves in ways that are mechanistically dehumanizing, such as in this quote from an Amazon worker: "We are machines, we are robots, we plug our scanner in, we're holding it, but we might as well be plugging it into ourselves" ("Amazon Workers Face 'Increased Risk of Mental Illness,'" 2013).

Yet writers and thinkers also invoke alternative frames to articulate needs and experiences not captured by the machine metaphor. For example, Austin Kleon (2021) invokes biological and garden imagery explicitly in his piece titled "I'm not languishing; I'm dormant." Here, he articulates a space for a state of being that is not flourishing and not languishing, but simply pausing until the next phase.

In describing the origins of machine metaphors in dominant systems, it is also important to highlight that metaphors can become part of the cultural milieu through strategic and conscious choice. Individuals, groups, and leaders can consciously choose to use some metaphors over others, and can choose to use them in humanizing or dehumanizing ways. For example, political groups and leaders commonly adopt dehumanizing language to describe outgroups during times of conflict in order to justify violence committed against these groups. Metaphors that dehumanize can adopt either mechanistic or animalistic dehumanization (Haslam, 2006; Haslam & Loughnan, 2014; Morera et al., 2018). Striking examples include the dehumanization of Jewish people by Nazi leaders and in Nazi propaganda—described as cargo (Sereny, 1983), maggots (Weitz, 2003), or cattle (Sereny, 1983). Indeed, scholars have identified dehumanizing language as an early warning sign of genocide (Stanton,

2004). Language readies both speakers and listeners for action and inaction, and both explicit and implicit choices of language matter.

Thus, the problem is not simply that metaphors can fall short of what it means to be human; it is that focusing on the cultural reliance on particular metaphors can elicit confirmatory processes, in which focusing on one metaphor to the exclusion of others can lead individuals to act in ways that elicit behaviors that correspond to the metaphor, as we describe below. Whether these metaphors emerge organically as individuals observe common events and systems, or overtly as individuals select a particular frame to view and understand experiences, this capacity further emphasizes the point that it is key to understand (a) what metaphors are explicitly and implicitly evoked and (b) what different metaphorical frames might offer for the shaping and interpretation of human experience.

Why metaphors matter

Metaphors provide an accessible lens to view, interpret, and remember experiences. Yet the impact of metaphors is not solely an individual process, but a deeply social and cultural process. Further, aspects of metaphor can be subject to conscious awareness, but can also exert effects outside of conscious awareness. Given this, understanding how different metaphors come to be culturally dominant and what their implications might be is key to illuminating the ways in which individuals have choice about what metaphors to invoke in what situations.

Language both reflects and influences thought. The Whorfian hypothesis (or Sapir-Whorf hypothesis) posited the idea, in various forms, that cognition is shaped by both the content and the structure of language. Gentner and Goldwin-Meadow (2003, p. 12) succinctly capture the range of ways that language might influence thought: “Language can act as a lens through which we see the world; it can provide us with tools that enlarge our capabilities; it can help us appreciate groupings in the world that we might not otherwise have grasped.” Elaborating the Whorfian hypothesis from a cognitive perspective, Hunt and Agnoli (1991) posit that language guides thought by making certain modes or

content of thought more accessible. In this way, they liken language to the act of building, with cultural schemas functioning as a blueprint. Language does not determine what is thought, but provides a structure for more efficient and accessible understanding. The point is not that certain types of cognition are wholly unavailable depending on one's language, but that certain types of thinking have higher costs if the language does not customarily afford them: "At any point in time a language user thinks most efficiently about those topics for which his or her lexicon has provided an efficient code" (Hunt & Agnoli, 1991, p. 378).

Yet language does not exist solely within one person's mind; language evolved for people to communicate with each other. These social functions in turn amplify these meaning making processes, as language informs not only the content of thought, but the social and cultural values of particular modes of thought. The idioms that are available in a culture reflect the dominant preferences and operations of that culture; using these idioms is not only efficient for accurate communication between members of a shared culture but also reifies the value of a particular lens for viewing experience. For individuals who do not share that particular lens, metaphors leveraged for shared meaning may not only prove inefficient, but also reinforce exclusionary boundaries..

Metaphorical frames can influence a range of cognitive processes, including attention, interpretation, and memory. They provide a frame to make meaning of incoming stimuli. Any particular object, action, or event can mean a variety of things to an individual, and metaphors serve as interpretive and explanatory frames. For example, goal pursuit might be framed as a destination, in which an actor reaches a particular goal, or a journey, in which an actor focuses on the ongoing path. After considering a journey metaphor, relative to a destination metaphor, individuals persist longer in goal-consistent behaviors (Huang & Aaker, 2019).

The subjective meaning attached to particular experience shapes individuals' behavior. The evidence for wise interventions (Walton & Wilson, 2018) particularly leverages the power of shifting

individuals' subjective construals of events. For example, in the literature examining group disparities in achievement, the construal of negative feedback is essential: Is the experience of failure a signal to quit, or a signal that there is more to learn? The stories we tell about events matter: Narratives about events, above and beyond the events themselves, contribute to positive psychological outcomes (McAdams, 1993; McAdams & Guo, 2015). Metaphors emphasize some stories more than others, and in this way, metaphors lead events to be construed in particular ways.

The meaning guided by metaphorical frames is not only important on an individual basis; this meaning is also extrapolated because individuals are embedded within social interactions and larger institutional systems (Diekmann & Schmader, in press; Markus & Kitayama, 2010). Metaphorically-based meaning contributes to the design and evaluation of systems; it informs how evaluators determine whether an individual is succeeding or failing. Metaphorical frames guide questions such as these: What is the goal of this system? What do different levels of activity or production mean? Is there an expectation of transformation or stasis? Is difference or uniformity valued? As we delineate below, the dominant cultural frame of machine metaphor leads to different answers than the alternative metaphor of biological beings.

Overview of paper

In this paper, we examine the differences between viewing human experience through the lens of machinery versus biological beings. The same experience, when viewed through different lenses, can take on different meaning and influence behavior in markedly different ways. We examine the implications of a cultural view of human experience using a metaphorical frame of machinery contrasted to a cultural view of human experience using a metaphorical frame of living beings, embedded in an ecosystem.

Defining Features of Living-Being vs. Machine Metaphors

In this section, we map out the defining features of metaphorical frames based on living organisms versus machines. Some examples can blur the lines between these categories (e.g., factory farms; artificial intelligence), yet the essential issue at hand is illuminating how divergent assumptions and interpretations might follow from invoking one frame instead of the other.

Table 2 *Contrasting Living-Being and Machine Metaphors*

	Transformation, development, change	Source of motion, expansion, development	Role of environment and season
Being/organism defaults	Growth, decay, and qualitative change	Internal plan; intrinsic motivation	Organism intertwined with surrounding ecology and time
Machine defaults	Assembly, deconstruction, stasis	Propulsion/movement from external input	Standardization across environments and locations
Implications for motivation and evaluation	Expectations and interpretations of nonlinear or linear patterns	Emphasis on internal or external motives	Expectations of cyclicity; focus on externality as supporting or impeding internal will

Transformation, Development, Change

Inherent to living beings is the quality of development in which the biological entity transforms from one phase to another. For some creatures, the early phases are more similar to the later stages; for others, developmental stages differ strikingly. A prominent example of metamorphosis is a larva that builds a cocoon and emerges as a butterfly. This development of the core entity through visibly and

sometimes structurally different phases can connote an acceptance of transformation that is greater in biological than mechanical entities.

The inherent capacity of biological beings to develop can carry implications for living-being versus machine metaphors. One implication is that development unfolds over time, and thus viewing living beings over a span of time might yield more variable observations than viewing machines over a span of time. Yet another implication is that the core purpose of living beings versus machines may be quite different. Both living beings and machines can produce outputs (e.g., food, structures, information). Certainly, both biological beings and machines can be viewed over time or can enact processes over time. Yet for a machine, the designed activity is always towards its programmed or designated output. For biological beings, however, activity can contribute to its own development and growth; the being itself might be the “output.” For biological beings, time spent without producing measurable outputs is not necessarily idle. A larva’s time is industrious both as it builds a cocoon, but also as it remains inside it. The animal needs time for its own transformation, and it must suspend other activities in order to undergo this process. Periods of low or suspended activity towards measurable outputs are ubiquitous across living organisms and allow for necessary developmental processes to occur.

The assumptions of machine metaphors, on the other hand, reflect an “on or off” state: They are either productive or idle. An individual machine does not need time to “be” or to transform its “being.” (Although certainly artificial intelligence pushes the boundaries of this claim; the breakdown of this distinction in emerging AI and in science fiction certainly illustrates lay conceptions of differences between machines and sentient beings.). Time use, in a machine, is for doing. Under a machine metaphor, periods of low or suspended activity (e.g., assembly, maintenance, updating), are a pause from the machine’s normal processes, not an inherent part of them.

Source of Action or Change

Metaphors based on biological beings or machines differ in their assumptions about whether there is an internal force or will to develop. A machine model does not assume that the machine or parts of the machine possess will or internal forces; machines exist because an external agent (a being) designed and built them. Thus their movement or action requires input from an external agent. Put extremely, the assumptions of a machine metaphor reflect that the cogs in the machine do not possess the ability or will to act any differently than what is programmed or initiated by an agent. The operator initiates the start of the machine: The pilot launches the airplane; the dressmaker presses the pedal of the sewing machine; the software engineer boots up the computer. The machine itself requires input, performs an action, and then ceases once the operator signals to stop.

In contrast, assumptions under living-being metaphors differ: Biological beings possess an internal impetus to transform, which we witness in plants growing in seemingly impossible situations (e.g., through cracks in concrete) or in animals developing through life stages. Certainly, environmental conditions influence growth and development. One obvious example is that the timing of puberty within girls has shifted with a diet that is both more nutritionally stable but also includes higher levels of estrogens (e.g., Biro et al., 2012). The onset of biological transformation can be cued by external triggers, but these work in concert with internal processes.

Applying these metaphorical frames to human psychology differentially emphasizes human potential for *agency*. Bandura's (1986) social cognitive theory centers the ability to select a goal and execute a plan to move toward that goal. Indeed, ascription of mind includes both human experience as well as mental agency (Gray et al., 2007). As a consequence, dehumanization can occur through either denying mental agency (likening an individual to an animal) or through denying capacity for experience (likening an individual to a machine) (Haslam et al., 2008).

An implication of differential ascription of agency may be that living-being versus machine metaphors carry implications for intrinsic and extrinsic motivation. *Intrinsic motivation* is defined as will that comes from the activity itself: The behavior itself is rewarding. *Extrinsic motivation* is defined as will that comes from outside of the activity: The behavior is incentivized by reinforcers that are separate from the behavior. For example, some people exercise for the feeling of strength or energy that occurs within the exercise (i.e., intrinsic); others exercise so that they can achieve external reinforcement of stronger muscles or eating certain foods (i.e., extrinsic). These different motives influence engagement in the activity and in subsequent behaviors (Sansone & Harackiewicz, 2000). Generally speaking, activities that engage intrinsic motivation show greater persistence and goal engagement over time (Deci & Ryan, 1985; Ryan & Deci, 2000). As we elaborate in the implications section below, assumptions about whether intrinsic motivation is possible and what conditions foster it profoundly differ when considering human experience from a living-being versus a machine metaphorical frame: If assumptions are based on organisms, an intrinsic, inherent will is possible and can be cultivated; if assumptions are based on machines, then all that matters is whether other agents initiate action.

Role of Environment and Season

These metaphorical frames also differ in the emphasis they place on viewing an individual as separate from or intertwined with their surroundings. The living-being metaphor might lead us to see that the life cycle of a particular creature is fundamentally intertwined with its ecological setting, such as other creatures, environment, or weather. In contrast, the machine metaphor may imply more interchangeability. A particular unit can be installed in a wide range of settings; indeed, machines are made to operate uniformly and reliably in different contexts. Certainly, extreme temperatures or a deluge of water will ruin most machines; yet part of the design and function of a machine is that it will operate within a range of different settings.

The rootedness of biological beings in local ecology also leads to a metaphorical frame that can encompass seasonality and cyclicity. Biological beings do not experience growth across all seasons; particular temperatures, light, or humidity provide conditions that allow different phases of development. As we drafted this in Bloomington, IN, during the summer of 2021, the Brood X cicadas emerged from the ground; the soil warmed enough on this seventeenth winter for them to emerge en masse, for a brief time. A machine-based metaphorical frame does not include an emphasis on seasonality that might encompass periods of rest and gathering or conservation of resources along with periods of growth and bearing fruit. Yet the dominant culture, built on industrialization, does not fully attend to the cyclicity inherent to humanity and other living beings. A prominent example is that secondary school schedules do not prioritize the shifts in circadian rhythms that necessitate more sleep for adolescents; instead, school schedules are built based on the logistics of transportation and extracurricular activities. Even small changes to delay the start of school can lead to benefits in students' self-reported hours of sleep, alertness, and mood (Owens et al., 2010). Another example of designed ignorance of different life cycles comes from the observation that designing contemporary institutions around distinctly male bodies and experience can lead to de-emphasizing - or willfully ignoring - female bodies and experience, such as menstruation, pregnancy, or lactation (e.g., Perez, 2019).

Living-being metaphors and machine metaphors also shape expectations about the degree to which human activity can be synchronized and the purpose of that synchronization. Synchronization is common in nature, but it usually serves both individual and group goals. Animals can move synchronously to hunt, achieve fluidity (e.g., aerodynamics), or to ward off predators. Each individual contributes to a greater whole, but does so in idiosyncratic ways that are determined both by ecological and individual factors. The movement, timing, and contribution of each individual is not exactly the same, though the overall result can look strikingly synchronous. Machines, on the other hand, can be synchronized with exactitude. Twenty televisions in a sports bar can play the same game at the exact

same time, without need to account for small environmental factors or individual differences. The purpose of machine synchronization is also different. It is usually to achieve an external goal, and does not impart any benefit on the collective or any one individual. More efficient production is the goal of machine synchronization.

These metaphors may also lead to a different emphasis on the timescale that is important in understanding human experience. Emphasizing the ecosystem in which living beings are embedded can facilitate seeing each living being as part of a system that transcends the life cycle of a particular being. The life cycle of any particular creature may end, but that creature continues to contribute to its ecosystem after its death: Flora and fauna decompose and become part of the soil that supports new growth. In this way, any biological being is part of a greater whole, and its life cycle is better understood within that context. In contrast, when machines are finished being used, they are most frequently discarded. As the world begins to understand the consequences of discarding millions of machines, more emphasis is placed on recycling or reusing component parts. Indeed, this illustrates the potential of viewing even machines as embedded in the ecosystem.

Consequences for Psychological Meaning-Making

In this section, we examine the implications of these different metaphors for understanding human experience. In particular, we focus on how viewing particular experiences through the lens of a living-being or a machine metaphor might influence both lay understanding and the scientific study of well-being and goal pursuit.

Meaning of Action or Change: What is the purpose? What is productivity?

The starting assumption of a machine framing is that the machine is designed, built, and set into motion in order to produce some effect for a living being. The goal is productivity, both literally and figuratively. The starting assumption of an organismic frame is that the being exists to be; oftentimes, this being yields outputs that are useful and indeed essential to other beings within the ecosystem. Yet a

living being framing leaves space for meaning and purpose *outside of producing*. There is meaning in being still; there is meaning in simply being. The reality that some biological beings exist simply to exist can challenge typical ways of thinking, as captured in Bill Bryson's (2004, p. 736) discussion of slow-growing lichen. He quotes David Attenborough: "They simply exist, testifying to the moving fact that life even at its simplest level occurs, apparently, just for its own sake." Bryson notes, "It is easy to overlook this thought that life just is. As humans we feel inclined to feel that life must have a point. We have plans and aspirations and desires. We want to take constant advantage of all the intoxicating existence we've been endowed with." The recognition of ontological meaning may vary considerably when a perceiver starts from assumptions derived from machines (where the goal is to produce observable output) compared to assumptions derived from living beings (where the goal is to exist or experience).

These assumptions then lend themselves to differently valenced interpretations of stillness: Is this valuable in and of itself? Is this a means to an end? In machine metaphorical frames, the "good" requires measurable, observable, and/or tangible output. In living-being metaphorical frames, the "good" can also include simply existing or experiencing. For example, fruit trees *can* yield fruit that is consumed by other beings, but they continue to be—whether the fruit is produced and consumed or not. The metaphorical frames of machinery versus organisms might thus differentially privilege *function* (machinery) relative to *experience* (living beings). The costs of fitting a living being to expectations, schedules, and institutions shaped by machine-based metaphors can be immense (a point to which we return in Implications below).

Jenny Odell (2019, p. ix) aptly captures both the appeal and the challenge of trying to fit broader human experience into machine frames:

Nothing is harder to do than nothing. In a world where our value is determined by our productivity, many of us find our every last minute captured, optimized, or appropriated as a financial resource by the technologies we use daily. We submit our free time to numerical evaluation, interact with algorithmic versions of each other, and build and maintain personal brands. For some, there may be a kind of engineer's satisfaction in the streamlining and networking of our entire lived experience. And yet a certain nervous feeling, of being

overstimulated and unable to sustain a train of thought, lingers. Though it can be hard to grasp before it disappears behind the screen of distraction, this feeling is in fact urgent. We still recognize that much of what gives one's life meaning stems from accidents, interruptions, and serendipitous encounters: the "off time" that a mechanistic view of experience seeks to eliminate.

Odell claims a space for being and becoming beyond a machine-focused understanding, even as she notes the appeal of these frames or strategies for goal pursuit and attainment.

Predictions: The value attached to productivity, as well as the meaning and measurement of valued outcomes, differs under living-being versus machine frames. The assumptions derived from a machine frame might lead people to feel guilty or negatively evaluate the self or others in the absence of observable output. Work that cannot be seen or measured may be devalued or not recognized, even if it is essential to a longer-term process and outcome.

Meaning of Nonlinearity

The meaning of nonlinearity can fundamentally shift under a living-being metaphorical frame versus a machine metaphorical frame. The dominant cultural emphasis on flourishing and productivity can lead to an expectation of constant upward motion. Under this frame, any deviation from upward growth is a signal of failure. Yet a living-being metaphor might view these ebbs and flows differently. In a biological context, growth is not always at the same pace or in the same direction; slowing down may not reflect stagnation.

Under a machine metaphor, rest is not required and so inactivity is a signal of lack of growth or a deficit in production. If a machine is not producing, it is not fulfilling its purpose. Under mechanical assumptions, absence of activity is, at worst, a signal of failure. At best, a lack of activity can indicate "recharging"—getting back to baseline in order to produce more. For instance, the productivity bestseller *Deep Work* (Newport, 2016, p. 146) promotes rest as "Downtime helps recharge the energy needed to work deeply."

A living-being metaphor can provide a different lens to these pauses, in which they are valuable phases of development and experience in their own right. Under a living-being metaphor, there is a different view of rest or dormancy; these phases are not simply the absence of activity but a different and necessary form of development. Some plants cannot flourish again without a dormant period; some animals need hibernation in order to survive harsh conditions.

Indeed, a look at different pauses in biological cycles leads to a more nuanced understanding of their different characteristics and functions. Whereas a machine-like focus on productivity views stillness in terms of the absence of productive motion (“inactivity”), a biological focus recognizes that not all stillness is the same, and it may not even be all that still. To return to the example of a cocoon, what appears to be stillness from the outside is anything but still on the inside, as the larva metamorphosizes to a butterfly. Stillness in the form of sleep is restorative, allowing for renewed energy and cognition upon waking. Yet hibernation is different still: It is not restorative but a vegetative state that allows the animal to conserve energy and interact with the world again in more favorable environmental conditions. Even these brief (and oversimplified) examples illustrate the point that some pauses can be productive (as in the cocoon), protective (hibernation), or restorative (sleep). The cultural recognition of these different aspects of stillness could allow different meanings to be made of them and positive (rather than negative) value attached to them.

What might we expect under cultural practices that assume machine-like productivity, rather than organismic cycles of dormancy and growth? Under machine assumptions, both personal and professional schedules might assume a stable or growing level of high productivity, and any pause or decline in that action would be perceived negatively. Daily, yearly, or longer schedules would be assumed to be static and unchanging, rather than shifting with the time of day, month, season, decade, or phase of life.

These different metaphors have profound implications for individuals and systems experiencing nonlinearity in desired outcomes. To take the example of scientific productivity, a gap in a scientist's publication record can raise the eyebrows of hiring or promotion committees: Is this person losing motivation or checking out? Have they "used up" their good ideas? Particularly early in a career, these phases can be threatening both to self-efficacy and to career prospects. Yet looking at the publication record of any scientist who has been in the field for some time will inevitably show some ebbs and flows; sometimes the time period where it appears as if "nothing is happening" are phases where new protocols or ideas are germinating and finding their legs. Sometimes the work requires taking in and integrating a great deal of information before output from that work is visible. Indeed, these ebbs and flows of creativity, output, contemplation, and rest appear central to the work of thinkers, writers, and artists (e.g., Currey, 2013; Pang, 2016).

Embracing nonlinear development under a living-being metaphor has implications for how the culture and individuals value periods of stillness and rest. All living beings engage in some cycle of rest and activity; in contrast, machines, if connected to an energy source, can be active until they simply wear out and need parts replaced. Yet the dominant culture does not adequately accept the truth that humans require rest as part and parcel of phases of activity, and instead focuses on movement faster and faster (Honore, 2005). Indeed, the pause in motion from the COVID-19 restrictions is one example of both the challenges and the benefits of such pauses, given differences in resources.

Predictions: Metaphors of living beings that experience phases of stillness and activity will foster more favorable interpretations of cessation of activity or downward slopes. Recognizing the inevitability of the ebb and flow will lead to the experience or observation of downturns or pauses with less threat and negative interpretation.

Meaning of Difference and Variability

Living-being and machine metaphors also diverge in the meaning that they provide to difference and variability. Under a living being metaphor, variability within and across species is not only an observable truth but a core mechanism of evolutionary success. Living beings would not exist without variability that suits them to their environments. In a machine model - and particularly given the assembly line - uniformity is necessary and valued. As a result, the metrics and systems to gauge success value uniformity over variability.

Variability itself manifests in different ways, including across individuals and within individuals. One particular being will be distinct from another particular being; even members of the same species in the same environment will not develop the same features or capacities. Further, beings will vary in the time course of their development: “Normal” development includes a wide range as individuals move from one phase to another.

Yet the evidence about the limitations of expectations of uniformity is accumulating, particularly as educational, government, and corporate systems seek to serve a much broader range of individuals. Theoretical traditions, such as intersectionality theory (Cho et al., 2013; Crenshaw, 1990) or standpoint theory (Harding, 2006), clarify that dominant systems and knowledge are designed by and for individuals with power. Those who have privilege design and operate those systems in ways that reflect their own experience and maintain their own privilege (see Ledgerwood et al., in press, for analysis applied to psychological science). The consequence is that the uniformity that is advantaged will be the uniformity based on those with privilege, and variation from that privilege will be devalued.

The assumptions of a machine metaphor can then amplify inequality through expectations and value of uniformity. Indeed, the use of standardized curricula or metrics is particularly problematic when considering social inequalities due to race, gender, and socioeconomic status, because the “standardization” of curricula or metrics will occur based on those who have the most access or

visibility. This exclusion is problematic in any domain - but particularly in domains like education where development is the purpose. In these settings in particular, cultural lenses that emphasize each student's potential and trajectory - rather than emphasizing uniformity across students - will facilitate development.

Predictions: Metaphors of living beings will incorporate variability within and across different groups. Variability will be viewed more favorably under metaphorical frames based on living beings than under metaphorical frames based on machines and mechanical production.

Meaning of Discomfort

Discomfort can take on different meaning when viewed from a living-being frame than from a mechanical frame. Discomfort provides a signal that something is wrong or threatening in the environment (e.g., the pain system in living beings; error messages in machines), and understanding such signals is essential under either frame. Yet metaphorical frames that assume biological transformation might have a broader set of interpretive frames for discomfort signals. In biological beings, discomfort is not only an "error signal" that something requires repair; discomfort can also signal a need for attention as a signal of growth and change. A pain or threat signal might be seen from either one of these vantage points: Yet we posit that the living-being metaphor that sees discomfort as a potential signal that change is happening, rather than that there is a fault in the unit, provides some advantages.

In a living being model, disequilibrium is necessary for the being to move to the next step, and that disequilibrium can bring discomfort. We can consider chicks breaking out of their eggs, snakes shedding skins, cicadas emerging from the exoskeletons, or plants rupturing their seed coats. In each of these examples, we do not know the inner state of the being, of course. Yet as a metaphor, we can see that the being must break out of its former state and launch into a new state. If we, as humans,

understand our own trepidation, anxiety, or disequilibrium as part of a normal process of change and growth, might we ease the negativity that can be a part of that process?

The accumulated evidence about growth mindset shows the advantages of understanding struggle as an opportunity to develop. When individuals perceive struggle as an opportunity to learn and grow, they are less demotivated by failure (Dweck & Leggett, 1988). In these growth-oriented responses, individuals are more likely to take remedial actions that help them learn, rather than actions that serve to protect their self-esteem (Hong et al., 1999; Nussbaum & Dweck, 2008). Moreover, how individuals perceive struggle can also affect physiological responses in difficult situations. Struggle can be perceived as a challenge (where resources are anticipated to meet the demand) or as a threat (where resources are anticipated not to meet the demand). Perceiving struggle as a challenge (vs. a threat) leads to a more adaptive pattern of physiological responding. Heart rate increases and arteries dilate, rather than constrict, to increase blood flow—supplying the body with additional resources to confront the task at hand (Blascovich & Tomaka, 1996; Seery, 2013). When organizations emphasize learning and development, individuals within those organizations trust the organization more, are more comfortable taking risks and collaborating with others, and are less likely to engage in unethical behaviors to get ahead (Canning et al., 2020).

Similarly, learning is amplified when educational contexts include “desirable difficulties” - that is, when problems push learners to stretch their existing skills ([Bjork, 1994](#)). The momentary experience of expanding skill is not always pleasant because it necessarily involves trying to reach for something outside one’s grasp; yet trying different strategies and persisting through that discomfort is what ultimately promotes skill acquisition. Indeed, framing processing difficulty as indicative of learning led to learning benefits for middle school students (Autin & Croizet, 2012). Sixth graders were randomly assigned to a brief intervention that framed difficulty as indicating learning versus incompetence; those

with the framing that equated difficulty with learning showed greater working memory capacity and greater reading comprehension.

Predictions. Under metaphorical frames that emphasize discomfort or disequilibrium as inherent to growth, more positive evaluations of sensations of expansion will emerge. This overall positive interpretation of discomfort as inherent to growth then can catalyze other known benefits of growth mindset psychology and contexts: more resilience after failure, greater likelihood of taking risks and embracing challenges, more learning and development, and better performance.

Implications

Thus far, we have elaborated the different meanings and different psychological experiences that might result from viewing nonlinear growth, difference, and discomfort from a metaphorical frame based on living beings versus machines. Each of these aspects of experience can be viewed differently when starting from the assumption that development includes dormancy, ebbs and flows, and variability across beings, space, and season. In this section, we consider the implications of these different metaphors for broader systems.

Approaches to system design and intervention

An increasing focus in the psychological literature is how to design and implement effective interventions. Considering interventions from a systems approach provides large benefits, because enacting a change in one part of the system reverberates throughout the entire system. When that change interrupts or sets into motion recursive processes, the changes in output can be striking compared to what may appear as small changes in input (Yeager & Walton, 2011). Yet, from the perspective elaborated in this paper, there are implications of considering systems as more biological versus more mechanical or technological. Given the metaphorical frames contrasted here, what might

we expect when we see interventionists as mechanics or engineers, and when we see them as gardeners or zoologists?

A machine model of intervention might suggest that the mode of action is to guide or force people to enact the desired behavior. Put extremely, the cogs in a machine, for example, do not possess the ability or will to act any differently. A living-being model, in contrast, starts from an assumption that the beings within this system possess the capacity and spark to develop. The gardener's task, then, is to understand and support the developmental trajectory of that being, balancing both the internal dynamics of the being and the environmental supports for that growth.

These metaphorical frames for intervention lead to asking different questions in identifying problems and designing solutions. A machine model might start with identifying a desirable outcome from the standpoint of the interventionist, and then putting in place mechanics that move the target of the intervention from one state to another. The "target" here is, in many ways, passive. A living-being model, on the other hand, considers both the desirable outcome from the interventionist's perspective, but also from the being's perspective. What does this individual desire? What will bring this particular student or employee satisfaction and meaning? How can this local environment support the development of their inherent potential and will to grow? How might this intervention both remove barriers to growth and provide scaffolds for greater growth? In this way, system design and intervention is a deeply collaborative process. The most successful intervention to maximize human activity, therefore, might be those that invoke elements of engineering design (e.g., clear blueprints, prototyping, iterative design; Yeager et al., 2016), along with the express cultivation of participant input, potential, and intrinsic motivation. This understanding of intervention might thus focus on a different set of outcomes, beyond typical products such as higher GPAs or more degrees, to also considering satisfaction, well-being, and psychological meaning. Even in systems that seek to produce or that

employ quantifiable metrics, those products or metrics can reflect goals that are valuable under living-being expectations (e.g., Diener & Seligman, 2004)

Psychological science

Considering metaphors based on living beings, contrasted to metaphors based on machines, can provide different directions of inquiry in psychological science. Here, we provide a brief overview of the new directions made possible by shifting the metaphorical frame.

Psychological science broadly might particularly benefit from asking questions that start from assumptions that human beings have internal wills to develop, grow, and change; that such change occurs in nonlinear patterns; and that such change is embedded within local context. Although contemporary science has the tools, methods, and theoretical frameworks to address each of these aspects, they are rarely considered as fundamentally intertwined.

As Weiner (1991) noted over twenty-five years ago, motivation science has shifted its questions and theoretical frameworks as different metaphors have taken root in researchers' minds. The explosion of work on automatic goal pursuit in the 1990s is consistent with a machine model: The context primes particular goals and the individual then engages in goal-directed behavior, with or without conscious awareness (e.g., Fishbach & Ferguson, 2007). Yet environmental primes are more likely to influence behavior when they align with an individual's internalized motives (e.g., fit between individual and environment). Unlike machine models, it is often not sufficient to simply impose a goal state on someone else externally; those external triggers can set into motion a goal-directed behavior latent in the individual but they are unlikely to initiate wholly that goal-directed behavior.

To consider nonlinear growth, we note that it is common for statistical models to "control for age" in linear regressions, and yet the possibility of nonlinear effects of age is rarely considered (Rohrer, 2018). And age of course is but one example: Why would skill, motivation, or other psychological variables occur only or mainly in linear forms? In this way, all branches of psychology might take

seriously the tenets of developmental psychology, in which critical phases and nonlinear development are essential elements.

Achievement and group disparities

The metaphorical frames elaborated here have profound implications for evaluations of the self and others within educational systems and workplaces. In particular, considering cyclicity and nonlinear growth can promote understanding of how best to support students in their development. The standardization of the US curriculum manifests the principles of uniformity and linear growth of the machine model. In contrast, educational systems might instead consider how contexts can support each student's success. Working from a living-being metaphor, such an educational system would take as a starting point that the possibility that each student can find intrinsic motivation for some topic because learning itself can be enjoyable: The teacher's task then is to help the student discover which aspects of learning are intrinsically motivating, and to support the student to navigate through aspects of learning that may be necessary but are not (yet) intrinsically motivating. The principle of nonlinear growth might suggest valuing those periods where skill acquisition is not increasing; perhaps these are necessary periods of rest, of trying new strategies, or of letting previously learned knowledge consolidate.

The negative effects of machine metaphors, or overapplying mechanical assumptions to living beings, will be exacerbated for individuals with less power in the system. In any system - biological or mechanical - individuals with less power have less ability to change how the system operates. In either system, the negative effects of misalignment between the individual's needs and the system's processes will be exacerbated for individuals with low power.

We now return to the example of nonlinearity in scientific output highlighted earlier, but with a focus on group disparities in recruitment, retention, and advancement in science careers. The expectation of linear growth in output and impact can have particularly deleterious consequences for scholars who are underrepresented in science - namely, women, underrepresented minority scholars, or

first-generation scholars (National Science Board, 2019). Individuals with more material and social advantage are positioned for more consistent output over time (see Vuletich et al., in prep, for discussion); compounding this advantage is that the deviation from linear growth may be an especially threatening signal to members of minoritized groups. Yet even a publication record with an apparent “steady state” of output might result from wide ranges of effort, rest, dormancy, and growth. A machine metaphor can embolden the expectation and interpretation of consistent and increasing output, and thus lead someone experiencing a dormant period to question their belonging or ability. The assumption of uniformity might lead to explicit and implicit beliefs that there is one way to enact high-quality science, and that any other commitment or role detracts from scientific success: For example, beliefs about and legal standards for the “ideal worker” are largely based on individuals without caregiving responsibilities (Williams, 1999). If, instead, departmental and field cultures used biological frames to understand development, nonlinearity, and variability, there could be more cultural and individual acceptance of ebbs and flows, whether they are apparent on a CV or not.

Closing

All metaphors are incomplete, and the two we have brought attention to here are no exception. A reader might conclude that our point is to promote living-being metaphors and garden metaphors above machine or factory metaphors. But, of course, living-being metaphors are also incomplete; they also do not quite fit, and at times they will misrepresent experiences or situations. Our goal is not to advocate that metaphors based on beings are always better than metaphors based on bots - but that they are different, and that these differences matter for how human experience is constructed and construed. Metaphors are a way of seeing and thinking, but they are one-sided insight--one that highlights certain interpretations while forcing others into the background (Morgan, 2006).

Organizational researcher Gareth Morgan puts it well: “The challenge is to become skilled in the art of using metaphor: to find fresh ways of seeing, understanding, and shaping the situations that we want to

organize and manage” (2006, pg. 5). This is precisely why awareness of these metaphors matters; neither metaphor adequately captures human experience, and so with awareness, we can choose what we focus on.

We also fully acknowledge that this paper’s focus on these two metaphorical frames leaves other metaphors out of consideration. For example, what about artisanal production, that might embrace variability more than a machine model, as well as intentional craft more than an organismic model? What about the meaning conveyed by radically different life forms, such as the slow-growing lichen? We hope that the framework and example here is a starting point, rather than an ending point, and that psychologists continue to consider what metaphors are culturally accessible and how these shape motivation, cognition, and behavior. The two frames explored here are not the only or even the most important frames across all time and space - but they are two contrasting metaphorical frames that differentially illuminate aspects of human experience and psychology. Perhaps the example provided by Sword (2017, p. 42) is helpful in noting that the utility is not solely in finding a metaphor that works, but in probing the assumptions embedded in different metaphors. She guides authors by providing several different oppositional metaphors: “As you read, you may want to question and collapse these oppositions, probing the nuances and shadings in between. Day or night—how about twilight? Black or white—what’s wrong with shades of gray? Sink or swim—why not float instead?”

Our purpose in laying out these different ways of seeing is that we enable readers to consider their own culturally- and individually-chosen frames more intentionally, and to provide a framework for empirical research that examines the psychological consequences of these different frames. Metaphors are of course not the entity they are applied to, but they can shape understanding of that entity. Being aware of these limitations is a powerful aspect of human consciousness. After all, we humans are not plants, and we are not machines. Instead, we have the capacity to consider these different frames for viewing our experiences, and we have the ability to focus on one or the other. It is up to us to be aware

of these frames for understanding, to see how they are integrated into our practices and systems, and to choose what we want to cultivate, and what we want to leave behind.

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