

Ko and Neuberg could more fully and accurately account for how individuals navigate environments in which affordance management depends on whom they trust, what information they receive, and how accurately they construe the systems they inhabit.

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Tracking affordances requires a sophisticated model of life stages, phases, and transitions

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Abstract

Tracking the emergence, use, and transformation of affordances across the life course requires a sophisticated evolutionary model of development. I argue that the proposed distinction between “childhood,” “mating,” and “parenting” stages suffers from important limitations and should be replaced by a finer-grained taxonomy in which stages are not identified with specific overarching goals. I also suggest that obligate life stages may be usefully distinguished from facultative, reversible life phases.

The target article by Ko and Neuberg is an initial, promising attempt to integrate the theory of “affordance management” (Neuberg et al. 2010) with a life history perspective on how fitness-relevant goals change across life stages. A coherent evolutionary reframing of the Gibsonian concept of affordances is overdue, and was foreshadowed decades ago by Miller and Todd (1995) (see Miller (2007) for a detailed, highly relevant treatment of “fitness affordances” and their role in evolutionary psychology). In this commentary, I leave aside the specific predictions made in the target article to concentrate on the underlying model of life stages, which – by the authors’ own admission – is still relatively crude and underdeveloped. I argue that accurately tracking the emergence, use, and transformation of affordances across the life course will require a sophisticated, fine-grained model that combines ultimate considerations of adaptive function with a proximate understanding of the processes involved.

Ko and Neuberg provisionally consider three major life stages labeled as “childhood,” “mating,” and “parenting.” This segmentation raises a number of problems, starting with the implicit tension between two alternative definitions of stages – one based on developmental patterns (as in “childhood” or “adolescence”) and one based on goal priorities (as in “mating” or “parenting”). To follow a consistent approach, one might recast childhood as the “growth” stage; however, childhood is about much more than just growth, and the same applies to most other life stages, which are characterized by profiles of goals and motivations rather than a single overarching priority. The authors recognize this when they allow for overlap between stages, but the solution is not very satisfying. An even bigger problem is that the adaptive goals considered by the authors do not map neatly on their subdivision: notably, the first manifestations of mating competition and (proto) sexual/romantic attraction do not usually emerge with puberty, but during middle childhood (approximately 6–11 years of age; see Herdt & McClintock, 2000; Del Giudice, 2014). In fact, the force of sexual selection has likely contributed to shaping the developmental features of this stage (corresponding to *juvenility* in primates and other social mammals), with implications for the emergence and intensification of sex differences in muscularity, aggression, and even attachment styles (Del Giudice, 2014, 2015; Del Giudice et al., 2009). The temporal decoupling between different steps in the expression of mating motivations is likely made possible by the physiological splitting of human puberty into *adrenarche* (the gradual awakening of the adrenal glands that marks the transition to middle childhood) and *gonadarche* (the awakening of the gonads that marks the beginning of adolescence). Crucially, some important affordances related to mating

(including the sex ratio, the intensity of status/dominance competition, and the attractiveness/mate value of both oneself and potential partners) seem to become salient and consequential already in middle childhood, well before the completion of bodily growth and the onset of sexual maturation.

A related difficulty with defining life stages based on adaptive goals is that developmental plasticity (in the form of predictive-adaptive responses, developmental “calibration” etc.) is inherently forward-looking, so that cues received in one life stage may influence the phenotype expressed at a later stage. For example, certain affordances that were salient in early “childhood” may entrain developmental processes that shape the later expression of “mating” or even “parenting.” Of course, this is only a problem if one implicitly assumes (as is often done in the Gibsonian tradition) that affordances must reflect the organism’s *current* goals and concerns; but nothing prevents an organism from experiencing affordances in view of potential *future* goals (e.g., I can notice a tree full of delicious ripe fruits, and memorize where it is even if I’m not hungry at the moment). Equating life stages with particular goals invites this type of confusion; instead, one should recognize that adaptive goals and motivations often follow complex, indirect, and multi-step trajectories throughout the life course.

Decades of research in evolutionary anthropology have yielded a detailed model of the stages of the human life course and the corresponding transitions (e.g., Bogin, 1999). A reasonably fine-grained taxonomy could include the following: a prenatal stage (rich in potential affordances: see e.g., Brown et al. (2024); Ellison (2010)); birth; infancy; early childhood; the “juvenile transition” (Del Giudice et al., 2009); middle childhood; adolescence; adulthood; and (in women) menopause and the post-menopause. These obligate stages and transitions are complemented by facultative phases, including pregnancy, parenthood (which may be further segmented according to the offspring’s life stages), and grandparenthood. Given the universality of marriage across human cultures (Brown, 1991; Chapais, 2009), being in a committed, socially sanctioned “marriage-like” relationship may qualify as an evolved facultative phase sustained by specific adaptations. To identify states such as marriage and parenthood, I suggest using the label of life “phases” instead of “stages” because (a) they do not follow a strict sequence; (b) they can co-occur with one another and with more than one life stage; and (c) unlike obligate stages, they are reversible (e.g., marriage may end with divorce or with the death of the spouse; parenthood may end with the death of the child) and can be experienced more than once. The distinction between obligate life stages and facultative life phases helps describe a number of important patterns, with more precision than would be permitted by a generic notion of “overlap.” This taxonomy, or something like it, could be integrated into future revisions of the affordance management framework.

A granular taxonomy of life stages, phases, and transitions, each with a characteristic (and possibly sex-differentiated) profile of goals and priorities, would also help extend the range of

affordances covered by the framework to those relevant to various kinds of dangers and protections, the acquisition of material and informational resources, the formation of groups and alliances, and so forth. Indeed, a sophisticated model of life stages calls for an equally sophisticated model of motivation (see Del Giudice, 2024, 2023, for some building blocks); and a lifespan theory of affordances like the one presented in the target article needs both, if it is going to succeed in its ambitious goals.

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Authors' Response

Ecological affordances across the lifespan: Refinements and Extensions through interdisciplinary perspectives

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Abstract

Twenty-nine commentaries suggest refinements offering greater conceptual granularity; empirical extensions across additional life

stages/phases, ecologies, and species; mechanistic proposals; and meta-theoretical reflections. Collectively, they underscore broad consensus on the value of an affordance management approach grounded in life-history logic for understanding human–environment interaction, and they highlight the importance of life-long flexibility in how individuals perceive and manage ecological affordances.

R1. Introduction

When deciding to present our developing ideas as a target article to *Behavioral and Brain Sciences*, our hope was twofold—to provoke thinking and empirical research about the ways in which ecologies matter to people differentially across the lifespan and to garner new insights to advance our own thinking about these issues. We have not been disappointed. Indeed, we are grateful that most commentators seem to appreciate the value of an affordance management approach, married to life-history logic, for better understanding how ecological opportunities and threats change across the lifespan, and we greatly appreciate the thoughtful feedback they have provided.

The commentaries offer a wide range of conceptual refinements, empirical extensions, mechanistic proposals, and meta-theoretical reflections. Several themes emerged. First, many commentators call for greater granularity—finer distinctions among life stages and phases, ecological dimensions, and social and cultural contexts. As theoretical “splitters” (rather than “lumpers”) ourselves, we welcome this push toward greater nuance, which sharpens the framework and extends its predictive reach. Second, commentators suggested broadening the framework to encompass additional life stages/phases, ecologies, and species, extending it to late adulthood, culturally constructed phases, novel and volatile environments, and non-human cases. These contributions highlight the model’s scope and flexibility. Third, several commentaries elaborate on the mechanisms underlying affordance management, ranging from neurocognitive and neurobiological processes to personality. Fourth, others situate the framework within broader theoretical traditions, including behavior analysis, ecological psychology, and socio-ecological approaches.

In the sections that follow, we respond to these themes in turn. We clarify and refine central concepts (R2), extend the model across additional life stages/phases (R3), consider comparative extensions beyond humans (R4), integrate insights on cultural systems (R5), expand ecological dimensions and modern contexts (R6), examine underlying mechanisms and processes (R7), and address meta-theoretical issues (R8). Together, these contributions highlight broad agreement on the value of an affordance management approach grounded in life-history logic for understanding human–environment interaction, while also providing opportunities for continued theoretical and empirical development.

R2. Conceptual refinements and clarifications

Many commentators focus on sharpening the core concepts that structure our framework. They call for finer distinctions in how we characterize lifespan, greater precision in our use of “perception,” and clearer articulation of how environments, motivations, and affordances jointly shape behavior. Together, these contributions invite a more nuanced and analytically precise formulation of the

framework, aligning well with our own theoretical inclination toward granularity and conceptual clarity.

R2.1. Life stages and life phases

We very much welcome **Del Giudice’s** argument for a finer-grained taxonomy that distinguishes between obligate life *stages* (universal developmental periods, e.g., infancy and adolescence) and facultative life *phases* (reversible, often choice-driven social states, e.g., marriage and parenthood).

In our target article, we introduced three broad categories (childhood, mating, and parenting) to provide a clear, illustrative comparison. This approach combined one developmental stage (childhood) with two goal-prioritized, facultative phases (mating and parenting) that typically exist within the same life stage of adulthood. Our intention was not to impose rigid categories but to mark functional shifts in goal priorities. We agree with *Del Giudice* that differentiating obligate stages more finely, and differentiating facultative phases from these stages, would enhance the conceptual precision and explanatory scope of the framework. Incorporating these distinctions will better allow the framework to capture universal developmental trajectories while also accommodating the substantial sociocultural variability in life courses—for example, among individuals who choose not to pursue sexual partnerships or parenthood.

By explicitly considering life phases, the framework becomes more clearly compatible with cultural influences and sociocultural variation. As **Kanaev and Ahmed, Mehmood, Rahoof, & John** (Ahmed et al.) note, shifts in goal priorities reflect not only biological constraints but also cultural norms, expectations, and institutions, serving as cues for recalibrating adaptive priorities. Some life phases may be culturally initiated, shaped, and ended by local customs such as apprenticeships, coming-of-age rituals, and other culturally specific practices, further enhancing the framework’s cross-cultural relevance.

Accordingly, we adopt *Del Giudice’s* terminology and refer to life phases where appropriate.

R2.2. Perception(s)

Tybur correctly notes that we employ the term “perception” broadly, not differentiating among processes with different psychological and mechanistic properties. His clarification highlights four separable ways minds identify ecological affordances: (1) *Detection thresholds* set decision criteria for ambiguous cues and are calibrated by developmental history and ecology; (2) *situational affordance identification* captures the goal-dependent perception central to our model, recognizing what actions the environment enables given the current priorities; (3) *perceptual qualia* guide adaptive responses when present, although the capacity to perceive specific environmental features is constrained by the evolvability of perceptual systems and by whether those features carried adaptive consequences ancestrally; and (4) *non-conscious regulatory processes* adjust behavior implicitly, as when hormonal shifts shape patterns of mating or parental effort.

We agree that disentangling these meanings would strengthen our framework by clarifying the diverse ways evolved psychology identifies ecological affordances. Moreover, these distinctions raise important questions for our framework: Which affordances

require conscious awareness versus subconscious tracking? How do detection thresholds for ambiguous cues calibrate across development? When do affordance shifts reflect goal-driven reinterpretation of consciously perceived features versus automatic recalibration by specialized mechanisms? Future research addressing these questions will advance the framework's precision and generate more nuanced, testable predictions.

R2.3. Environments, motivation, and affordances

We agree with **Dubourg & Baumard** that environmental features regulate motivational systems in addition to providing potential action possibilities. Our focus on ecological affordances, which emerge from the interaction of such environmental features and currently active motivational states (goals, desires, needs, vulnerabilities), was in no way meant to suggest that ecological affordances are the only way through which environments exert influence on psychological process and behavior. Adaptive behavior results from both motivational prioritization and action implementation, and features of the environment affect both.

We note that motivational calibration and affordance perception can be intertwined processes. In their bakery example, *Dubourg & Baumard* propose that a pastry affords caloric intake only when hunger is already salient. Yet seeing and smelling the pastry can itself activate or amplify hunger motivation—a foundation of successful marketing!—from which the affordance then dynamically emerges. Likewise, core environmental dimensions, such as genetic relatedness and sex–age ratios, can both calibrate motivation (e.g., high genetic relatedness can upregulate incest aversion and cooperation motives) and directly structure the local social opportunities for mate competition, coalition formation, or alloparenting. These direct opportunities and threats fit the definition of ecological affordances.

Olesen & Hansen encourage conceptualizing affordances in terms of constraints that both enable and limit possible strategies for goal attainment. They distinguish disabling constraints (e.g., laws of physics and legal systems) from enabling constraints (e.g., the rules that make chess playable) and note that goals themselves function as self-imposed constraints that narrow the action space to desirable options.

Their approach is an interesting and potentially valuable way to sharpen the precision with which we conceptualize our constructs and the relations among them—and, perhaps, thereby reveal extensions of it. For example, whereas our target article focused on how a particular environmental feature can serve as an opportunity to achieve predominant goals at one life stage or phase but as a threat to achieve predominant goals at another, their framing highlights that a particular environmental feature may enable one strategy to effectively achieve a particular goal (i.e., afford an opportunity) while disabling an alternative strategy to effectively achieve that same goal (i.e., afford a threat)—within the *same* life stage or phase—thereby expanding the scope of possible predictions.

R3. Extending the lifespan model to late adulthood

We believe a key strength of our framework lies in its applicability across the lifespan, and we appreciate the commentators who extended its application beyond the three life stages/phases, underscoring the model's conceptual flexibility and integrative potential. The proposal to incorporate late adulthood, or the post-parental and intergenerational affordance phase, is entirely

consistent with our framework's goal of presenting a comprehensive lifespan model.

Zhang, Rajaeian, & Varnum (Zhang et al.) extend our framework to late adulthood. They propose that as physical and reproductive capacities decline, sex differences in perceived ecological affordance converge, although some asymmetries persist due to men's longer retention of reproductive potential. The findings they present on increases in disgust sensitivity and self-protection concerns in older men exemplify how cognitive/affective attunements and ecological affordances shift with biological changes due to aging. **Martins** also emphasizes that late adulthood is characterized by distinct motivational priorities—such as fostering emotional stability and meaning, mentoring younger generations, and conserving social and energetic resources—yielding ecological affordances qualitatively different from those in earlier life stages/phases. Similarly, **Hohm & Schaller's** work on seasonality demonstrates that older adults, with diminished reproductive and energetic demands, benefit less from energy-conserving behavioral adaptations (e.g., seasonal affective responses) than younger adults, highlighting shifts in resource allocation across the lifespan.

Our target article briefly extended the framework to late adulthood, emphasizing the evolutionary significance of grandparenthood, particularly through the grandmother hypothesis, which highlights the adaptive benefits of post-reproductive caregiving (Hawkes et al., 1998; Mace & Sear, 2005; Sear & Mace, 2008). As *Zhang et al.* note, post-reproductive individuals—especially women—undergo a fundamental reorientation of their affordance landscape, with reproductive potential no longer salient. As a result, ecological affordances shift away from mating and fertility toward prosocial, caretaking, and informational functions (Coall & Hertwig, 2010; Hawkes et al., 1998; Strassmann & Garrard, 2011; Van Bodegom et al., 2010). In this context, *Martins's* concept of instructional affordances captures a defining feature of this phase, emphasizing opportunities for teaching, mentoring, and transmitting knowledge, experience, and resources to future generations.

R4. Extending the framework beyond humans

We agree with **Veit** that, because trade-offs in allocating time, energy, and resources characterize all life forms (Zera & Harshman, 2001), a comparative extension would strengthen the framework as a broader ecological model of cognition and behavior (Garcia et al., 2021). Broadening the empirical base in this way would clarify cross-species similarities and differences in affordance management (Halsey, 2016), and we appreciate his encouragement in this direction.

That said, a comparative perspective must also consider constraints on affordance perception. Although many of the environmental dimensions we discuss are relevant across sexually reproducing animals, the mechanisms for detecting them may differ. As **Baggs et al.** note, non-human species may lack the cognitive capacity to abstractly represent kin categories or anticipate inbreeding risks. Yet, they rely on other evolved cues, such as olfactory signatures, vocal patterns, or familiarity-based heuristics, to detect relatedness and avoid inbreeding (Leedale et al., 2020; Lihoreau, Rivault, & Van Zweden, 2016). These differences highlight that while the adaptive problems are shared, the mechanisms through which species identify and manage relevant affordances can vary substantially. Here, humans diverge sharply: symbolic culture enables us to conceptualize and institutionalize social norms, taboos, and customs that manage these affordances

at a collective level, a point echoed by several commentators, which we address below.

R5. Incorporating cultural systems

We appreciate the commentators who emphasized the important role of cultural systems in affordance perception and highlighted the need to address the diversity of human ecologies. For illustrative purposes, and given space constraints, our target article focused on three evolutionarily recurrent dimensions with cross-cultural relevance. We agree, however, that affordance perception, learning, and transmission are shaped by local histories and sociocultural contexts.

As **Corriveau, Richert, Jee, Anggoro, & Coley** (Corriveau et al.) and **Ahmed et al.** noted, cultural systems can shape which environmental features are perceived, valued, and acted upon. A child's developmental niche, structured by caregivers' cultural ethnotheories, can guide how ecological information is interpreted. Community interdependence, ancestral knowledge, or sacred relations with land can influence how environmental cues are interpreted. Incorporating mechanisms of selective social learning, such as decisions about whom to learn from and what to trust, can clarify cross-cultural variation in affordance management.

Kanaev emphasizes that cultural systems do not merely shape how individuals interpret environmental cues but also restructure the affordances themselves. For example, social stratification may create mating opportunities for older adults, while the strength of state institutions can influence the degree to which people rely on kin. These cases show how cultural and structural contexts shape the opportunities and threats individuals perceive. Likewise, cross-cultural differences in how children classify strangers demonstrate that cultural norms can function as enabling or disabling constraints on vigilance and cooperation. These insights suggest the value of systematic cross-cultural research for understanding how cultural systems reshape ecological affordances, expanding the scope of the affordance management framework across diverse human ecologies.

Baggs et al. and **Ramírez & Sosa** highlight that human affordance management may be mediated not only by biological systems but also by communal and institutional structures. Although biological asymmetries influence caregiving tendencies (e.g., maternal certainty), the distribution of caregiving responsibilities in human societies may often also depend on norms, expectations, and institutions—for example, regulating inbreeding through taboos or coordinating violence through legal systems.

Together, cultural contexts provide an additional set of factors shaping how environmental features are perceived and interpreted in interaction with life-stage and life-phase goals. It is crucial to note, however, that the existence of a role for cultural forces does not constitute an alternative explanation to the individual-level affordance management processes we focused on in our target article. Fortunately, nature *versus* nurture arguments have finally been recognized by most scholars to be intellectually misguided and unproductive. Rather, by incorporating these relational and historical processes, the framework can more fully capture how humans construct, transmit, and sustain affordances across diverse ecologies.

R6. Extending ecologies

R6.1. Characterizing social ecologies

As a highly social species, humans inhabit ecologies shaped largely by other people. Each of the three environmental dimensions discussed in our article emerges from social dynamics: the distribution of kin for genetic relatedness, interactions among individuals for physical violence, and population composition for sex and age ratios.

As **Sng & Setoh** point out, humans can track these social ecologies at multiple levels of resolution. Although broad attunement (e.g., general kin prevalence) may be useful, they argue that finer-grained sensitivity to specific subgroups (e.g., particular kin types) may better capture the most important affordances. For instance, whereas our framework focused on the broad ecology of genetic relatedness, different types of kin within an ecology of high genetic relatedness may pose unique affordances. For example, whereas parents may afford a teenage girl threats of corporal punishment, adult male relatives may afford her threats of honor-related violence.

That said, and as **Sng & Setoh** note, the level at which individuals track may depend on the ecological domain, the adaptive outcome of interest, and the individual's life stage/phase. Broader tracking may emerge early in development due to its general utility in navigating recurring environmental affordances, whereas finer subgroup differentiation may develop later as specific social demands become more relevant. Such flexibility in resolution exemplifies the context-sensitive nature of affordance management central to our framework.

Shackleford, too, presses us toward nuance and granularity by distinguishing forms of violence that create distinct affordance structures: (1) *Diffuse criminal violence* – of the sort we primarily focused on in our target article—elicits defensive self-protection; (2) *instrumental intergroup conflict* produces parochial altruism; and (3) *existential intergroup conflict* prompts defense of group identity at personal cost. We agree that there is much value in making these distinctions and exploring how each form of violence presents different opportunities and threats across life stages/phases. These refinements toward greater granularity are welcome, as they add conceptual precision and likely increase predictive power.

Rotella, Twardus, & Barclay (Rotella et al.) argue for the value of integrating our framework within biological market theory. We agree that, for goals tied to partner choice (e.g., mating, friendships, and exchange relationships), the additional parameters brought into play—such as partner availability, costs of switching partners, and one's value in the market—are likely to add greater precision in predicting the specific affordances perceived, under what circumstances, and by whom, as well as the specific strategies people are likely to engage to manage them.

R6.2. Extending to novel and modern environments

Many cues in modern environments are evolutionarily novel or mismatched with ancestral conditions. As **Corriveau et al.** noted, individuals must interpret ambiguous, evolutionarily new cues. Although our target article focused on ancestrally recurrent

dimensions, we believe the framework can readily extend to novel environmental dimensions. As we briefly discussed, humans possess flexible psychological systems that can be applied to novel and mismatched cues, such as disgust mechanisms tuned to pathogen threats that can generalize to modern contaminants (e.g., toxic waste).

French, Campbell, & Meltzer (French et al.) applied our framework to the evolutionarily novel environment of highly accessible hormonal contraceptives, illustrating how biocultural innovations generate novel affordances and mismatches. Contraceptives disrupt evolved mating and parenting mechanisms while introducing new trade-offs across development, reducing sibling competition in childhood, affording reproductive control and strategic flexibility in mating, and enabling intimacy maintenance in parenting. They further demonstrate that contraceptives can functionally alter the operational sex ratio: by enabling short-term mating without reproductive cost, widespread use effectively skews the operational sex ratio in favor of males, leading to cascading effects such as increased female competition, delayed marriage, and shifts in male jealousy—patterns supported by population data. French et al.'s analysis offers a compelling example of how our framework may be usefully applied to explore how people adapt their behavior across the lifespan to novel environments created through biocultural innovation.

Both **Chen and Peng & Li** extend the framework to digital ecologies, showing how hybrid physical-digital environments reshape affordance management. Chen illustrates that the same technology can become opportunities or threats through interaction with phase-specific goals. Peng & Li highlight how algorithmic design can structure affordance landscapes, distinguishing between platforms that promote collaboration and those that exploit attention, even at the expense of developmental needs. They argue that hybrid environments can disrupt feedback loops critical for embodied learning and weaken traditional role learning by sex and age. In their view, algorithmically optimized systems may undermine individual agency, posing a challenge to our framework's assumption of autonomous affordance management. We disagree, viewing these systems as less of a challenge to what individuals are *attempting* to accomplish and more of a challenge to the *effectiveness* of these attempts. That aside, we view these applications as valuable. They demonstrate how the framework can be extended to modern, digitally mediated ecologies.

R6.3. Environmental change

We appreciate the commentators' emphasis on the temporal dimension of environments and environmental dynamics. Our target article focused on how the same environmental feature might afford quite different opportunities and threats across life stages/phases. Of course, features of the environment can change within a particular physical location or social community, with implications for those who reside there. We thus concur that integrating both predictable and unpredictable environmental shifts will be necessary to fully realize the scope of the framework.

Hohm & Schaller highlight seasonality—a predictable, cyclical source of environmental change—illustrating how the affordance management framework can incorporate temporal regularities. Seasonal variation provides recurring fluctuations in energetic cost, risk, and opportunity that recalibrate behavior across the lifespan. Their functional explanation for reduced seasonal depression in older adults aligns with life-history logic: younger adults facing higher reproductive and social demands benefit more

from mood-based energy conservation, whereas these fitness-relevant benefits decline later in life. Because seasonal cycles are predictable, time-based recalibration mechanisms can evolve, producing seasonal shifts in risk aversion, mating effort, and social judgment. Linking these shifts to reproductive status, menopause timing, or hormonal contraceptive use yields novel predictions about how biological states interact with temporal affordances.

Heeren, in contrast, focuses on environmental volatility—the speed and unpredictability of environmental change—and argues that our framework, to a large extent, rests on the assumption of environmental stability. Without such stability, perceivers will likely be unable to predict the opportunities and threats afforded by their ecologies and therefore be uncertain of the behavioral strategies to pursue. We agree that volatility can alter opportunity structures and that its impact may vary across life stages/phases. In fact, we originally considered incorporating environmental volatility into our framework but chose to omit it in the current version to keep the proposal more focused and accessible. We're therefore especially glad that Heeren has raised this issue, as we see it as a promising direction for future development that could enrich the framework while preserving its core logic and practical relevance.

R7. Psychological mechanisms and processes

Although articulating the psychological mechanisms and processes underlying and enabling affordance perception and management was beyond the scope of the target article, many commentaries illuminate these proximate mechanisms. Their contributions show how individuals perceive, evaluate, and recalibrate ecological affordances across the lifespan, linking the framework to neurobiological, cognitive, and personality-related mechanisms underlying adaptive flexibility. These insights substantially broaden the framework's reach, and we are eager to see how future work integrates perspectives across these disciplines.

R7.1. Integrating neurocognitive and neurobiological mechanisms

Montefinese, Di Pietro, Viviani, & Ambrosini (Montefinese et al.) propose semantic control—the ability to flexibly access, retrieve, and apply conceptual knowledge according to context and goals—as a mechanism guiding which affordances are attended to, which behaviors are enacted, and how environments are restructured to achieve a goal. They argue that this system enables continuous, goal-contingent relabeling of ecological affordances across life stages/phases. We are open to the semantic control system as a promising candidate, provided it can be integrated with the broader logic of our framework—specifically, that affordance management depends on neural systems capable of flexible, experience-dependent learning.

We also welcome **Ortu's** contribution, which highlights the neurobiological basis of our framework and neuroplasticity—the brain's ability to reorganize in response to ecological relevance (i.e., affordances)—as a key mechanism enabling psychological flexibility across the lifespan. This supports our view that shifting goals recalibrate psychological salience by reshaping cortical organization. Ortu further shows how sociocultural environments influence this plasticity. Although exploration often declines after adolescence, factors such as enrichment, physical activity, and skill learning can reverse age-related decline. By linking behavioral variability to neural adaptability, Ortu reinforces our claim that

developmental phases reflect flexible, reversible processes shaped by ecological conditions throughout life.

Together, these insights provide an integrated account of how cognitive meaning-making and neural adaptability jointly enable lifelong flexibility in ecological navigation. Semantic control provides the computational “software” for interpreting and prioritizing affordances, while neuroplasticity supplies the biological “hardware” that enables continuous updating in response to environmental changes. This convergence grounds our framework in a multi-level understanding of human adaptability, clarifying the mechanisms through which individuals maintain flexible, goal-directed engagement with their ecologies across the lifespan.

R7.2. Personality as a psychological mechanism

Thielmann, Burghart, & Casali (Thielmann et al.) argue for the value of integrating personality into our framework, suggesting that personality traits contribute to stability in how individuals perceive and respond to environments. They illustrate how enduring dispositions shape behavioral responses in trait-relevant situations, how specific affordances elicit trait expression, and how traits themselves develop across the lifespan through repeated engagement with age-graded social roles and demands. We do not disagree that individual differences in “personality” likely play significant roles in how people respond to features of their environments.

Responding to this commentary, however, requires clarifying a conceptual point. *Thielmann et al.* treat *affordances* as if they were independent constructs, conflating *features* of an environment with ecological *affordances*, with personality moderating how individuals react to them. Ecological affordances are *not* features of the environment. Rather, they are perceived opportunities and threats that emerge as a function of features of the environment and a perceiver’s currently active goals, needs, desires, and vulnerabilities—some of which are themselves shaped by personality traits. Thus, personality is already embedded within the concept of affordance, not independent of it.

Moreover, as **Volk** beautifully articulates in his necessarily brief overview—and that *Thielmann et al.* may not agree with—personality traits are inherently intertwined with motivation (and are thus themselves components of evolved, functional systems). Noting that the HEXACO personality factors likely represent adaptive trade-offs to different environmental conditions, Volk suggests the possibility of personality as a mediating gene × environment mechanism that contributes to enacting and calibrating perceptions, motives, and behavior across the lifespan. This idea of personality as a pattern of cognitive and behavioral responses shaped through ongoing engagement with ecological affordances across development resonates with us.

Integrating personality into the affordance framework strengthens it in two ways. First, it accounts for stable individual variation in ecological affordance management, explaining why people with similar goals may perceive and respond to the same environment differently. Second, it highlights a complementary developmental pathway: personality traits both influence and are shaped by ecological affordance management across the lifespan, explaining why the same person responds differently in environments that present different affordances. Future research incorporating personality processes will enhance the framework’s explanatory and predictive power for understanding how

individuals perceive, evaluate, and manage ecological affordances throughout development.

R7.3. Proximal psychological processes beyond reproductive aims

We feel the need to apologize to **Siegel**, and to any others, too, who left our target article misunderstanding our reasoning. We’ll try to clarify here, beginning with the foundational distinction between ultimate and proximate causation in evolutionary theory (Tinbergen, 1963). Our framework does *not* assume that individuals consciously pursue reproduction or compute fitness trade-offs. Rather, evolved psychological systems operate through proximate motivations—for example, self-protection, disease avoidance, affiliation, status-seeking, and offspring care—because pursuing these goals ancestrally enhanced survival and reproduction (Kenrick et al., 2010). Reproductive success is the ultimate evolutionary consequence of these systems, not their consciously represented aim.

Affordance perception and management are not about calculating fitness but about responding to the environmental features through context-sensitive goals, which shift systematically across the lifespan. Our framework proposes that life-stage and life-phase goals play a central role in shaping the perception of ecological affordances. During the mating phase, for example, individuals are not only seeking or attracting partners, but they are also motivated to build skills, cultivate social networks, establish autonomy, and achieve financial stability. These pursuits promote success in mating but simultaneously support friendships, coalition-building, status attainment, and personal meaning. In our article, we describe these as management strategies—and they are supported via immediate psychological experiences of satisfaction, belonging, and purpose, not by any conscious awareness of reproductive outcomes.

From this perspective, the contemporary struggles Siegel highlights do not contradict the framework—they exemplify it. The model predicts that well-being depends, in part, on the alignment between psychological goals and environmental features. When modern environments—marked by economic precariousness, social fragmentation, and political instability—fail to afford security, belonging, competence, and purpose, distress is the expected psychological outcome. That said, our framework is not a theory of happiness but a theory of adaptive calibration—of how psychological systems adjust to environmental constraints. Emotional distress under unstable conditions functions as a signal to reassess strategies or redirect investment—an evolved response to ecological misalignment.

R8. Meta-theoretical perspectives

R8.1. Behavior-analytic selectionist paradigm

Armshaw, Otero, & Mason (Armshaw et al.) propose reframing our model within a behavior-analytic selectionist paradigm, arguing that constructs such as “goal setting” and “life stage” invite circularity and hinder experimental tests. They argue that behavior is selected and maintained by contingencies, without reference to internal goal structures.

A contingency account can describe learning within each context, but it cannot explain why contingency salience changes predictably over the lifespan. How does one explain why the same environmental

feature—the same contingency, such as kin presence—affords entirely different responses in childhood, mating, and parenting phases? Life-phase goals specify the functional problems most relevant at a given time, thereby shaping what becomes reinforcing.

Thus, contingencies select behavior, but life-phase goals organize and recalibrate sensitivity to those contingencies. The affordance management framework provides the motivational and cognitive structure needed to explain which contingencies matter, when they matter, and why they matter.

R8.2. Ecological psychology

We were heartened to see commentaries by ecological psychologists, even though we were not surprised that they took us to task on several grounds related to our insufficient explication of, and lack of adherence to, traditional Gibsonian ecological psychology. Some of this is based on misunderstandings of our approach, sometimes due to the (mistaken) assumption that if we failed to discuss a particular phenomenon, process, or concept, we must believe it is not important. But some of the pushback is based on an accurate understanding of our position—and we consider this critique useful!

Baggs et al. articulate a range of concerns, but we focus on what we believe is the most important one—that our abstract, goal-dependent affordances are insufficiently perceptual. We agree that affordances must be perceptually specified; however, the framework targets higher-order ecological affordances—such as inbreeding risk or reproductive competition—that cannot be captured by a single cue. These affordances are computed through evolved mechanisms that integrate multiple perceivable indicators (e.g., facial resemblance, co-residence duration, and sex-age ratios) and are recalibrated according to current life-stage/life-phase goals. What appears “abstract” is therefore grounded in perceptual processes that operate over broader spatial and temporal scales than those typically emphasized in ecological psychology. Moreover, these abstract affordances may then be represented in mind for future recall and guidance for shaping one’s behavioral strategies when similar cues are perceived in the future. We understand that mentally representing affordances is anathema to some ecological theorists—but people do represent opportunity and threat affordances of various kinds, and doing so is useful (Neuberg et al., 2020).

Ramírez & Sosa emphasize reciprocal organism–environment coupling, a principle with which we fully agree. Our contribution is to embed this relational view within a functional, life-history logic: affordances are the central explanatory unit, and shifts in life-stage/life-phase goals reorganize which environmental features are perceived as opportunities or threats. These reorganizations produce the cognitive and behavioral adjustments the framework seeks to explain.

Haraldsen & Trasmundi call for complementing our macro-level, lifespan perspective with a micro-dynamic, process-oriented view drawn from ecological psychology. This highlights an essential area for the framework’s expansion: incorporating contingency and the role of materiality in the moment-to-moment experience of affordance management. We believe their focus on embodied interaction and material creativity complements our lifespan framework by showing how individuals continuously shape and are shaped by their immediate environments through fast, responsive feedback loops.

Particularly valuable is their emphasis on creativity and unpredictability: when agents reorganize their material surroundings to discover novel solutions, they actively reshape their

affordance landscape rather than merely responding to pre-existing opportunities. Our framework operates at a broader developmental and ecological scale, but these micro-level methods offer a powerful way to observe how the adaptive flexibility we propose at the lifespan level may actually be realized through dynamic, real-time interactions with the physical and social world. This integration bridges our macro-level, goal-driven evolutionary framework with the fine-grained mechanics of ecological psychology. This synthesis may offer a more comprehensive model of human adaptation, acknowledging that the management of ecological affordances is not just about rational strategy but also involves the creative, unpredictable emergence of new possibilities through active engagement with the material world.

Kanaev offers a philosophical synthesis positioning our framework as a bridge between ecological psychology and the philosophy of mind. He adopts a Kantian perspective, viewing perception as an active engagement, arguing that consciousness is an adaptive and generative capacity, and that affordances capture the balance between the objective world and the subjective stance.

We welcome this synthesis, as his emphasis on generativity provides a philosophical underpinning for our third management strategy: restructuring the environment. This reframing supports our assertion that adaptive affordance management is fundamentally an act of controlled cognition: individuals don’t merely respond to environmental constraints but actively shape their affordance landscapes through intentional modification of physical, social, and cultural environments. Greater attention to cultural evolution and cross-cultural variation in how affordances are perceived and managed remains an important direction for extending the framework.

R8.3. Socio-ecological approach

Cha, Ingram, & Oishi draw a useful distinction between top-down evolutionary approaches and bottom-up socio-ecological ones. Socio-ecological research clarifies how contemporary cultural, economic, and institutional conditions shape psychological outcomes, whereas our top-down framework identifies the deeper, ancestral problems that organized the design of these psychological systems in the first place. Far from competing, the two approaches operate at different levels of analysis and together provide a richer account of ecology–mind interactions.

Cha et al. raise a central challenge: how can a framework rooted in ancient environments explain minds navigating modern ecologies—such as extremely low kin density today? Our answer is that evolved mechanisms do not vanish when inputs change; rather, their application shifts. Even in kin-scarce settings, kin-detection systems and incest-avoidance mechanisms remain active, but the adaptive problem changes—from avoiding inbreeding to securing reliable support. This reapplication can produce strategies such as forming bonds with the few available relatives or establishing fictive-kin arrangements. Novel environments reshape how mechanisms are deployed, not whether they operate.

More broadly, modern environmental features often appear unprecedented, yet they still map onto the same fundamental social challenges—cooperation, alliance formation, threat management, and status competition—that shaped human psychology over evolutionary time. Our mechanisms are constrained by the architectures built to solve these problems, so even novel environments are processed through familiar psychological systems. Cultural meaning systems then interpret and transform ecological inputs, as *Cha et al.*’s example of income inequality in rural China

illustrates: cultural schemas about mobility shape the motivational consequences of status-related cues.

In this sense, our top-down approach using the affordance management framework provides the functional logic and mechanistic expectations, whereas the socio-ecological approach documents how these mechanisms manifest under specific cultural and economic conditions. Integrating the perspectives should help better explain why certain patterns should emerge and how they unfold within modern ecologies.

R9. Conclusion

We are grateful to the 29 commentaries for helping refine and extend the framework we presented. It has been valuable to see how scholars from diverse disciplines and traditions interpret the framework, press for greater granularity, and suggest ways to integrate cultural, mechanistic, and meta-theoretical perspectives. Collectively, these contributions sharpen our original proposal and clarify both its scope and its limits. The result is a more articulated picture of affordance management as a multi-level, dynamic process that unfolds across development, ecologies, and species.

The next step is empirical testing. Many predictions we outlined now need systematic evaluation using longitudinal designs that track how individuals recalibrate their affordance perception and management as they transition across life stages/phases. Such work can directly test claims about sensitive periods, reversibility, and the conditions enabling flexible recalibration. Cross-cultural studies can map how different societies perceive and manage ecological affordances through norms, institutions, and practices, and how cultural systems create, obscure, or transform affordances associated with genetic relatedness, physical violence, sex–age ratios, and beyond. Cross-species work can clarify which aspects reflect broadly shared life-history trade-offs versus uniquely human capacities, such as symbolic culture and institutional design. Experimental, neuroscientific, and computational studies can examine how detection thresholds, semantic control, neuroplasticity, and personality processes jointly shape ecological cue attention, interpretation, and strategy selection.

In summary, the commentaries have helped transform an initial scaffolding into a more articulated and testable framework. We believe our framework has significant potential to reveal the remarkable lifelong flexibility and adaptive capacity of human psychology across the lifespan—capacities often taken for granted but crucial for understanding how people navigate various environments and life circumstances. Given how rapidly some aspects of the environment can change, the lengthening of human lifespans, and the large costs of maladaptive responses, it would seem critical to better understand human psychological flexibility. We hope our developing framework will provide useful insights for doing so.

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