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Seeing and thinking groups: embodied foundations of perceptual and social structuring

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The processes of perceptual organization and social categorization share the goal of simplifying and structuring the world, though they have traditionally been studied within separate branches of psychology. Drawing on embodied cognition, this perspective suggests that both processes stem from bodily experiences. Early sensorimotor experiences, such as being held in proximity or rocked in synchrony, may have shaped the principles of perceptual organization and provide the foundations for social categorization. To integrate these domains, a triadic embodied model is proposed, linking bodily experience, perceptual organization, and social categorization as dynamically interacting vertices. The model allows bidirectional influences, whereby each element can prime and reinforce the others, and may also involve activation of metaphorical concepts. It further explains how cultural context can bias these interconnections. The model situates social categorization along a continuum of representational depth, from shallow symbolic tagging to deep embodied simulation. While prior work has demonstrated dyadic links between bodily experience, perceptual organization, and social categorization, the present article explicitly integrates these domains in a unified model, offering new directions for understanding how people structure their physical and social world.

KEYWORDS

perceptual grouping, social categorization, embodied cognition, organization, ingroup, outgroup

1 Introduction

How do people make sense of their surroundings? Whether interpreting the inanimate environment or navigating human social life, the underlying cognitive need is the same: to impose structure and coherence onto a stream of information. In vision science, Gestalt theory (e.g., Wertheimer, 1955) argued that perceptual organization, via figure-ground segregation and grouping principles such as proximity, similarity, and closure; constructs meaningful wholes from fragmented input. In a distinct line of research, social psychologists (e.g., Tajfel et al., 1971) showed that categorizing people into groups is a fundamental way of simplifying and interpreting the social world.

The fields of perceptual organization and social categorization have developed largely independently, at different levels of explanation within psychology. Perceptual organization has been studied as a process in visual perception, while social categorization has been treated as a higher-level cognitive function. Yet, their shared role in imposing structure raises an intriguing question: might these processes, despite disciplinary separation, be shaped by a common foundation?

Recent advances in embodied cognition provide a framework for exploring this question. The idea that sensorimotor experience shapes abstract thought and language (Barsalou, 2010; Johnson, 2015) resonates with the possibility that the principles we use to organize both perceptual and social information may emerge from bodily interactions with the world. Earlier developmental theorists such as Piaget (1962) and Mandler (1992, 2008) proposed that bodily experiences scaffold thinking, warranting a reconsideration of their insights beyond infancy.

This Perspective article proposes that bodily experience, perceptual organization, and social categorization are interconnected. Drawing on prior psychological frameworks, I argue that bodily experiences shape how we draw lines in organizing the visual world as well as in understanding social belonging. Rather than viewing perceptual grouping and social categorization as separate processes, I suggest they may be linked through a triadic system, where each element (body, perception, and categorization) can prime the others.

2 Traditional models of social categorization

Social categorization refers to the cognitive process by which individuals classify others into distinct social groups based on salient characteristics such as race, gender, or age (Fiske and Neuberg, 1990; Tajfel et al., 1971). This process has been extensively studied within social psychology, typically conceptualized as a means of simplifying the social environment and preserving cognitive resources (see, Macrae and Bodenhausen, 2000). Categorization enables quick judgments and guides social interaction, but it also underlies the development of stereotypes, ingroup favoritism, and intergroup bias (Brewer, 1999).

Dominant models of social categorization have focused on higher-order cognitive and motivational mechanisms. For example, Social Identity Theory (Tajfel and Turner, 1979) highlights individuals' motivation to achieve positive distinctiveness through group membership. This process entails classifying others into ingroups and outgroups, and attributing greater value to the ingroup relative to the outgroup, thereby enhancing one's sense of self. The Continuum Model of Impression Formation (Fiske and Neuberg, 1990) proposes that categorization functions as a default process unless attention and interpretation allow for more individuated judgments. Developmental models reflect similar assumptions (Nesdale, 2004). While these models have generated rich insights into intergroup behavior, they share the assumption that social categorization builds on processed perceptual input.

3 Principles and development of perceptual organization

Perceptual organization refers to the cognitive process by which individuals structure sensory elements into coherent wholes rather than perceiving them as isolated units. Early Gestalt psychology pioneered this insight, proposing that principles such as proximity, similarity, continuity, closure, and common fate govern grouping of sensory input into meaningful patterns (Wertheimer, 1955). These principles describe how sensory elements are organized based on their spatial or temporal relationships, reflecting a tendency of the perceptual system toward simplicity, good form (Prägnanz), and coherence. For instance, when viewing a series of colored dots, individuals tend to group them into rows or columns based on shared color, creating a simplified visual organization. Research has shown that some forms of perceptual grouping processes can unfold rapidly, as early as 40 milliseconds, and may be accomplished without conscious awareness (Kimchi and Razpurker-Apfeld, 2004; Razpurker-Apfeld and Kimchi, 2007; Razpurker-Apfeld and Pratt, 2008).

Perceptual organization emerges early and refines across development. By two months, infants group by luminance similarity, by 4 months by shape, and later by proximity (Farran et al., 2008). Some forms of perceptual organization appear even near birth when defined by dynamic cues (e.g., Valenza and Bulf, 2007). Grouping abilities grow more sophisticated through childhood (Hadad and Kimchi, 2006) and continue to refine into adolescence (Scherf et al., 2009).

4 The embodied perspective: linking body, perception, and meaning

Embodied cognition theories propose that the mind operates through the body, with thoughts, perceptions, and emotions intertwined with sensory–motor experiences (Barsalou, 2008; Tirado et al., 2018). Rather than viewing cognition as a detached symbolic system, embodied approaches emphasize the dynamic interaction between body and environment. Embodied experiences are stored in memory and are reactivated in relevant situations (Barsalou, 2008).

Empirical research overall shows that bodily experiences are deeply woven into psychological meaning-making across domains. Physical sensations such as temperature are linked to social perception (e.g., Bargh and Shalev, 2012), odors influence trust judgments (Lee and Schwarz, 2012), and feelings of physical suffocation shape perceptions of emotional suffocation (Razpurker-Apfeld and Tal-Or, 2024). Spatial experiences also matter: right-handed individuals link positivity to the right side, left-handers to the left (Casasanto, 2009). Embodied effects have been replicated cross-culturally (Yamada et al., 2024) and in communication contexts (Yin and Goller, 2024). They even extend beyond the individual: when readers strongly identified with a lonely character, they felt their own room as colder (Tal-Or and Razpurker-Apfeld, 2021), and matching a viewer's taste experience with a character's emotion enhanced identification (Razpurker-Apfeld and Tal-Or, 2025).

Early bodily experiences become integrated with psychological meanings, and leave lasting traces. For example, physical warmth paired with emotional security in infancy (being held by a

caregiver) later extends to adulthood, where even subtle warmth evokes feelings of social closeness (Williams et al., 2009).

5 An embodied view of perceptual and social structuring

In line with the embodied perspective, the foundations of both perceptual organization and social categorization can be traced to early sensorimotor experiences. Being held closely and warmly by a caregiver may scaffold grouping by proximity, while being rocked in synchrony in the caregiver's arms may scaffold grouping by common fate. Over time, such perceptual groupings may acquire social meaning, with closeness and synchrony implying social affiliation.

Recent empirical studies show that Gestalt-like cues such as proximity and synchrony shape impressions of social connectedness (Cracco et al., 2024; McEllin and Sebanz, 2024; Vestner et al., 2019). These influences are bidirectional: higher-level conceptual processes like social categorization can also reactivate bodily states. For example, viewing outgroup members can reduce motor resonance, reflected in lower sensorimotor activation when observing their actions (Riečanský et al., 2015). Thus, categorization may be both grounded in and capable of reactivating bodily experience.

Language offers clear illustrations of how bodily experience shapes social thought, as expressed in the conceptual metaphor theory (Lakoff and Johnson, 1980). For example, describing someone as "a close friend" draws on bodily experiences of physical proximity (e.g., being held), maps onto perceptual grouping principles such as proximity, and conveys the social inference that close people belong together. Similarly, calling someone "an outsider" metaphorically invokes figure-ground segregation: the self and ingroup are at the center (figure), while the outgroup is pushed to the periphery (ground). These metaphors are not merely linguistic. They reveal the embodied structure of social knowledge. Cognitive neuroscience and psychology further demonstrate that metaphorical language engages brain regions linked to perception and action (D'Angiulli et al., 2015). From this perspective, language is embodied and inseparable from sensory, motor, and affective processes (Khatin-Zadeh and Vahdat, 2015). The embodied view of perceptual and social structuring therefore suggests that perceptual organization and social categorization may rely on similar principles for making sense of the world, as they both emerge from the same embodied mechanisms.

6 Social categorization along a continuum of embodied engagement

Predictive processing theories describe the brain as a hierarchical prediction system that constantly generates and updates hypotheses about the world attempting to reduce errors. Clark (2016) stressed that this is not just a computation, but a process tied to body and action, enabling people to move and interact effectively with their environment. Building on this view, Michel (2021) illustrated that cognitive activity unfolds along a continuum of representational depth. At one end, shallow processing yields abstract, amodal representations of a concept with minimal sensory-motor engagement. At the other, deeper processing activates rich, multimodal simulations rooted in bodily experience. Crucially, the same concept can be processed at different levels of this continuum, depending on factors like attention, prior learning, and task demands. Social categorization may similarly vary along this continuum.

At the deeper embodied end, bodily experiences provide the scaffolding for perceptual grouping, and both in turn may shape social categorization. For example, the Gestalt principle of common fate can be extended into the social domain. When individuals walk side by side or act in synchrony, they are often perceived as belonging to the same group. This perception arises not only from visual regularity but from early embodied experiences in which coordinated movement with the caregivers signaled unity, safety, or affiliation. Over time, these embodied associations shape social perception, so that shared movement evokes expectations of social closeness or group membership. Such mechanisms help explain how fleeting perceptual patterns like coordinated walking or simultaneous gestures can rapidly trigger categorization into "us" vs. "them." Moreover, bodily states may play a role in shaping categorization. For example, avoidance-related motor activations have been shown to increase intergroup bias (Razpurker-Apfeld and Shamoa-Nir, 2021). While this finding concerns attitudes toward outgroups, it raises the possibility that similar bodily mechanisms could also influence the categorization process itself. If so, sensorimotor engagement might not merely accompany categorization but may contribute to its formation.

At the shallower end of the continuum, social categorization may rely less on direct bodily experiences and more on semantic knowledge and culturally acquired associations, consistent with traditional models. Visual cues such as race, sex, or age, as well as markers like clothing styles, religious symbols, or hairstyles, can guide categorization by drawing attention to salient similarities and dissimilarities. The social meaning of these cues typically emerges through learned associations and interpretive processes. For instance, children can articulate ethnic and religious differences by using culturally acquired concepts and verbal labels (Shamoa-Nir et al., 2022). The way they categorize their social world and think about ingroup–outgroup distinctions reflects how they attend to salient perceptual cues while being guided by knowledge and context.

7 An embodied triadic model

To integrate the ideas presented thus far, I propose a triadic model in which bodily experience, perceptual organization, and social categorization are mutually reinforcing components, as shown in Figure 1. This framework conceptualizes these elements as the three corners of a triangle, dynamically connected. Sensorimotor experiences not only scaffold early perceptual grouping mechanisms (e.g., proximity, common fate), but may also shape social categorization. Conversely, social categorization can prime perceptual expectations and organization. For example, categorizing a person as an outgroup member may bias subsequent visual perceptions, leading groups of individuals or even objects to be seen as more distant than they actually are, and can also

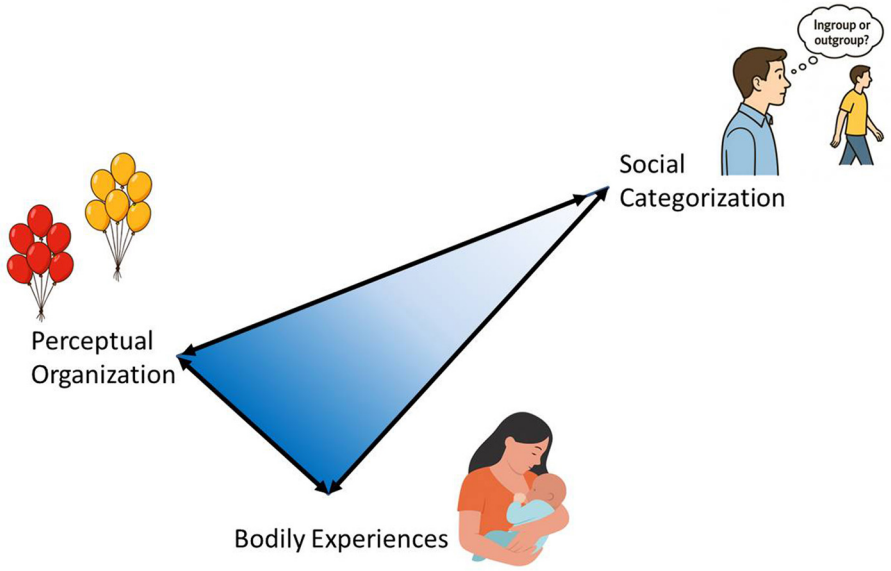

FIGURE 1
A triadic model illustrating the proposed embodied foundation of perceptual and social structuring. The three vertices represent core components: bodily experiences, perceptual organization, and social categorization. The triangle's edges emphasize the bidirectional relationships among these components, while the gradient shading from dark **(bottom)** to light **(top)** reflects increasing levels of representational abstraction, consistent with predictive processing accounts of cognitive depth. Each illustrative icon exemplifies the corresponding domain.

reactivate embodied states, such as a readiness to withdraw or adopt an avoidance posture. Perceptual grouping, in turn, may both reflect bodily priors and guide future categorizations. The triangle also conveys representational depth, demonstrating how social categorization can range from shallow symbolic tagging to deep embodied simulation, depending on context, task demands, and attention. This model extends existing embodiment accounts by integrating the idea of bidirectional influences and representational depth and showing how both perceptual and social structuring are ultimately grounded in bodily experiences. Within the triadic model, metaphors such as "close friend" or "outsider" can be seen as linguistic expressions of the triadic integration of bodily experience, perceptual organization, and social categorization.

These reciprocal influences are assumed to work through priming and activation of embodied and abstract schemas. Bodily cues can activate perceptual groupings and social categories, while perceptual or social cues can reactivate bodily states. Similar to predictive processing principles, multiple schemas may be partially activated at once, with the most accessible or contextually fitting schema guiding subsequent perception, action, and social judgment.

To illustrate how this triadic system operates, imagine encountering a stranger walking past you. That stranger may be walking close to you or at a distance, moving in synchrony with your pace or out of step, and appear dressed similarly to you or quite differently. The more these cues align with organizational principles such as proximity, similarity, and common fate, the stronger the tendency to group and categorize the stranger as ingroup. This resembles clustering balloons together based on shared features or separating them into distinct bunches when features differ. At the same time, such perceptual input can re-enact early bodily experiences, such as being held in physical proximity or rocked in synchrony during infancy, thereby activating embodied expectations of affiliation and unity and reinforcing ingroup categorization. Such a process may involve activation of corresponding linguistic concepts such as "closeness" or "togetherness". This fluid integration enables rapid, intuitive categorization in everyday life, helping explain why social categorization is often resistant to conscious control and why resulting social judgments are prone to bias.

The model also accommodates more abstract categorization processes. For instance, noticing a salient feature of the stranger may activate only the social categorization node and be accompanied by the activation of related concepts. That feature could be interpreted as a cultural or religious marker, thereby drawing on semantic knowledge that guides ingroup or outgroup categorization and conceptualization and elicits affective or motivational responses such as empathy or distrust. Importantly, activation at the social categorization node may remain localized or diffuse to the other two nodes, depending on the magnitude of activation and relevance.

This model builds on universal principles grounded in bodily experience (e.g., infants are typically held by parents), perceptual organization (e.g., Gestalt principles), and social categorization (e.g., basic ingroup–outgroup distinctions), but also allows for variation. Individual differences may emerge from diverse physical interactions with caregivers and surroundings, which fine-tune these common principles into individualized patterns. Some variations may be shared within cultures. Indeed, East Asian parents more often keep infants in physical proximity at night compared to Western parents (Astbury et al., 2025), and holding

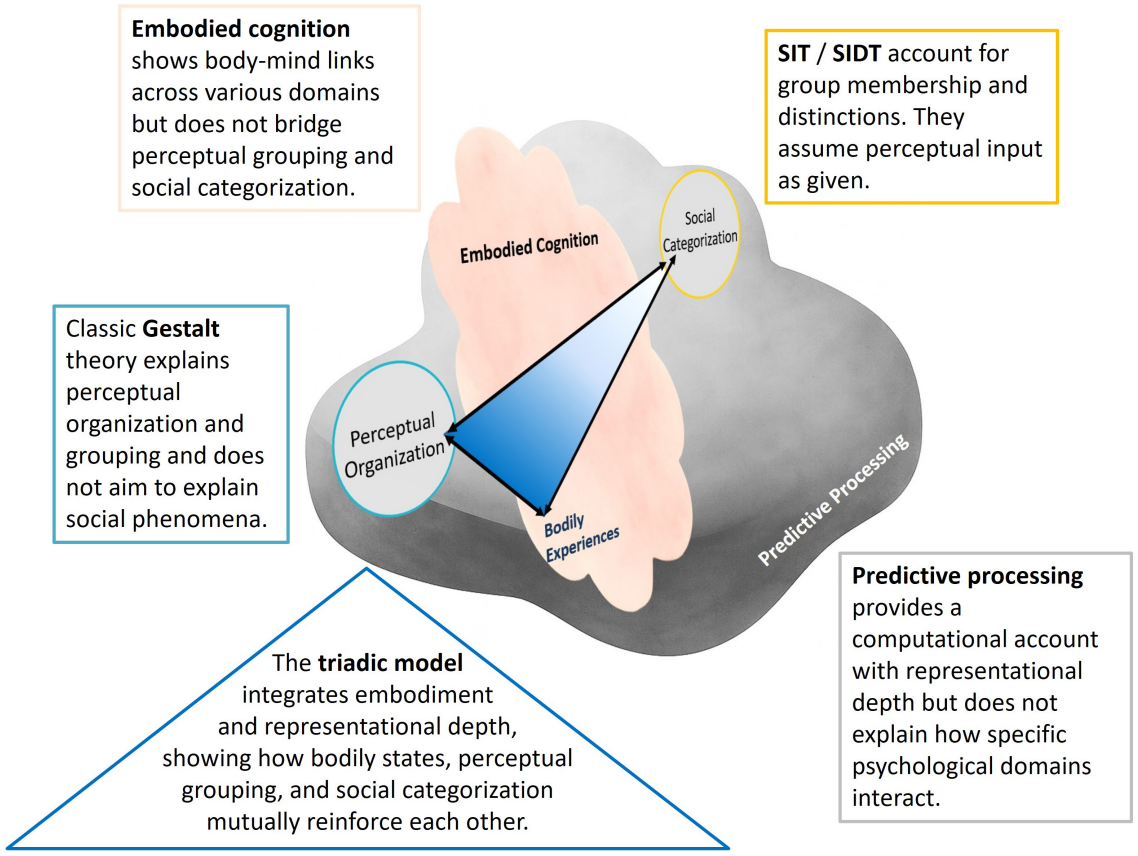

FIGURE 2
Conceptual positioning of the proposed embodied triadic model. The psychological plane shows an embodied framework linking processes of perceptual organization and social categorization. It is positioned on a foundational computational layer of predictive processing. The boxes summarize the main contributions and challenges of each theoretical approach. SIT = Social Identity Theory and SIDT = Social Identity Development Theory. Note that different scholars may construe the relation between predictive processing and embodied cognition differently.

and pick-up postural styles also diverge (Negayama et al., 2015). In addition, East Asian perceivers often attend more holistically to relationships and background, whereas Western perceivers focus more analytically on focal objects (Ji et al., 2000; Nisbett and Miyamoto, 2005; but see, Weigl et al., 2023). Based on these findings and the model's grounding in bodily experience, the interconnections among the vertices may develop differently, and, in turn, account for contextual cultural biases. Collectivist contexts may bias bodily, perceptual, and social processes toward closeness and inclusion, likely to support broader ingroup definitions, whereas individualist contexts may bias them toward boundaries and separation, tending toward stricter ingroup-outgroup distinctions.

8 Discussion

Theories of cognitive development sparked the idea that body and mind are interconnected from early stages of life. Mandler (1992, 2008), for instance, theorized that infants extract image-schemas from perceptual and motor interactions as precursors to abstract thought. Building on such early insights, psychological theories of embodiment have extended body–mind connections across the lifespan. Barsalou (2010) and Lakoff and Johnson (1980) emphasized how bodily experience affects (and is also affected by) attitudes, behavior, and language. The current model uniquely brings perceptual grouping and social categorization, traditionally studied as separate domains, under the umbrella of embodiment.

Predictive processing accounts (Clark, 2016; Michel, 2021) describe the brain as a prediction system that minimizes error by continuously generating and updating hypotheses about incoming input. These accounts place concepts along a continuum of representational depth, from shallow, amodal, to richly embodied. The present model uses predictive processing as infrastructure. In accordance, it assumes bidirectional layered connections between bodily states, perceptual grouping, and social categorization so each can prime and reinforce the others. Thus, social categorization may be shaped by how perceptual and bodily systems structure input and can also reactivate them once initiated. Figure 2 illustrates this positioning: the triadic model operates at the psychological level within the scope of embodied cognition, while predictive

processing lies beneath as a computational foundation informing these higher-order processes.

Evidence supports the plausibility of connections between the vertices of the triadic model. The body–social link is evident in social thermoregulation, where physical warmth fosters interpersonal closeness and vice versa (Ijzerman et al., 2011), and in findings that motor resonance varies with social categorization (Riečanský et al., 2015). The body–perception link is shown by studies where bodily constraints influence perception. For example, hills appear steeper when people are fatigued or carrying a load (Proffitt, 2006), though such effects may partly reflect demand characteristics (Durgin et al., 2009). Further evidence demonstrates that experiencing warmth promotes global processing (Ijzerman and Semin, 2009). The perception–social link is reflected in the tendency of individuals high in need for structure to organize both social and non-social stimuli into fewer, more coherent categories (Neuberg and Newsom, 1993), as well as in work showing that perceptual grouping cues such as proximity and synchrony shape social perception (Cracco et al., 2024; McEllin and Sebanz, 2024; Vestner et al., 2019) and that even arbitrary group assignments bias visual perception of ingroup vs. outgroup faces (Van Bavel et al., 2008). Together, these findings establish dyadic links between bodily experience, perceptual organization, and social categorization. The novelty of the present model lies in broadening the scope of embodiment beyond its usual applications, showing how perceptual grouping and social categorization can be understood as interconnected through shared embodied mechanisms.

The proposed model offers concrete, testable predictions about the causal pathways linking bodily states, perceptual organization, and social categorization, as well as their relation to conceptual representations. Bodily states (e.g., warm touch) might prime perceptual grouping (e.g., perceived proximity) and increase the likelihood of categorizing ambiguous figures as ingroup members. Conversely, categorizing someone as an outgroup member could bias perceptual organization (e.g., estimating larger spatial distances) and trigger avoidance-related motor states. Likewise, exposure to ungrouped vs. grouped patterns might bias categorization toward outgroup membership and evoke bodily states such as feeling colder or adopting avoidance-oriented actions. Similar dynamics are expected with conceptual metaphors: reading about a "close friend" may enhance perceptual grouping processes, social inclusion and approach tendencies, while reading about an "outsider" may strengthen figure-ground segregation and avoidance preparedness. Neuroimaging may reveal activation not only in linguistic regions but also in perceptual and motor systems when people process such metaphorical concepts. The model also predicts cultural variation: in collectivist contexts, closeness metaphors may be more frequent and their effects on grouping and social inclusion stronger, whereas in individualist contexts, boundary metaphors such as "outsider" may appear more often and more strongly tied to segregation in perception and avoidance-related bodily responses. By providing a structured framework, the triadic model highlights how bodily, perceptual, and social processes are interconnected, offering a foundation for testing how these links vary across developmental, situational, or cultural contexts.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

IR-A: Conceptualization, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author declares that Gen AI was used in the creation of this manuscript. The author used ChatGPT (OpenAI, 2024) to obtain suggestions for improved wording of selected sentences. The final phrasing was formulated by the author, who takes full responsibility for the content and language of the manuscript. The author also used ChatGPT to generate the illustrative icons in the Figure 1.

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