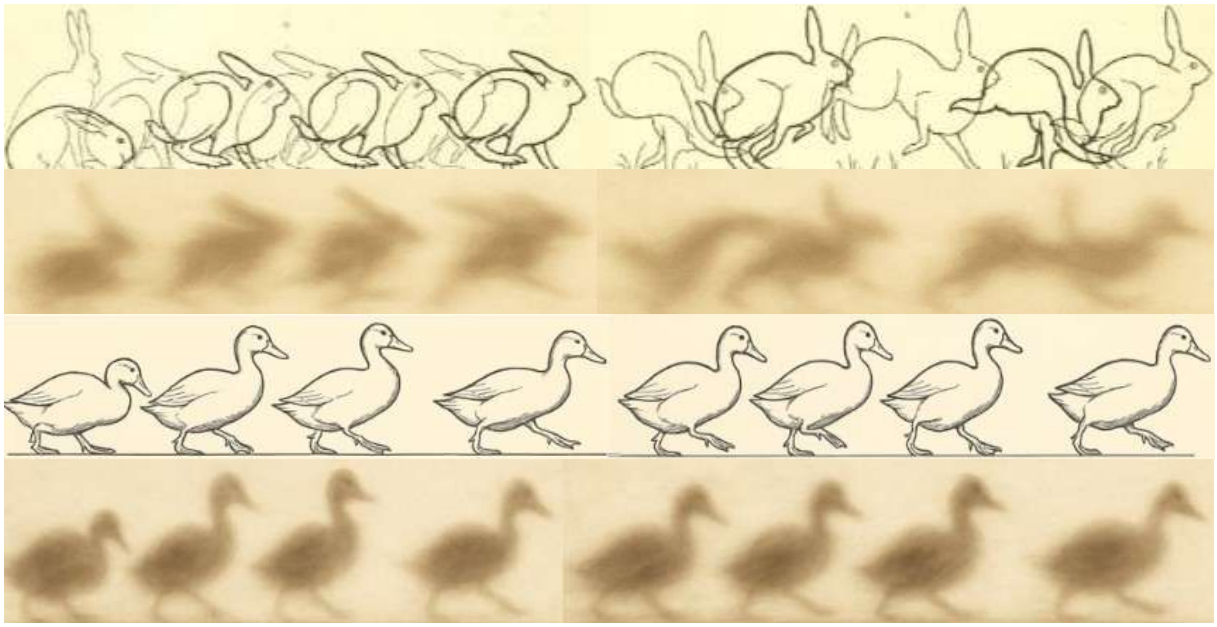
The Duck-Rabbit Figure Is Not an Illusion

Rethinking Visual Attention and the Foundations of Vision Science



Caught In A Line
The explanatory model of all motoric movement actions

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Abstract

Current vision science continues to treat context-dependent perceptual interpretations as evidence of perceptual distortion, commonly labelled as visual illusions. The Duck–Rabbit figure is a canonical example, in which a single static stimulus affords two mutually exclusive object interpretations depending on attentional set. Traditional accounts appeal to ambiguity resolution, competing representations, or bistable perceptual mechanisms, implicitly assuming that perception is fundamentally designed to determine static object identity.

This article argues that this premise is fundamentally incorrect. Perception does not operate ecologically as a system for resolving static object identity, but primarily as a continuously active comparison process whose functional role is to detect, evaluate, and predict movement-motion in the service of action. Within this framework, object recognition plays only a derivative role, insofar as object categories provide information about potential future movement patterns. Maintaining multiple object interpretations therefore reflects functional flexibility rather than perceptual failure.

From this perspective, the Duck–Rabbit figure is not an illusion but an indivisible, action-irrelevant static configuration for which no spontaneous object disambiguation is required. Apparent alternations between "duck" and "rabbit" arise only under explicit cognitive or instructional demands that impose an artificial requirement for categorical interpretation. The Duck–Rabbit figure therefore reveals not a limitation of perception, but the inadequacy of representational theoretical frameworks.

More generally, this analysis underscores that scientific progress in vision research is by far better achieved by understanding the functional tasks of perceptual systems than by explaining the innumerable apparent anomalies generated by inappropriate theoretical expectations.

Keywords: *Duck–Rabbit figure (illusion); visual attention; ecological perception; object recognition; ambiguous figures; motion-based perception; action-oriented vision; temporal comparison*

Explanatory Introduction

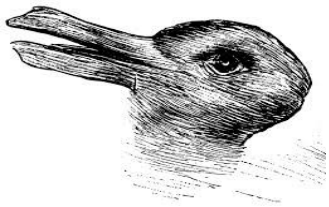
Despite decades of extensive empirical investigation, vision science continues to lack a coherent mechanistic framework for visual attention and perceptual function. Instead of being grounded in a unified account of what perceptual systems are functionally designed to do, the field has historically progressed through the identification and categorization of isolated phenomena. These phenomena are subsequently interpreted within implicit theoretical assumptions that often remain unexamined. When

perceptual outcomes do not conform to these assumptions, they are commonly labeled as *visual illusions*. Such labels, however, rarely provide explanatory insight; rather, they function as placeholders for effects that resist integration within the prevailing theoretical framework.

The Duck–Rabbit figure represents a canonical example of this practice. A single static stimulus affords two mutually exclusive object interpretations, commonly described as alternating perceptual states. Traditional explanations appeal to mechanisms such as ambiguity resolution, competition between object representations, or bistable perceptual processing. Despite their differences, these accounts share a common premise: they assume that visual perception is fundamentally designed to determine static object identity, and that perceptual ambiguity therefore reflects a failure or instability in perceptual processing.

In this article, it is argued that this shared premise is fundamentally incorrect. Visual—and auditory—perceptual processes did not evolve to resolve static object identity as an end in itself. Ecologically, their primary function is to detect, evaluate, and predict change in the environment, particularly movement, in relation to the organism's own potential actions. Perception operates as a continuously active comparison system that evaluates differences across adjacent temporal frames. Within this architecture, perceptual relevance arises from change over time, not from static spatial or categorical determinations.

Within such a system, static stimuli are processed as zero-motion states. They do not intrinsically demand perceptual resolution beyond their confirmation as temporally stable. Object recognition therefore plays only a secondary, derivative role in perceptual processing. Object categories are recruited insofar as they provide information about potential future movement patterns and action contingencies. From this ecological standpoint, maintaining multiple object interpretations is not a deficiency of perception but a functional advantage, allowing the system to remain flexible in the face of uncertain or incomplete information.



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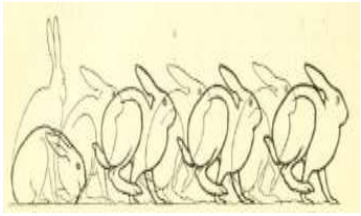

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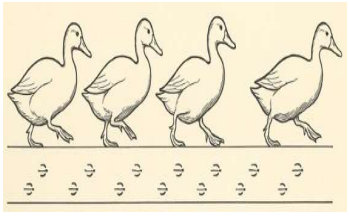

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Illustrations[1]**:** *When the Duck–Rabbit figure is presented, scientific researchers are often theory-driven and attentionaly conditioned to focus immediately on the two alternative head configurations corresponding to "duck" and "rabbit" interpretations. This article argues that such a perceptual focus is fundamentally misguided. When viewing a static image on a physical medium, observers possess prior cognitive knowledge that the stimulus does not move. Consequently, upon encountering an image such as the Duck–Rabbit figure, in the absence of explicit task demands, visual attention is directed toward the configuration as a whole (fig. 1), that is, the complete arrangement of all elements as a single, undivided visual scene.*

Under normal viewing conditions, when no movement is detected, there is no ecological or functional basis for isolating and resolving a specific object interpretation within the configuration. Only when movement is detected does the perceptual system immediately attempt to establish a causal relation between how something moves and what kind of object it might be[2]*. Within milliseconds,*

[1] The red-circled areas merely indicate the attentional field. They are not part of the illusion and do not constitute part of the explanation.

[2] The causal relationship between the duck–rabbit recognition and associated movement is fully explained on page 9.

characteristic movement patterns are associated with object categories—for example, coupling a particular motion pattern to a "duck" or a "rabbit."

This, conversely, demonstrates that perceptual processes are not primarily fallacious or error-prone, but are organized to maintain multiple interpretative possibilities for as long as action-relevant information remains absent. Rather than forcing premature categorical closure, perception remains maximally flexible and supportive, optimizing functional readiness for interaction with a dynamic environment.

From this ecological perspective, the Duck–Rabbit figure loses its status as an illusion. The configuration is not perceived as two alternative object heads that ought to be internally disambiguated, but as a single, indivisible, and static configuration devoid of immediate action relevance. Within such a configuration, the perceptual system has no intrinsic task to isolate abstract object identities or to resolve categorical object interpretations. Consequently, the absence of a definitive "correct" object judgment cannot be regarded as a perceptual failure.

In this case, the concept of illusion proves to be primarily the result of incorrectly formulated expectations about perception. By abandoning representation-based models and reinterpreting perception as an ecologically grounded, action- and motion-oriented, temporally comparative process, the Duck–Rabbit figure can be understood without recourse to presumed distortions or instabilities of the perceptual system. The explanatory burden thus shifts from an alleged perceptual deficit to a revision of the theoretical framework itself.

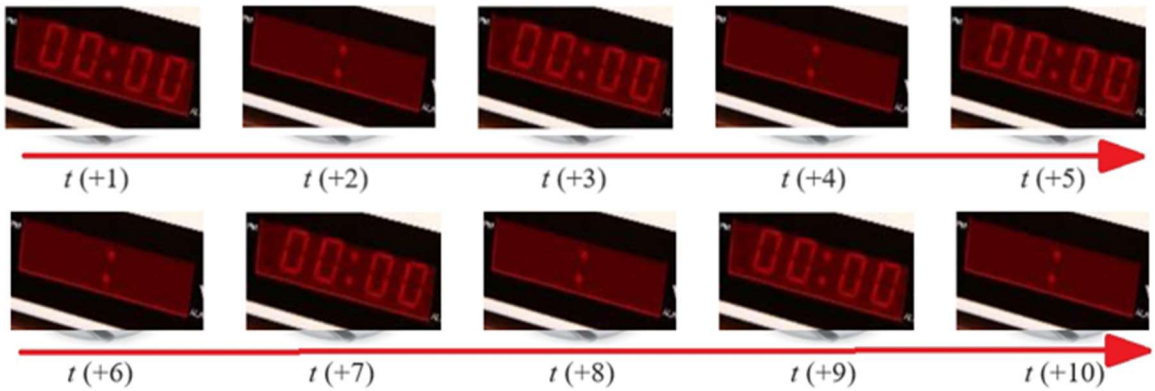
That illusions may and should be studied is beyond dispute. The difficulty does not lie in the investigation of possible perceptual effects as such, but in treating speculative perceptual failures or instabilities as primary explanatory targets. Scientific progress is better served by rigorously examining what perceptual systems are functionally organized to do than by cataloguing hypothetical modes of error generated by inappropriate theoretical expectations.

From this perspective, it becomes clear that the Duck–Rabbit figure does not reveal a deficiency of the perceptual system, but instead exposes the limitations of a theoretical framework that fundamentally misconstrues perceptual function. When perception is understood as a permanently operating comparison system that evaluates changes across adjacent temporal frames in the service of action, the Duck–Rabbit figure is processed exactly as expected. The concept of *illusion* thereby loses its explanatory value and functions primarily as a historical label for phenomena that fail to conform to an incorrect theoretical premise, rather than as an insight into perception itself.

Perception Organs Are Mainly Comparison Organs

The entire current discourse on conscious visual (and also auditory) perception overlooks a fundamental issue. Long before organisms developed any interest in what exactly was moving, they were solely interested in if something visually or auditorily moved. In order to establish contact (for feeding or mating) or to avoid contact (being eaten) of that environmental movement with their own egocentric movement which completely corresponds with the fight-or-flight narrative. For all organisms, the perception of pure motion in the environment—relative to the self (as described by Gibson)—holds the highest ecological and evolutionary value. Initially, we do not need to know what is moving, only that something is moving (potentially toward us).

This principle becomes evident in the example of a digital clock after a power outage. When the zeros on the display begin blinking, the perception of the first set of zeros have absolutely no relationship with subsequent sets of zeros. They only gain meaning through comparison.



This provides definitive scientific evidence that our perceptual organs/systems are, above all, comparison systems. Such comparison systems operate continuously; they do not require activation and therefore impose no reaction-time limitations on their earliest perceptual stages. Even more crucial is the implication derived from Gibson's notion of direct perception: motion is perceived consciously the very moment our eyes open.

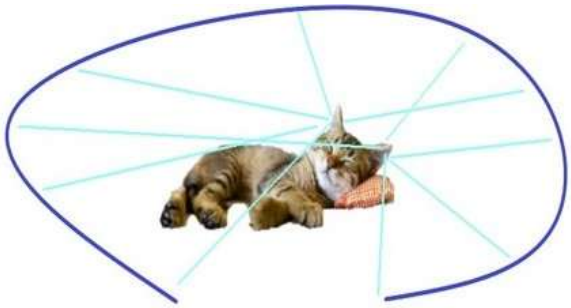
This requires a major paradigm shift in the science of perception: 1. Visual perception involves multiple autonomous phenomena, 2. All perceptual organs and systems are, in their essence, comparison systems—continuously relating separate, successive temporal images (as in a flipbook). In other words, all perceptual systems are fundamentally designed to, first and foremost, consciously detect movement, and 3. Zero-motion, as with stationary objects (e.g., the blinking zeros of a digital clock), is perceived just as actively as actual motion.

Crucially, the perception of the blinking zeros remains a perception of their motion, regardless of any later recognition that the shapes represent numerical digits. Object recognition forms a fully autonomous layer that is added on top of—rather than replacing—the ongoing motion-based comparison. Thus, the perceptual system maintains both processes in parallel: the continuous detection of change and the later, independent identification of what the changing pattern happens to be.

The Complete Ecological Account of Attention

The complete ecological explanation of all attentional foci encompasses one auditory and four visual phases of increasing specificity. Audition provides an initial 360° deviation detector. Visual phase 1 registers the first divergent point in the vista; phase 2 determines whether it reflects genuine motion and whether its latent continuation may intersect with the organism. Phase 3 identifies the object and uses its action trajectory shape and *tau*-value to project its continuation. Phase 4 refines this projection for time-critical motor preparation.

I. Auditory Phase



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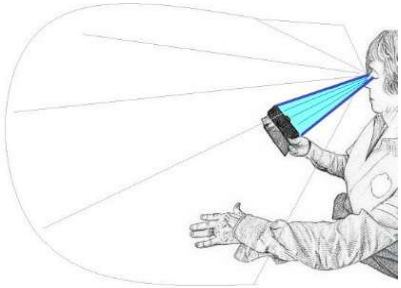
The primary level of motion detection encompasses the auditory attentional processes. They cover a 360° auditory field, which marks the lateral positioning of the ears—situated at the sides of the head, in relation to the eyes, close to the brain, and always active (even during sleep). During sleep (fig. 1) they remain functioning, albeit in a more basal form, which is far more parsimonious than keeping both eyes and ears fully engaged at all times. Note the by far strongest level of reduction (fig. 2): from the auditory detection phase of the ears (blue) to the peripheral visual attention phase of the eyes (red).

II. Visual Attention Phase 1a

Goal: Reduce peripheral visual attention from the entire vista to one point c.q. an extremely restricted region[3].



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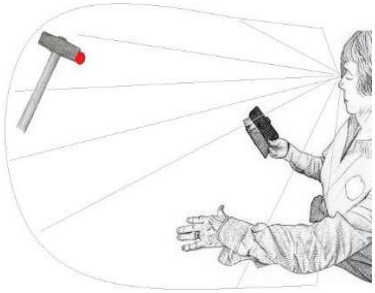

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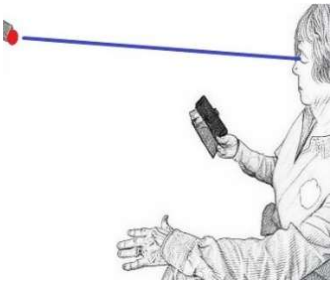

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Illustrations: *Within the Rubber Hand Illusion*[4] *a hammer suddenly appears within the visual field attacking the (rubber) hand.*

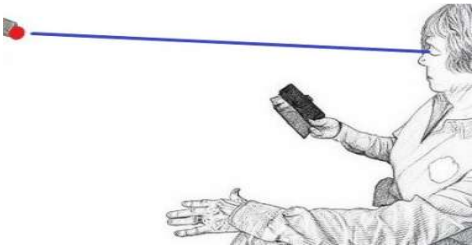
While direct gaze is directed at a book or a phone (fig.1), peripheral vision remains continuously attentive. This peripheral visual attention does not have to be activated; it is continuously present whenever

[3] The ecological primary objective within an optimization process.

[4] https://www.researchgate.net/publication/397770908_The_Complete_Mechanistic_Clarification_of_The_Rubber_Hand_Illusion_-_Why_External_and_Internal_Hand_Perception_Are_Autonomous_and_Cannot_Be_Unified_Without_Motor_Action

the eyes are open and forms the baseline condition that enables phase 1a to occur. Within this remaining vista, the first level of visual motion detection concerns only whether *any* significant deviation occurs. At this stage, the system registers merely a detectable difference across adjacent temporal frames within the peripherally covered field. It is therefore *not* yet concerned with whether the stimulus is a hammer, nor whether it is moving. Figure 2 is therefore not an accurate representation of this first level of visual motion detection; Figure 3 illustrates it much better by depicting the hammerhead as an abstract red dot, emphasizing once more that this phase concerns only the appearance of the dot itself.

In this phase, object recognition is entirely irrelevant, and no motion is yet extracted. The initial appearance of an environmental object—the emergence of the first deviant pixel—serves exclusively to delimit the vista. In the case of the Pong[5] game, we may know that the appearing dot must be the ball, but that is not the purpose of this phase. Its only function is to achieve the ultimate reduction of the visual field. This reduction does not arise from an initiated attentional shift but from an always-operational comparator system that is permanently active once the eyes are open.



When the eyes are open, this visual attention—just like the ever-present auditory attention—is always active, because our perceptual processes are implicitly developed to this goal. We are continuously capturing c.q. catching the entire vista, and so the conscious registration of this entering movement is direct. The transition to phase 1b therefore does not reflect the activation of a new attentional state but merely a refinement of this continuously operating baseline comparison process.

Although this phase involves a more detailed visual examination of the detected vista change, auditory perception remains continuously active as a general monitoring system. From an ecological perspective, anything in the environment can develop into a potential threat and must therefore be signaled as early as possible within the broadest possible field. The auditory system thus remains globally engaged, providing an ever-present 360° deviation detector that continues to operate while visual refinement progresses.

III. Visual Attention Phase 1b

Goal: Convert peripheral visual attention focused on a single point into peripheral visual attention focused on the *movement* of that point[6]. Visual attention phases 1a and 1b are tightly linked in temporal duration. Phase 1b, however, clearly *follows* phase 1a. Both phases are characterized by the fact that object recognition is not yet relevant.

[5] https://www.researchgate.net/publication/393795043_All_functional_perception_processes_in_relationship_to_PONG?_sg%5B0%5D=MWLOACaRyovQ-Qutu-udxE0V_rpgcFIWF1Y4-NxwJogcOAnYInwhV-4wfisP1HMKCFL5dxaUm33S-qNWu8uurkvq8fq5nxLwISak3zWw.qB--dcOSexBo7MiS-jTZMKzlmNsVZYKiQfBDJKPb8TNszhc7KxekMrUvJVSi67-CcMqJPv09D3uDPA-d5KAm8GA&_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6ImhvbWUiLCJwYWdlIjoicHJvZmlsZSIsInByZXZpb3VzUGFnZSI6InByb2ZpbGUiLCJwb3NpdGlvbiI6InBhZ2VDb250ZW50In19

[6] Visual attention, as used in this model, does not refer to a triggered resource or selective activation process. It denotes a continuously active baseline comparator present whenever the eyes are open.

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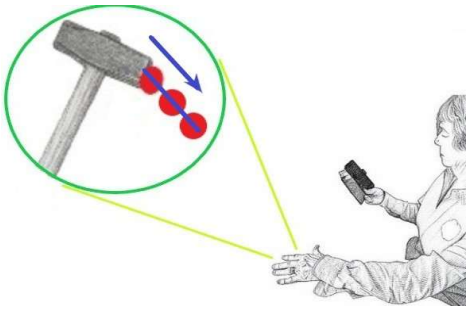

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Illustrations: *The core of the renewed paradigm demonstrated here is that every movement c.q. every perception of movement must originate from the previous positions of the action object. Which has never been sufficiently recognized in vision science. All perceptual registrations of the motion of the pong ball*[7] *or of the hammer are therefore always connected in line segment shapes, reflecting the fundamental conclusion that our perceptual system is primarily a comparison system for movement.*

In this subsequent phase, the system determines solely whether the detected point continues into actual motion and whether that motion may generate a potential point of intersection with the organism's own movement. At this stage the stimulus remains an UMO (unidentified moving object). The system compares only the earliest adjacent time frames[8].

From the manifest positions of the UMO, one can draw a line to the current position, enabling the organism to form a perceptual representation of the latent part of this *action trajectory shape*. If this perceptual projection suggests that the latent trajectory may intersect with the body's own movement, the organism will, out of caution, often withdraw the hand pre-emptively.

Although this phase involves a more detailed visual examination of the detected movement, auditory perception—together with the continuously operating detection of any vista-wide change—remains active as a general monitoring system, as mentioned within the previous paragraphs. From an ecological perspective, anything in the environment may develop into a potential threat and must therefore be registered as early as possible across the broadest possible field. The auditory system thus remains globally engaged, functioning as an ever-present 360° deviation detector that continues to operate while visual refinement progresses.

Motion Recognition versus Object Recognition

The explanatory model of the motoric movement action provides a definitive account of all attentional foci within visual perception. On the one hand, it confirms established findings in current vision science that object recognition is relatively slow, typically emerging around ~400 ms. On the other hand, it introduces several novel insights, most notably that the visual recognition of pure motion (>30 ms) is fast, continuously active, and always operational.

The model shows that motion recognition and object recognition form autonomous components of the attentional perceptual processes and do not exclude one another. Thus, even when object recognition becomes active, the detection of motion within the vista continues independently.

The primary aim of this article is to convey these autonomous principles. In this boxed section, it is explained that object recognition may already take place—or, at the very least, may be decisively

[7] All functional perception processes in relationship to PONG – page 7

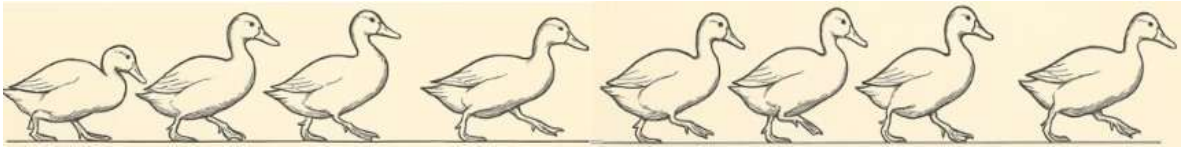
[8] The above shown images to illustrate this process probably show far too many positions of the pong ball and the hammer.

guided—by prior recognition of pure motion. Before a hare or a duck has actually been identified as an object, such a conclusion may already have been inferred from the specific movement characteristics of the action object.

Illustrations[9]**:** *When it is established that a hare is moving within a vista, the fast and slow autonomous visual perceptual processes can be distinguished as well. The realization that something is moving c.q. that something occupies successive positions becomes apparent very rapidly, whereas the recognition of that moving "something" as an object, in this case a hare, emerges more slowly. These remain distinct and autonomous phases. However, through acquired cognitive knowledge, it becomes possible to associate a specific movement idiom with a particular action object. Thus, even if the hare has not yet been visually identified or recognized as such, one may already infer from its characteristic movement pattern that it must be a hare, or at least a hare-like entity.*

The perception of (external) motion is ecologically developed primarily to estimate, from the manifest positions P of an action object, the latent part of its action trajectory shape c.q. its near-future positions.. The action trajectory shape of an external environmental object may potentially yield a point of intersection with the observer's own egocentric action trajectory and must therefore be detected and evaluated.

At this stage, no account is given of how the recognition of motion c.q. the specific movement pattern of an action object may relate to object recognition and thereby allow object recognition to proceed more rapidly than explained above. The interaction between the (qualitative) perception of a specific movement idiom and definitive object recognition c.q the perception of the specific environmental object is merely identified in this blocked section.



Illustrations: *When it is established that a duck is moving within the vista, the same two autonomous visual perceptual processes, a fast and a slow one, can be distinguished. As with the hare, most observers recognize the movement idiom of a duck almost immediately and will already have associated this idiom with a duck before the "abstract moving entity" is definitively recognized as such. It should be noted, however, that there is a substantial difference in tau-values between the rates at which a hare and a duck fill their respective action trajectory shapes, reflecting the pronounced difference in their movement dynamics.*

[9] Alfred Brehm: https://archive.org/details/brehmstierlebena11breh/page/n21/mode/2up

From these examples it follows that an interaction may arise which, under the same observation, can produce a clear difference in perceptual outcome. At the same time, the examples show that hybrid forms may occur, or that under identical observational conditions no interaction emerges at all between movement-pattern recognition and object recognition.

This latter conclusion can be reformulated into the ecological observation that early movement-idiom recognition can give rise to a powerful reduction process. On the basis of specific movement characteristics and object-specific *tau*-values, one can very rapidly conclude—negatively—that a moving entity is certainly not a hare when observing a duck, and conversely not a duck when observing a hare. This occurs "long before" object recognition, which typically takes place much later around ~400 ms and can therefore accelerate the object-recognition process by providing strong directional constraints.

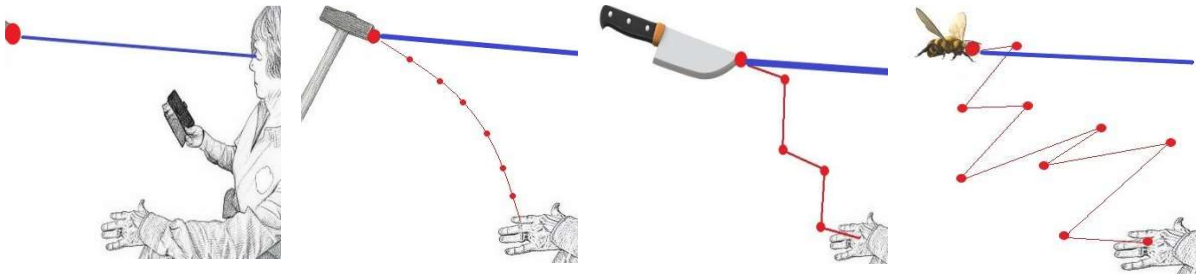
This mechanism is directly comparable to the perception of zero motion. When entering a new environment, the entire vista is initially parsed into moving and non-moving points or pixels. We very rapidly recognize whether something is absolutely stationary and will not move at all. Although this does not yet reveal whether the perceived object is f.e. a coffee cup or a stuffed hare, it nevertheless produces a substantial reduction of possible interpretations.

Illustrations: *The rapid observation of the movement idiom of an unfamiliar environmental object can contribute to a reduction process before a hare or a duck is actually visually recognized. In the same way, a substantial reduction can be initiated by observing absolute absence of motion. We recognize absolute zero motion in an as-yet unknown environmental object in such a way that we still do not know whether it is a coffee cup or a stuffed hare, yet a large number of possible interpretations are already excluded.*

This reduction process operates independently of explicit object identification and conscious categorization and reflects an ecologically primary perceptual mechanism optimized for early constraint of possible action-relevant interpretations.

IV. Visual Attention Phase 2

Goal: To transition from peripheral detection of confirmed movement (phases 1a and 1b) into direct focal vision, where the moving action object is recognized and the manifest portion of the action trajectory shape, including its *tau*-value, is constructed with greater precision..

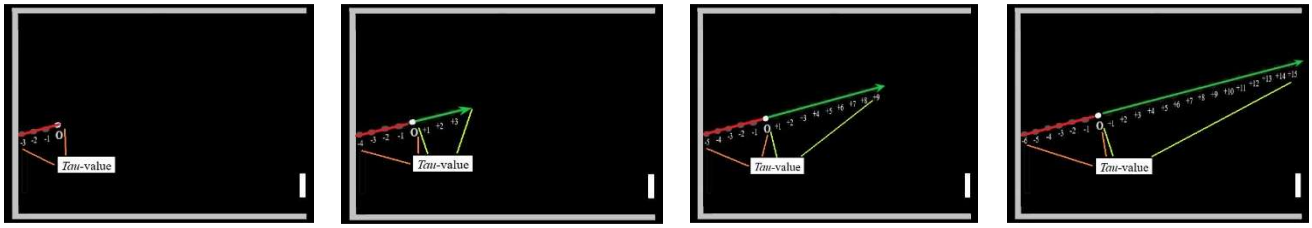


Illustrations: *The recognition of what exactly is moving provides additional information about both the shape and the tau-value of the relevant action trajectory. Thus, object recognition is essential, but it must be understood within an entirely different framework: its ultimate purpose remains to determine how the object's movement relates to the organism's (future) egocentric movement. So recognizing the future movement of a hammer, a knife, or a bee has far-reaching consequences.*

By explicitly identifying phases 1a and 1b as consciously distinct phases dedicated solely to the detection of movement, it becomes evident why object recognition emerges only later. Not every detected movement poses a threat, and therefore no energy needs to be expended unnecessarily—a principle that fits seamlessly within an ecological perspective.

However, when the movement detected in phases 1a and 1b exceeds a certain threshold, further visual investigation becomes necessary. Naming or identifying the specific action object must then provide essential information—*in relation to the developing action trajectory shape and its tau-value*—for determining how the trajectory will continue.

We possess extensive cognitive knowledge concerning the characteristic action trajectory shapes and *tau*-values of many different types of action objects. The explanatory model of the motoric movement action has demonstrated, across a wide variety of actions, how a perceptual representation of the latent part of the action trajectory—including its *tau*-value—arises directly from the manifest portion.



Illustrations: *The explanatory model of the motoric movement action shows that the movements of any conceivable action object (i.e., a pong ball[10], hammer, knife, or bee) must always originate from earlier positions. All perceptual registrations of actual movement (in red) therefore necessarily become part of a line-structured representation. Factually it follows that the latent portion of the trajectory (green) must arise from the manifest part. This applies both to its shape (x-axis form) and to its tau-value, related to time-to-contact (TTC).*

The greatest scientific breakthrough lies in the recognition that the successive positions of an action object must always originate from one another. As a direct consequence of the continuous visual attention to movement—i.e., the continuous comparison of adjacent time frames of the action object—all movement is necessarily perceived in the form of an action trajectory shape. It can therefore be

[10] All functional perception processes in relationship to PONG – page 8 & page 12.

established that the latent part of the trajectory must arise from the manifest part, both in its geometric form (x-axis structure) and in its *tau*-value, which is intrinsically linked to time-to-contact (TTC).

Consequently, we do not perceive the movement of the pong ball, hammer, knife or bee as a series of isolated points; rather, we perceive a moving object embedded within a single overarching projective structure. The perception of motion thus presupposes a unifying framework in which spatial succession is integrated into a coherent temporal experience, rather than being registered as a sequence of disconnected events.

Although this phase provides a more detailed specification of the detected movement, all other perceptual phases remain simultaneously operational. Newly arising sounds and any vista-wide changes indicating additional threats continue to be monitored without interruption, as the broader comparator architecture remains continuously engaged.

V. Visual Attention Phase 3

Goal: Continuously update the latent action trajectory, because predictive coding is only an approximation. The system must track the movement of the action object—and the required egocentric response—until the final moment of contact.

The perceptual processes described in the previous phase must remain active until the end of the action, because predictive coding of the latent part of the *action trajectory shape* provides only an estimate of the probability boundaries of future fluctuations. It is part of an optimization process that can predict the future positions *P* of the action object within a certain bandwidth with considerable accuracy, yet never exactly. Perception can make a reasonable assumption about the future, but never determine its precise unfolding; the action object will always deviate—infinitely—from the predicted segment.

Therefore, the incoming pong ball, hammer, knife, or bee must be visually mediated up to the very last moment, exactly as described in phase 2, and must be answered with an egocentric movement that either blocks the threat or avoids it (fight or flight). In the case of Pong[11], both the movement of the ball and the egocentric movement of the paddle must be mediated by the cortical streams until the final instant. With respect to visual attention, this means that the perceptual process does not cease until the entire attack or incoming movement is fully completed.

Although this phase is a continuation of the previous phase, all other perceptual phases remain simultaneously operational. Newly arising sounds and any vista-wide changes indicating additional threats continue to be monitored without interruption, as the broader comparator architecture remains continuously engaged.

[11] All functional perception processes in relationship to PONG.

References:

Amerio, P., Michel, M., Goerttler, S., Peters, M. A. K., & Cleeremans, A. (2024). *Unconscious perception of vernier offsets*. **Open Mind, 8**, 739–765. https://doi.org/10.1162/opmi_a_00145

Amir, D., & Firestone, C. (2025*). Is visual perception WEIRD?* Journal of Experimental Psychology. https://psycnet.apa.org/record/2026-18054-001

Alais, D., & Burr, D. (2004). *The ventriloquist effect results from near-optimal bimodal integration*. **Current Biology, 14**(3), 257–262. https://doi.org/10.1016/j.cub.2004.01.029

Békésy, G. von. (1960). *Experiments in Hearing*. McGraw–Hill.

Bermond, B., Van Heerden, J. *The Muller-Lyer illusion explained and its theoretical importance re-considered*. *Biol Philos* 11, 321–338 (1996). https://doi.org/10.1007/BF00128785

Bruno N, Franz VH. *When is grasping affected by the Müller-Lyer illusion?* A quantitative review. Neuropsychologia. 2009 May;47(6):1421-33. doi: 10.1016/j.neuropsychologia.2008.10.031

Carrasco, M. (2011). *Visual attention: The past 25 years*. Vision Research, 51(13), 1484–1525. https://doi.org/10.1016/j.visres.2011.04.012

Castanheira, J. da S., Shea, N., & Fleming, S. M. (2025). *How attention simplifies mental representations for planning*. **eLife** (advance online publication). https://doi.org/10.7554/eLife.108034.1

Cleeremans, A., Mudrik, L., & Seth, A. K. (2025). *Consciousness science: Where are we, where are we going, and what if we get there?* **Frontiers in Science, 3**, 1546279. https://doi.org/10.3389/fsci.2025.1546279

Cleeremans, A., & Tallon-Baudry, C. (2022). *Consciousness matters: Phenomenal experience has functional value*. **Neuroscience of Consciousness, 2022**(1), niac007. https://doi.org/10.1093/nc/niac007

Fleming, S. M., & Michel, M. (2025). *Sensory horizons and the functions of conscious vision*. **Behavioral and Brain Sciences**, 1–53. https://doi.org/10.1017/S0140525X25000068

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Houghton Mifflin.

Green, D. M., & Swets, J. A. (1966). *Signal Detection Theory and Psychophysics*. Wiley.

Kahneman, D., & Treisman, A. (1980). *Changing views of attention and automaticity.* In R. S. Nickerson (Ed.), *Attention and Performance VIII* (pp. 29–61). Erlbaum.

Lee, D. N. (1976). *A theory of visual control of braking based on information about time-to-collision*. **Perception, 5**(4), 437–459. https://doi.org/10.1068/p050437

Leopold, D. A., & Logothetis, N. K. (1999). *Multistable phenomena: Changing views in perception.* **Trends in Cognitive Sciences, *3*(7), 254–264.** https://doi.org/10.1016/S1364-6613(99)01332-7

Luce, R. D. (1986). *Response Times: Their Role in Inferring Mental Organization*. Oxford University Press.

McCauley, R. N., & Henrich, J. (2006). *Susceptibility to the Müller-Lyer illusion and theory-neutral observation.* **Philosophical Psychology, 19(1), 79–101.** doi/abs/10.1080/09515080500462347

Miall, R. C., & Wolpert, D. M. (1996). *Forward models for physiological motor control*. **Neural Networks, 9**(8), 1265–1279. https://doi.org/10.1016/S0893-6080(96)00035-4

Michel, M. (2023). *How (not) to underestimate unconscious perception*. **Mind & Language, 38**(2), 413–430. https://doi.org/10.1111/mila.12406

Michotte, A. (1954). *La Perception de la Causalité*. Publications Universitaires de Louvain.

Peterson, M. A., & Gibson, B. S. (1994). *Must figure-ground organization precede object recognition? An assumption in peril.* **Psychological Science, 5(5), 253–259.** https://doi.org/10.1111/j.1467-9280.1994.tb00622.x

Posner, M. I. (1980). *Orienting of attention*. **Quarterly Journal of Experimental Psychology, 32**(1), 3–25. https://doi.org/10.1080/00335558008248231

Regan, D., & Gray, R. (2000). *Visually guided collision avoidance: Time-to-collision is faster than optical tau*. **Journal of Experimental Psychology: Human Perception and Performance, 26**(2), 303–321. https://doi.org/10.1016/S1364-6613(99)01442-4

Sanders, A. F. (1998). *Elements of Human Performance: Reaction Processes and Attention in Human Skill*. Erlbaum.

Shelton, J., & Kumar, G. P. (2010). *Comparison between auditory and visual simple reaction times*. **Neuroscience & Medicine, 1**(1), 30–32. https://doi.org/10.4236/nm.2010.11004

Simons, D. J., & Rensink, R. A. (2005). *Change blindness: Past, present, and future*. **Trends in Cognitive Sciences, 9**(1), 16–20. https://doi.org/10.1016/j.tics.2004.11.006

Sterzer, P., Kleinschmidt, A., & Rees, G. (2009). *The neural bases of multistable perception.* ***Trends in Cognitive Sciences, 13*(7), 310–318.** https://doi.org/10.1016/j.tics.2009.04.006

Stockart, F., Schreiber, M., Amerio, P., Carmel, D., Cleeremans, A., Mudrik, L. (2025). *Studying unconscious processing: Contention and consensus*. **Behavioral and Brain Sciences**. https://doi.org/10.1017/S0140525X25101489

Warren, W. H. (2006). *The dynamics of perception and action*. **Psychological Review, 113**(2), 358–389. https://doi.org/10.1037/0033-295X.113.2.358

Weidner, R., & Fink, G. R. (2007). *The neural mechanisms underlying the Müller-Lyer illusion. Cerebral Cortex, 17(4), 878–884.* https://academic.oup.com/cercor/article/17/4/878/376930