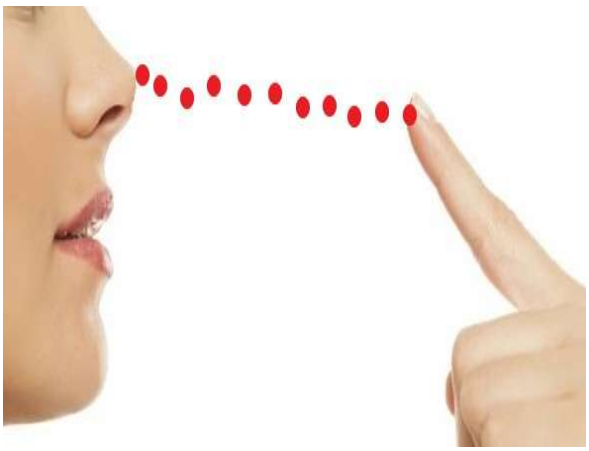
Touching the Nose Without Seeing It: How We Guide, Sometimes Miss, or Intentionally Can Halt the Action Just Before Contact



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

N.J. Mol

Contact: kwillinq@gmail.com
https://www.researchgate.net/profile/Nj-Mol/research
https://www.explanatorymodel.nl/

Abstract

Touching the tip of the nose without visual feedback presents a compelling challenge to dominant theories of motor control, predictive coding, and action planning. Classical frameworks such as predictive coding, efference copy, and motor imagery suggest that once a motor command is internally generated, execution unfolds automatically. However, while a finger-to-nose movement can sometimes be completed accurately, it frequently misses the target—and, crucially, can also be consciously halted just before contact. These latter phenomena expose fundamental flaws in the classical frameworks, to the extent that they must be reconsidered, if not rejected outright.

This paper introduces a novel explanatory framework in which the brain constructs egocentric representations of action trajectory shapes guiding the finger toward the nose. In which it is crucial that we consider the position of the nose within a tactical deliberation prior to the execution, but that during the execution we are solely occupied with the dynamic bridging process between the fingertip and the nose. This internal pathway remains cognitively interruptible, allowing for both volitional stopping and natural deviation, even under full motor preparation.

The model further incorporates tau-based perception—the ongoing estimation of time-to-contact—to explain modulation of speed and intensity as the fingertip nears its destination. Importantly, this approach challenges assumptions within models such as Vickers' The Quiet Eye (TQE) framework, which equates longer gaze durations with higher motor success. In contrast, our findings reveal that no amount of preparation or focus guarantees successful execution: even in optimal internal states, the system may still produce misses due to mapping drift, proprioceptive noise, or subtle control variability.

This framework redefines how volitional action, inhibition, and spatial representation interact in self-directed behavior, and provides a falsifiable alternative to deterministic motor models in neuroscience.

Introduction

The act of touching the nose with the index finger has long served as a clinical benchmark in neurology, used to assess cerebellar integrity, proprioceptive accuracy, and motor control stability (Schmitz-Hübsch et al., 2006; Ilg et al., 2007). Despite its apparent simplicity, the finger-to-nose task reveals striking cognitive complexity. When performed in the absence of visual or auditory feedback, the task becomes a powerful probe into how humans internally model, plan, and execute spatially guided actions.

The prevailing theories in cognitive neuroscience—predictive coding (Friston, 2005), efference copy and forward models (von Holst & Mittelstaedt, 1950), and motor imagery (Jeannerod, 2001)—generally assume that once a motor plan is formed, the body carries it out through feedforward pathways

with minimal flexibility. These frameworks emphasize prediction-matching and outcome simulation, suggesting that success is a function of how well internal models align with expected sensory consequences (Wolpert et al., 1995; Shadmehr et al., 2010).

Yet even under ideal conditions, individuals miss the tip of their nose, or can halt the movement just before contact, despite fully forming and preparing the action. This contradicts the notion that internal planning guarantees successful execution. Moreover, it calls into question the broader assumption—found in motor learning literature such as Vickers' The Quiet Eye (TQE) model (1996, 2007)—that longer gaze durations or attentional focus correlate reliably with better motor outcomes. While TQE has demonstrated relevance in sports and aiming tasks, it implicitly assumes that attention ensures success. In contrast, self-directed motor actions like the finger-to-nose gesture routinely show failure or interruption, even in the absence of sensory uncertainty.

To address this, we present an alternative account based on spatiotemporal motor templates. In this model, the motor system constructs egocentric action trajectory shapes, guiding the finger through body-relative space towards the nose. Execution is not allocentric target-driven in a ballistic sense, but rather relies on egocentric bridging across a perceptual image of an action trajectory shape. This perspective reframes movement not as a fixed output, but as a dynamically selectable and interruptible process—one that incorporates real-time monitoring via tau-based timing (Lee, 1998).

As such, the model accounts for three core observations: 1) successful, accurate contact; 2) erroneous misses despite planning; and 3) conscious inhibition just prior to execution. It thereby provides a comprehensive and falsifiable framework that bridges cognitive motor control, embodied representation, and the limits of prediction-based models.

Part 1

The perception of action trajectory shapes

The explanatory model of the motoric movement action demonstrates convincingly that within every conceivable action, a perceptual image of a latent action trajectory shape is always created first, before the action can even be executed. It shows this with scientific evidence and an abundance of logical reasoning.

A true novelty within this explanation concerns that the end of the trajectory shape is evaluated within the preceding *tactical movement action* (TMA), but that it is equally essential to take the bridging process into account. This bridging process constitutes the very essence during the actual execution, the *factual movement action* (FMA), and that has been completely overlooked by science.

The explanation shows that precisely this egocentric process requires the double and reciprocal mediation of the cortical streams, and it demonstrates that without a perceptual image of an action trajectory shape, nothing could ever be executed — and that it always happens implicitly, even when one consciously tries to deny the existence of the action trajectory shape.

In this part, a various range of motoric actions become clarified, all of which display the aforementioned universal principles and the multitude of perceptual processes that are inevitably coupled to them. The explanation proceeds from the example of grasping a coffee cup toward motoric actions involving one's own body. Within that discussion, it becomes evident that *self-tickling* is no exception to these universal principles, and that we will never be able to tickle ourselves.

A. Motor actions with an External Environmental Object

To fully unravel the phenomenon of action trajectory shapes, motoric actions are divided into two groups: 1. Actions involving an external environmental object, and 2. Actions involving one's own body part as the environmental object.

It will be shown that the perceptual processes regarding the creation and execution of the action trajectory shapes do not differ within this twofold division. All actions can only be executed if a perceptual image of a latent action trajectory shape has been created. Without such a line, an action cannot begin.

This simultaneously touches upon a *novum* that emerges within its explanation: the action trajectory shape indeed has a clear end goal, but it also concerns an autonomous bridging process of all places *P* of the end-effector between the starting point and the endpoint of the action trajectory shape. This fact is equally essential within our perceptual processes and has never before been recognized within science.

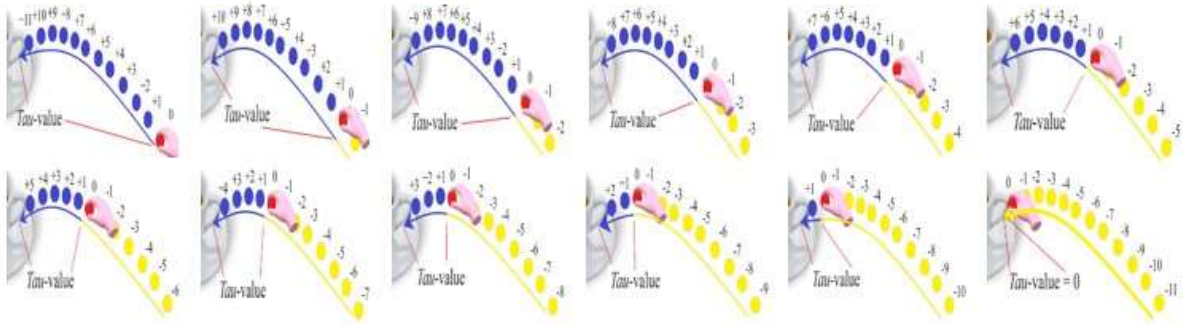
Furthermore, it demonstrates that in the execution of actions directed toward one's own body, proprioceptive perception can be far more dominant and is even capable of executing actions autonomously. Which also reveals the *novum* that proprioceptive perception will always remain present in a hybrid form, even when the action can be performed through visual perception.

1. Grasping a Coffee Cup[1]

The explanatory model of the motoric movement action shows, with scientific evidence[2], that before the actual execution of grasping can take place, a latent action trajectory shape is always created between the current position of the fingertips and the cup. It thereby provides a final answer to the entire scientific issue concerning *predictive coding*, *predictive processing*, and *prediction errors*, and shows with the formation of this action trajectory how grasping is afforded and how, during its actual execution, it is mediated online.

It is furthermore demonstrated that we can only execute the exclusively external line from the fingertips by means of internal bodily movements[3]. The outer surface of the fingertips consists of living cells, yet they can't be moved there. The movements belong to two entirely separated worlds, therefore concerning two foci, and thus the internal and external perception are completely autonomous.

When grasping a coffee cup, the main purpose therefore concerns the construction of the action trajectory shape as part of the tactical movement action (TMA) and the actual execution of the external action trajectory shape during the factual movement action (FMA) — as that compels the phenomenon that actually reaches the cup — and therefore the primary focus must be directed toward it. The internal bodily movements are only important for realizing this main goal and therefore concern the secondary focus, which must accordingly be directed toward that action trajectory shape.



Illustrations: *From any random position P of the fingertips, prior to factually grasping a coffee cup, a perceptual image is constructed of a successful latent action trajectory shape. Within that tactical processing — the tactical movement action (TMA) — the eventual grasping is considered, but, equally essential, it is determined whether the bridging process can take place through a continuous sequence of positions of the fingertips. This represents the very essence of the great omission within scientific thinking. The tactical deliberation encompasses the environmental object but the factual execution of that task in its ecological and evolutionary essence concerns the reduction of the number of places between the fingertips and the coffee cup. The perspective within this motor action must therefore be regarded out of the fingertips, and not out of the coffee cup.*

[1] https://www.explanatorymodel.nl/common-daily-actions/grasping
[2] https://www.explanatorymodel.nl/common-daily-actions/grasping/within-the-grasping-of-a-coffee-cup-we-always-first-construct-a-perceptual-image-of-a-latent-action-trajectory-shape-out-of-the-perspective-of-the-finger-tips-the-scientific-evidence
[3] https://www.explanatorymodel.nl/common-daily-actions/grasping/grasping-requires-a-compelling-collaboration-between-an-internal-and-an-external-focus

Due to the two autonomous foci, a peculiar figure arises during the act of grasping a coffee cup, just as in every other motoric action. Solely the action trajectory shape — consisting of future fingertip positions — will perform the very essence of the task, yet it can do nothing by itself. It can only be executed by a completely different, autonomous, internal movement.
The explanatory model of the motoric movement action reveals, with this given, the most economical system ever conceivable. It shows that we are able to start moving the fingertips from any random position, to stop them at any moment, to change their path, or otherwise. It shows that with a minimum of means a maximum output can be achieved.

However, there is a price to be paid for this ultimately economical system. Because two autonomous foci are involved in the action, and because the secondary focus must entirely take care of the realization of the pre-imagined action trajectory shape, the fingertips will definitely deviate at every position P from the perceptual image of the latent trajectory we had in mind. We do wish to perform that beautifully straight trajectory we have envisioned, but we simply cannot. The action trajectory shape is not directly controlled but secondarily, and therefore the fingertips will, at every position *P*, infinitely and randomly deviate from the perceptual image of the latent trajectory shape. It is thereby demonstrated that there must be a very heavy correction system present which mediates these deviations. The explanatory model connects them with the processing mechanisms of the perception[4], which do not consist of one, but of two pathways: the ventral and the dorsal stream.

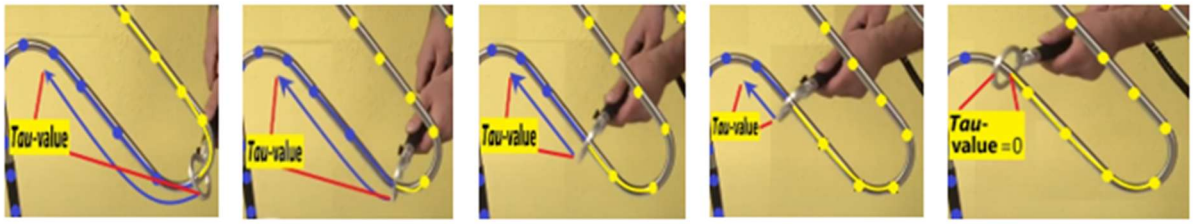
These two streams mediate all deviations within the entire phenomenon of the relationship between fingertips and action trajectory shape, like a marble within a marble run, in a double and reciprocal process. The ventral stream is primarily concerned with the processing of all perceptions toward the entire trajectory shape, while still maintaining awareness of the actual position P(0) of the fingertips. Conversely, the dorsal stream is primarily concerned with the processing of all perceptions toward the actual position P(0) of the fingertips, while maintaining awareness of the entire trajectory shape.

In this double and reciprocal process, the cortical streams correct each other in continuous alternation. They are therefore not activated in exact simultaneity, but because the reaction times are so short, it almost appears as if straight trajectory shapes are being created — which is clearly refuted in the execution of the nerve spiral[5].

The fingertips, in the transversal direction, will at every successive position infinitely and randomly deviate from the trajectory shape. These deviations along the x-axis are defined within the explanatory model as the *zigzag-process*. Likewise, an action object will always, at every successive position, infinitely and randomly deviate from the trajectory shape in the longitudinal direction. These deviations along the y-axis are defined within the model as the *accordion-process*.

These are difficult to visualize in an animation, yet driving a car or cycling without hand brakes provides an exact and tangible example of the autonomy of these two processes.

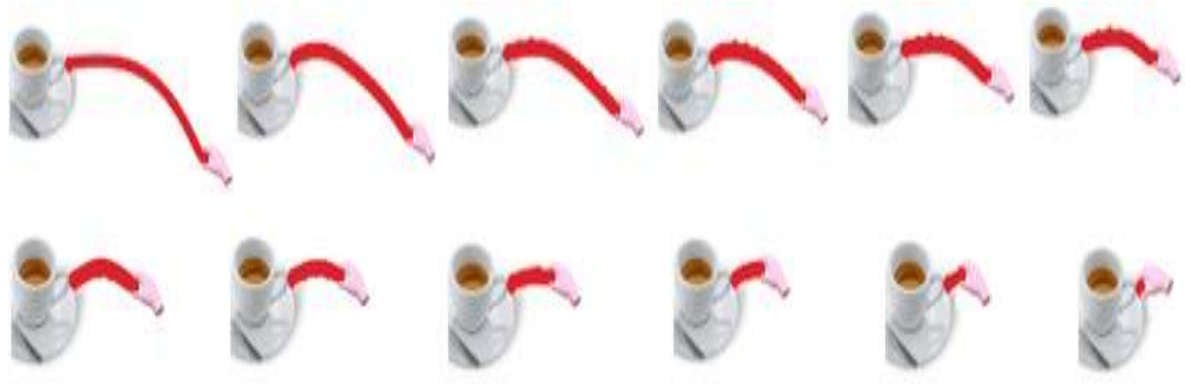
[4] https://www.explanatorymodel.nl/common-daily-actions/grasping/the-explanation-of-the-emergence-of-the-cortical-streams-we-can-only-guide-the-fingertips-to-a-coffee-cup-with-a-zigzag-movement-yet-the-ingenious-mediation-by-the-cortical-streams-creates-the-delusion-of-a-straight-action-trajectory-shape
[5] https://www.explanatorymodel.nl/common-daily-actions/the-nerve-spiral-game



Illustrations: *Within science, it is still often assumed that one can create a straight action trajectory shape. The nerve spiral game shows convincingly that this is impossible and that, on the contrary, it concerns the opposite fact. Namely, that no one will ever be able to perform an identical action trajectory shape in any motoric action whatsoever. We probably create a perceptual image of a smooth action trajectory, but we can simply never execute it in that exact way. The double and reciprocal relationship of the fingertips within the action trajectory shape toward the coffee cup will, just like the ring toward the entire spiral, be continuously adjusted alternately by the ventral and the dorsal stream.*

Illustrations: *Deviations are mediated, within every conceivable motoric action, in two autonomous ways: in width (form) and in length (line). It is difficult to visualize this within most actions. However, within driving a car or cycling (without hand brakes), one can clearly and unmistakably observe that the steering wheel can only mediate the zigzag-process, and the pedals can only mediate the accordion-process.*

The explanatory model of the motoric movement action shows that the act of grasping a coffee cup concerns a highly complex system — a system that would receive no ecological grounding at all, if it were not reducible to something very simple.



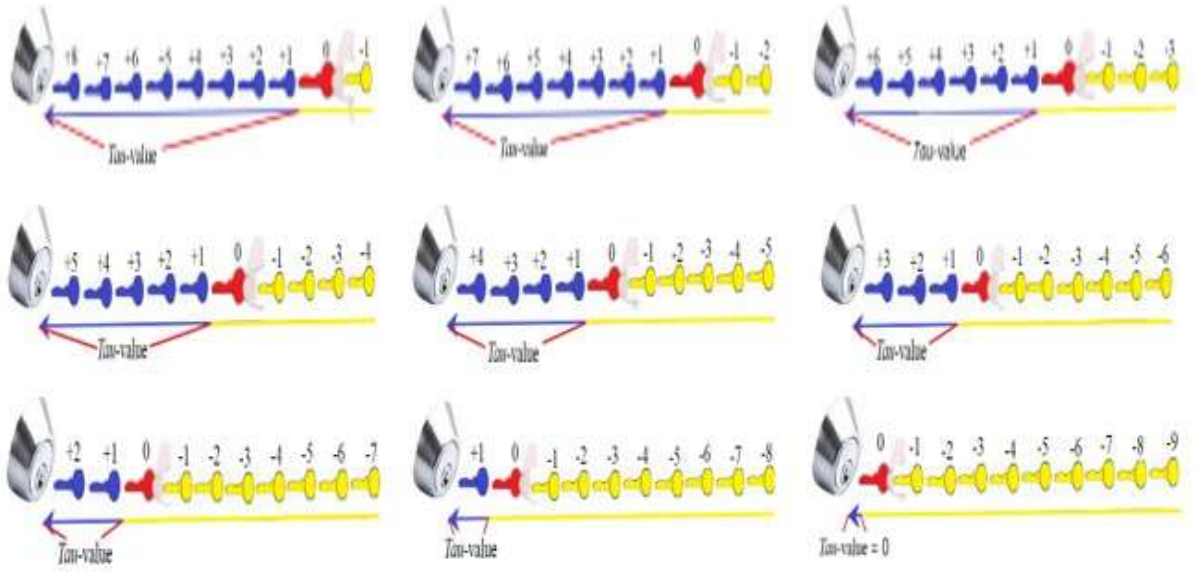
Illustrations: *The explanatory model of the motoric movement action reveals such a complex dynamic system that an ecological approach would have great difficulty with it. Yet, the complex whole can be reduced to one very simple phenomenon: the mere observation of the disappearance of a line segment. This is analogous to the disappearance of the gap as described by D. N. Lee within his tau-coupling theory.*

It must be remarked that under normal circumstances we observe the closing of the gap between the fingertips and the cup visually. But that is not the whole truth. In the subsequent explanations concerning the opening of a lock with a key, it will become abundantly clear that one primarily perceives the closing of the gap through visual perception. Nevertheless, proprioceptive perception will always remain present in a hybrid form. Thus, even though one mainly sees the closing of the simple line segment of the gap, one also always feels — proprioceptively — the closing of that same gap as the movement of the fingertips toward the coffee cup.

2. Opening a Lock with a Key[6]

The explanatory model of the motoric movement action has also shown with scientific evidence that, when opening a lock with a key, just as with grasping, there is always first an action trajectory shape constructed between the current position of the key tip and the lock[7]. It has furthermore demonstrated that we can only create the exclusively external line of the movement of the key tip by means of internal bodily movements[8] that extend only up to the outer surface of the key head. The movements belong to two entirely separated worlds, and therefore the internal and external perception are completely autonomous.

When opening a lock with a key, the main issue concerns the construction and execution of the external action trajectory shape — as solely that phenomenon reaches the lock — and therefore the primary focus must be directed toward it. The internal bodily movements are only important for realizing this main goal, and they therefore concern the secondary focus, which must consequently be pointed toward that action trajectory shape.



Illustrations: *From any random position P of the key tip, during the act of opening a lock, a perceptual image is created of a latent action trajectory shape that will be successful. Within that process —*

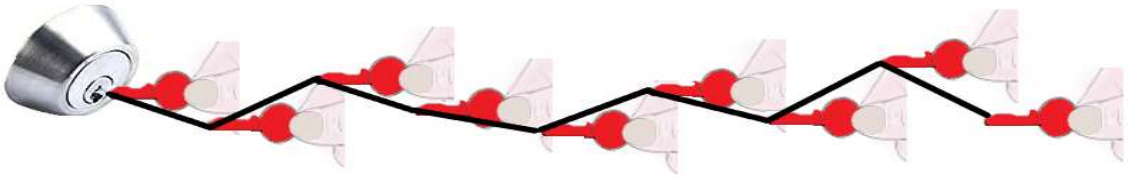
[6] https://www.researchgate.net/publication/382267910_The_complete_clarification_of_all_functional_perception_processes_when_opening_a_lock_with_a_key?_sg%5B0%5D=W6UVo1a1zvrmPd-JFIX4DFmO-XbDhd9aBT1WJ_zcHsUmM8HrJyWec7pU-8HNrL5SAY6n9YjwDrSF3SVVglfxqYcdNIVxLLjBA
[7] https://www.explanatorymodel.nl/common-daily-actions/opening-a-lock-with-a-key/lock-opening-prior-to-opening-a-lock-we-always-first-con-struct-a-perceptual-image-of-a-latent-action-tra-jectory-shape-out-of-the-perspective-of-the-key-the-scientific-evidence
[8] https://www.explanatorymodel.nl/common-daily-actions/opening-a-lock-with-a-key/opening-a-door-lock-with-a-key-requires-a-compelling-collaboration-between-an-internal-secondary-focus-and-an-external-primary-focus

the tactical movement action (TMA) — the eventual insertion into the lock is considered, but, equally essential, it is determined whether the bridging process can take place through a continuous sequence of positions of the key. This represents the very essence of the great omission within scientific thinking. The tactical deliberation encompasses the environmental object but the factual execution of that task in its essence concerns the reduction of the number of places between the key tip and the lock. The perspective of this motor action must therefore be regarded from the key tip, and not from the lock.

Due to the two autonomous foci, a peculiar figure arises during the act of opening a lock with a key, just as in every other motoric action. Solely the action trajectory shape — consisting of future key tip positions — will perform the very essence of the task, yet it can do nothing by itself. It can only be executed by a completely different, autonomous, internal movement. The explanatory model of the motoric movement action reveals, with this given, the most economical system ever conceivable. It shows that we are able to start moving the key tip from any random position, to stop them at any moment, to change its path, or otherwise. It shows that with a minimum of means a maximum output can be achieved.

However, there is a price to be paid for this ultimately economical system. Because two autonomous foci are involved in the action, and because the secondary focus must entirely take care of the realization of the pre-imagined action trajectory shape, the tip of the key will definitely deviate at every position P from the perceptual image of the latent trajectory we had in mind. We do wish to perform that beautifully straight trajectory we have envisioned, but we simply cannot. The action trajectory shape is not directly controlled but secondarily, and therefore the key tip will, at every position *P*, infinitely and randomly deviate from the perceptual image of the latent trajectory shape. It is thereby demonstrated that there must be a very heavy correction system present which mediates these deviations. The explanatory model connects them with the processing mechanisms of the perception[9], which do not consist of one, but of two pathways: the ventral and the dorsal stream.

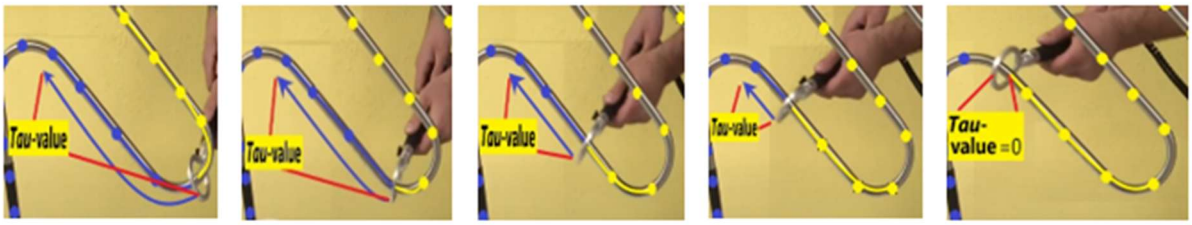
These two streams mediate all deviations within the entire phenomenon of the relationship between the key tip and the action trajectory shape, like a marble within a marble run, in a double and reciprocal process. The ventral stream is primarily concerned with the processing of all perceptions toward the entire action trajectory shape, while maintaining awareness of the actual position P(0) of the key tip. Conversely, the dorsal stream is primarily concerned with the processing of all perceptions toward the actual position P(0) of the key tip, while maintaining awareness of the entire action trajectory shape.



In this double and reciprocal process, the cortical streams continuously correct each other in alternating succession. They are therefore not activated at every time interval simultaneously, but because the reaction times are so short, it almost appears as if straight action trajectory shapes are being created — which is clearly refuted in the execution of the *nerve spiral*[10]. The key tip, in the transversal direction, will at every successive position infinitely and randomly deviate from the trajectory shape. These

[9] https://www.explanatorymodel.nl/common-daily-actions/opening-a-lock-with-a-key/the-explanation-of-the-emergence-of-the-cortical-streams-we-can-only-guide-the-key-toward-a-lock-with-a-zigzag-movement-yet-the-ingenious-media-tion-by-the-cortical-streams-creates-the-delusion-of-a-straight-action-trajectory-shape
[10] https://www.explanatorymodel.nl/common-daily-actions/the-nerve-spiral-game

deviations along the x-axis are defined within the explanatory model as the *zigzag process*. Likewise, an action object will always, at every successive position, infinitely and randomly deviate from the trajectory shape in the longitudinal direction. These deviations along the y-axis are defined within the explanatory model as the *accordion process*. They are difficult to visualize in an animation, yet driving a car or cycling without hand brakes provides a perfect and tangible example of the autonomy of these two processes.



Illustrations: *Within science, it is still often assumed that one can create a straight action trajectory shape. The nerve spiral game shows convincingly that this is impossible and that, on the contrary, it concerns the opposite fact. Namely, that no one will ever be able to perform an identical action trajectory shape in any motoric action whatsoever. We probably create a perceptual image of a smooth action trajectory, but we can simply never execute it in that exact way. The double and reciprocal relationship of the fingertips within the action trajectory shape toward the coffee cup will, just like the ring toward the entire spiral, be continuously adjusted alternately by the ventral and the dorsal stream.*

Illustrations: *Deviations are mediated, within every conceivable motoric action, in two autonomous ways: in width (form) and in length (line). It is difficult to visualize this within most actions. However, within driving a car or cycling (without hand brakes), one can clearly and unmistakably observe that the steering wheel can only mediate the zigzag-process, and the pedals can only mediate the accordion-process.*

The explanatory model of the motoric movement action shows that the act of opening a lock with a key concerns a highly complex system — a system that would receive no ecological grounding at all, if it were not reducible to something very simple.

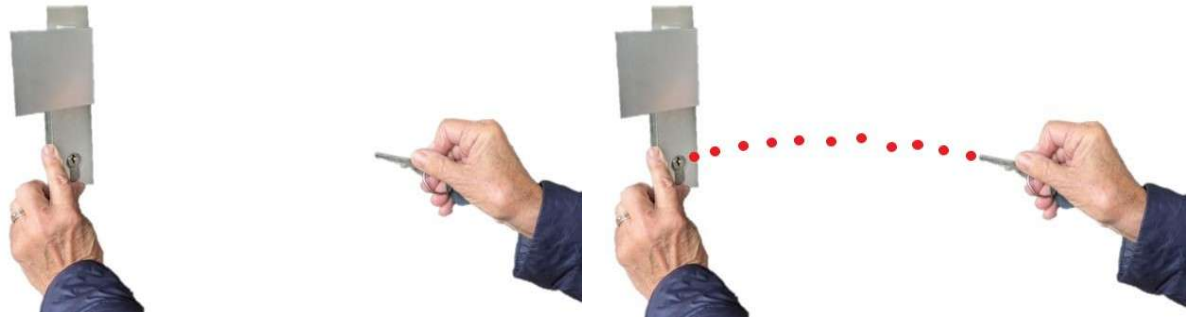
Illustrations: *The explanatory model of the motoric movement action reveals such a complex dynamic system that an ecological approach would have great difficulty with it. Yet, the complex whole can be reduced to one very simple phenomenon: the mere observation of the disappearance of a line segment. This is analogous to the disappearance of the gap as described by D. N. Lee within his tau-coupling theory.*

It must be remarked that under normal circumstances we observe the closing of the gap between the key tip and the lock visually. But that is not the whole truth. In the subsequent explanation concerning the opening of a lock with a key within pitch black darkness, it will become abundantly clear that one primarily perceives the closing of the gap through visual perception. Nevertheless, proprioceptive perception will always remain present in a hybrid form. Thus, even though one mainly sees the closing of the simple line segment of the gap, one also always feels — proprioceptively — the closing of that same gap as the movement of the fingertips toward the coffee cup.

3. Opening a Lock with a Key Within Pitch Black Darkness

The transition from opening a lock in daylight to performing precisely the same task in pitch black darkness will reveal many fundamental aspects. It will show that every motor action is always carried out through a *hybrid* form of perceptual processing. Which stands in sharp contrast to the prevailing assumption within contemporary science. The dominant belief still holds that only one type of perceptual process is involved in a motor action, and that it always occurs in a fixed constellation.

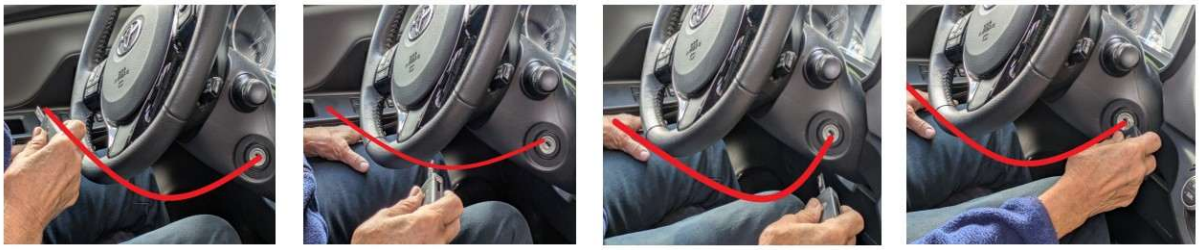
When we want to execute actions in complete darkness, a perceptual image of the action trajectory shape must still first be created. This can be achieved by using the non-key hand to first locate the lock and then placing that hand near the lock. By combining previous cognitive knowledge of the (familiar) lock with this haptic perception, we can now construct an action trajectory shape between the key tip (which we perceive proprioceptively at a distance) and the keyhole (which we now perceive proprioceptively in direct contact).



Illustrations: *In total darkness, we place the non-key hand at the lock. The entire action is then carried out identically to the procedure in daylight. The novum here, however, is that the three obligatory foci are now perceived completely proprioceptively: 1. The movement of the lock, 2. The external movement of the key tip (primary focus), and 3. The internal bodily movements directed toward the key head (secondary focus).*

With this action trajectory shape, one can now, exactly as in the previous description where visual perception was possible, reduce the *tau*-value to zero through the cooperation of the two foci and the mediation of the cortical streams within the zigzag and accordion processes, and thus execute the action successfully — purely through proprioceptive perception. In here it must be remarked that the perception of the hand placed at the lock coincides with the perception of the end of the action trajectory

shape — which in practice makes no difference — but that, in essence, it concerns the perception of the hand itself. We must therefore keep the non-key hand positioned at the lock.



Illustrations: *In an unfamiliar vehicle, the process of starting the car must first be calibrated, which often provokes the visual location of the ignition slot. However, with repeated execution, an implicit perceptual image of the action trajectory shape develops, which is internalized as a cognitive template after just a few repetitions. This results in an autonomous representation capable of guiding the motor execution without any visual control. Solely depending on proprioceptive perception processes.*

The action is therefore executed entirely through proprioceptive perception. Within this, a unique insight emerges: that the primary and secondary focus originate directly from this dual perceptual engagement. It thereby demonstrates that proprioceptive perception must contain *two autonomous phenomena*. The explanatory model of the motoric movement action aligns these with the known phenomena regarding proprioceptive perception: *limb position* and *movement*[11].

Within the context of this article, however, the most crucial point is that proprioceptive perception does not disappear when we open a lock in daylight. It remains the foundational layer of all perceptual processing. The breakthrough insight lies in the realization that even when we *see* the key moving along the action trajectory shape toward the lock, we also *feel* it — always, and inevitably, in a hybrid form.

B. Motor Actions with One's Own Body as Environmental Object

From actions involving an external environmental object, the transition is now made to those motor actions in which the end point of the action trajectory shape concerns a part of one's own body. The conclusion will show that there is no essential difference in how these action trajectory shapes are created, nor in how the cortical streams must mediate their execution *online*.

This section gradually builds toward the phenomenon of *self-tickling*, demonstrating that a multitude of egocentric perceptual processes must be activated in such cases — processes that render the experience of an "unexpected" tickling sensation absolutely impossible.

Beyond providing a complete description of the *tickling paradox*, this part also delivers the comprehensive explanation of how all parts of our body relate to one another within our perceptual processes. This, in turn, gives rise to the final and complete clarification of *The Rubber Hand Illusion*.

1. Head, Shoulders, Knees and Toe

Once the insight has been established that we can create an action trajectory shape between two hands solely through proprioceptive perception, as explained within the key task, it becomes evident that such action trajectory shapes can also be formed between *all* parts of the body. In relationship to which it can be remarked that these shapes are latently present between every conceivable pair of body

[11] Proske, U., & Gandevia, S. C. (2012). The proprioceptive senses: their roles in signaling body shape, body position and movement, and muscle force. *Physiological Reviews, 92*(4), 1651–1697.

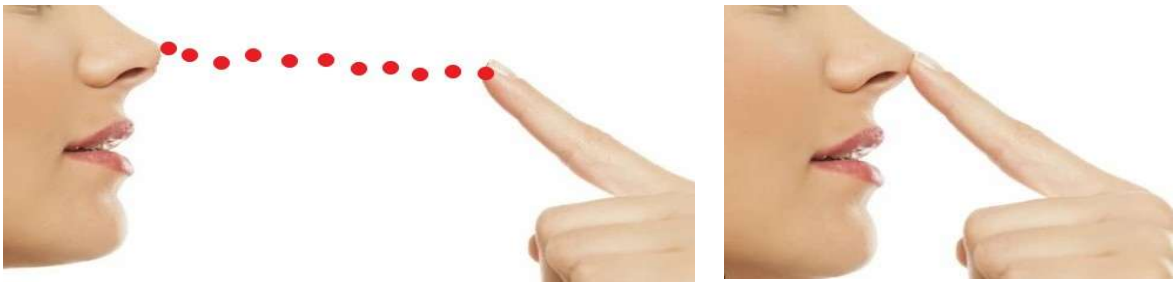
parts, yet they only become relevant within an *egocentrically formulated intention* — they are activated only when attention is directed toward them.

As an illustrative example, the international children's song and dance *Head, Shoulders, Knees and Toes*[12] is taken. The explanation follows precisely the same principles as the grasping process described earlier with the coffee cup. The only difference here is that the end point of the action trajectory shape now concerns a body part of one's own.

Illustrations: *At the moment when both hands are positioned on the head as their starting point, we can, from both hands simultaneously, construct and execute action trajectory shapes toward any other part of the body. With some practice, we can even perform separate action trajectory shapes at the same time — for instance, one toward the shoulder and one toward the knee (or combinations such as belly–knee, ear–hip, and so forth). Within this children's dance, however, the movements are synchronous. It can be noted that they ultimately form two autonomous yet perfectly mirrored templates. Like within the coloured image.*

In precisely the same way, the action trajectory shapes within this children's dance are created as they are when grasping a coffee cup or opening a lock with a key. The cortical streams must therefore mediate the autonomous action trajectory shapes of both the left and the right hand.

One can observe that the distances between the respective body parts differ, and yet the system is able, through the previously described *zigzag* and *accordion processes*, to mediate the deviations of the hands within the significant action trajectory shapes perfectly in rhythm with the music.



[12] https://www.youtube.com/watch?v=S2eRNzsAZg4

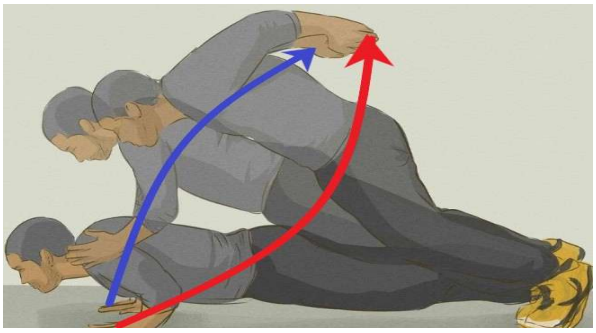
As the song comes to its conclusion, the index finger must also be brought to the tip of the nose. At this very moment, the *nerve spiral game* once again comes into play, revealing that all action trajectory shapes — including those within this dance — can never be executed identically c.q. will always undergo a *zigzag process*.

When the music is played slowly, there is sufficient time to mediate the deviations, and the tip of the nose will usually be reached directly. However, when the tempo of the music exceeds a certain threshold, it can be observed that the fingertip will regularly miss the exact tip of the nose.

The explanation is simple: the hands constitute relatively large surfaces, which can compensate for a great many deviations within their own size. In short, if one had to bring the palm of the hand to the nose, the action would never fail. However, because the index finger represents a relatively small surface, even minimal deviations within the action trajectory shape toward the nose will have a far greater effect.

2. Clapping the Hands Behind the Back

The example of bringing the index finger to the nose, or bringing food to the mouth, already demonstrates that visual perception is not essential for the successful execution of a motoric action. To substantiate this principle with convincing evidence, the act of clapping the hands behind the back will now be examined in more detail.



Illustrations: *It makes no difference whether we clap our hands in front of or behind the back. In both cases, we create from each hand an autonomous action trajectory shape directed toward a point of intersection between the two lines. Although we could in principle observe this process in front of us visually, we usually perform it predominantly through proprioceptive perception. Due to the fact that we can proprioceptively feel the tau-values of both action trajectory shapes approaching zero with great accuracy, it is even possible to execute a crescendo within the clap itself.*

When clapping the hands there are, as in the dance Head, Shoulders, Knees and Toes, two moving body parts with two autonomous action trajectory shapes. This makes the action more complex than a motor action requiring only a single trajectory shape to be created and executed. Nevertheless, we can easily bring the hands together, because the deviations within each action trajectory shape are never large enough to cause one hand to miss the other. Moreover, we can add a *crescendo* to the actual clap purely through proprioceptive awareness. Thus, we can feel with remarkable precision the moment when the *tau-value* between the hands approaches zero.

3. Tickling

With all the preceding explanations, it can now be made crystal clear why *being tickled* differs so profoundly from *tickling oneself*.

When one is being tickled — no matter how predictable the situation may seem — it represents, from an evolutionary and ecological perspective, an *attack* on the body. Such an event triggers a basal haptic alertness of the organism, a readiness to face a potential struggle of survival. The body therefore prepares itself for a (tickling) attack, yet the attacker (the tickler) conceals the lines of the attack within two autonomous phenomena: *time* and *form*.

Within being tickled we do not plan anything ourselves, as we do in all previously discussed motoric actions, and the (tickling) attack remains uncertain in both time and place until the very last moment. This sustained uncertainty, this perceptual impossibility to anticipate, generates the maximal tickling sensation.

With all the preceding information, it becomes equally clear why *tickling oneself* is fundamentally different. In self-tickling, all of the conditions described above disappear. One cannot attack oneself, and one cannot engage in any motoric act toward one's own body without already knowing the exact *action trajectory shape* that connects the acting effector to the target area.

Every self-directed movement is therefore preceded by a precisely anticipated and proprioceptively formed action trajectory. The cortical streams need to heavily mediate this process, the body already knows the location, and the hand already knows the time-to-contact c.q. the *tau*-value. Thus, no element of surprise can ever arise and it is precisely that absence of uncertainty — that perfect internal mediation of time, space, and intention — which abolishes the tickling effect altogether.