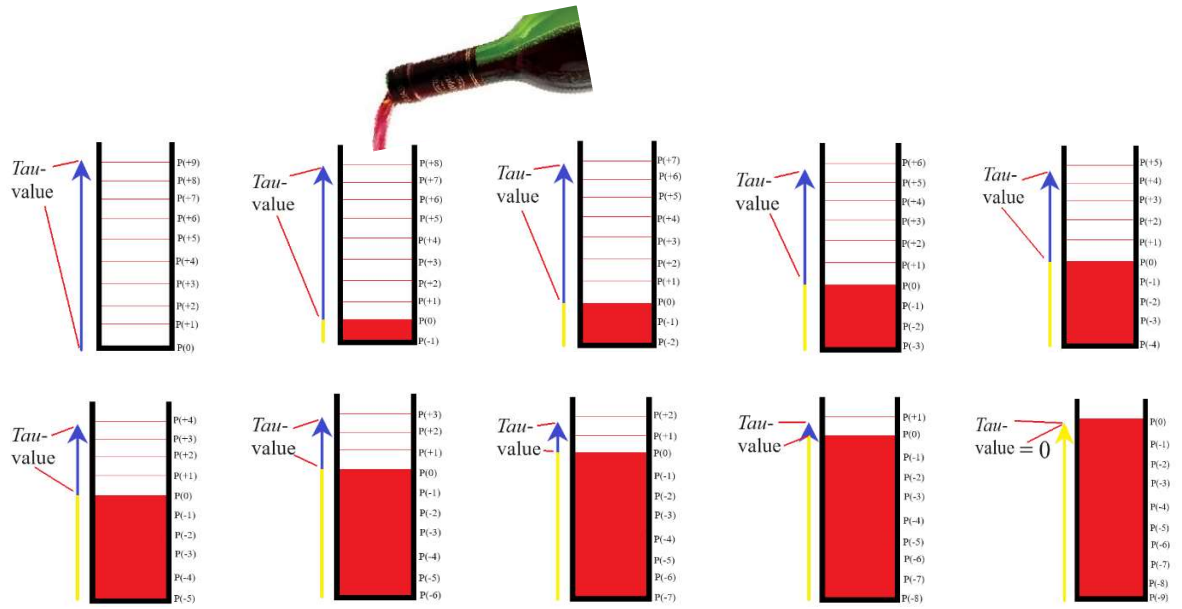
The *tau*-coupling process within pouring demonstrates that we absolutely do not need a motor plan; Executing an external action trajectory shape along which the liquid level rises dictates all internal sensorimotor perception processes



Caught In A Line

The explanatory model of all motoric movement actions

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Introduction

When we aim to fill a glass, the explanatory model of the motoric movement action has demonstrated that only the (ascending) movement of the liquid level embodies the core of the task and thus the essence of our egocentric intention. In which scientific evidence has been provided that, prior to the actual execution of any conceivable action, we first create a perceptual image of an entire latent action trajectory shape along which we can successfully move all dimensions of the action object[1], in this case, the liquid level, to the edge of the glass[2].
However, science has so far completely missed all the essentials in regard to the action trajectory shape and only indirectly noticed that (action) paths are formed between the end effectors c.q. the action object, and the goal of the action. While it can be quickly established that all positions P of an action object are invariably constrained within one single line segment shape within any conceivable motor action. This should have led to several revolutionary insights:

1. Factually, the action object invariably fills an action trajectory shape in the same way as a marble moves within a marble run, in which the perception of the marble's current location always marks the exact boundary between the manifest and latent parts of the perceptual image of the action trajectory shape.

2. All latent positions P of the action object effectively always have to sprout from the manifest positions P, or effectively always have to originate from the manifest part of the action trajectory shape.

3. Within the action trajectory shape, it factually always becomes apparent when the action is coming to its end due to the perception of the disappearing of the complete latent action trajectory shape c.q. the *tau*-value approaching to zero[3].

However, although the explanatory model demonstrates that the perception of the movement of the action object within the perceptual image of a latent action trajectory shape encompasses an autonomous phenomenon and thus exclusively is going to perform the essence of the task, the explanatory model also clearly shows that the action object itself absolutely isn't capable to move on its own. Even when grasping with the fingertips, the explanatory model shows that the movement of the fingertips along an external action trajectory shape on the outside of the body can't be moved by the outside of the fingertips themselves. So even within grasping, the movement within the external (primary) focus can only be executed with movements that must always be perceived within the body, within the internal (secondary) focus. In the present action, in which the liquid level moves at an obvious distance

[1] Science and the explanatory model of the motoric movement action use the terms 1. end effector and 2. action object for the same phenomenon. For example, in eating with a spoon, science refers to the spoon bowl as the end effector, whereas the explanatory model designates the spoon bowl as the action object. The action object in pouring is the liquid level, and this may feel somewhat peculiar. Nevertheless, this is the aspect we focus on during pouring, and which has been demonstrated within scientific research (Hayhoe, Land e.a.).
[2] https://www.researchgate.net/publication/372290282_Grasping_encompasses_two_consecutive_autonomous_phases_-_The_scientific_proof_that_we_tactically_construct_an_action_trajectory_shape_prior_to_the_factual_execution_of_that_exact_same_action_trajector
[3] https://www.researchgate.net/publication/373167637_Pouring_is_a_rare_motor_action_because_the_action_trajectory_shape_becomes_visible_-_Pouring_requires_a_compelling_coupling_of_a_secondary_internal_focus_to_a_primary_external_focus

from the body, this insight will be easily recognized, and it will also be easy to determine that the rising of the liquid level can solely be moved along an external action trajectory shape with movements within the body that solely reach up to the outer surface of the bottle[4,5].

Images: The explanatory model of the motoric movement action shows, beyond any reasonable doubt, that there is no need for a motor plan to initiate an action. It demonstrates that all sensorimotor perception processes within the internal (secondary) focus simply need to follow the lead of the external (primary) focus. This clarification, which does not require any hierarchy, underscores our freedom from being tied to specific sensorimotor movements and this perspective is in perfect alignment with an ecological approach to motor actions.

In summary, this leads to the conclusion that the phenomenon of the perception-action coupling is solely related to the perception of movement within the external (primary) focus. Only within this focus, a perceptual image, consisting of the future positions P of the action object, is filled by the future actual positions of that exact same action object. Also, only within this focus, the *tau*-value can be perceived. This publication now explains how the perception of the *tau*-value should be linked to the internal (secondary) focus and extensively discusses the consequences this has for the perception processes within the internal (secondary) focus c.q. for all sensorimotor actions.

A universal *tau*-coupling is present within every conceivable motoric action

The explanatory model, in conjunction with previous publications, demonstrates that the *tau*-value can be universally observed within any conceivable action. This aligns with the findings of D.N. Lee, who showed that in many actions, a gap c.q. a line segment shape between the action object and the end goal[6] gradually approached zero and eventually completely disappeared. While Lee's discovery generated significant interest in the scientific community, a major breakthrough remained elusive. Lee connected this crucial *tau*-value to various irrelevant other possible *tau*-values without realizing that multiple foci could be distinguished and linked within a single motoric action.
However, this insight proved to be highly relevant for the explanatory model of the motoric movement action. By understanding that the movement of an action object along an action trajectory shape

[4] https://www.researchgate.net/publication/373624625_Within_any_imaginable_motor_action_the_external_primary_focus_cq_the_essence_of_the_task_is_solely_executed_by_the_action_object_-_Solely_the_external_movements_of_the_spoon_compel_the_primary_focus_

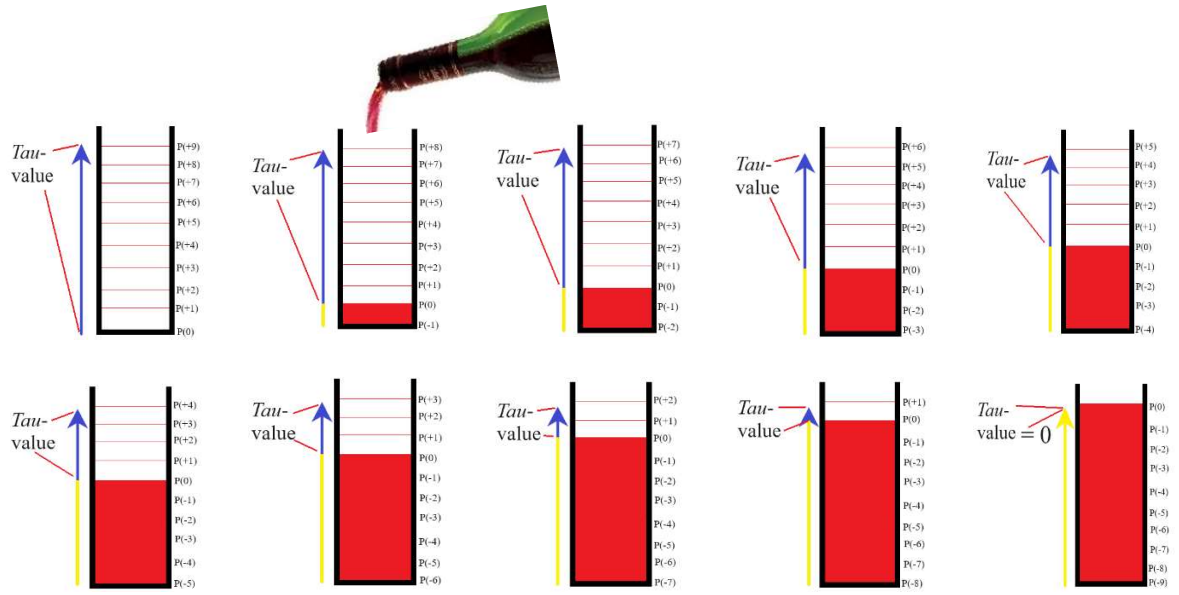
[5] This intriguing dualism demands our utmost attention as it presents the essence of our perception processes. The internal (secondary) focus not only meticulously tracks the movement of the action object within the action trajectory shape but is also the instigator of this movement. It might sound paradoxical that the very action you initiate creates your own reliance. However, this is precisely what occurs because it is an implicit fact that when you move something inside your body, an external part of your body will inevitably move within an action trajectory shape on the outside of your body.

[6] In the original work, examples include a long jumper leaping towards the take-off bar, a Northern Gannet diving toward the water surface, and a bee heading towards a flower.

outside the body is a completely autonomously observable phenomenon, and can only be executed by a completely different autonomously observable phenomenon within the body, it is now possible to explain precisely which phenomena should be connected and how the *tau*-coupling is established. The perception of the *tau*-value approaching zero within the external (primary) focus should ultimately guide the observations within the internal (secondary) focus.

The *tau*-coupling when filling a glass

In general, we typically fill objects (glasses, buckets, kettles, etc.) with a substantial fill capacity. This means that, after a short, probably slightly slower initial phase, the liquid level must first traverse a relatively long distance during which seemingly nothing remarkable happens. Although the explanatory model of the motoric movement action indicates that bridging[7] this apparent 'nothingness' by the liquid does indeed demand much of our perception processes, where the cortical streams are crucial, the egocentrically formulated will is only finalized at the end of the action trajectory.



Images: Before we proceed to fill a glass, a perceptual image is constructed of a latent action trajectory shape, along which the liquid level is capable to successfully reach the rim of the glass. By observing the illustrations, it can be objectively determined that only the liquid level fills this action trajectory, thus exclusively embodying the essence of the task. Furthermore, it is objectively ascertainable that the liquid level moves akin to a marble in a marble run, where the current position P(0) of the liquid level always precisely demarcates the separation between the manifest (yellow) and latent (blue) segments. The disappearance of the latent segment of the action trajectory shape can be perceived in two ways: one can observe how the yellow (manifest) part supplants the blue (latent) part of the action trajectory or, in a more fundamental sense, one need only observe the speed at which the blue segment vanishes c.q. at which the blue gap closes.

While it may appear that only the end of the action trajectory is crucial, the explanatory model is clear: the bridging process of every position P of the liquid level between the bottom and the top of the glass is equally vital for success. The finalization of the action and the bridging process are, in fact, two

[7] In contrast to current scientific beliefs, the explanatory model of the motoric movement action demonstrates that, contrary to prevailing thought within the scientific community, the essence of the task is indeed finalized at the end of the action trajectory shape. However, it also asserts that the transitional phase is equally integral to the task. Both phases hold equal significance, and they must both be executed successfully for the entire motor action to have any chance of success.

distinct phenomena that must be successfully executed sequentially. One can never reach a successful conclusion if the bridging phase has not been successful as well.
However, the successful execution of the ending is also crucial for a motoric action to succeed. The final success of a motoric action depends on observing that the *tau*-value within the external (primary) focus approaches zero. Then, within the internal (secondary) focus, adjustments must be made to the movements towards the outer surface of the bottle, ensuring that the liquid level ends precisely at the correct height in the glass, preventing it from being too little (which the customer would not accept) or overflowing. So within many motor actions, it can be observed that after a phase of relative acceleration during the bridging phase, there is a relative deceleration of the action object as the end of the action approaches[8].

The perception of the sensorimotoric movements inside the body within the internal (secondary) focus while manipulating the outer surface of the bottle within a pouring action

The explanatory model of the motoric movement action presents a completely new paradigm. It's based on the factual observation that an autonomous internal movement of any organism will implicitly induce an autonomous external movement on the outside of that organism. In which it is also a fundamental fact that the movement of any given position P on the outside of that organism will need to sprout from each other c.q. that all those positions P will always be interconnected[9]. Which factually means that those connected positions on the outside of the body will always create an external line segment shape. So the most important conclusion reveals that the internal and external movements are implicitly connected, but that the perception processes mediating these movements are completely autonomous and independent of each other[10].
The previous explication does not concern the paradigm itself, but rather its foundation. The explanatory model notes that the mentioned phenomena will emerge regardless of which focus you centralize. The new paradigm, however, involves the novel concept that you can complete a motor action entirely by focusing solely on creating and completing the aforementioned external action trajectory shape. In contrast to the idea that the earliest organisms began with an emphasis on arbitrary motor movements within the body and then experiencing what external results they would have, the explanatory model asserts that these roles, after millions of years of evolution, have now been entirely reversed. When filling a glass, we predominantly perceive, within the external (primary) focus, the (rising) movement

[8] As explained in this section, the explanatory model underpins the notion that within many motoric actions a bell-shaped profile is capable to occur when plotting the execution speed of an action against time in a graph. In many actions, it is indeed typical that after a short initiation phase, a smooth and faster bridging phase occurs, followed by a more precise phase towards the end. Although the model generally supports these principles, it doubts the emergence of a highly proportional bell shape in all cases. Additionally, the explanatory model illustrates that this is certainly not the case for all actions. In situations where you need to create a crescendo at the end of the action, such as clapping your hands or defending against an attacker with a punch or a kick, you must accelerate the relevant body parts in the final phase. Similarly, in many ball sports, achieving a necessary "crescendo" can only be accomplished if, after an initial relatively slower catching phase, you maximize acceleration of the ball towards the end of the action trajectory shape.
[9] If you, for example, isolate your arm and make random internal movements, all outer parts of your arm will start to move as well. So the fingertips, the knuckles of your hand and the elbow will randomly move as well about which can solely factually be remarked that, within our worldly dimensions, they will always construct only one line segment shape. The movements of all action objects c.q. all environmental objects are always caught in a line.
[10] While the explanatory model of the motoric movement action has a strong suspicion that the earliest organisms initially engaged in random motor movements, it demonstrates that after millions of years of evolution, the roles of internal and external have reversed. It's much more efficient for organisms to work from an action trajectory shape rather than relying on random motor movements. Creating an action trajectory shape, for instance, from fingertips to a coffee cup or from a spoon to a soup bowl, is by far more effective and efficient than repeatedly generating random internal movements with the hope that the fingertips will reach the coffee cup or the spoon will reach the soup.

of the liquid level in the glass outside the body, and guide that progression with motor movements within the internal (secondary) focus, which extend only to the outer surface of the bottle.
Thanks to this new paradigm, the explanatory model of the motoric movement action is now capable of identifying all functional perception processes within any conceivable motoric action, thus enabling it to describe all sensorimotor perception processes. In this section, a list of the most crucial insights will be outlined, with a focus on challenging many prevailing assumptions within the scientific community.

a. Visuomotoric perception processes

Of course, science views both visual perception and motor action as essential in executing actions, assuming they share a close relationship. Which, out of a single-focus perspective, led to the rather artificial birth of the term *visuomotoric* perception processes. While one might argue that the term provided some direction in scientific thinking, its content remained vague and never led to any significant consensus.
The explanatory model now emphatically reveals that this term represents an erroneous way of thinking within the scientific community and that it must be expunged from the realm of scientific discourse. The explanatory model effectively illustrates that, in practice, when visual perception comes into play, its exclusive role is to contribute to the perception-action coupling taking place within the external (primary) focus, and has no bearing whatsoever within the internal (secondary) focus. In plain terms, visual perception, by itself, will never induce any movement.

b. Sensorimotoric perception processes

Just like the concept of visuomotoric perception processes, science introduced the term *sensorimotoric* perception processes. In contrast to the previous paragraph, the explanatory model provides a significantly broader description in regard to those sensorimotoric processes than previously presumed in the scientific community and shows unequivocally that we even can execute motoric actions solely through proprioceptive perception, expanding our capabilities beyond what science has traditionally acknowledged. Many actions can be executed with ease, albeit less efficiently, in complete darkness or without any visual input[11,12]. Consider activities like clapping your hands behind your back, unlocking a door with a key at night, or swatting an annoying mosquito behind your ear. In all these actions, the *tau*-value within the external (primary) focus can be entirely perceived proprioceptively[13].
Additionally, the explanatory model unmistakably reveals that within any conceivable action, an external (primary) focus, operating within a strict *tau*-coupling process, can only be executed by an internal (secondary) focus. It highlights that this secondary focus is exclusively perceived within the body, and therefore, all perceptions within this focus are inherently of a sensorimotoric nature.

[11] Motoric displacement actions from point A to point B, such as walking, cycling, rowing or car driving, can hardly be executed without visual input. However, a person with 100% visual impairment is perfectly capable to navigate through their home freely and by foot travel significant distances outside using a cane. This cane vividly demonstrates that our perception processes are not solely focused on reaching point B but are also deeply engaged in the bridging process. With the cane, the individual is essentially "observing" (feeling) whether the next position P (+1) within the perceptual image of the latent action trajectory shape, is accessible and can be occupied by their body. This observation mirrors what was mentioned earlier regarding the spoon's journey towards the mouth or towards the plate of soup.
[12] Think also of inserting a car key into the ignition. In an unfamiliar car, we need visual perception several times initially to create an action trajectory shape, but after a few repetitions, we do it entirely blindly.
[13] https://www.researchgate.net/publication/342715828_The_complete_functional_explanation_of_limb_position_and_movement_in_relationship_to_the_proprioceptive_perception_-_The_behavioural_perception_processes_within_clapping_behind_your_back

c. The internal (secondary) focus has an indispensable interdependent relationship with the external (primary) focus.

The explanatory model revolves around an entirely new paradigm, which reveals that within the execution of a single action, implicitly two autonomous foci arise in relation to two autonomous movements. These two autonomous foci must enter into a mandatory collaboration to accomplish the action successfully. The collaboration involves the motor processes within the internal (secondary) focus, which alone can enable the action object to move, compellingly following the movement within the external (primary) focus. When one is first confronted with this concept, it may evoke an extremely paradoxical feeling. How can a phenomenon that is inherently essential to the action and only solely can ensure the action's success be so dependent on another autonomous phenomenon that it itself brings to life. However, with further contemplation, one will come to realize that it is a remarkable evolutionary discovery and that it provides an explanation for all functional perception processes within any conceivable motor action. Moreover, the explanatory model clearly elucidates how this phenomenon must have developed from the earliest stages of evolution, but further details are omitted here for the sake of brevity[14]. It is emphasized that these two phenomena are entirely interdependent, and without either one, no motor action can be successfully executed.

d. No motor plan and no hierarchy

If the scientific community were to acknowledge that the perception of the movement of an action object within an action trajectory shape, within the external (primary) focus, has the capability to guide the entire execution of any conceivable motoric action, several challenges within science would be resolved immediately. If it were accepted that, prior to the execution of a motor action, we create an all-encompassing and directing perceptual image of an external latent action trajectory shape, the need for a motor plan would instantly disappear. Which would lead to the understanding that all sensorimotor movements simply serve the external (primary) focus, and as a result, there would be no need to recognize hierarchy within the sensorimotor structure. Then all sensorimotor activity can hierarchically be regarded at the exact same level which just obediently have to carry out the task within the external (primary) focus.

e. The explanatory model reflects an optimal ecological approach

In the current scientific paradigm, there is a consensus that motor planning exists, but there is absolutely no agreement on how such a motor plan is developed. While it's acknowledged that creating a motor plan demands more cognitive capacity from an organism, it essentially reveals that, even after many decades, there is no clear answer to this question. An important, unanswered scientific question is how a motor plan adapts when a sudden change occurs during an action. Which also leads to the pressing follow-up question of how more primitive organisms can cope with such altering situations. The explanatory model of the motoric movement action demonstrates that perceiving the *tau*-value, despite its inherent complexity, can be distilled into a very simple universal phenomenon. Which is

[14] In future publications, where the precise role of the cortical streams in regard to this phenomenon will be explained, this evolutionary development will be further elucidated. In brief, the explanation will demonstrate that organisms initially started with just random (!) movements within their bodies to move a part of the external body somewhere. After millions of years, we 1. realized that this specific external body part, like a marble in a marble run, fills an external action trajectory shape, and 2. gained a solid understanding of the involved motoric movements. This understanding allowed us to reverse the roles, shifting from initiating movements from inside the body to initiating them from the outside. This line of thinking even goes so far as to suggest that the cortical streams within an organism have evolved evolutionarily to precisely mediate this relationship of a marble-marble run in a double and reciprocal process.

also explained within the motoric action of pouring[15]. To perceive the *tau*-value, all you need to do is register the speed at which the latent part of the perceptual image of the entire action trajectory shape disappears. Which essentially amounts to a straightforward observation of the disappearance of a two-dimensional line segment.
Subsequently the explanatory model reveals that the internal (secondary) focus can align itself with the external (primary) focus as a whole, without any rigid hierarchy. This simplifies the observation of the *tau*-coupling process to such an extent that, within an ecological framework, it's hard to surpass and which concept can also be applied to the earliest organisms.

f. The sensorimotoric movements towards the outer surface of the bottle are perceived proprioceptively

The explanatory model clearly demonstrates that the internal (secondary) focus is exclusively perceived within the body, showing that there is never any visual perception involved. The internal (secondary) focus can only be proprioceptively perceived. You can actually verify this while pouring by covering everything except the glass. As long as the glass remains visible, it will have no impact on the pouring action.

g. Hybrid (proprioceptive) perception processes

A significant shortcoming in current scientific research pertains to the notion that motor actions are always executed with roughly the same sensorimotor perception processes. The explanatory model reveals a universal framework, but it clearly demonstrates as a novelty that often multiple constellations of perception processes are involved within the execution of the same motoric action and that we are capable to endlessly, *ecologically* (!), vary within this realm.
For example, when in pitch black darkness, we bring our (non-key-holding) hand to a lock, we can successfully move the key to the lock using solely proprioceptive perception within the external (primary) focus c.q. we can successfully move the key along a perceptual image of a latent action trajectory shape using solely proprioceptive perception processes. So even if it then appears that we perform this motoric action with only visual perception in broad daylight, that's factually incorrect. Visual perception will be highly dominant, but proprioceptive perception will always remain in some hybrid form. So within broad daylight, we not only see the key to the lock, but we also *feel* (!) the construction of the action trajectory shape. In pouring, there are also many hybrid forms of perception processes possible. However, this is not extensively discussed here. Briefly, it is explained that we can auditorily perceive the filling of a bucket/watering can to a large extent, and we can even do that purely based on cognitive knowledge regarding the relative filling time.
Within the internal (secondary) focus, it is no different. You can quickly ascertain that you could move the bottle only with trunk action or even with just a walking action if you were to rigidly hold the bottle. In this way, you could even make it move with just upper arm and/or forearm action. Moreover, you can quickly ascertain that you could use relatively more hand action or relatively more finger action. In short, you may have developed your own preferred motor skills to execute a pouring action, but it will always consist of a constantly changing constellation of hybrid sensorimotor perception processes. Due to the fact that such a complex phenomenon is involved will never allow an identical configuration of perception processes to arise. Upon which the explanatory model of all motoric movement actions again hastily wants to add that these hybrid possibilities in the utmost harmony align within an ecological approach and that a parsimonious organism would never have strived to achieve identical executions.

[15] https://www.researchgate.net/publication/374145315_The_external_primary_focus_within_pouring_solely_encompasses_the_rising_movements_of_the_liquid_level_in_the_glass_The_liquid_level_behaves_like_a_marble_within_a_marble_run_depicting_the_perception-a

h. Optimization process

The explanatory model of the motoric movement action demonstrates that a motor action can only be executed by the stacking of two autonomous foci and shows within the previous paragraph that the perception of movement within the internal (secondary) focus is inherently of such a high complex nature that it will definitely prevent the occurrence of an identical internal configuration to occur. Consequently this will cause that the action object is capable to and definitely shall deviate from the perceptual image of the latent action trajectory shape at each progressing point P and even though the cortical streams ingeniously mediate this process, it is empirically evident that an identical execution of any action trajectory shape is unattainable. This unequivocally portrays that performing any conceivable action can only be viewed as an optimization process. Hence, you will never be able to fill a glass in an identical manner. Instead, you solely can optimize the perceptions within both foci, which also allows you to perform actions in a very successful manner but in ever-varying ways.

i. Within the internal (secondary) focus the line and shape within the line segment shape of the action trajectory demand autonomous perception processes; Solely the line generates the *tau*-value

The explanatory model of the motoric movement action demonstrates, beyond any reasonable doubt, that we do not (need to) create motor plans and that all sensorimotor processes can be compellingly guided by the external (primary) focus. But if a motor plan would have been necessary, science would still have remained remote from a breakthrough, as sensorimotor processes must accompany two autonomous phenomena within the action trajectory shape that have never been recognized in science. The frequently used compound term "action trajectory shape" is in fact a line segment shape and encompasses two autonomous components: the line and the shape. The explanatory model illustrates that they are perceived entirely separately but simultaneously. For experts, this is clearly recognizable within any conceivable action. However to make it comprehensible for everyone, these phenomena are explained within the context of the motoric movement action *car driving* (or riding a bicycle) since this action inherently contains the scientific evidence of these two autonomous perceptions.

Images: In the case of a car and a bicycle without hand brakes, only the steering wheel can compensate for deviations in the width of the action trajectory shape, and the pedals can only compensate for deviations in the length of the action trajectory shape.

When driving a car, it becomes immediately evident that one can exclusively influence the movement within the shape (!) of the action trajectory with the steering wheel. This defines the explanatory model as mediating the deviations in the y-axis. Additionally, it should also become immediately clear that with the pedals, one can exclusively influence the movement within the line (!) of the action trajectory. This defines the explanatory model as mediating the deviations in the x-axis[16]. So, when

[16] The same explanation naturally applies when considering a bicycle with coaster brakes.

driving a car, it becomes crystal clear that perceiving (and controlling) the shape has absolutely nothing to do with perceiving (and controlling) the line. In which it is essential to mention that perceiving the filling of the latent line (within the x-axis) by the manifest places P of the action object within the external (primary) focus solely involves the *tau*-value which within car driving is solely executed by the pedals. Solely the speed with which the line is filled determines the duration of the action c.q. determines the finalization of the action.

The explanatory model of the motoric movement action demonstrates that the perception of movement within the internal (secondary) focus in any conceivable action, including the current pouring action, contains the same x- and y-axis components. Although it places greater demands on the development of an organism, conversely, it can be shown to fit perfectly within an ecological approach. The dichotomy, where a separate x- and y-axis component is distinguished, can actually deliver the final breakthrough in the understanding of why we are capable to reduce very complex perception processes to the perception of such trivial and simple phenomena. The mere perception of the x-axis can be traced back to simply perceiving how the latent part of the perceptual image of the latent action trajectory disappears. Pouring is in this regard a very special motor action because a glass (bucket, kettle, etc.) doesn't allow deviations in the y-axis and so they don't need to be mediated.