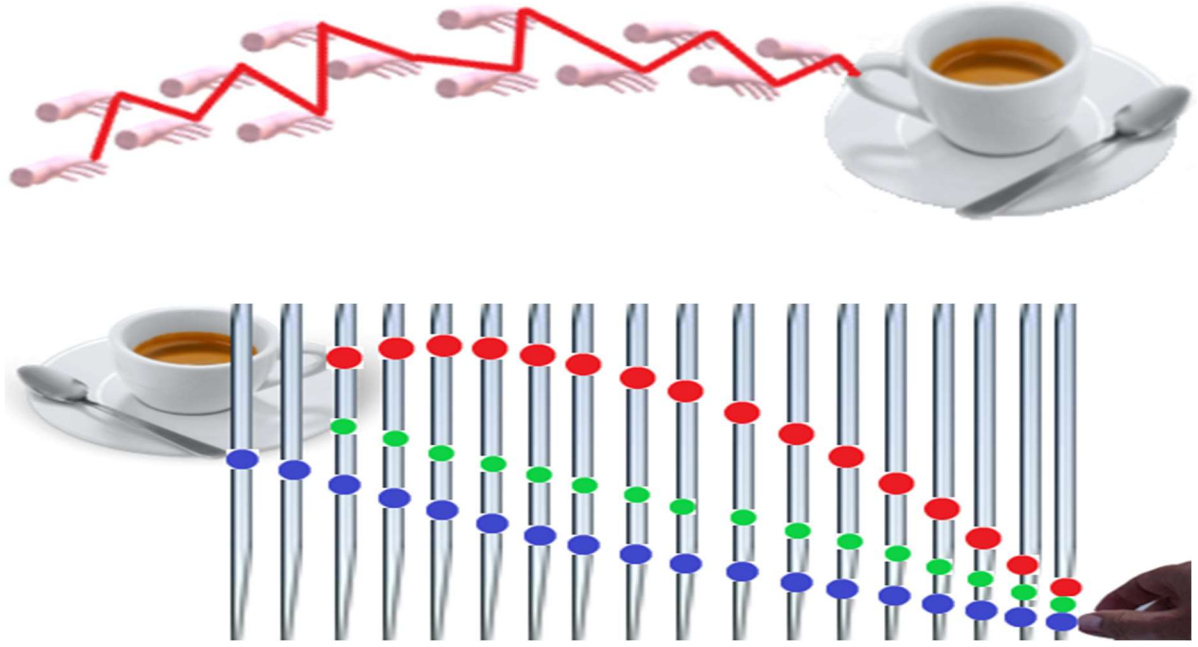
Within grasping the cortical streams will have to mediate the egocentric zigzag movement of the fingertips toward the coffee cup



Caught In A Line

The explanatory model of all motoric movement actions

N.J. Mol

June 2024

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

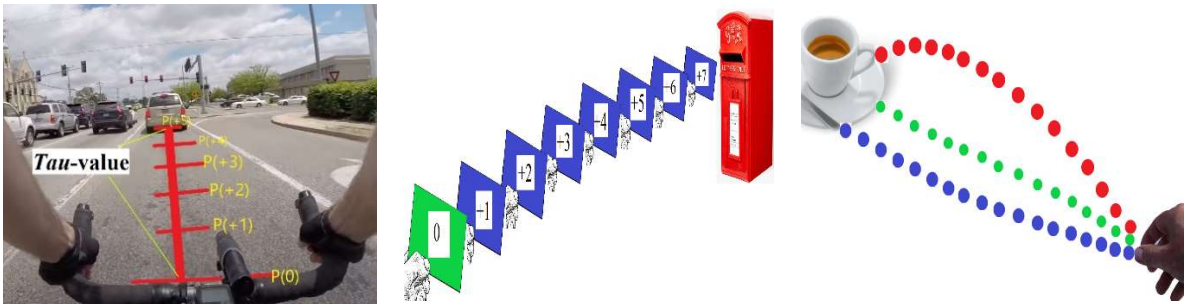
Introduction

Current science views the execution of motor actions as a single and indivisible process because it assumes that only one focus can be present during the execution of one motor action. It assumes that when catching a ball or grasping a coffee cup, the perception processes are primarily concerned with these objects, upon which a motor plan (movement plan) is then formulated to get them into the hand. This explanation thus presupposes a considerable degree of automation of the hand's (fingertips') movement as a result of the dominant c.q. leading perception of the ball or the coffee cup. After all, only one focus can be assigned and this has led to the fact that in scientific research, the (perception of the) movement of the hand has so far occupied a subordinate place.
Since 2016, however, an explanatory model has been developed that sheds a completely different light on the execution of motor actions. It concerns a universal explanation and shows that the execution of any conceivable motoric action always requires the simultaneous perception of three autonomous foci[1], in accordance with the theory of J.J. Gibson, which includes both the movement of the animal/organism and the movement of the environment. When catching a ball or grasping a coffee cup, one autonomous focus remains engaged with (the movement of) the ball and/or the cup as the environmental object, which universally represents a catching action. The other two autonomous foci are concerned with the perception of the movement within the egocentrically executed action: specifically, with the movement of the hand (the fingertips) along an action trajectory shape towards the ball and/or the coffee cup, which universally represents a throwing action. In this way the explanatory model confirms the autonomy of perceiving (the movement of) the ball and/or the coffee cup, conform the current scientific mindset, but conversely also reveals the novelty that the throwing action of the hand (fingertips) is also an entirely autonomously perceived part of the action.
Precisely because the scientific relevance of this aspect has never been recognized, this article specifically focuses on the two foci that belong to the throwing action of the fingertips within an egocentrically executed action trajectory shape in relation to, for example, the catching of a ball or the grasping of a coffee cup. It convincingly shows that the fingertips can only be moved autonomously and in a zigzag manner towards a ball or a coffee cup. Whereby the cortical streams, entirely in accordance with the current scientific literature, must compulsorily mediate this process, and this explanation can only be understood if one realizes that our perception processes must be egocentrically directed towards the autonomous guidance of the fingertips along an action trajectory shape towards the coffee cup.

1. The main goal of the tactical movement action (TMA) encompasses the construction of a perceptual image of a latent action trajectory shape

[1] The cortical streams mediate the grasping of a cup equal as they mediate within the nerve spiral (youtube.com) https://www.youtube.com/watch?v=QP4vPVAw-Yg

Supported by scientific evidence[2] the explanatory model delineates that the execution of any motor action involves two distinct sequential phases: the tactical movement action (TMA) and the actual movement action (AMA). The tactical movement action is focused solely on planning the upcoming action and must be finalized before any actual execution occurs. A crucial aspect of the tactical movement action is the creation of a perceptual image depicting the latent action trajectory shape between the current fingertip position and the intended target, such as the handle, saucer, or spoon[3] of the coffee cup. Within which the specific target significantly influences this process.
While the explanatory model aligns with existing scientific research, it also introduces a novel conclusion not yet acknowledged by the scientific community. It suggests that the creation of a perceptual image of the latent action trajectory shape between the fingertips and the coffee cup involves tactical consideration of whether the space between them can be bridged by a continuous line segment shape encompassing all fingertip dimensions. This proposition is substantiated by incontrovertible scientific evidence but one can empirically arrive quickly to the same conclusion[4].



Images: Within cycling and letter posting we also construct a perceptual image of a latent action trajectory shape during the tactical movement action (TMA) like in any conceivable motoric action, over which *all dimensions* (!) of the action object (i.e., the bike and the letter) will enable the action to succeed. During the actual execution within the actual movement action (AMA), akin to the fingertips when grasping a coffee cup, one must perceive the movement of the action object during the bridging process, as only the bike, the letter, and the fingertips are going to move c.q. can be moved. Within the images, it is particularly noticeable that we actively perceive whether the entire path through all dimensions of the fingertips, the bike, or the letter can be filled in a continuous action trajectory shape c.q. we mainly perceive the "nothingness" in the vista in front of us. Because only in that empty void there is (empty) space to execute an action.

In addition to unveiling this novelty, it is also revealed that when the tactical movement action has been finalized, we are primarily going to focus on the movement of the fingertips towards the coffee cup. This contrasts with the traditional perspective of science, which remains constantly focused on the coffee cup itself. During the actual movement action, our main concern is the egocentric bridging process of the fingertips, guiding them over the perceptual image of the latent action trajectory shape which is solely determined during the tactical movement action[5]. So when the factual execution starts the coffee cup itself is not any longer the focal point, but rather the movement of the fingertips

[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] Within scientific research, participants are often tasked with grasping unfamiliar objects. The explanatory model acknowledges that individuals still attempt to estimate, based on general cognitive knowledge, how to approach the special features before actually executing the grasp.
[4] The action trajectory shape of the fingertips towards the coffee cup will vary significantly when an obstacle like a large shopping bag is situated in front of the cup. Moreover, in scenarios where the coffee cup is obscured by a substantial shopping window, no action trajectory shape can be formed at all.
[5] The explanatory model emphasizes this semantically by replacing the phrase "grasping a coffee cup" with the phrase "moving the fingertips towards the coffee cup."

towards it c.q. the bridging of the void (!) between the current location of the fingertips and the coffee cup forms the essence of the action.
Another revolutionary novelty aligns with the previous thought. Although reaching the end of the action trajectory shape will eventually lead us to grasp a coffee cup, the explanatory model, supported by scientific evidence, demonstrates that we also tactically determine beforehand whether the entire (!) space between the fingertips and the coffee cup can be filled by a continuous line of fingertip dimensions. This means that all positions P between the current location of the fingertips and the coffee cup are observed as actively and as crucially as the endpoint of the action trajectory. This realization provides a solid foundation for the fact that during the actual movement action (AMA), we are solely focused on traversing the latent positions P associated with the action trajectory shape. This implies that upon reaching position P(x), for example, somewhere midway along the action trajectory, we are mainly focused on the perception of three positions: position P(x-1), where we just came from, position P(x), where we are now, and position P(x+1), the perception of the next position where we need to move the fingertips. In this phase, we are primarily engaged in the aforementioned bridging process and only monitor whether the gap between the fingertips and the coffee cup is closing. This also reveals another essential ecological novelty, showing that during the actual movement action, we are indeed not concerned with the coffee cup itself, but only with reducing the number of latent positions P between the fingertips and the coffee cup.

2. <u>The reciprocal dependency between the internal and external focus results in absolute deviations of the fingertips within the perceptual image of the latent action trajectory shape</u>

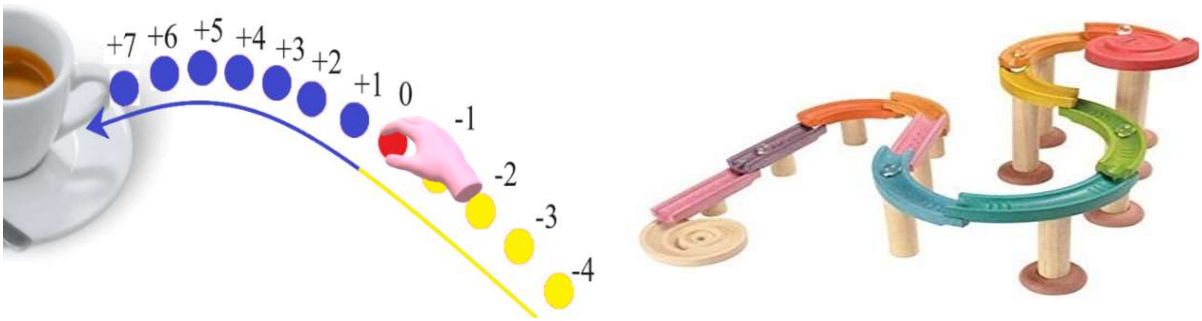
The explanatory model of the motoric movement action illustrates within the context of grasping a coffee cup that two foci always arise. We can only guide the fingertips[6] along an external action trajectory toward a coffee cup with a focus on internal movements. These foci are autonomous because the (perception of) movements occur strictly separated inside and outside the body, rendering them incompatible.
However, as the explanatory model now demonstrates that the movement of the fingertips within the external action trajectory shape are going to fulfil the essence of the task, an intriguing phenomenon of reciprocal dependency emerges. Only internal motor movements can lead the fingertips externally along an action trajectory shape, yet the progression of the fingertips within that trajectory will, as the primary focus, dictate those internal motor movements. The inevitable consequence of this observation encompasses that it is not a matter of whether the fingertips will deviate within the perceptual image of the latent action trajectory shape, but rather that this is an absolute certainty. In which this absoluteness logically stems from the factual nature of the autonomous perception of both foci.

3. <u>Within the actual movement action (AMA) the cortical streams will have to mediate the continuous flow of absolutely emerging deviations</u>

If we now combine the two preceding paragraphs and proceed to actually grasp a coffee cup, our main endeavour will primarily become to initiate the bridging process of the fingertips in which the perceptual image of the latent action trajectory shape serves as an open yet compelling guiding[7]

6 The outer surface of the fingertips is composed of living cells, but they definitely cannot ensure movement of the fingertips within an external action trajectory shape.
[7] Upon perusing the explanatory model, one will start to realize that the construction of a perceptual image of a latent action trajectory shape is necessary to initiate any motor action, but it doesn't need to be followed precisely. That's the essence of a highly economical system. In the initial stages of an action trajectory shape, it's not a problem at all if the fingertips deviate, as long as the fingertips come closer to the endpoint. However, without a (precisely global) perceptual image of a latent action trajectory shape, motor actions cannot commence and the explanatory model introduces the term "*precise global*" in this context. The perceptual image of the latent action trajectory shape must precisely indicate the global (fluctuation boarders of the) direction it should take.

phenomenon. This means that we aim to *step by step* (!) reduce the distance between the current position of the fingertips and the coffee cup, starting with the first step of moving the fingertips from position P(0) to position P(+1).

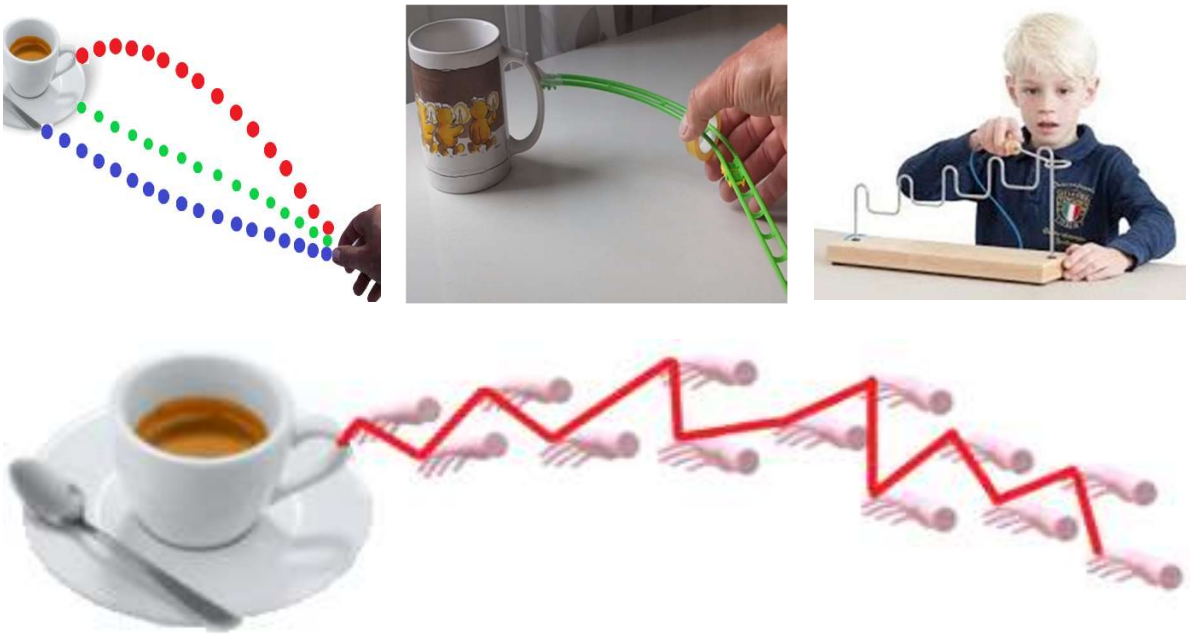


Images: The explanatory model of the motoric movement action provides a tangible example with the marble in the marble run, illustrating the continuous reciprocal perception-action coupling within any conceivable motoric action. From the perspective of the marble's current position, one can perceive the relationship within the entire marble run, and vice versa, one can perceive the relationship with the marble's current position from the perspective of the entire marble run. Although all this remains invisible when grabbing a coffee cup, it is present in an equivalent manner. Because in our worldly dimensions, it is just a mere fact that all positions P of any moving object, including the fingertips, must emerge from each other, meaning that the perception of fingertip movement when grasping a coffee cup is always captured in one single line segment shape. In which the current position P(0) of the fingertips will always form the precise separation between the already manifest positions P(-x) and the still latent positions P(+x). In which could be further added that the perceptual image of the still latent action trajectory involves future projections that must arise from the observation of the movement of all subsequential manifest fingertip positions prior to the current position P(0).

The perceptual image of the entire latent action trajectory shape thus also represents an image of its very beginning, and at the outset of the action, we will try to guide the fingertips to follow that beginning. However, even during the bridging to this first position, due to the aforementioned mutual autonomous dependency of the internal and external focus, the fingertips will inevitably deviate[8] from the perceptual image. It is an absolute factual given that cannot be avoided, and it would quickly lead to chaotic action trajectories[9] if there were not a system capable of mediating these deviations.

[8] As stated in footnote 7, this precisely illustrates an optimal parsimonious model, where nothing needs to be executed very precisely, but only provides a general (albeit compelling) direction. If you had to approach a coffee cup with your fingertips identically every time, drinking coffee would become a neigh impossible task. The task, where you only need to reduce the distance, offers countless more possibilities and demonstrates that the bridging process is just one aspect of the task at hand.

[9] The description of the cortical streams within the motoric movement action *car driving* is particularly notable in this regard. If deviations from the driving lane on a highway do not lead to corrections the exponential product will soon lead to accidents. Deviation upon deviation will cause an exponential grow due to the fact that they belong to two complex subsystems.



Images: The perceptual image of a latent action trajectory shape, within the tactical movement action (TMA), depicts a smooth line segment shape from the fingertips to the coffee cup. However, during the actual execution, the fingertips, akin to a nerve spiral[10], will definitely deviate at every position P within that perceptual image due to the autonomy of the internal and external focus. This necessitates redirecting the fingertips back to the original perceptual image to prevent a stacking of deviations. In practice, this means that a corresponding adjustment in the remaining part of the latent action trajectory shape must be made from the micro-deviation[11]. Similar to a marble in a marble run, the fingertips in relationship to the whole action trajectory shape will become a part of a continuous mutual perception-action coupling, in which the dorsal stream primarily monitors the actual position of the fingertips towards the action trajectory shape, and vice versa the ventral stream primarily monitors the action trajectory shape towards the actual position of the fingertips. This ingenious mediation of the cortical streams creates the delusion of a straight action trajectory shape. Although the execution of a nerve spiral unequivocally shows the opposite.

Within there the explanatory model of the motoric movement action illustrates that the execution of action trajectory shapes indeed encompasses the essence of motor tasks, and that success hinges on the meticulous management of deviations of the action object within the action trajectory[12]. Therefore, it ideally presupposes a mutually reinforcing system that continuously monitors the relationship with the action trajectory shape from the current position of the fingertips, and conversely, constantly monitors the actual position of the fingertips from the perceptual image of the action trajectory.
The explanatory model thus implies a rather heavy correction system, and based upon current scientific literature, it concludes that the conceptual steps within the explanatory model precisely presuppose what is described neuroscientifically regarding the processing of perceptions: namely, the functionality of the dorsal and ventral stream. At every time *t* or at every position P, all observations are processed by the ventral and dorsal stream in such a way that deviations simply cannot escape

[10] https://www.researchgate.net/publication/376888581_The_nerve_spiral_demonstrates_that_random_motor_activity_implicitly_generates_an_internal_and_external_focus_and_provides_scientific_evidence_that_the_external_focus_can_guide_the_action_due_to_the_in

[11] You can speak of micro-adjustments or of updating c.q. renewing the perceptual image of the remaining latent action trajectory.

[12] One must be able to push away an opponent in a precise *tau*-coupling process at just the right moment, and not a moment earlier or later; one must bring food precisely to the mouth, and the fingertips must also stop precisely at the coffee cup without knocking it over repeatedly.

attention. The ventral stream primarily processes deviations from the perceptual image of the entire action trajectory to the actual position of the fingertips, while the dorsal stream does so vice versa, primarily from the actual position of the fingertips to the perceptual image of the entire action trajectory. The mediation of these two processing streams leads to continuous micro-adjustments of the original perceptual image of the latent action trajectory shape, happening so ingeniously and swiftly that the absolute zigzag and accordion-like deviations barely stand out, making the executed action trajectory shapes appear deceptively straight.

4. The cortical streams mediate two autonomous groups of deviations within every conceivable action

The preceding paragraphs extensively delve into the fact that the action object will inevitably deviate from the perceptual image of the latent action trajectory shape, determined within the tactical movement action, when the action is actually performed. The occurring deviations of an action trajectory involve two autonomous phenomena[13], which relate to the words *line* and *shape* in the compound word *line segment shape*. The explanatory model demonstrates that they are observed and processed completely separately, yet simultaneously. Driving and cycling (without hand brakes) show, beyond any reasonable doubt, that the line and shape are autonomously observed and processed.

Images: The deviations within each action trajectory shape involve two autonomous phenomena, as indicated by the explanatory model, referred to as the zigzag process and the accordion process. In driving and cycling (without hand brakes), it becomes immediately apparent that steering exclusively influences the *movement within the shape* (!) of the action trajectory. This defines the explanatory model as mediating deviations along the x-axis and causing the zigzag process. Additionally, it becomes equally evident that using the pedals exclusively influences the movement *within the line* (!) of the action trajectory. This defines the explanatory model as mediating deviations along the y-axis and causing the accordion process. Therefore, in driving, it becomes crystal clear that perceiving the shape has absolutely nothing to do with perceiving the line. In which it is essential to note that processing observations regarding filling the latent line with the manifest positions P within the external (primary) focus solely involves the perception of the *tau*-value and is thus actually generated solely by the pedals of the car or bicycle. Only the speed within which the line is filled determines the duration of the action, thus finalizing the action.

Deviations along the length axis or y-axis of the action trajectory shape involve deviations of the movement of the action object over time. They are related to determining the *tau*-value within a motor action, and deviations of the action object along the line can be characterized as an accordion process.

[13] In essence, they form two complex subsystems within the larger phenomenon of the whole cortical stream operation, revealing that perceiving deviations c.q. the processing of deviations leads to an unprecedented variety of hybrid perception processes. This article does not delve further into this complexity.

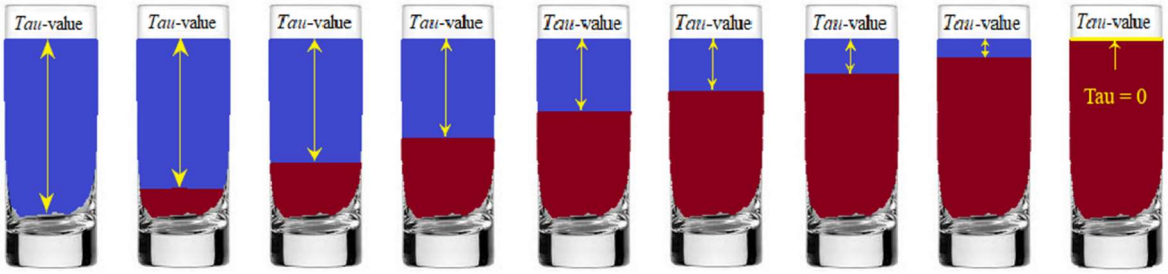
Deviations along the width axis or x-axis of the shape of the action trajectory involve deviations of the movement of the action object within the shape and can be characterized as a zigzag process.

5. The zigzag process and the accordion process when grasping a coffee cup

The explanatory model of the motoric movement action demonstrates that both the zigzag process and the accordion process occur within any conceivable action[14]. However, it's much harder to demonstrate this when grasping a coffee cup compared to, for instance, driving a car. Yet, even when grasping, one must consider separate pedals and a steering wheel that autonomously influence the filling and mediating of the latent action trajectory shape between the fingertips and the coffee cup, which will now be processed through hybrid forms of these phenomena. The zigzag process (the steering process) is easy to capture in an animation, but not the accordion process.

Images: The zigzag process in any conceivable action can easily be represented in an animation. Due to the fact that the primary focus can only be executed by the autonomous secondary focus, the action object (respectively, the fingertips, the pointer, and the spoon bowl) will definitely deviate from the perceptual image of the latent action trajectory shape in width.

The accordion process (the pedal process) when grasping a coffee cup is difficult to represent in an animation because it involves compressions and elongations of time[15]. Yet, just like within car driving, you must realize that you can never move the fingertips identically in time along an action trajectory shape. You are quickly capable to empirically establish that the fingertips will infinitely vary within certain fluctuation boarders.



Images: In the motoric movement action *pouring*, the accordion process is still difficult to capture in an animation. However, it can be factually stated that when filling a glass, as a very rare exception, there are absolutely no deviations within a zigzag process. The cortical streams are fully dedicated to the accordion process during pouring.

[14] While this imposes greater demands on organismal development, conversely, it allows for a compelling demonstration of its seamless integration within an ecological framework. The dichotomy that distinguishes a separate x- and y-axis component actually constitutes the breakthrough that allows us to reduce highly complex perception processes to such seemingly simple phenomena.

[15] Wherein it should be noted for the record that the fingertips do not move back within the action trajectory shape.