Anticipatorial Maps

Cornelius A. Steckner

D-50996 Cologne, Etruskerstr. 22
fax: +49 221 221 4030 email: 101.59215@germanynet.de
http://geocities.com/CapeCanaveral/Hall/2923/

Abstract

Anticipatorial maps, which newely are detected, are visually percepted personal representations of true objects to prepare the path of intentional goaldirected movement. The mapping process cuts the action-relevant external object qualities from the environmental background to constitute the needed true objects of reference within the organisation of the personal space. These virtual object representations then become the references to anchor the path of intentional movement and to bind the visual constancy in object perception. Thus either the path or the object, motion or motion perception is dominating the consciousness. These investigations in motion and perception are related to the experimental background of the personal symbol formation processes described by William Stern, Heinz Werner and Ernst Cassirer.

Keywords: anticipatorial maps, behavioural cybernetics, personal space and time, cortical maps, crossmodal transfer, symbol formation.

1 Introduction: Anticipation and Teleology

There are certain dependencies in the actual understanding of goaldirected movement (Vision for Reach and Grasp, 1997), visual robot arm guidance inclusive (Smagt, 1998). In actual behavioural cybernetics the model is that in grasp and other goaldirected actions there is a looped feed-back - feed-forward process in humans to respond and to access environmental information. The successful grasp there serves as a rather mechanical model of goaldirected actions, where in fact there is no "Archimedian point" to anchor the needed transformations, nor there are the needed entities. This traditional view will be matched against a view in concern of neural correlations of consciousness and certain implications

in the formation of the quantum and relativity theories (v. Weizsäcker, 1969, 64. 166; Holton, 1981).

"Behavior, Purpose and Teleology" was the impressive title of an essay written by Arturo Rosenblueth, Norbert Wiener and Julian Bigelow in 1943 to promote such behaviorists study of *natural events as a change of an entity with respect to its surroundings.* Well advised by Rosenblueth, the primary model of teleological purposeful behavior became the successful feed-back in reach and grasp, matched against the pathological intention tremor of a patient: "*If he is asked to carry a glass of water from a table to his mouth, however, the hand carrying the glass will execute a series of oscillatory motions of increasing amplitude as the glass approaches his mouth, so that the water will spill and the purpose will not be fulfilled. This test is typical of the disorderly motor performance of patients with cerebellar disease. The analogy with the behavior of a machine with undamped feed-back is so vivid that we venture to suggest that the main function of the cerebellum is the control of the feed-back nervous mechanisms involved in purposeful motor activity.*" (Rosenblueth,1943, 20)

This became the key to circular causality and feedback mechanisms in biological and social systems, not yet labeled as "cybernetics". Many in the view of man and machine communication and control has changed since, but still the human intention tremor as a negative model of teleological motor activity of a closed system towards static and dislocative goals is worth to look at. In the grasp meet visual communication and motor activity control of a mechanical device. The mechanical side of the grasp had been from the beginning the model of feed-back circularity. And when the physiologist Eduard Pflueger (1829-1910) in 1877 wrote first about teleological mechanics, Felix Lincke (1840-1917) followed in 1879 with the design of an appropriate mechanical feed-back mechanism. The paper "Behavior, Purpose and Teleology" still followed this technical view on behalf of its behaviorist background, namely the concept of negative and positive tropism in topotaxis by Jacques Loeb (1859-1924). But this view has hidden presumptions, which become visible by the paradoxes in the teleological paths.

1.1 Time, Space, Identity: the Paradoxes of the Turtle and the Cake

The unsuccessful move of the hand to carry a glass from a table to the mouth, though the goal is static, in its logic has much in common with the race of Achilles and the turtle, which in the paradox of Zeno of Elea (James, 244), never would have been passed by Achilles - because he always would reach a point, the turtle just has left. And thus the turtle would always have an advantage in her path. This paradox in the two paths is somehow present in the oscillatory motions of increasing amplitude of the path of the hand approaching its goal. The mechanical feed-back suggestion seems to clear with the oscillations also the

paradox in the paths. But the increase in the oscillations still remains mysterious. the more the oscillations of a thirsty patient during a meal would vanish (Cassirer, 1929, 316. 319). According to such pathological paradoxes, Kurt Goldstein and Ernst Cassirer suggested, that the successful paths were just reflex actions, while the oscillatory movements had misleading addresses in their path designs.

Any grasp has to bridge forward the personal space and time to the glass on the table and then back to the self. And apparently a defect in the related transformations performed the oscillations in the path. The observation of the pathological cases then unveiled different anchors of transformation. The more the movement followed preconcepted and body bound reflex actions, the less the intended movements were disturbed. But if patients paid attention to the path, the movements oscillated. In other cases the object perception broke up (Cassirer, 1929, 302. 320). Such broken objects a patient recorded, who could not realize that there was just one ball in the game: "*A straight shot with two balls was not so bad. but the third ball confused me.*" (Cassirer, 1929, 320)

There were as many balls realized as players. Insted of motor oscillations towards one object there was something like object oscillations. As many balls there appeared as there were possessors of object coordinate dependencies. The following broken object identity has much to do with the paradox of the cake, which you can not have and eat. There the object coordinate dependency is switching between the cake to possess and the cake to eat (Wertheimer, 1912, 247. 255; Kleint, 1940, 70) This makes the two different cakes at one time, and many children, realizing the vanish of the cake to have, will cry.

Obviously in successful goaldirected paths there is a stream of unbroken object identifications in switching assignments, the first relating the person to the goal, and then the relation of the goal back towards the person. The goal first has to be distinguished from its environment as a set of bound qualities to give identity, and then this "true object" has to be related to the personal space. Apparently, because there is no "Archimedian point" accessible to anchor and guide the path to the goal by Cartesian coordinates, instead there have to be series of transformations to produce a stabile interrelation in the "true object" and the "true self". On top the path must be organised to reach the goal from the initiate personal position of the movement.

1.2 Object Coordinate Dependency and Physical Quality

The constancy and identity of an object will not only include shape but also shape dependent physical properties. We may detect the spatial location of a hand relative to a table and it's relative position towards the goal. So far primary environmental time and space transformations related to the body are involved. But to become purposeful the qualities of the glass as a movable object must be anticipated. And this anticipatory distinction has to allow a successfull move of the physical qualities bound by the object. The physical properties of a glass

of water standing on the table change when we touch the glass. Then physical relation of the stand to the table has to shift to a relation of the handle and the hand, to carry the glass with further water equilibrium - until again there is a change from the hand to head coordinates to sip from the rim of the glass. So the whole path incorporates environmental as well as body dependencies which must be covered to bring the rim and the mouth together - all devoted to the constant physical equilibrium of the glass filled with water. With the physical viscosity of the water to drink a specific motor timeliness becomes involved.

1.3 Object Coordinate Dependency and Time

In the time-line of these balanced spatial transformations towards the meeting point there are many time shifts to be covered by interpersonal communication. The addressing word "glass" is as sound based as the quality of the hit of a ball, and both is transmitted according to the speed of sound (Guski, 1996, 190. 337). But the visual identification of the material quality of the glass to handle and drink from is as light based as the visual control of the liquidity of water, and at least the movement of the hand to carry the glass and the movement of the lips to meet the rim have to be brought together on behalf of independent motor activities.

A successful binding of such shifts in time and space according to the involved physical objective and personal properties must be brought together by a kind of body related meta transformation. By that meta binding the variety of the involved body movement and object equilibrium related transformations appears to the consciousness synchronised within the same space and time frame. And obviously the related light, sound and movement control performs a communication to detect from the geometrical object constraints in advance the physical object qualities to join all these transformations. Following, the related mapping processes prepare the paths of movement, but they are not actual part of the consciousness - though the personal object maps in these transformations can be made visible to the consciousness in accessing the bridging processes in the transformations involved - which to show is the purpose of this essay.

2 Unification of Personal Space and Time

The last shift from the visual control of the hand to the head in its interrelation with the visual field apparently is the main problem of the intention tremor. This looks like a rather simple shift in coordinate dependencies, but here meet at the end of the path in fact the transformations in object constancy the transformations in body constancy - while the visual control and understanding are bound to the head (Fig. 1).

To the constant "true objects" in the steams of transformations William James

(1890, 285) had addressed his interest. The emerging quantum- and relativity theories shared this interest. Nils Bohr was in communication with Edgar Rubin in Copenhagen (Rubin, 1936; Holton 1981), and Ernst Cassirer, William Stern and Heinz Werner in Hamburg designed new key experiments to understand constancy as symbol formation (Stern, 1936; Steckner, 1993b): *"Denn eben jede derartige mittelbare Leistung ist im Grunde stets eine symbolische Leistung; sie muss sich von der Gegenwart des wirklichen Objektes losreissen und sich in freier Vergegenwaertigung ein bloss gedachtes, ein ideelles Ziel vor Augen stellen."* (Cassirer, 1929, 320)

Nevertheless the mechanist view remained in opposition to the concept of preconception: *"James appears to regard all mental pre-adjustment for perceiving an object as involving an anticipatory mental image; but this doctrine seems untentable. A Batsman attending to the course of the ball as it comes from the hand of the bowler does not usually construct an anticipatory picture of the course it is going to take. If he does, his wicket is in great danger."* (Baldwin 1928, 2, 331 s.v. Preperception).

While the critic remained in the position of the observer, James had addressed the action determinative references in the flow of information. (James, 288). If a hit sounds weak (Guski, 337) and the ball is going to miss the wicket, the player may watch the path in calm, but he has to catch the ball if the wicket is in danger. So there is either a movement perception of the ball in distance, or a domination of the self to meet the physical qualities of the ball in a future position. Such complementary relation either to the path or the compound of object qualities to be grasped and the way such alternatives may be analysed and recorded attracted the interest of the new key interest (Cassirer, 1929, 322f.), while Max Wertheimer investigated the spatial anchor in movement and motion perception (Wertheimer, 1912, 255f.; Johansson, 1978). Likely a film may either record the path of the ball or focus the moving ball to follow the move, while another camera may record the player acting towards future positions to reach anticipated balls. In this perspective there is no qualitative difference in static and dynamic relations. The question is reduced to the organisation of the player's self reference to relate any motion of the ball to the range of his active motion?

2.1 Cerebellum and Cerebrum

Actually there is a consent to relate purposeful movements to the cortical maps as personal common reference of sensation and motion, which mainly are reproduced now from W.G. Penfield and E. Boldrey (1937) or from W.G. Penfied and T. Rasmussen (1950) (Fig. 1). But the interpretation of these cortical "homunculi" is in question (Wiesendanger, 1996), though undoubtedly the order is somatotopic. In recent robot design as common reference intermodal cortical maps are used. The MIT cog project (cdp@ai.mit.edu) in this case recently follows the cortical

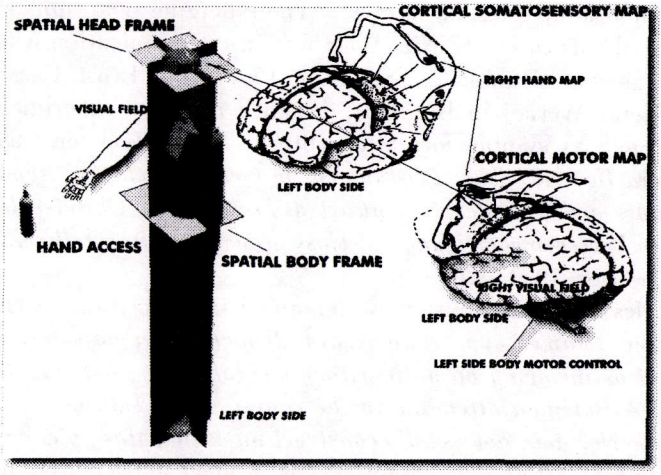

Fig. 1: The symmetries of the cortical somatosensory and motor maps are organised according to the twofold organisation of the personal spatial frames of the body. The left-side maps are related to the right eye and the right hand. The right field of vision is crossed-over to the left visual cortex. But the cerebellum beneath controls the left side of the body.

maps of cats reduced to sets of arrays. But an array is not a map and the cortical body maps have map qualities only to some extent (Clarke, 1973, 103-134).

Ernst Cassirer had arguments for a rather skeptical view of such localisatorial attempts. He was aware of misleading pictorial qualities of the maps. Among the skeptical studies mentioned was Kurt Goldstein's essay of 1910: "Einige prinzipielle Bermerkungen zur Frage der Lokalisation psychischer Vorgaenge im Hirn", who had asked to realize the phenomenological or imagination related aspects in the functionality of mental maps (Cassirer, 1929, 322. 253).

Such distinction of symbolic and motor processes implicitly the essay on "Behavior, Purpose and Teleology" had, suggesting motor activity to be the main function of the cerebellum. This implicitly delimited the cerebrum related symbol formation, even emphasised by the next article in the 1943 journal by William Seifriz on "Creative Imagination and Indeterminism" (Rosenblueth, 1943).

The cerebellum related motor restriction easily is overseen. Clearly purposeful motor activity is related to the cerebellum, while the cortical maps are related to the cerebrum, which makes much difference in real-world coordinates and their transformations, though these circumstances, if ever, are found worth only curious footnotes (Fig. 1): *"Curiously, the 'crossing-over' behavior of the cerebrum does not apply to the cerebellum, so that the right-half of the cerebellum largely controls the right side of the body and the left-half the left side of the body."* (Penrose, 1989, 380)

Exactly this is the crucial point. All the maps related to the cerebrum must be phenomenological, because they have different spatial coordinates than the movement control. We just have to bend the head to realize the head to move, and not the view of the environment (Becker-Carus, 1981, 76). But if a camera follows the bending head and the film is watched later full screen, we then may feel our body move. These differences unveil that there is not only a spatial interrelation with a dependent switch in body and environment relation, but also there must be a spatial frame which anchors the transformations in the relation of the body to ground and vision. What we feel as left and right, up and down must be anchored in such a framework. This framework must anticipate the spatial order of motor activity to become the common reference to coordinate vision and body movement.

2.2 Spatial Frames

Normally just a misleading subset of the spatotopic cortical maps in the different Penfield-drawing styles is reproduced, and not all (Becker-Carus, 1981, 98). Both the incompleteness and the undiscussed interpretation of these impressive pictures are misleading. Among many others Roger Penrose published the left side 3d-style maps representing the right side of the body (Penrose, 1989, 367), but not the equivalent cortical right-side maps, which represent the left side of the body. When all the related somatosensory and motor maps are joined, they show the spatial frame of mind related to the anatomy of the body and purposeful motor activity in the real world (Fig. 1).

2.2.1 The Spatiotopic Logic of the Cortical Body Maps

It is significant that in the centre of the cortical maps the hands are located, followed by the upside-down but upright positioned head-maps of about the same size, and equivalent in size to the body map. This way the hands are located closest to the eyes. Here met the crossed over upside-down body maps and the upright positioned head images. If we follow the logic of this order, the somatosensory and motor activity of the hands meets the visual perception and in this the hands are located in balance with the head and the body. This distribution suggests a spatiotopic interrelation or even interchangeability in these cortical sectors.

Though these orders in personal body space are not actual part of our consciousness, the spatiotopic logic of the cortical body maps clearly is realized by a introspective test - which prepares the design of an intentional conjoint measurement, which will follow then. The experiment is very simple. We need no surgery to detect these planes of the body to which the anatomists gave specific names (Becker-Carus 1981, 20-21).

We have to stand relaxed on the ground, and the only "instrument" we need are our own hands to move along the body. While we do that we anchor our concentration (Wertheimer, 1912, 253); in the position of the hands towards our body, with the emphasis on the hand or the hands, and not on the body or towards the ground, which each aspect would produce different results. These movements make the invisible frames of personal space visible for the observer.

2.3 Personal Space Related to the Visual Coordinate Frame

The following experiments give access to two Cartesian coordinate systems in the spatial body organisation (Fig. 1). These give the spatial frame of the transformations needed to perform the crossmodal mapping process to use visual information for goaldirected motion.

2.3.1 The Head Coordinate Frame

Experiment 1:
According to the cortical maps, the left or the right flat hand is brought in position parallel to the ground in front of the face. Moving the hand up and down we may ask our self: is the hand "up" or "down"? While we do that, a kind of neutral plane should be felt, which is neither up nor down, dividing the space, though related to the head, into the different regions, which are addressed by the words "up" (dorsal inferior) and "down" (ventral inferior).

Perhaps we had closed the eyes to improve the concentration. The plane is felt about in the height of the ears. If we then regard the flat hands in this position, we can realize that this is eye level, and in concern of vision the related horizontal plane.

Experiment 2:
We move the left or the right hand or both hands in front of the face, but this time the flat palm upright. Again there is a spatiotopic sensation, but this time the hand is felt either in the left side space or in the right side space of the body, again with a neutral plane between (sagittal plane).

This result fits the cortical somatosensory maps, showing half the upright face. But clearly the related motor maps represent the head from the side. Taking the drawings not just as functional representation of the personal body space, we now may start a third experiment.

Experiment 3:
We move the upright flat hands parallel to the body forward and backwards at either side of the head. We will feel yet another plane separating the front (anterior coronal) and the back of the body (posterior coronal).

2.3.2 The Body Coordinate Frame

These tree experiments with hand movements demonstrate a body perception related to the head as dependent on the spatial Cartesian order of the vestibular apparatus in inner ear, but showing, that the terms "up" and "down", "left" and "right" belong, parallel to the planes of the vestibular system, to a personal spatial frame. By this spatial frame the upside-down and crossed-over visual field is bound obviously by transformation to world coordinates, while the hands as detecting instruments give access to this personal spatial order. The relation of these transformations to the personal space and the order of the cortical maps helps to understand the way blind people can see by substitutive systems bound to the body (Becker-Carus, 1981, 305).

The detection of the spatial frame of this personal space may be extended by further experiments. These extensions also are a precondition for the main experiment to detect anticipatorial maps.

Experiment 4:
Now the sensation is switched from to the body. We should move the flat hands as in experiment 1 from the plane above the eyes and beneath the cerebrum downwards. If we move the hands down along the whole body side, again the same up and down sensation, but now related to the entire body is detected about in the height of the diaphragm. This neutral plane is detected about in this spatiotopic middle of the body (body segmental plane).

Experiment 5:
Moving one hand in front of the body like in experiment 2, the crossing of the vertical middle of the body gives the feeling of the hand located either on the left (left lateral) or on the right (right lateral) side of a neutral vertical body plane (sagittal plane).

Experiment 6:
If we move both the hands on either side of the body like in experiment 3, there is a plane felt dividing the front and the back of the body (body coronal plane).

Experiment 7:
Moving both hands in front of the body like in experiment 5, but now simultaneously crossing the plane dividing the right and the left side of the body will less produce the sensation of moving the hands to cross the plane, than the sensation give of a body side switch in the lateral directions.
These experiments in the division of personal spatial framework should be performed for different reasons. First it is important to adapt the kind of concentration needed in this kind of introspective experiments (Wertheimer, 1912, 240). The body responses to the movements of the hands must be felt, because "up" and "down" as a functionality of personal space is hardly described by words. In this respect any spatial sensation is based on motor activity related to the head coordinate related vision. Hence the dominant body orientation and the

cross-over and upside-down in the visual cortex has to be transformed from head based coordinates to body based coordinates - which results in many asymmetries in spatial movement. Therefore Ernst Mach (1838-1916) in his "Analysis of sensations" is distinguishing **optical interest** from **motor interest** while he also is using the term "teleological" (Mach, 1918, 91f.).

3 The Self and the Environment

3.1 The Cockpit View of the Self

The cockpit-view of the self as the steersman of the personal space in the world is reproduced by any cockpit environment. The spatial distribution an localization of the instruments in the car or the plane is thus a distribution following the two body maps and therefore the frame for teleological movements. Just beneath or above the visual field there are the cockpit-instruments to control location and speed in self movement (for the investigation in the split of optical interest and motor interest see Fig. 2 and Fig. 3). Accordingly the instruments are clearly located according to the horizontal orientation of the personal space of vision and action. But beneath the ventral plane there are especially for the sitting steersmen the active motion controls. So not only the personal spatial sensation and the environmental spatial frame, but also the overlapping of hand movement and vision leads to the suggestion that there is a profound interrelation. And in fact, on the basis of these transformations, related to the operators space, it is even possible to read in advance from the turn of a street how far we may speed up or speed down the vehicle.

The primary body related spatial outline of the operators space is a extensional transformation of the general body map. If we sit in front of a table of comfortable height, the comfortableness is defined by the tables horizontal plane related to the horizontal body plane, and any movement on and above the table and beneath the table this way is related to the spatial cranial or caudal directions in the spatial body frame (Becker-Carus, 1981, 20), and any comfortable hand and arm movement hence is comfortable within these two planes. These spatial planes are preconditions of a glass to carry to the mouth: the table on which a glass is located, and the position of a person's spatial planes towards the environment.

The operators environment and the personal space of the operator - the one may be taken as the transformation of the other spatial frame, and we know to handle this switch in transformation. Sitting in the train, the car and the boat another vehicle, moving in the view of the window, leads either to the feeling of the moving self or the moving object. And we may switch in this relation. We may switch between the sensation of personal movement and landscape movement in a train, in the car and the boat - but if too many dimensions are involved

Fig 2: The self as the observer of the self: "*In a frame formed by the ridge of my eyebrow, by my nose, and by my moustache, appears a part of my body, so far as visible, with its environment.*" (Mach, 1918).

with the well known uncomfortable result. But if the body has a comfortable self-confidential place we may look at movies reproducing pictures from moving cameras to feel our own spatial movement. This spatial movement of the camera man is then realized as a moving self by transformations between the different body frames.

3.2 Personal Space Mapped to Environment

The detected doubled personal spatial frame is congruent to the anatomical symmetries (Becker-Carus 1981, 20-21). The two frames are related to visual environment control and spatial body movement. But the space between the horizontal head plane and the horizontal body plane has, as the division of cortical maps in the body, the hand and arm, and the head related field may suggest a definite functionality in relation the intentional hand and arm movement. Ernst Mach has sketched 1870 in a famous drawing this spatial relation by a the cockpit-view of the self as the steersman of the personal space (Fig. 2). Anything to take and to carry with the hands happens within this framework of body space - while this space is under personal visual control. The head, the body, the acting hand and the environment, all is set in relation to the personal space: "If I observe an element A within my field of vision, and investigate its connexion with another element B within the same field, I step out of the domain of physics into that of physiology or psychology..." (Mach 1918, 15)

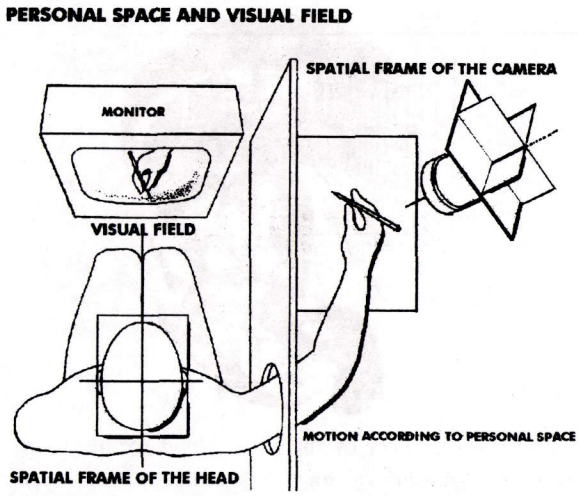

Fig 3: Dislocated split of active personal space and vision in intentional movement. The visual information in the spatial orientation of the camera is transferred to the monitor. This serves as visual information to be transformed to guide motion according to the spatial references of the self (Fig. 1).

3.3 The Split in the Body Frames and the Environment

Historically, the moving steamboat moving and the moving pictures are to owe to steersmen and inventors like Robert Fulton in realizing switching consciousness transformations either related to body or environment coordinates. In that time of the invention of the steamboat, the balloon and later the train, two main orientations of moving observers became dominant, the one optic flow streaming from the left to the right or inverse, and the other streaming top down or inverse. And within this stream first the split of the body related spatial frame from the visual field frame was realized and sketched on a boat moving down the Rhine in the view from a balloon. The body on the boat passing down the Rhine, and the position of imagination were split and transformed to map the landscape and guide the imagination of the drawing. With such a map of continuous parallel projection then the journey on the Rhine switched from the mountain panorama view of landscape to the bird's view (Steckner, 1993a). Obviously there is a fundamental interrelation in motion and motion perception, though actual research focuses the optic flow of the resting observer (Arbib, 1995, 585).

Accordingly the dislocative spatial transformations of the resting person may be studied. Like in motion and motion perception a split in the body orientation and the visual field may be focused. This split is shown by Ernst Mach (Fig. 2). There the visual field is related to the left eye of the head, but the body seen within this field has a different orientation.

A further moving visual field, even unlinked to the body focused the telepresence studies of K.U. Smith and W.M. Smith (1962). There the visual motor information of the acting hand, taken by a camera in any position around in space, was transmitted to a video screen in front of the acting person to control their own motor activity. In this case the acting individual became also his own observer of his somehow dislocative intentional movements. This are transformations according to the internal organisation of spatial reference (Fig. 1 and Fig. 3). The intentional movement of persons in their double role as the acting self and their own observer recorded no problems, but these arouse when there was delay in the visual report. So obviously visual information serves not only as spatial "feed forward" information, but covers any slower processes in spatial movement and action. This way the steersmen behind his wheel interrelates the physical boat and the physical landscape within the frame of a given time and space - where the delayed reaction of the machine in the water only can effect in extrapolated future positions which are beyond the personal actual spatial position and beyond personal actual time.

4 Certainty in Anticipatory Mapping Processes

Short distances might be seen as predictive or extrapolated from the body spatial frames (Rosenblueth, 1943). But a steamboat reacts in really and long distance predictions must include even invisible reefs, which are known in advance from maps. There are alike spatial transformations which help to reach around many corners an invisible goal in a town just by reading a map in advance. Such orientating localisatorial mapping processes, which pathological defects are classified as topographical disorders (Beaumont et al. 1996, s.v. topographical disorders), must be distinguished in their certainty, where somnambulistic localisational certainty is proverbal. There seems to be a map-based orientation predominant to any optic flow. Alike the steersman can not estimate the path in advance from the optic flow he gets from a scenery. He must be certain in the consequences of his doing according to the interrelation of the physical properties of the boat and the physics of the environmental space. All the relating effects of his acting must be seen as a kind of extension of his proper personal space and time. The everyday life is full this personal certainty extended to the environment even in the simplest cases. To carry something with success, we must be certain in advance about the leading object qualities. To avoid failure we have to be certain if something is not too fast for us, or too high or too far, or too hot, too heavy, too big, too slippery, too sharp, too fragile or perhaps too expensive or misfitting. Though we may suggest, that all this was learned by experience, still the question is remaining, how the factual qualitative certainty is established to start the intentional movement at a certain spot at a certain moment. The argument of "experience" does not meet the factual aspect of physical anticipation

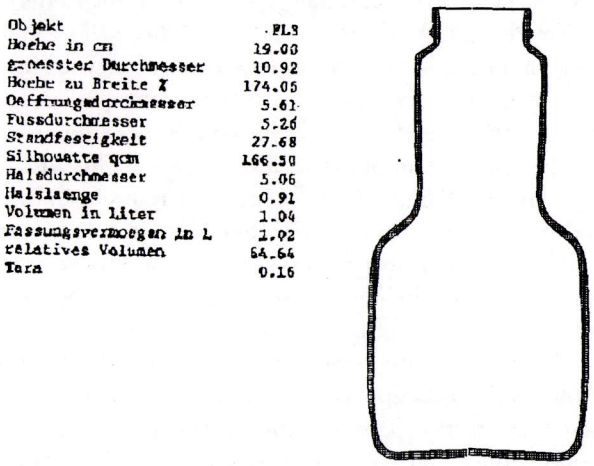

Fig. 4: Example "virtual physical bottle" (h = 19 cm; v = 1.04 l))to measure the physics of shape and its visual realisation. The "bottle" is a set of numerical coordinates in the relational data base.

in purposeful movement anyhow - neither in reflex like motor response nor in the needed object identity and the reacting personal coordinate dependency.

4.1 The Anticipation of Object Qualities

Though the intentional tremor was studied by drinking from a glass, for the following experimental design, instead of beer glasses or goblets, the qualitative content anticipation by shaped glass bottles was studied. Bottles have closed surfaces. Their content can not be spilled. And there is some knowledge of bottles in terms of generalised cylinders since the early speech bound AI suggestions by Hollerbach (Hollerbach, 1976). Shape is the main quality of object constancy related to the personal space. But shape in size also is the precondition of qualitative and quantitative physical object properties. To get the physical properties related to shape properties and following permutation, a system had to be designed to calculate contour based physical properties from virtual objects (Steckner, 1995b) (Fig. 4). The related techniques actually addresses single objects, but in the given context the qualities of shaped objects must be controlled by quantitative statistics of shape (Steckner 1992), which also is a wide field (Small, 1996). And to understand the intermediate function of shape related to object quantities and qualities on one side, and to the understanding of shape by vision series of multivariate analyses had to be made in advance.

Then, to understand the physical shape in its relation to the visual field and the personal space, the dependencies in the act to carry a shaped object were addressed. The test was designed as a marketing test. In this envelop, the phys-

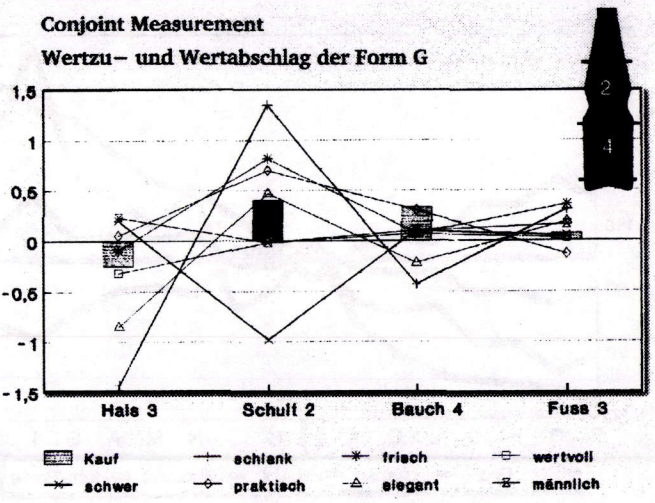

Fig. 5: Result of the visual appearance related to the composite bottle "G". The segment 2 which is addressed to the hand and the buy (Kauf) is dominant.

ical constraints of shape, which constitute the identity of the object, could be included as well as names, economic values and the estimation of physical properties to motivate the intention to carry the given object. Shape as a constraint of physical properties, interrelates the field of vision to the hand to carry. The conjoint measurement analyses the objective constraints of shape to the perception of these physical properties. From a permute mix of sections composite objects are formed. The stimulation by shape, related to its physical properties was asked in a test of visual evaluation: Would you carry and buy this? And so the shape based estimation could be related back to the physical facts.

The primary information came from a representative set of characteristic bottle shapes, covering milk, water, beer, wine and champagne. These objects were scaled to equivalent volume, then cut by mouth, neck, body and foot. These resulting parts were mixed and from the table of permutation a subset of composite bottles was chosen. These composite bottles again were scaled to equivalent volume to represent the objects for the test (Fig. 5).

The result of the opinion-polling was merely astonishing. Tall composite bottles the same way were overestimated in their volume, as the square composite bottles were underestimated. This error did best fit to what is seen in the market in concern of high and low prices and different qualities. But there was one of the composite bottles (G) just between the extremes with a high rate of carry and buy interest (Fig. 5), which had a shape which also represented best the objective shape and volume relation (Fig. 6). The overestimation of the tall and the underestimation of the square bottles hardly may be understood as a function of experience.

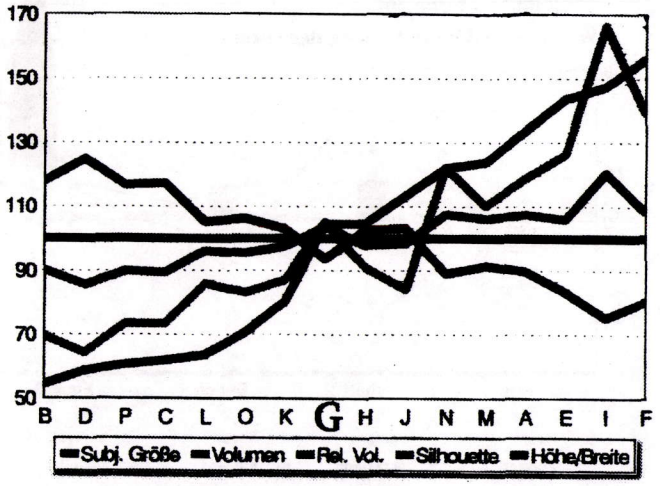

Fig. 6: The composite shape "G" represents best estimation of physical qualities. While the horizontal line represents the physical volume, the other composite shapes were either underestimated in their volume like "B" by 50 %, or overestimated like "F" by 160 %.

The conjoint measurement is a typical third party experiment, which just regards the transformation in input and output. The consequence of the detected relation of the objective properties and its anticipating knowledge was the attractiveness of G to be carried and bought. And the visual dominated estimation was misleading in the shape of all bottles, except for the composite G - as if the hand had directed to the facts. Could this successful interrelation of hand and vision be a function of the related operating space in coordination with the visual field? And how could a hand anticipate the physics of a bottle´s shape?

4.2 Shape Anticipation in Purposeful Movement

To switch the position from the observers position towards the space of the observed, we may take a position in the eye level of the observed. From this position the operating space is in the visual field and the object detected by its shape. A film made from this camera position shows clearly, that there are anticipating goaldirected movements, unrealized by the person. While the person focuses the goal, the hand, entering the visual field, is twisting around in the direction of the goal. Then the hand shapes to fit to the body of the bottle. The hand becomes more and more related to the position of the head and the axis of focus while moving fast directly towards the object to be carried. There is no hesitation as if there were not only an anticipating knowledge of the bottles shape but also of material and weight (Fig. 7).

Fig. 7: According to internal references (see Figs. 1 and 8) the hand is shaping the negative form of the bottle in advance to take it. This kind of complementarity indicates crossmodal mapping processes to transfer visual information to the grasping hand (see Fig. 8).

The film of such a personal movement suggests a visual based knowledge of the physical properties to success. Even in respect to unknown objects there is apparently sufficient visual information to prepare the shape of the entire hand to fit the bottle standing on a table or even in a shelf, where the operating space and the head related visual space overlap. Always the shape of the hand becomes the negative anticipatory map of the object to be carried, based only on visual information. Or is former experience involved here? A different experiment design may help to decide.

5 Anticipatorial Maps in Purposeful Movement: the Red Bell Experiments

In this class of experiments first a red bell had been the object of observed introspective experiments, to include the qualities of shape, material and related sound and colour. The last qualities are omitted here, to address mainly anticipation in shape and spatial orientation. Roger Penrose in this context had addressed the interest to Kornhuber's 1979 experiment (Pernrose, 440), suggesting a foreknowledge of the intention to flex finger. My interest was to get the anticipatory map in this foreknowledge, constituting the path of the purposeful movement.

In general there are different positions in environmental space to scan the anticipatory movements. Among these there are positions where the observer and the self become identical - as in the view of Ernst Mach (Mach, 1918; Fig. 2) and in the Smith experiments (Smith, 1962: Fig. 3). Visual tracking instruments imitate this by fixed environmental positions. Some catch the eye movements, and related to the operating space, recent systems track hand gestures such as

Fig. 8: From the perspective view of the visual field the true object is mapped as a haptic sensation in correct size and orientation inside the palm immedeately. The three slides show the twisted right hand of the observed. The contour of the object map in the palm is outlined by the left hand. For the path of this crossmodal transfer see Fig. 1.

the hand tracking system SIVIT (virtual touch screen). Alternatively the walls of a room give the primary coordinates, and the body movements are tracked in relation to these. This performed in 1983 the Critter Interaction in Videoplace Installation by Myron Krueger. To some extent eye-movements and gestures give access to sufficient information to extrapolate intentional activity. The related personal paths and the goals are already designed. And there is no access to the internal references to constitute these intentional paths. Fortunately there exist alternate methods of experimental investigation (Mach, 106).

5.1 Anticipatorial Maps made visible

The circle of Cassirer, Stern and Werner had access to methods to observe the interpersonal processes of object or symbol formation (Steckner 1993b). The films recording such investigations and the related manuscripts were lost or destroyed intentionally in the years after 1933. The "red bell" experiments are a redesign of certain experimental aspects in the access of internal object references to organise intentional movement. According to the transformations involved, these references may be understood as maps to guide the intentional movement. Four experiments will give access to different aspects in the related maps. In general in these investigations, the visual attention of the observed is bridged by touch to stimulate the crossmodal transfer.

5.1.1 Experiment A:

The person to be observed is sitting in front of a table. On the table, about at arm length, a shaped stone of about 65 mm * 55 mm * 8 mm is positioned. The person is asked just to look at this stone, while a camera on the shoulder clearly records the time and the shortened shape realized in the perspective of the visual field (Fig. 8). Both hands of the observed are in front of the body just

comfortable on the table, the palm flat. The observer is sitting at a side of the table. He is pointing the stone with one hand, the other touching the back of the hand on the table to stimulate the sensation of touch. The sensation of the objective shape occurs in far less than a second on the palm on the table. The palm of the relaxed hand still is invisible to the observed and the observer, but if the person is asked to outline the sensation on the turned hand, clearly this it is the real shape, not the shortened one . The video record of the experiment then shows the shortened, incorrect shape in perspective and the corrected shape outlined as on the palm.

The mapped haptic sensation of shape, as described by the observed, also includes material qualities such as surface and somehow the weight. But is this map of the true shape just following vision? Or is it a kind of productive fantasy or mere knowledge and memory? The next experiment may help to decide that.

5.1.2 Experiment B

The stone on the table is twisted towards the visual field of the observed, and again the directed concentration is asked. After about a second the shape of the stone occurs again in the palm on the table, but the shape now also has twisted in the palm, while also the whole hand has a tendency to twist slightly for a better fit. This clearly as an anticipatory body response covering the personal visual space and the personal body space of the observed.

If this second experiment is following immediately the first, still an afterimage of the first position is felt, superposed by the new object map of different orientation. Not only the map twisted according to the object position proves that these maps are anticipatory because they follow the actual view. Also the overlay of the new shape-corrected and twisted map, felt simultaneously with the first, clearly unveils actual information to be communicated and transformed, and not at all knowledge or experience. Shape is dominating in the qualities mapped. Therefore the mapping clearly is related to the personal processes forming object identity and constancy.

5.1.3 Experiment C

The visual field (as shown in Fig. 3) is moved independently towards the personal space of the observed person. Again the shape is mapped objectively on the palm and the position of the hand is corrected according to the relative position of the stone. This experiment in its variation is the precondition of remote anticipatory mapping processes. This way the object formation clearly bridges time and space from the location and orientation of the observed to the location and orientation of the visual field.

5.1.4 Experiment D

The object is moved within the visual field unreachable by hand. The stimulation of the hand is bridged over the spatial distance. Again the true object is mapped in the palm. This kind of investigation combined with the dislocation of the visual field gives the possibility at hand to touch true things in unreachable places and over long distances. Though not performed yet, it should be possible to touch true things on a planet somewhere far in space. The visual information for the personal visual field and the bridging just has to be synchronised. This could perform be a new key in telepresence.

5.2 Shape, Space and Time

The anticipatory maps, though they occur in less than a second, may last for hours. Like Contingent Perceptual Aftereffects, sometimes the maps return after two weeks. But these mapping processes are transferred across the modalities, and in some cases the focused object may first produce an intensive smell and then the true shape, the feeling of the specific object material qualities (Mach, 6).

Further experiments have shown that larger objects - which do not fit into the palm - are mapped by those parts of their shaped surface the hand possibly could take, like the neck of a bottle or the shoulder. This indicates that there is a wider spatial frame of the mapping processes. And it is quite possible that movements of larger scale, and perhaps even motion in landscape is based on this kind of mapping processes (Mach, 93).

The true object shape is the dominant sensation in anticipatory maps. Shape in the sense of "Gestalt" seems to organise the mapping processes in anticipation. There spatial qualities meet time. It is known that in purposeful movements the fastest communicative processes are bound to the slowest. Roger Penrose in this respect addressed Libet's experiment (1989, 442). So there should be a time related function in shape so far visual information prepares the most rapid bodily response to the environment.

This time aspect in shape may be demonstrated by certain puzzles, where lines have to connect given sets of ordinal numbers. There point # 1 is connected to point # 2, and a further line joins the next item. This procedure is rather slow - until someone is realizing the shape organising the given array of ordinal numbers. Then immediately the shape organising the array is found. Any discursive process takes time, summing up t1 + t2 + t3 + ... But if the shape is detected, at once t comes close to 0. It is suggested, that this kind of object shape detection bases on generalised cylinder transformation (Guski, 1996, 195), but such an explanation does not touch the time critical interrelation of the active personal space and the environment.

6 Feed-Back and Feed-Forward in Formation

In his papers related to the experimental approach to personal space and time Heinz Werner, then in the US, tried to explain some of the results to the new behaviourism dominated audience. Again, like Cassirer, he has some of the arguments of Kurt Goldstein, but now to gain some plausibility for the spatial relativity and switching realities in personal entities, who live in their personal time and space boxes to coordinate the different streams of communication to be able to act and fit their environments. Now Werner found himself in an new environment with different spatial and timely adaptions and wrote in Brooklyn his article on "Motion and motion perception: a study on vicarious functioning" (Werner, 1945), "*to understand the paradoxic relationship between motor activity and motion vision in terms of a dynamic theory of perception.*" These experiments followed the introspective observations in teleological behaviour by Ernst Mach (1918, 152), who had found, "*dass bei festgehaltenem Auge die ruhenden Objekte durch die blosse* ***Bewegungsintention*** *des Auges eine Verschiebung im Sehraum erfahren muessen.*"

Any intended as well as the unsuccessful motor activity dislocates the goal in perception (Werner, 1945; 1964, 26). The detected intermediate anticipatorial maps anchor the paths and the visual object. Obviously the disturbances in goaldirected motor activity are transformed back to vision vice versa. The misleading transformations then either result in motion disturbance or complementary dislocative effects, the recorded pathologic cases of multiple object realization inclusive. And because object dislocation and motion both are bound by the fundamental mapping processes, the interrelation of the path and the established goal will increase the intentional tremor, the closer the hand is approaching the goal. To these fundamental anticipatory mapping processes the consciousness has no direct access to, neither to correct the following path, nor to correct the localisatorial effects - or even to bring both to balance. The visual feed-back in motion has not access to the suggested cartesian frame (Smagt, 1998, 75f.). Instead, the anticipatorial mapping processes both in the visual feed-back in motion and the motion feed-back in vision form a self-sufficient system according to the personal space - which the observer may describe only to some extent by Cartesian positions.

Obviously fundamental purpose of this map-based interrelation in vision and motion is the unification of the broad variety of personal communicative streams by a normalised space and a normalised time, not only to design and optimise goal directed personal acting in environment, but also to allow the interaction of different individuals, which as humans all act on behalf of the same kind of transformations. The maps, made visible by the experiment, actually transform environmental information to a communicative normalised space and time frame. There the observer meets the individual personal space of the other, realizing these mapping processes to link vision and grasp. And apparently similar map-

ping processes are determinative factors in the bipolarity of motion and motion perception (Werner, 1945).

The original definition of an anticipatory system is "... *a system containing a predictive model of itself and/or its environment, which allows it to change state at an instant in accord with the model's prediction to a latter instant.*" (Rosen, 1985) But as shown, the actual space and time frame in consciousness is the result of a stream of bridging processes from personal space and time to the environment and back. So apparently there should be a distinction in anticipatory maps which address the common reference in time and space, and "virtual" anticipatorial maps in active personal space and time to bind the personal paths and constituted goals. It is a suggestion to call the first kind **anticipatory maps**, but **anticipatorial maps** the maps in active personal processes (like "virtual", "localisatorial" or "pictorial").

7 Conclusion

"*Thus my table-top is named square, after but one of an infinite number of retinal sensations which it yields, the rest of them being sensations of two acute and two obtuse angles; but I call the latter perspective views, and the four right angles the true form of the table, and erect the attribute squareness into the table's essence, for aesthetic reasons of my own..*" (James, 285)

The investigated mapping process constitutes both the constancy of such a true object and anchors the path to guide the grasp. A variety of experiments has shown, that the reference of all intentional goaldirected movement is this kind of true but virtual object representation within a twofold personal space (Experiments 1- 3 and 4 - 7). This also is the key of complementary object and path perception - and of haptic telepresence (Fig. 5 and 6 and Experiments A-D). Thus the investigations in perceptural thing-constancy by Egon Brunswik (Teuber, 1978, 338) and the Sensory-Tonic Field Theory by Heinz Werner (Avant & Helson, 1973, 427) and their followers just have different views of the same mapping processes. The related transformations base on a crossmodal transfer according to the spatiotopic organisation of the cortical maps and the organisation of a manyfold personal space.

8 Bibliography

Arbib Michael A. (1995) The Handbook of Brain Theory and Neural Networks. Massachusetts Institute of Technology.

Avant Lloyd L., Helson Harry (1973) Theories of Perception, pp. 419 - 447. In: Wolman Benjamin B. (1973) Handbook of General Psychology. Prentice Hall.

Baldwin James Mark (1928). Dictionary of Philosophy and Psychology. The Macmillan Company.

Beaumont J. Graham, Kenealy M. Pamela, Rogers Marcus J.C. (1996). The Blackwell Dictionary of Neuropsychology. Blackwell.

Becker-Carus Christian (1981). Grundriss der Physiologischen Psychologie. Quelle & Meyer.

Clarke Edwin, Dewhurst Kenneth (1973). Die Funktionen des Gehirns. Heinz Moos.

Cassirer Ernst (1929). Philosophie der symbolischen Formen III [9th ed. 1990]. Wissenschaftliche Buchgesellschaft.

Guski Rainer (1996). Wahrnehmen. Kohlhammer.

Gregory R.L. (1987). The Oxford Companion to the Mind. Oxford University Press.

Hollerbach J. (1976). Hierarchical Shape Description of Objects by Selection and Modification of Prototypes. MIT Artificial Intelligence Laboratory Thesis (AI-TR-346).

Holton Gerald (1981). Thematische Analyse der Wissenschaft. Suhrkamp.

Kleint Herbert (1936-1940). Versuche ueber Wahrnehmung. Zeitschrift fuer Psychologie, pp. 138. 140. 142. 143. 148. 149.

James William (1890). Principles of Psychology. Holt.

Johansson Gunnar (1976) Visual Event Perception. In: Teuber, 1976, pp. 676-711.

Mach Ernst (1918). Analyse der Empfindungen. Fischer.

Penfield W., Boldrey E. (1937). Somatic Motor and Sensory Representation in the Cerebral Cortex of Man Studied by Electrical Stimulation. Brain 60: 389-443.

Penfied W., Rasmussen T. (1950). The Cerebral Cortex of Man. Macmillan.

Penrose Roger (1991). The Emperors New Mind [Oxford University Press 1989]. Penguin books.

Rosen, R. (1985) Anticipatory Systems - Philosophical, Mathematical and Methodological Foundations. Pergamon Press.

Rosenblueth Arturo, Wiener Norbert, Bigelow Julian (1943). Behavior, Purpose and Teleology. Philosophy of Science 10, pp. 18 -24.

Rubin Edgar (1936). Some Elementary Time Experiences. X. International Congress of Psycholgy, Copenhagen 1932. Acta Psychologica 1, pp. 206-211.

Rudel R.G., Teuber H.-L. (1963) Decrement of Visual and Haptic Mueller-Lyer illusion on repeated trails: a study of crossmodal transfer. Quarterly Journal of Experimental Psychology 15, pp. 125ff..

Smagt Patrick van der (1998) Visual Robot Arm Guidance using Neural Networks. http://www.robotic.dlr.de/Smagt/thesis/.

Small Christopher G. (1996). The Statistical Theory of Shape. Springer.

Smith K.U., Smith W.M. (1962). Perception and Motion: an Analysis of Space-structured Behavior. Saunders.

Steckner Cornelius (1992). Designanalyse und Packungsoptimierung. Analyse und Retrieval von subjektiven und metrischen Objekteigenschaften in statistikfaehigen relationalen Datenbanken am Beispiel eines Packungstestes. Goebl. H. , Schader M. Datenanalyse, Klassifikation und Informationsverarbeitung. Physica-Verlag (Springer), pp. 241-251.

Steckner Cornelius (1993a). Das erste Rheinpanorama. Schaefke W., Bodsch. I. Der Lauf des Rheins. Koelnisches Stadtmuseum, pp. 33-38.

Steckner Cornelius (1993b). Personalistik und Wissenschaftskritik der Hamburgischen Schule. In: Montada Leo (1993). Bericht ueber den 38. Kongress der Deutschen Gesellschaft fuer Psychologie in Trier 1992. Hogrefe. 2. pp. 356 - 367.

Steckner Cornelius (1995). The sigmatic relation in historical communication. In: Jaritz Gerhard, Kropac Ingo H., Teibenbacher Peter. The art of communication. Akademische Druck- und Verlagsanstalt, pp. 34-45.

Steckner Cornelius (1995). SAMOS: Automatic Classification of Ancient Greek Pottery according to Shape. In: Nissan Ephraim, Schmidt Klaus M. From Information to Knowledge. Intellect books, pp. 126-150.

Stern William (1936). Raum und Zeit als personale Dimensionen, X. International Congress of Psycholgy Copenhagen 1932. Acta Psychologica 1, pp. 220-232.

Teuber Hans-Lukas, Held Richard, Herschel W.L. (1978). Perception. Handbook of Sensory Physiology VIII. Springer.

Vision for Reach and Grasp (1997). Vision for Reach and Grasp Conference Abstracts. URL: cogsi.psych.umn.edu/Vision_Conference/Abstracts.html.

v. Weizsäcker Carl F. (1969) Kritik der Wissenschaften. Tonbandnachschrift Hamburg.

Werner Heinz (1945). Motion and Motion Perception: a Study on Vicarious Functioning. Journal of Psychology 19, pp. 317-327.

Werner Heinz, Kaplan Bernhard (1964). Symbol formation. Wiley. 2nd. ed.

Wertheimer, Max (1912). Experimentelle Studien ueber das Sehen von Bewegung, Zeitschrift fuer Psychologie 61, pp. 162-265.

Wiesendanger M. (1996). The Little Man in the Brain. In: Schmutz Hans-Konrad (1996). Phantastische Lebensraeume, Phantome und Phantasien. Basilisken-Presse. pp. 239 - 254.