# 5. IMAGINATION SUPPOSES PHYSICAL MOVEMENT



## § 16 LEARNING SUPPOSES PHYSICAL MOVEMENT

I assume that there is a world outside of me. I do not share the solipsistic idea of idealists from Socrates and Plato onwards[a] that everything is already within our minds. My mobile and transient impressions always provide me with news in a multitude and diversity that I can not contain, let alone make up myself.

That diversity must therefore come from somewhere else than from me. This is all the more so if others tell me to have seen, felt, heard or smelled something similar. If that is also different, then that only makes it even more convincing that I can not invent everything myself or have inherited it a priori.

From that variety I detach objects that look similar to each other (differ mutually less than from the rest), to hold them as an image. But I always get new impressions, of which I have no idea yet.
How did you and I then learn to find our way in a constantly changing chaos of impressions (Piagets 'tableau mouvant'[kkkkk])? How did that start from birth and possibly even before ('prenatally')?

Science remains a human design, a reconstruction, a co-agitation (see note hh p**Fout! Bladwijzer niet gedefinieerd.**).
This chapter is not intended to rewrite conventional child psychology. I acknowledge that existing scientific possibility to reconstruct the development of our thinking capacity, but there are other designs possible.

This chapter argues one of those other possibilities from the physical conditions at every stage of development as we think we know as adults. It then argues which conditions can be made predictable at each stage as assumptions on the basis of previously constructed assumptions. Postmodern difference thinking did not yet succeed in this.[b]

a For example Berkeley(1710)Treatise concerning the principles of human knowledge(Dublin)Pepyat: 'there is no object without a subject'.
b See for example Deleuze(1994)Difference and Repetition(New York)Columbia University Press.

**Piaget introduced movement as the source of knowledge**

Piaget[a] has uncovered the importance of own movement ('motor skills') from birth. His influence has been great, for example on education. After his publications full of experiments with children, they got more gymnastics and sports scheduled and they were allowed to stand up from their chairs in the classroom without being asked. I was not allowed to do so yet.

Previously, the psychologists tried to understand our mind primarily from sensory perception ('sensory') and association. The rest they attributed to innate facilities that apparently did not need any explanation (a kind of Dei ex Machina, axiomatic shyness solutions like the a priori's from Kant).

The development of our imagination in the first two years (Piaget's 'sensory-motor phase') is shrouded in mystery in the absence of expression in language and drawings. From the movements of the child, however, you can draw up 'action plans' at that stage, schemes building forward on each other. Piaget observed them, did wonderful experiments, then concluded stages in the development of that sensory-motor phase, and left it at that.

That is empirically pure, but in my opinion there are unspoken assumptions in his conclusions that seem to be unnecessarily a priori. There is more learned than what we have words for as adults.
Our words generalize and they have unspoken assumptions that children do not yet have.

According to Piaget, the mental image, for example, arises only *after* that sensory-motor phase.[b] He sees, after the imitative (by repetition 'practicing') child's play, for the first time in the subsequent symbolic game, that the child uses symbols (released from previous impressions) with (in the act) a meaning where it apparently still has no words for.

Symbols (for example dolls) still *resemble* the impressions (eg people), he says.
Only then can symbols become abstract signs, such as words ('pop', 'human'), which refer to more similar impressions at the same time. According to Piaget, those symbols are then the forerunners of the mental image.

The use of symbols then is a preceding condition for the language acquisition and the mental formation of images. And language is a holy grail for psychologists, the

a Piaget(1966)La psychologie de l'enfant(Paris)Presses universitaires de France I quote this publication here and in the following as Piaget(1966), because his other publications relevant to my purpose have been summarized sufficiently for the time being. You will find a complete list of partly downloadable titles http://www.fondationjeanpiaget.ch/fjp/site/bibliographie/index_livres_chrono.php (2016). The relevance is evident from titles such as: (1926)La représentation du monde chez l'enfant, (1927)La causalité physique chez l'enfant, (1937)La construction du réel chez l'enfant, (1941)Le développement des quantités chez l'enfant: conservation et atomisme, (1941)La genèse du nombre chez l'enfant Neuchâtel, (1942)Classes, relations et nombres: essai sur les groupements de la logistique et sur la réversibilité de la pensée, (1945)La formation du symbole chez l'enfant: imitation, jeu et rêve, image et représentation, (1946)Le développement de la notion de temps chez l'enfant, (1946)Les notions de mouvement et de vitesse chez l'enfant, (1948)La géométrie spontanée de l'enfant, (1948)La représentation de l'espace chez l'enfant, (1966)L'image mentale chez l'enfant: étude sur le développement des représentations imagées, (1966)La psychologie de l'enfant, en (1970)L'épistémologie génétique. I only refer to this in special cases.

b Piaget(1966)p69

beginning of the story. I'm going to reverse that here. With that I partly return to the psychologists before Piaget, philosophers before Kant to their forerunner Hume, but I do take the role that Piaget gave to physical movement as the starting point.

If symbols still *resemble* impressions, how can that similarity be perceived otherwise than by a previous mental image (representation) that is laid over both cases (eg human and doll)? Only through a mental image can a prior impression (human) resemble (show less difference with) the later symbol (doll).

This also applies to the imitative game, which requires the transfer of other people's movements to yours, while the impressions of both (seeing and doing) are totally different. Think of yes-nodding, no-shaking or 'day-waving': what you see doing is totally different from what you do. How do you explain that imitative relationship?

The question is, however, how monkeys and parrots[a] can imitate. Do they also have a mental image as an intermediary? Do the totally different impressions of two eyes on each side of a horse's head not also produce one mental image (representation) that can apparently 'work'?

**An image precedes its name; verbal language refers to images**

However that may be, with the opposite assumption that there is already an image before it gets a name, you can make a conditional series of stages in child development different from that of Piaget. You can interpret the experiments of Piaget and others differently and observe children yourself, avoiding to take any adult skills and words for granted.

I think that Piaget too much takes adult logic, physics and biology as a starting point, to be able to find back their traces in the childlike expressions and with that assumption to name phases in their development. You can, however, not understand the development of a slug house by checking at each stage to what extent it will look like our houses.

Imagine the limited possibilities (conditions) in a newborn child. I do not suppose that at birth there is *nothing* inborn ('tabula rasa'). There is a neural system. Prenatal movement reflexes are visible and they are repeated.
As soon as a child has success with something, it will lapse in repetition. That's what adults do also, by the way.

I leave the conditions for that repetition skills (exercise) to the biologists.
Repetition can be found everywhere in nature (stretching and relaxing of muscles, heartbeat, breathing, routines). Physicists also know the operation of a pendulum and of waves with their sinus movement.
Repeating makes equal changes continuously: a scale paradox of change and continuity in time.

a It has recently been discovered that birds also have enough brains to be able to think like primates (eg imitate?): Olkowicz(2016)Birds have primate-like numbers of neurons in the forebrain(PNAS)0613 1517131113

The primary question is: which representations of the world around you are possible at all in this stage, and which conditions have to be fulfilled in succession building up more comprehensive representations.
Only then you can ask Piaget's reverse question: what must have preceded the skills of maturity that you discover in subsequent stages, described in observations (such as that of Piaget and his successors) of subsequent phases.

In order to find a comprehensible conditional sequence, you have to alternate these two questions, starting with the first. As a meticulously empiric, Piaget supposed nothing more than a 'tableau movant' in the beginning and then concentrated on the second question reasoning backwards. I will first reason forwards as a designer in order to explore the possibilities of the newborn as soon as it applies and explores its new possibility of own movement after birth.

**Distinctive ability supposes movement**
I assume that after birth the discernment of *differences* is the first condition to see, feel, hear and so on, and therafter to imagine, to think and choose something (an 'object').

I therefore refrain from the habit of immediately thinking in categories. Words are general categories or classes.
I can not express my line of thought without words, but categories exist primarily through their mutual (external) *difference*, not the other way around (by its internal *equalities*).

With 'difference' you immediately think of the differences of character (quality), as you perceive them looking or groping and represent them as well: color, shape, texture. You can then add the impressions from other senses (sound, smell) to that quality. That starting point, however, always led me to discover that there were still unspoken conditions missing for future skills, for example difference of place or 'direction'.

If there is a constructable sequence in the conditions that allow us to distinguish differences of quality, then it is first of all necessary in advance that you can distinguish *objects* in between which the difference occurs ('object constancy').
It was clear to me that endless parallax exercises are needed for this.
Parallax requires repeated own movements (Piaget!), but what does that parallax mean for the newborn?

**Movement supposes direction**
In the end, I did not escape the condition of difference of direction, but it seemed strange to me to suppose something as abstract as 'direction' in a newborn. Direction, however, is supposed in the practice of every movement, especially in the movement

of your eyes. Once they are open, they have a gaze *direction*, but that may be just adult talk.
A newborn can not 'understand' anything yet, let alone 'direction'.

Even plants focus on the sun with movement, but they can not leave their location. Animals (like us) are distinguished from plants by the possibility of free movement. This movement must be focused on fleeing, fighting and eating in order to survive. To this end, numerous muscles in their movements must be coordinated simultaneously.

The effective direction must guide the coordination of all necessary muscle movements.
Perhaps then 'thinking' is only the further development of that old capacity to coordinate partial actions in an inborn reflex, in a learned routine or finally with a conscious image of simultaneous or successive actions.
Movement is then an evolutionary condition for 'thinking' (p243).

Especially moving with your eyes is impressive. It changes the whole world, while the previous world is still afterglowing. That must be incomprehensible, but it is a self-generated, all-encompassing sensation of difference.
As adults among each other, let us call that 'difference of direction' for the time being.

**Movement lets you 'know'**
Movement remains crucial in every subsequent phase. As adults we can release and quantify something like speed: distance d divided by time t (d/t). We express this, for example, in the number of kilometers traveled per hour.
If you include the mass m, you get an even more complex concept: 'amount of movement' (m∗d/t, 'impulse'), but both have a direction ('vector').

If they both have a direction, why should you distinguish between movement and direction as a baby?
Direction is at most an animal feeling of 'forward!' or 'get out!', possibly connected with desire and fear.
The only result of your movement is a difference, and that is noticeable with all sorts of senses.

There is still no observable distinction between d and t, 'distance' and 'time'.[a] You only notice their quotient when you bump into something. 'Nice' is, if the value of that ratio is low (so laugh), otherwise 'pain' (so cry).
'Mass' only comes when you start handling things, and 'space' or 'time' come much later.
Movement supposes change, just a difference with now.

a Einstein regarded speed as a primary quantity, of which space and time are derived. He seems to have asked Piaget if you have to suppose a sense of time in children before they could develop a sense of speed with the help of that. In this way Kant's a priori of space and time would be refuted. The fact that children initially do not distinguish space and time in a movement seems to follow me from a note from Piaget (1966) note p67 in the Dutch version: "Like some primitive painters, the child will indeed try to realize the chronological development in a single drawing: sees, for example, a mountain with five or six males, while it concerns a single person in five or six consecutive positions."

Everything is 'now', with an after-image in your eyes, an after-feeling on your skin (pain!), a reverberation in your ears, which only *differ* from the current impression. Memory is no more than an after-image yet, and that is also 'now'.
Later you have to learn from gurus again, to unlearn stress. Regret? Care? Nonsense all. Adult talk.

## § 17 MOVING, ORIENTATING AND RECOGNIZING ENABLE CONCEPTS

### DIFFERENCE OF DIRECTION IS A GIVEN AFTER BIRTH

The recognition of an object and its boundary supposes a gaze direction (or probing direction) and perpendicular thereto an image plane that you can scan in arbitrary directions, until a border (continuous difference) appears, which you possibly know from previous impressions.

Orientation to objects follows from comparing different directions and distances with their own directions (in your image plane distorted). Movement supposes taking, holding or changing a *direction*.

Animals can apparently do that all too, and sometimes even incomprehensibly much better. What more can we do?
Perhaps we can imagine more directions between 'forward!' or 'get out!'. In any case, I can not imagine a length, surface, content, form (in short space, and thus geometry) without a primary distinction of differences in direction.
I even suspect that any distinction supposes a distinction of directions and imagined movement.

### Gaze direction (frontal) differs from directions in the image plane (lateral)

This directional distinction may differ in frontal gaze direction (forward from the observing and thinking subject), but also (perpendicular thereto) directions in the plane on which images are projected (the retina or the skin). In the future, I will summarize these directions as 'frontal' and 'lateral' respectively.

When I change my look frontally, then I see something change laterally. Without a connection with my own frontal movement and gaze direction, I can not yet understand that lateral change of my image. Every ability to distinguish supposes a sense of frontal or lateral difference in direction. That awareness must have its origin in the senses.

### All senses are direction-sensitive

A prenatal directional sense is probably of no use. It therefore does not have to develop in the embryo.
In the mother's belly it probably has no other connecting factor than gravity, and there are no tangible differences in pressure distribution over the swimming body. It is

conceivable that other senses such as hearing, smell and taste do give prenatal impressions, but they do not have to be direction-sensitive yet.[a]

The question now is what the contribution of different senses to our directional sensitivity is.
It is not certain which senses become operational successively after birth and in what proportion their influence on the sense of direction then develops. So the order below is arbitrary.

**The touch, pain, heat and cold sensitivities** are probably the first (already at birth), and the most impressive sensory impressions. They are mainly localized in the skin. How do they contribute to the primary directional sensitivity?

Adults can pinpoint the stimulus place. They are place-conscious, but in newborns you do not have to assume that.
It is conceivable that newborns only have an unconscious avoidance reflex that automatically follows an opposite 'flight direction' of limbs, body parts or the entire organism.

Without the ability to crawl or walk, the ability to move is not yet fully grown. It can not contribute otherwise to the sense of direction than moving eyes, head and limbs. Whether the awareness of body polarities (front-back, left-right, top-down) already plays a role in such an avoidance reflex is also questionable.[b]

In adults with all movement possibilities and their upright gait (with a clear top and bottom) such a notion has the role of coordinates with respect to which the stimulus (threat or attraction) can be localized and a flight or approach direction can be weighed.

**The hearing** is in principle direction-sensitive due to the placement of our ears.
I do not know at what stage that difference in direction between the two can be made out of the child's reaction.
Sound directions can probably only later be associated with other impressions on the left-right polarities of the body.

It is clear that the unique designation of 'left' and 'right' due to the symmetry of the body takes a long time (at least I needed a mnemonic for a long time: 'the side with which you write'). *Making* a sound is directionless, but it does give a first effective influence on the environment. So you will repeat that (cry!).

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a A nice example: Clombelli(2016)Vocal imitation of mother's calls by begging Red-backed Fairywren nestlings increases parental provisioning(The Auk Ornithological Advances)Volume 133 p273–285, http://americanornithologypubs.org/doi/full/10.1642/AUK-15-162.1 shows that birds learn the songs of their parents already in the egg.
According to Piaget (1966), repeated reflexes (such as exercising with the gripping ability of the hands) are prenatal preparations for the 'outdoor life' that will develop after birth to more complex habits (such as targeted gripping), adapting oneself (physical adaptation, not just intellectual association) to the new demands of the postnatal environment.
For my argument it is important that of the prenatal reflex rhythm, repetition of once effective movements remains as a habit. Repetition is then a priori innate. It occurs everywhere in nature. For that I do not have to look for any reasoned conditions.

b Sinnott(1960)Plant morfogenesis(New York)McGraw-Hill, distinguishes very illuminating in all living beings 'polarity' as the first principle of form alongside (perpendicularly) symmetry, and (wrapping around it) spiral formation.

**Odor sensitivity** can be decisive in animals. Butterfly males can find a female at a great distance due to the concentration gradient of her scattering fragrance ('pheromone').
The role of odorants in humans is insufficiently known, but it is conceivable that the newborns on the trail of their mother brings, such as kangaroo-embryos look for the pouch.

Something similar can be assumed for **taste sensitivity**, which at the same time as the sense of touch of the hands, lips, mouth and tongue, arouses attraction or disgust. The tendency to put everything into the mouth and make it 'own' can be more difficult to associate with sense of direction, but with the body polarity in which mouth, nose, eyes and bringing the hands to the mouth point in the same direction.

Due to their variable direction of **vision**, the eyes are also guiding without any other movements from the moment they open, even though this can already be prepared by other senses. Direction could then be an important factor in the integration of impressions from different senses ('synaesthesia').

The gaze is varied from the first moment on its own initiative with very different impressions as a result.
In order to be able to change your impressions yourself (such as that with crying and primitive movement before) could in the beginning have an enchanting impression, (if there is at least something different or going on in the environment[a]).

You do not have to distinguish various impressions by your own eye movement at this stage from changes in an image without eye movement. In other words, you do not have to suppose a distinction between space and time.

This only becomes topical when you learn to distinguish between what you can do yourself (different impressions) and external changes that you obviously can not influence (unless you can conjure, a wish that will later fascinate every child). That is also the painful moment when you have to make a distinction between 'me' and the rest, in other words: if a solipsistic 'all' splits to one's own will and the arbitrariness outside of it. Piaget calls that 'decentralization'.

In the center of the eye, the highest concentration of cones (***Fig. 53***) is the most detailed and color-sensitive part of the image (I call the impression of that center further 'focus'). The surroundings of the center will decrease from there in color and detail. This probably focuses on the biggest differences of brightness and color, but for the distinction of objects, long-lasting parallax practice is required.

a In an orphanage with foundlings who spent a long time in bare spaces with few stimuli, a relatively high mortality was observed:
Spitz(1945)Hospitalism An Inquiry Into the Genesis of Psychiatric Conditions in Early Childhood(Psychoanalytic Study of the Child)1, 53-74.
Dember(1979)The Psychology of Perception(New York) Holt, Rinehart & Winston

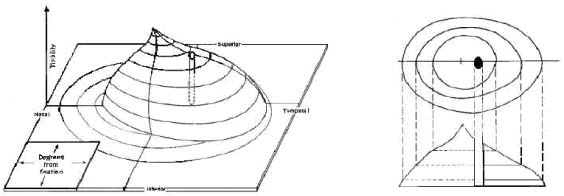

*Fig. 53 Visibility from the center* [a]

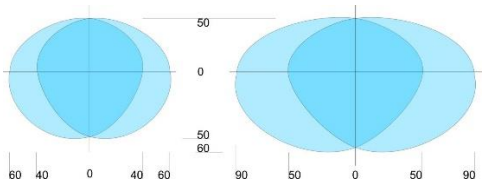


*Fig. 54 The field of view of children and adults (in degrees from the center)*[b]

Eye movements are difficult for adults to make gradually (just try it). They lead jerkily from one object to another, so that directions and corresponding impressions can be clearly distinguished from the observer.
Something similar can already be the case in newborns, even though one may not yet speak of objects, but of surfaces with the greatest differences in color, clarity and detail.

The field of vision of children is smaller than that of adults (***Fig. 54***), but it can eventually be extended with head and eye movements by intellectual composition to a 'panoramic' image.

You can not assume depth effect in the beginning, although the stereoscopic image with two eyes for adults is self-evident. Animals with eyes on the sides of the head probably also can not directly form a stereoscopic image. This must then be constructed from the two very different images, supplemented with movement impressions.
The first impression should be as flat as the retina or skin that passes on the differences.

'Distance' then only relates to directions in the lateral image plane and becomes plausible from differences in direction of eye movements. The frontal distance between the observing subject and an object in the gaze direction is probably only associated with it much later. With that, you can finally also make an objective image of yourself as an object in the midst of surrounding objects ('self-objectification').

Only own movements of head and body (motor skills) can lead to a construction of depth in the image through parallax exercises and the awareness of a frontal distance between background and something that is later recognized as a limited 'object', in the foreground.

Here, the grasping of tangible and apparently still elusive objects in the image also plays a role.
With this, the motor depth insight is supplemented with the sense of touch. Grabbing to elusive objects changes to 'pointing with a finger'. The appropriation has given way to a grip on direction. This finger pointing occurs before language development and is even an important condition for this. It is the first form of 'referring'.

a Anderson, D.R. (1984) Testing the field of vision (St. Louis) Mosby http://www.msac.gov.au/pdfs/reports/msacref13.pdf
http://www.msac.gov.au/pdfs/reports/msacref13.pdf
b http://www.shef.ac.uk/personal/l/lgf/visiondeaf/ ; http://home.zonnet.nl/jcamps/gezichts.htm

It is conceivable that other direction-sensitive senses have been developed in the animal and plant world, such as the orientation of migratory birds, the orientation of plants on the sun, etc., but I assume that these have a subordinate role in people with highly developed other senses.
The conclusion must be that directional difference can be made from all sensory impressions.

#### 'OBJECT' SUPPOSES DIFFERENT DIRECTIONS

**The concept 'one' (object) enables a logical 'no', refusing and wanting**
If parallax exercises allow you to permanently separate a moving part in the field of vision from its background ('object constancy'), then the first substantial spatial difference emerges: object and non-object.
The sense of direction stems from different senses. It enables targeted gripping.
If the object is also accessible and tangible, then you will get a proper 'grip' on the object.

'Comprehension' (prehension is 'grip') supposes separation from the impression as a self-made representation.
You can remember, represent (make present) the object without input from the senses (imagination).
This imagination, however, is a strong reduction of the first impression. From that information you have demonstrably very little made aware.[a] There remains only a tiny part in your memory.

However, many elements associated with that impression (smell, sound, context) can remain associated with the representation of the object. With a next impression, a similar object is 'redefined' and the representation is adjusted (expanded or limited) if necessary.

In the impression itself the focus and attention on the object is concentrated, while the rest (non-object) in the outwardly fading periphery remains largely undetermined. Object constancy is then a necessary condition for the development of another ('logical') concept for that indefinite rest (for the denial of the object): your first conjunction 'not' (although that does not yet have a name). That makes refusing and wanting possible, because you have an image of what is *not* there.

If the same object disappears behind something else ('in the nothing') and then reappears (the essential game of 'peek-a-boo'), then there is a moment of indeterminacy (loss, hope, expectation?), which upon resurrection is resolved by recognition (relief!). This recognition after a short disappearance is initially not yet essentially different from the recognition of appearing and disappearing images that you pass moving and re-appear looking back.

a According to Silbernagl(1991)DTV-Taschenatlas der Physiologie(Stuttgart)Thieme p274: less than 0,00001%.

The first object that you have made aware of in this way is probably your mother. What remains of that appearance in the memory as first presentation is initially only which is useful for survival (especially associated with food). That is sometimes sobering for adults.[a]

Adults mainly think to be seen as 'human' by babies, but that may be an illusion until the second year. For babies, we may be no more than objects that may or may not be wanted. I observed that the eyes of a one year old child continued to look straight ahead, while my head passed her field of vision. She even laughed with pleasure, but not at me. Probably she was still only fascinated by the change of background at the more permanent foreground of my head (parallax).[b]

You must already have that stage long behind in order to be able to distribute your attention to more objects.
If two objects move in different directions, you can no longer follow them in one go.

**The concept 'two' (difference of object) supposes decentralization of the individual**

In order to distinguish a second object from this first object, requires a further kind of distinction: *difference of object*. For example, to be able to distinguish mother and father from a distance, requires more coupled associations (soft, warm, drinking! or moving, news, frolicking![c]). That requires a more advanced pattern recognition than parallax alone.

The second object claims its own focus, added to the image that you have just released from the first object as a memory, incorporated within your own (solipsistic) unity. If they are similar, you can still experience that as movement, unless they move in different directions. If they differ in character, then that second focus is no longer part of that unity, there is something else. It is 'no', but not 'nothing'. Your unity in which everything is yours may fall apart.

This supposes room for more 'memory places' than the one immediatly recording your own recent movement.
That increasing memory space may be occupied primarily by the *succession* of reduced impressions, a primitive 'past'.
Being able to crawl and walk creates a new revolution in imagination. This experience of own movement through different places enables an awareness of *sequence* corresponding with the sequence of impressions.

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a The answer of two children at the age of two who were able to answer on my question "What is a mother?" was: "Large and warm". See also Piaget(1966) p28 in the Dutch version.

b 'I remember my niece celebrating her first birthday. Grandma held her on her lap saying "Quiet my darling, quiet!". But she stayed crying all the time kicking her legs. I had been reading Piaget recently and said: 'Give her to me'. Grandma handed me the child and I helped her kicking legs to move her body up and down to see my face alternating with the background. She started laughing! Grandma, somewhat embarrassed, thought she loved me more than her, but I explained her the baby was experimenting parallax: changing object and context by moving up and down. She did not see me as a person, she tried to understand the difference between my face and my background first. That is why moving on a seesaw is so fascinating for children.' Jong(2005)Child perception(Delft)Contribution ChildStreet Conference 26th of august

c Excuses for the stereotype of the parent role of wife and husband that seems to be expressed here. I do not know the difference a baby may observe, but this example is only meant to indicate that once any *difference of object* should be observed.

The subject 'me' supposes a centre in which all directions come together. The primitive past, the sequence of recent impressions and objects may disturb that unity of the subject with its once observed and incorporated 'own' object.
In adult terms it raises the question 'was that me?', because that imagined past is no longer the actual centre.
That 'decentralization' requires a 'subject constancy' enabled by *sequence* of movements on your own initiative.

At a later stage you may restore the unity also summarizing and remembering a series of *similar* objects as an object on itself (set). That is another kind of order than sequence.
That set may once get a name (a denominator), to be manipulated co-actively again on your own initiative.

However, *different* objects can only be summarized if they share the same *place* of one impression, but the concept of different 'places' requires suppositions that have not yet been constructed as a concept. 'Different objects' still cannot be 'placed'. Objects that do not obey your own movements should get their own place, but they are no longer 'yours'.

#### 'SEQUENCE' SUPPOSES DIFFERENT OBJECTS

Repeatedly moving yourself along the same series of different objects, repeats impressions in the same order.
Own movement combines the sequence 'in time and space' still without any abstract distinction between space and time.
From these repeated impressions you can detach and use the repeatedly observed sequence.
This later will form a condition for naming, numbering and counting.

Sequence can then be associated with (and transferred to) *actions* such as crawling and walking.
With this, people can finally see a series of actions of which only the first is directly feasible and only the last satisfies.[a]
Only the *number* of intermediate actions (such as making tools and using language) distinguishes people from animals.

At this stage, it may be useful to play with animals, because children can identify with their arbitrary behavior.
As soon as they recognize the sequential arbitrariness of their own actions that they still see in animals, this association contributes to their identity (distinction) as a human being. Playing with animals introduces the human 'third action' in the game, a goal extending the series of two actions (eg throwing a ball extends the dog's routine of 'run and catch').

a A demarcation criterion between humans and animals according to Harrison(1970).

# 5 IMAGINATION SUPPOSES PHYSICAL MOVEMENT

Language use and calculation will later suppose 'sequence'. A series of words or figures supposes unspoken and self-evident one direction. In the opposite direction that series loses its meaning. Any qualitative consideration supposes a series (from low to high valuation) that can fill simple black-and-white thinking with nuanced intermediate values.
Every quantitative assessment will also suppose a series (from small to large or from little to much).

I can not imagine a sequence of objects without 'direction'. Sequence supposes objects and a direction.
However, an image has a story in all directions. That gives rise to different stories, and therefore widens imagination.

### 'SIZE' SUPPOSES DIFFERENT SEQUENCES

In the lateral image, the difference of size is relative. One object fills the field of vision more than the other.
The impression of a small remote object also increases when approaching. This happens in a fixed order from small to large, but these seeming changes in size still stand in the way of an awareness of absolute size and distance.

An approaching or approached object eventually becomes tangible, and that gives a hold.
What comes within reach is first given two absolute values. Handable objects are 'small', non-manageable are 'big'.

With the 'growing up' itself, intermediate values arise of more and less manageable objects, associated with their own efforts as 'light' and 'heavy'. The focus is naturally on the largest, most screen-filling object, but that also offers the greatest chance of unmanageability. The boundaries of manageability are explored and shifted.

This creates a feeling for the order of sizes between manageable and not yet manageable. It must be a fascinating experience to be able to handle ever larger objects, such as 'larger ones' can. 'If you are big, you can do everything.' People are also normative. There are 'smaller' and 'bigger' brothers, sisters and friends.
Many qualitative associations are linked to this self-evident order.

### 'DISTANCE' SUPPOSES DIFFERENT SIZES

Distances are distorted in perspective in our visual image. They also change with movement.
How do you construct the absolute distances between the objects in your environment from that relativity?

Own movement lets objects disappear sideways from the field of view, while the frontal object of focus fills the image until it is tangible. The laterally increasing distances in the image (widening, removing and disappearing) must be related to the

progressively decreasing distance of approaching (from unreachable to tangible). Both suppose a sequence.

To make that connection seems a difficult task, but that perpendicular coordination between frontal and lateral is a prerequisite for a 3D concept with absolute distances in different directions.
Only in this way objects do acquire a unique and mutually determined place in space. This also gives stereoscopic vision (in fact an inborn constant parallax) its spatial content.

'Distance' in the lateral image is initially no more than a difference in viewing direction.
'Distance' in the frontal direction is initially only the difference between unattainable and tangible.
'Inaccessible' is 'not tangible', but approaching bridges that contradiction with one's own effort.
Own locomotion relates both to each other, through the advancement with respect to laterally passing objects.

If all of them have disappeared from view, only the forward object remains, and finally becomes tangible.
A reminder of sideways disappeared objects gives intermediate values between unreachable and tangible as 'almost tangible' ('I'm almost there').

However, the geometric concept of 'distance' itself is still difficult to understand. After all, it can only take meaning in the abstract 'nothing' between the objects. That object-negative 'nothing' is only determined between objects.
Jigsaw puzzles do establish a connection between object and missing object (non-object).

By filling up, a void is given the dimensions of an object.
Jigsaw puzzles with pieces of different sizes and shapes practice the concept of absolute distance in different directions. Jigsaw puzzles with pieces of the same size require other additional impressions (shape and color).

You can also fill the 'nothing' between objects, by grabbing them and bringing them together, stacking them, or colliding them with a blow (associating hard or soft sound with your effort). Conversely, you can throw an object out of the box. That makes the frontal distance larger and the object smaller, but also unreachable and intangible until it is returned by someone.

Clashing and throwing may be important experiments to understand the relationship between frontal distance and size. The relation with distances between laterally passing objects is thus limited to relative (topological) relationships, but their geometric distance can already have some content due to a prior awareness of size. Absolute distance requires more insight into difference of place.

#### 'PLACE' SUPPOSES DIFFERENT DISTANCES

Difference of location is only a lateral distance for two objects. Only with a third object that simultaneously fills your field of view through frontal movement you can develop some understanding of place. The objects that you pass get an increasing distance to the left and right until they disappear and only the central object remains in focus.

However, it requires a representation of, and a memory for those objects (and for the effort to pass them) in order to be able to relate their distance apart from you to the distance to the frontal object of focus before you. Probably looking sideways during your own movement is crucial. A laterally disappearing object then appears for a short time between the objects that you passed and will pass, until you continue the route to the one in front of you.

The difference of place becomes real (associated with your effort) when you crawl from object to object and return with a sense of recognition to the original object. There you have already chosen a direction, the focus on a next object. Arriving at that second object you choose a different direction, a different focus on next object, small at some distance, but big when you have arrived on the spot again. Repetition is again the mother of the representation.

In doing so, you have gone through all the conditions for positioning in the previous sections several times. When you have arrived at an object, you see from there the other objects in the usual perspective, but now with a motor reminder of the distances that separate them.

It is the beginning of locating with an anchor point ('origin'), and the primitive precursor of every route to school, work or recreational purpose that starts at home and ends at home with an increasing range (**Fig. 55**). From that anchor point, directions, objects and sequences can be chosen, sizes and distances can be understood and places determined.

However, that does not yet yield the abstract image of a map seen from above. This is only inspired by the symbolic game with reduced models such as a dollhouse and small structures that you make with the block box, so that you can stand above it.

| years old | m radius R | area of awareness |
|---|---|---|
| 0 | 1 | Action space |
| 1 | 3 | Room |
| 3 | 10 | House |
| 5 | 30 | Yard |
| 7 | 100 | Neighbours |
| 9 | 300 | Neighbourhood |
| 11 | 1000 | District |
| 13 | 3000 | Town |

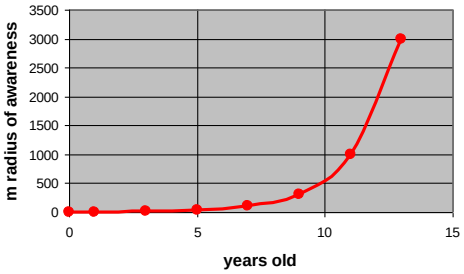


***Fig. 55 Estimate of the increasing area of awareness by age [a]***

A place is not yet an abstract point (location) in the beginning, but a place with a border ('frame') and a smallest perceptible detail ('grain'). Each place differs from the outside, but that difference is only recognizable from memory if deviating sensory indications exist within it: differences in quality (points that is not the case).

By repetition finally every object becomes an anchor point from which location determination can take place: the bed, the bath, the dining area, the play corner and so on. They all have their own perspective, and their own familiar variety of impressions ('atmosphere') that no longer surprise us. They differ in quality.

In order to include objects outside the current field of vision in that primitive representation of place, a further development of the imagination is required. The not directly perceptible must be included in the representation.
Only then you can find the bathroom and your bedroom yourself. The radius of action initially restricted to the field of vision will gradually increase with age until the mind is ripe for the abstraction of a map (**Fig. 55**).

#### 'QUALITY' SUPPOSES DIFFERENT PLACES

Nothing can be distinguished without a difference of location. That difference is determined externally by the own movement that was always central to this before, and internally by the increasingly sophisticated observation of differences of 'nature' (quality) of the objects that are permanently in that location.

You crawl to your focus object, and all objects around it (a collection) disappear left and right one after the other, until you see only one object, which you can then touch and grab, your doll: laugh!
Your parents pick you up and let you take a step back to eat: cry! Taking distance is literally abs-traction.
What we call 'scale' is frontal distance for you, varying between tangible (doll) and unreachable (play corner).

a Jong(2005)Child perception(Delft)Contribution ChildStreet Conference 26 august 2005http://www.taekemdejong.nl/Publications/2005/Child%20perception.doc

With increasing distance, the objects that you passed through are fading into one homogeneous object in one place: a collection or set. You can no longer distinguish the order, size, distance, place or quality in which they occur.
The distinction between multiplicity and unity is no more than the operation of approaching and removing itself.
The broadening of the field of vision that is associated with distance-taking gives room for more collections: the people, the room, the trees outside. They have become objects that you can capture and remember in one representation.

At the table, your collection of 'toys' ogles. Now suppose you have a doll and a bear, but your neighbor also has a dino. Apart from that dino, there is something different between your toys and the collection of your neighbor. If you can later make the sounds they call language, then you'll tell them you want a 'dino', or 'something else', or 'more' (then that doll and that bear), or ... 'three '.

There are, of course, many experiences in a child's life, in which an extra object has its own designation and is 'something else' or 'more'. How do you make the step, after the necessary repetition of such an experience, to replace that particular term with a word that has nothing to do with those objects themselves, such as 'three'?
How did you first get the idea to separate that number from three objects?

This happens when it concerns 'equal' objects. After all, they no longer have their own distinctive quality.
You get that indication from older people who make different sounds each time with the next object. Now they get names in order. You could repeat actions before your birth as a reflex, so why not also make noise?

That you have to make a different sound every time, even if it concerns equal objects, you have to hear and imitate the elderly. It makes repetition possible. Birthdays can now be counted on your fingers.

You can only 'number' them, make a difference where there is only a difference of place.
To be able to 'count' you must also include the objects on a different scale level as a set in the representation.
The total number of elements in that set is simply indicated by the triumphant sound with which numbering ends.
That representation as a set is a form of abstraction, taking distance.

If sets only differ from place to place, then there may be only one quality left for discernment: the difference in 'number' of elements ('cardinal number'). If you do not distinguish differences in density, then that *number* is independent of the physical size of the set. The *size* can still be the same if the *number* differs from an imperceptible difference in density of the objects at this stage. If that number is the same, you can multiply.

I will not elaborate furter the conditions for advancing mathematical insight (the distinction with numbers other than natural ones, with operators other than addition and multiplication). What I wanted to demonstrate is achieved: 'number' supposes a last remaining quality of sets that no longer show any other difference.
Quantity supposes quality. Counting is the language of *equality* and repetition *within* a set, *different* from *other* sets.

**Variables suppose external difference and internal equality**
The abstraction of numbers into *variables* can sow life-long confusion and be a barrier to a career that requires mathematical skill. "A variable can be any number," says a teacher, "and another variable as well."
Whatever else (s)he is going to say, here you have lost everything: 'the same, but not the same'.
(S)he could better introduce variables simply as *words* (nouns) distinguishing different *kinds* of numbers.

Variables are words, although you may write them as an abbreviation. Words such as 'animals' also refer to all kinds of animals. You only say 'this is an animal' if you still do not know which animal it is, let alone *how many* more there are.
'Plants' is then another variable with a different *quality*.[a] Any quantity first supposes a quality before you can count it.
Regardless of any number you have to distinguish *different* quantities with *different* qualifications, named as *variables*.

## § 18 ABSTRACTION SUPPOSES CO-ACTION

In § 17 and onwards there is always talk of detachement (abstraction, extraction) from impressions and recording them in a representation that can then be manipulated independently of the outside world and its spatial and temporal limitations.
This is a real *action*, performed as a follow-up to, and separated from, impressions, a '*co-action*' (note hh p**Fout! Bladwijzer niet gedefinieerd.**).

The distinction between a physical object in a mobile appearance (object constancy) is already a form of abstraction.
In the case of more similar appearances the object that you keep in mind is a set, an object that covers more memories.

If two of these sets have something in common, you can make a third object of it.
This creates a stack of abstractions. They are the underlays of 'well-grounded' adults who have reached 'years of discernment' with a growing sense of distinction and imagination.

a This seems contrary to Tarski(1914)Introduction To Logic And To The Methodology Of Deductive Sciences (New York 1941)Oxford University Press. On p4 he writes: "As opposed to the constants, the variables do not possess any meaning by themselves." This may be true 'by themselves', but the reverse is true 'mutally'. Variables such as speed v, distance d and duration t certainly do have a meaning, expressed in a formula such as v=d/t. They can function as words in a mathematical sentence with the operators as verbs. This is a clear example of the paradoxical opposition between a view from inside or from outside, defining a set by internal equality or external difference. 'In itself no meaning' may mean 'numerically no meaning', but even then the variables have the meaning 'a number' or 'a not yet determined quantity'.

# 5 IMAGINATION SUPPOSES PHYSICAL MOVEMENT

Below I review the stacking of first necessary abstractions.
They release the first primitive representations from a series of impressions.

### DIFFERENCE OF 'DIRECTION' SUPPOSES A FIRST ABSTRACTIVE CO-ACTION

Looking in a different direction gives a different impression. Moving forward is not even necessary. You can gain that wonderful experience already by turning your eyes or your head. It changes the world as if you can conjure.
If you turn your head, you also feel motor impressions and you may notice a change in sound or smell impressions.

You do not need an understanding of 'direction', but if you do not yet have words for it, then we, mature outsiders, call your primitive total experience (movement and its impressions): 'change of view direction', or (without a distinction of impressions): 'difference of direction'. After all, any change is a difference (with 'now').

If you are short-sighted and color-blind in the beginning and you do not distinguish much details, then perhaps not much will change, but you see, feel, hear or smell a 'difference' in more directions. You can make that difference yourself by movement. You do not have to distinguish between image, feeling, smell or sound to experience the *difference*.

In the beginning it can not be more than 'difference' in general, but it always differs each time you move and through repetition you turn that around as well: you move to *make* a difference. If that is the case, then something has become detached from the impression itself: a different representation as a goal for action.

This may play a role in making a connection between your totally different impressions from different senses (synaesthesia). This requires some primitive representation as a binding agent.
According to Piaget, it is only the 'prefiguration' of a 'senso-motor scheme'.[a]

### 'OBJECT' SUPPOSES A SECOND ABSTRACTION

Object constancy is also loosening, separating (co-agitare) a representation from impressions by movement (parallax). For that, those impressions must come from a different direction.
So far, animals probably can do that too, but it is difficult to take *different* objects in one representation at a time.

The number of objects in such a representation distinguishes us from animals, especially the number of action objects (later named as verbs). You do not have to suppose more of that difference, to ever see tools, language and order of action as typically human.

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a Piaget(1966)

#### 'SEQUENCE' SUPPOSES A THIRD ABSTRACTION

Sequence (whatever the order) supposes again detaching from a representation of movement impressions.
If you always pass the same objects, you can keep their order. It supposes that you have remembered any difference between those objects, and with that they can become milestones to which the degree of accessibility of the focus object can be associated ('I'm almost there'), until the object is tangible as well.

#### 'SIZE' SUPPOSES A FOURTH ABSTRACTION

The difference between the objects probably concerns first the extent to which they fill your field of vision, but because this varies with advancement, the experience of their manageability must be added for a sense of size.
It is a reminder of the effort ('fatigue') of grasping, lifting and appropriating (not the moving forward until reaching).

#### 'DISTANCE' SUPPOSES A FIFTH ABSTRACTION

The size of empties between objects requires a reminder of the locomotion effort to pass objects laterally or to reach them head-on, an experience of increasing that void, reducing it (until colliding) or filling it with objects of different size and form (jigsaw puzzle). You keep a primitive representation of different distances, the different degree to which objects are (un)accessible to you.

#### 'PLACE' SUPPOSES A SIXTH ABSTRACTION

Reaching an object by your own movement makes that object tangible, but the previous object has lost that possibility. Again an effort is needed to make the next object tangible.
The return to the first object must bring about a recognition of previously occupied places after a few rounds.
Looking back they each offer a different view on the passed objects.

After an inviting gesture from your father you will leave your mother and vice versa (''Who comes in my house?'').
The field of vision turns around, and that difference separates itself from both impressions as 'difference of place', although that has no name yet. A permanent place for every activity (eating, sleeping, playing) associates each field of vision from which the rest is seen with more different sensory impressions ('atmosphere', the predecessor of a set).
This gives each place a different representation that can serve as a motive or goal of action.

#### 'QUALITY' SUPPOSES A SEVENTH ABSTRACTION

Objects can only differ if they occupy a different place, otherwise they would be one and the same object.
From the child seat at the dining table, the play corner, the kitchen and the garden are objects with a different *content* in different perspectives. From a distance, places with a group of objects become one object.

When approaching, that object falls into separate objects, each with its own place, its own collection of sensory impressions and possibilities for action. So different quality differences appear at every distance (at each level of scale). Just as a place in the case of approach falls into smaller objects, their quality itself falls into different 'attributes'.

A doll can be small, blue or soft. In addition to these substantive characteristics, a bear also has a different *form*.
A tower composed of building blocks can be large, strong or hard. It can fall apart in smaller objects if you overturn it.[a]
In addition to these differences in content and shape, various objects also do have a difference in *structure*.

You can put a doll in your block building and let it walk. This shows differences in *function*.
When you have finished eating, you look forward to your play corner. You can play with your dolls there, build a tower with blocks or draw. The objects that you have available there can evoke different *intentions*.

Intention, function, structure, form and content are adult terms for characteristics of objects that suppose each other in this order. The abstraction of these different characteristics to categories is of course far from present in small children, but they are all already used to distinguish objects from each other according to quality.[b]
Insight can arise from repeated use. The knowing follows its ability.

When you move objects, the place no longer forms a hold for their recognition from a familiar atmosphere of a place.[c] They are then only recognizable from specific 'differences of nature'.
They have thus gained their own 'place' in the memory, apart from the impressions.

**THE ABSTRACTION OF 'NUMBER' SUPPOSES DIFFERENCE OF QUALITY, PLACE, DISTANCE AND SO ON**
The human capacity to oversee a larger series of objects than animals supposes the abstraction of one representation that contains more objects at the same time.
This set, as one generalized object, can in turn be represented with other sets in one representation.

If different sets (in that composite representation) contain similar sub-objects that are not distinguished by direction, sequence, distribution, size, distance or place, they can stil differ only in 'number'.
This last remaining number attribute can again be released from these sets and

a Children about 3 years old may like to tease you overturning the tower you have built for them. They can take away something that you have created with effort: structure. It is an age in which, according to some researchers, contradictory needs for autonomy and esteem produce counter-conflict. It is, however also a useful experience to understand structure as it disappears.
b The frequent 'why?' questions from the fourth year onwards reveal, according to Piaget (1966), that in that 'pre-causal period' the intention is paramount. The structural-functional 'cause' of events escapes the child, because their own will is a model for what happens. Thus they may attribute everything a will, a purpose-cause that they know from their own actions (compare animism in cultural anthropology).
c My father told me to remember that as a child at a meeting with people who were all dressed in black, he saw a 'sweet' lady who took him on his arm. It took him some time to recognize her as his mother.

manipulated.
Arithmetic then supposes a further accumulation of such abstractions.

In the case of a series of disparate objects, similar *partial* characteristics (for example energy content) can be released therefrom, and quantified on the basis of this similarity. Science supposes further distinguishing such characteristics, their quantification (if possible) and then the manipulation of those quantities until they prove themselves as repetition, prognoses in the outside world: again a further accumulation of abstractions.

The verbal language is now confronted with more overlapping sets, in which formal logic has to put things in order.
This logic is not 'a priori' innate or a characteristic of reality, but a correction of everyday language.
It must be learned from practical experience with sets as a correction of ambiguities in the verbal language.

## § 19 'DESIGN' ADDS AND SUBTRACTS QUALITIES

'Quality' supposes an *effect* of objects on their observer. This effect can vary according to 'content', 'shape', 'structure', 'function' or 'intention' ('object layers' in **Fig. 46** p51).
These are qualities of increasing abstraction, distinguished with these words only later in the development of our imagination, but they are already *used* earlier as characteristics for distinguishing differences in quality.

### CONTENT

The 'content' consists of what can be directly sensually distinguished, such as size, color, touch, smell, taste or sound. It is the impression of 'material', a resource that can also take a 'form'.

Size is already a first impression that introduces a concept for difference of quality. It is a *quality* that does not yet have to be related to countable *quantity*.
A mother (the 'big and warm' of note uuuuu p79) is something other than a manageable doll (small and cold).
For that distinction, therefore, no quantitative concept is required.

However, the size does not only concern the objects, but also the frame, the field of vision and the boundary within which objects occupy their place and the smallest grain with which different details can be distinguished.
The size of the frame varies from your toy until (much later) the 'place' where you live.
With your age grows the framework that limits you concept of 'place' (**Fig. 55** p85).

Color is a powerful, but sometimes also confusing 'content' tool for distinguishing objects.
If the objects themselves are multicolored, with many nuances and contrasts, then the distinction between the objects is difficult. If the environment is also multi-colored,

you can speak of camouflage, so that only movement (parallax) or stereoscopic viewing gives a definite answer.[a]

The touch impression is an amazingly distinguishing feature for differences in quality. I saw a one-year-old boy drying his hands with a towel in the kitchen. Then he walked to a curtain of much thinner textiles, and with his dry hands stroked on both sides for a long time and apparently fascinated by the fabric and then walked back to the towel. On another occasion, he threw himself at me, and once again touched my short shaven beard obsessively long with his cheek. This was apparently not a sign of affection, but of an inquiring mind.

Smell or taste play an important role in distinguishing differences in quality. They seem to intervene deeply in the memory and are associated with the other impressions as 'defining the atmosphere'. An 'atmosphere' is remembered as a 'summary impression' of a place, object or person in which more senses and representations are involved.

However, the smell or taste impression is difficult to share with others, other than by calling and combining an odor or taste image of other objects (see a wine catalog). In many animals it is an important, or even crucial, distinguishing agent (dogs, pheromones). Perhaps that is why it takes such an important place in our memory.

Sound is, just like smell or taste, 'mood-determining' and associative (birds-nature, cars-city and so on).
Sound, on the other hand, is not durable but temporary, and varies in tone. What we apparently remember well is the order of sounds (music) and recurring patterns. Due to the mass media and devices, the location and object connection has been reduced. As a result, sound now probably contributes less to the distinction of places and objects.

#### FORM SUPPOSES CONTENT

I take form as a *distribution* of some content (such as color or tangible material). Its *impression* (the projection on the retina or the pressure on the skin), *expression* and its intermediate *representation* also suppose such a distribution.
This form concept covers both the *shape* of a single-colored (or with its possible nuances contiguous colored) object with a clear *contour*, and a diffuse distribution (such as a constellation of stars or a city full of buildings in a empty space).
Form is a crucial distinguishing means. The recognition of letters is still without any attachend meaning based on form.
The distinction between different types of plants requires images on different levels of scale. The verbal language does not go beyond 'elongated', 'round', 'cone-shaped' or other indications that must evoke an appropriate pictural reference.

a Illustrations in children's books often use different colors for different objects, in clear contrast with the background. The impression of colors is also not unambiguous, because they are influenced by their environment and lighting.

The representation of a form as a state of dispersion is only possible if some content can take that form, but the form itself can be abstracted from that content. It is a construction from what is left over, if the content is disregarded.
Touch and shape impressions may precede any conclusion about the color or substance (content) that may be supposed.

From repeated, current impressions, a reduced representation (mainly contour) is released, so that it can be manipulated (as a variable), adjusted with new impressions, supplemented with previously unnoticed details and even filled with a different content.

The *expression* of shape can, conversely, first be limited to the contour and then provided with coloring of content. Children's drawings of a head are first round, then oval and only get ears later. The form presentation thus behaves as a spreading condition of which the components can be moved until they resemble sufficiently.

When you talk *about* a form, no impression, but a representation of that form is discussed. The impression itself can not be fully expressed in verbal language. You never know for sure which image it awakens within another person.

A *representation* refers to different impressions and evokes different memories in different people.
That can be surprising and useful, because a dialogue can supplement the image of the participants with unnoticed details. It can radically change, stimulate or develop their imagination.
The reading forces you to *make* imaginations. The filming confronts you with another, elaborated, image.

You can express a shape in a picture, but even a photo is not equal to what you have left out of different impressions as 'shape'. Everyone selects his own abstractions from that picture. A picture, however, has more directions than a verbal language. A picture allows more routes for description when viewing. Each route through that image can be discussed one-dimensionally, but no matter how many discussions you devote to it, they can never fully cover the image.

They are at most a network that is stretched over the image. There always remain holes. The drawback of an image is, that it allows more interpretations through all those possible routes. However, that can also be an advantage.
An image that allows only one interpretation is not 'Art' that challenges our imagination. That may be the reason why we appreciate Art. If the challenge remains predictable, you could speak of 'kitsch'.

You can also give separated concepts a form ('scheme'). You then give their elements a different 'place' compared to each other. Such a state of distribution suggests strong and weak relationships in more directions. One concept is 'further away' from what you mean than the other concept. You can use lines to express relationships of

different quality as a 2D pattern. It can not easily been 'laid out' (ex-plained) or adapted in a one-dimensional verbal language.

If such relationships can be named as separations or connections, then I call their composition 'structure'.
Without physical separations or connections it is merely 'composition'.

#### STRUCTURE SUPPOSES FORM

I define structure as a set of separations and connections with a given distribution (p54).
Separations prevent movements in certain directions. In the directions allowing movement, you can speak of connection (the zero value of separation).

For example, you can not walk through a wall, but you can walk alongside it (a perpendicular paradox, ***Fig. 5*** p13).
The experience with separations and connections therefore includes movements and their limitations.
The separations and connections themselves are dispersed in space. So structure supposes form.

Structure already plays a role in the sensory-motor phase, because the possibility of moving, approaching, fleeing or clogging is limited by separations in (the structure of) the environment.

A nest or box has the affective value of *security*, a play corner as well, but one direction has already been sacrificed for more *freedom.* A wall only gives back coverage.
In all cases the environment is 'directed', so that it makes a stable contribution to the distinction of directions.

In order to be able to detach a representation of these elementary structural components (the selectors of ***Fig. 49*** p54, possibly composed in a construction) from such impressions, reduced *models* are effective (such as a doll's house or their own constructions made with a block box).
Such imitations make the environment *within* which you move into an object that can be viewed from *outside*.

Structure as a means of distinguishing differences in quality supposes a distinction between places, sizes, sequences, objects and directions.

#### FUNCTION SUPPOSES STRUCTURE

With function 'operation' is meant here. Operation supposes movement and a selective limitation thereof. Within a structure, each selector has an outward function for that structure (eg producer or consumer), and the structure may have an inward function for its components (eg government). The structure as a whole may have itself an external function in a larger structure. Function therefore supposes (inward or outward) always a structure (internal or external).

A mathematical function f(x) is also an operation of x.
If it is clear, whereupon x works (for example on y), this can be simply expressed as a 'complete function' y(x).
The brackets then represent the verb (the operation), the x for the subject, the y for the direct object.
In the expression y(x)=x+1, the operation (addition) is made explicit with the operator '+' and one object ('1').
The movement with its limitation (action) that was supposed to be 'functional' is 'take up '.

If the function is entered as 3=2+1, or what amounts to the same thing as 1+2=3, then it is no longer a function, but the expression of an action in which 1 is 'taken' at '2'. It is the movement from 1 object to a collection of 2 objects, which then changes into a collection of 3. The '=' sign separates the situation before and after this movement.

Something similar can be said about the equation x+1=y, but x and y remain changeable (remark the paradox).
You can imagine this effect in a graph where you give x and y a different direction.
In it every change becomes a movement under the restriction of the prescription '+1'.

A broadly interpreted term 'function' as operation is a distinctive feature for every object in any disciplin.
In physics objects are often distinguished on the basis of their (quantifiable) effect.
Quanta and Quarks, which can no longer be distinguished from their shape or internal structure (particle, wave, or composition), are only distinguished by their operation.

In distinguishing between cells, organs, organisms and organizations in biology and ecology, form and structure play a much larger role, but the big challenge remains there, in order to discover their different functions, their operation.

In the human sciences, the form plays a less distinctive role, because it concerns only one species.
On a larger scale than the individual, between the individuals of that species, structure and function are again highly distinctive.

By the way, 'function' is often confused with 'goal', but a function does not have to contain a goal yet. The sunlight has an important function for us, but that function is not its 'goal'. Conversely, a goal always supposes a function.

In itself, however, a goal can be distinctive. You can swim in a lake or in a swimming pool, so they have a function in common, but not the same goal. Unsuspecting children do not have to be aware of their difference in content, form, structure or functions, in order to make a distinction based on their goal.

Regardless of the other differences in nature, you can ask: "What is this meant for?". The answer to that question quickly explains the underlying functions, structure, form and content with which the object also differs from other objects.

#### INTENTION SUPPOSES FUNCTION

If people distinguish themselves from animals, because they can imagine a greater sequence of actions (of which only the first is directly feasible and only the last accomplishes an intended state), then that end state is the first action as setting a goal.

From this, the desired functions, structure, form and content are derived in reverse order (design), and the necessary actions to bring them back in time sequence (plan). To build a house (execution), after designing you collect stones (*content*), locate them in a *form* that makes the separations and connections (*structure*) possible, in order to provide the *functions* you have meant according to your *intention*.

However, people's actions are not always so conscious and unequivocally focused. Goals also originate from some more vague 'motive'. People are 'in motion' (motivated) by needs, for example by hunger, the need for security, affection, esteem, or to realize a satisfying self-image. According to Maslow's motivation theory[a], every need supposes some fulfillment of prior ('prepotent') needs.

For example, the need for safety only plays a role once the greatest appetite has been satisfied. Hunger supposes a body function and safety supposes functions that can prevent threats to that body function, and so on. I can not therefore imagine an intention without (desired) functions, but functions without intention I can. Then intent supposes function.

### § 20 LANGUAGE SUPPOSES A DESIGN OF LANGUAGE

In the earliest phase, the use of language only supposes that you can distinguish differences of quality, combined with different sounds made by older people. You only need to imitate them for the time being and hold on to that association. Distinguishing verbs (naming a change) from nouns (naming a difference) is a condition for being able to combine words in sequences (form), connections and separations (structure) that are understandable for others (grammer).

#### GRAMMAR SUPPOSES CONTENT

Linguists assume that grammar can be studied separately from meaning ('semantics') and, regardless of the content, represent an inborn logic.[b] However, meaning has already been supposed in every grammar.

Without prior difference in meaning between nouns and verbs, variables and operators, grammar, symbolic logic or mathematics is not possible at all. Conversely, designating a static or dynamic object by a meaningful (shared) name does not necessarily suppose a grammar.

This semantic premise does not only apply when speaking *about* grammar (meta-language). Also in everyday speech, the choice of words demands a semantic distinction between noun and verb, before they are more precisely filled in (specified,

a Maslow(1943)A Theory of Human Motivation(Psychological Review)50 p370-396
b For example Chomsky(1971)Syntactic structures(The Hague)Mouton chapter 2 The independence of grammar p13.

declared, with adjectives more precisely defined) and put in a sequence apparently understandable for others.
This interpretation with generalizing words also remains a generalization. Only proper names are specific.

That prior semantic distinction plays a crucial role in the determination of the correct grammatical order and thus in the choice of the first word of a sentence. This is apparent, for example, when someone searches for words under pressure or confusion and starts with 'I ... I ...', knowing that a verb must follow to be understandable.

#### A VERB IS NOT A RELATION, BUT AN OBJECT

A verb is an independent word that *may* have relationships in other words. As an operator, it is also a real object of action[a], an expression for the change in an often unspoken state of affairs that you want to communicate.
The expression 'Go!' already has an understandable meaning for every audience without any further explanation.

You may imagine a changing 'state' of affairs as 'stable' for a while, naming it by a verb.[b]
It is possibly restricted with other word types, but the verb is the most relevant object to communicate with.
Even if your impression concerns 'no change', this 'zero change' you can describe it with a verb ('be', 'have' or 'stay').

That operator is not a 'relation', but an action object that can have relations with surrounding words. These relationships are determined by an agreed word sequence and proximity (grammar). This suggests first of all a causal relationship with the actor and subsequently possibly an impact relationship. An effect relationship with a result or direct object of that action is not even necessary to be able to form an intelligible sentence (for example 'I go').

The linguistic distinction subject - predicate conceals the indispensable and crucial verb in the predicate. That is a phrase, in which a primary relationship is wrongly established between the verb and the *result* of action or direct object.

Even the primary relationship with the actor does not have to appear in a sentence. It can be supposed tacitly.
The statement 'Go!' has an implicit actor: the addressed subject. Grammatically dressed-up into a full sentence it would read: 'You must leave.' 'Must' is an auxiliary

a Our imagination supposes self-action with every representation you 'make'. Every object of attention is actively established. It is therefore plausible that an object is primarily identified with that activity, before it is stabilized in a memory, made retrievable (action) and possibly expressed in words (action). Attention primarily focuses on changes in the external environment that initially has no other analogy in our imagination than our own action and can therefore be remembered and possibly put into words as 'action'. In that sense, 'action' is an object. It can be remembered as an action. It is the co-action of which we primarily remember motor skills, just as a violinist can play the rehearsed music without having the notes in mind. In my opinion, this motor memory, in which many muscles have to be coordinated in a learned neuro-physiological scheme, is the precursor of every memory and imagination.

b Leibniz(1663-1716)Kleine philosophische Schriften(Leipzig1879)Koschny, XXV. Fünfter Brief von Leibniz an Herrn Clarke. 1716. p221 says rightly: "Streng genommen ist es richtig, dass kein Körper vollkommen und gänzlich in Ruhe ist, aber man sieht bei einer mathematischen Betrachtung der Sache davon ab."

verb of modality, with which the statement is said to belong to the modality of the desirable. In the order form 'Go!' it is unspoken supposed and sounds harder.

#### MODALITIES DISTINGUISH REASONING ABOUT TRUTH, POSSIBILITY OR DESIRABILITY

'Can' brings the statement into the modality of the possible ('potentialis'): 'You can go.' 'You go.' is a description (whether or not true or probable).
Without an auxiliary verb, this modality of (un)truth or (un)probability is usually assumed tacitly in adult language.

The 'singing' or 'call' of birds is probably in the modality of the desirable. If it were not a direct expression of emotion, but a description of it, then that description requires more distance from a direct physical intention than imaginable in birds. The 'singing' of birds obviously has the double meaning of luring and chase away ('come and 'go'). The lure is meant for the partners, the simultaneous expulsion is meant to mark a territory against competitors.

The 'call' usually concerns an alarm cry probably with the meaning 'Go away!'. The barking of dogs also may have a distance-increasing purpose, but the intonation and body language (especially the tail) can also mean other desirables such as submission (tail between the legs). Cats have more tonal possibilities of expression (spinning, growling, screaming, meowing in different keys), but even then the tail is an important bearer of meaning.

It seems likely that babies also basically express themselves in the modality of the desirable (crying and laughing).
The first learned nouns (such as mamma! and pappa!) would then primarily mean the distance-reducing 'come here'.

#### A VERBAL LANGUAGE SUPPOSES VERBS

A sentence that is pronounced or read in the opposite direction loses its meaning. Unlike the language of a two-dimensional drawing, a verbal language is linear and supposes tacitly a time direction or succession.
There is no message perpendicular to the sentence direction. The meaning itself is bound to a time sequence.
Each succeeding word limits the scope (extension) of communicated meanings to an increasingly smaller set.

A drawing can be read in all directions and every route of the infinite number of possible routes delivers a story. Crossing and even parallel stories can contradict each other. For example, in one direction you can truthfully say: "The road becomes wider", and in the opposite direction: "The road becomes narrower".

A verbal language supposes first of all verbs (objects of change) and (pro)nouns (objects of difference, including the subject). These are the primary carriers of meaning. The other word types mainly specify or connect them.
A verbal language also supposes commonly accepted sequences of words, enabling

communication.
If you violate the sequence, then the meaning may be lost or changed. For example: "A calls B" versus "B calls A.".

In mathematics additional specifications of sizes, distances, places and qualities are necessary.
The resulting representation of differences of quality makes the distinction between sets possible.
The handling of overlapping sets requires a logic that is supposed in mathematics.

Logic concerns only conjunctions (or, if, and) that dissect or merge overlapping sets in their components.
Conjunctions join. Such operators can be replaced by verbs. They represent an action taken to obtain a result.
For example 'A or C' may be replaced by '*Add* a set A to C without overlap', and 'if A then C' may be replaced by '*Subtract* from C non-A' and so on. Something similar applies to mathematical operators (+, -, ×, etc.).

#### FORMULATING SUPPOSES DIFFERENCE OF QUALITY

So far only a conditionally substantiated reconstruction of a *possible* development of human discernment is outlined without empirical pretentions.
In the following chapters 'difference' simply means 'difference of quality', regardless of how *people* have learned to distinguish that difference.

From such differences we derive categories, external impressions of internal equality in sets that can be summarized in words. This does not mean that these attributes are 'specific' to objects outside of us, but that we suppose to know them from their effect on us (perception). They are therefore external attributes of *operation*, not internal 'properties'.

I suppose that there is an independent world outside of me.
There are differences in quality that do not require human distinction. They also exist without observers who have learned some discernment. That does not have to be supposed in that outside world.

We express the partially repeating impressions that we continually receive from the outside world in formulations.
If they match the wording of others (in whom we suspect a similar childhood experience and school), they will get a probability value that can be tested by anyone else. This test is required by research-oriented action.

This is only possible if verbs (actions) occur in that formulation that can be 'actually' carried out.
If such an action repeatedly yields the same result, then we take the formulation as 'true'. That presumption of truth therefore only relates to the formulation. *Actual* 'reality' concerns an outside world in which we can bring about changes through *action*. Our conclusion may then be that the formulation is 'actually true'.

**A FORMULATION MUST OVERCOME 7 BARRIERS**

However, this formulation takes at least 7 barriers between observation and proven application (truth).

A. ('selective observation') In the first place, our perception is a small selection of what actually 'plays'.
   It is no more than a sample from a set that you should consider as very large. This selection is influenced by what we can see, want to see or are used to see.
B. ('selective representation') Our re-present-ation (bringing back to present) of the observations is again a small selection, a further reduction of that sample.
C. ('stenciling') These selections are fitted into old generalizations, previously designed, updated and culturally restricted or certain templates that seem to fit.[a]
D. ('verbal tolerance') The words with which these templates are expressed as standards for exchange never fit exactly. They include different images and are therefore generally 'too big'. They must then be restricted and adapted with adjectives, conjunctions and adverbs. However, these are also generalizations themselves, so that even a restricted result is a generalization.[b]
E. ('word choice') As soon as the observations are described in words, two more barriers have been passed. The speaker must use the correct words (culturally agreed in previous communication) and
F. ('interpretation') the listener should receive similar images and associations for those words.
G. ('covering') The proof that 'the message has come over' can only be done by action (a laboratory test, replaying a crime, following a cooking recipe) or reaction (the apparent recognition of a specification drawing in different details).
   The verbal reaction 'you are right' indicates the equality of two images with two realities. That proof is never conclusive. The repetition of a reported action gives the same picture can be a coincidence. How often you repeat that, it remains 'inductive' (p37).

This last point supposes that the message is a sentence. It must contain a verb, even if it concerns a description of a static situation without real (actual) action ('That house *is* on the other side'). The verb is usually a conjugation of 'being' or 'having'. That non-action is nevertheless represented as a verb, an action-object ('I *am* the mother, you *are* the father').

Usually an 'unblocking stimulus' is enough to trigger a clear and often complicated action schedule in the addressed organism.[c] That is not different for people, but an

a Even before they are recorded in nouns and verbs, there are templates for actions (for example, picking, throwing, catching) in our memory, using neural action schemes. This results in templates for more static objects (eg stones, plants, animals). With growing distinction, they are replaced by 'smaller', less generalizing sub-templates or concepts.

b Sequential words limit each other's scope until the restriction is reached in a sentence that adequately describes an action. The language of plants, animals and people first of all has to coordinate actions. It concerns actions and reactions such as between predator and prey, partners in reproduction, production and consumption. With people this can be a co-action: forming an image. The fact that communication results in a coordinated action, however, does not prove that communication contains a formulation that covers the action.

c Tinbergen(1965)Social Behaviour In Animals(London)Methuen

action program for scientific research, for example, is not always ready in the person addressed. This requires formulations that describe the required actions more precisely.
In addition, the aforementioned barriers must be eliminated.

The sensory barrier (A) is partly eliminated by devices that can enlarge the image with resolutions, wavelengths and observation locations in which our senses do not provide.
The representation that is constructed from it (B), leaves aside on the one hand many circumstances that do not seem important in advance (context), on the other hand limits the focus on objects that you can also limit differently.

The suppositions with which both selections are made (C) limit the possibility of a drastically different object selection and limitation. The plasticity and elasticity of available templates recurs with increasing discernment, because in an increasingly filled overall picture their boundaries touch and overlap.
Each limit change then has an effect on other object boundaries and reduces the willingness to change the borders.

Such comprehensive changes ('reframing') are design moments in the scientific development that I want to look for in chapters 5 to 7. I have described in detail only a few examples of the development of our abiotic, biotic and cultural assumptions, but these cross-border moments are an inspiration for designers. Furthermore, these are assumptions that can shift the view of possibilities.

The formulation of our representation (D) limits the view on possibilities for which there are no collective templates and words available. That is also a motive for designers to make drawings. These are not illustrations for a story, but images wherin different stories can be told. It is then not easy for a (often dyslexic) designer to choose the right words for the explanation of a design.

Just as wrongly chosen (E) or interpreted (F) words, drawings and sketches can also mislead (G). The listener or viewer may have other references and associations than the speaker or designer. Their templates can be differently limited.
The plasticity is in principle greater for designers. A border shift can hardly be explained otherwise than in metaphors. The design is completed in a dimensionally fixed specification drawing that allows an operator to coordinate actions.

#### LOGICAL AND MATHEMATIC FORMULATION SUPPOSE VERBAL LANGUAGE

A verbal formulation that sufficiently covers an action requires a unambiguity in which formal logic provides and a dimensional stability of well-defines variables. Because they play an important role in chapters 6 to 9, I will first pay some attention to them.
In chapter 3 I give my overview of the current truth logic and its limited value for finding new possibilities.

Equality-oriented mathematics can reduce qualities to quantities.
The probability calculation reduces the most explicit differences of quality into quantitative deviations (§ 24 p105).
However, the set in question is defined with one or a few 'properties' in which its elements are equal, but how many properties are left out of the picture? Each actual set is heterogeneous in detail.

The repetition oriented mathematics (chapter 6, p105) also *produces* diversity (§ 24 p115). Minimal differences in the beginning of iterations can infinitely vary the end result. The resulting forms sometimes remind of nature (spirals, ferns), but they do not cover its diversity. They are determined by the process, difficult to predict and to steer by any intention.
Can you ever impose them the limitations of function, structure or content to explore the limits of what is possible?

I will not answer these questions.
The following chapters explore only the limit of their contribution to the design and the role of design in their creation.

In order to be able to see through a number of Abiotic, Biotic and Cultural conditions in chapters 6 to 9 as widely shared (cultural) assumptions, to be able to designate the design moments and finally to elaborate them in a systematic order, you must have worked with it. In what sense do they also work to find new possibilities in a design?

## § 21 LOGIC REDUCES IMAGINATION (FIG. 52 P63)

#### LOGIC SUPPOSES HUMAN DESIGN DIMENSIONS

If you do not want to understand logic as a priori or innate basis of our thinking, but as a human design on the basis of practical experience, then that design should meet the practical conditions for design of ***Fig. 52*** p63. Logical variables are indeed *different words* or assertions that *change* with operators into a new *combination*. So far the logic as a design therefore meets the conditions A1 (difference), A2 (change) and A5 (combination).

According to ***Fig. 39*** p35 you may say 'If a man is an animal, then the earth is round'. That is both true and therefore valid as a logical implication '$\Rightarrow$', but it does not make sense. Those words or claims must have some *connection* (A3) with each other in order to give a meaningful *combination* as a result. In ***Fig. 39*** p35 I have therefore added a condition: 'a and c must contain an effect on the same variable x' (antecedent $a = f_1(x)$ and consequent $c = f_2(x)$).

However, also the effects $f_1$ and $f_2$ should be of the same 'type'. You cannot connect red and round in the assertion 'x is redder than round', even if it concerns the same x. 'Redder than round' is not 'imaginable'. There must be some criterion in order to decide if something is 'imaginable'. I think 'imaginable' might be synonymous with 'constitutable'.

The selection (A4 ⇓ separation in that connection), which makes the logic for a combination, could be the distinction between true or false. In the case of a multivalent logic with more possibilities than 'true' or 'false' (no excluded third), that selection must therefore play a major role. This also plays a major role in other designs, because the object that has yet to be designed is limited in the beginning. There is still a margin between 'well' and 'not'.

#### THE CONSTITUTION OF LOGIC SUPPOSES ABIOTIC CONDITIONS

The abiotic conditions of ***Fig. 52*** p63 are largely recognizable in logic as a design. These are supposed in the biotic and cultural conditions that follow them as a further specification.
The logic does not have those specifications, but you may need living organisms with a culture to *design* this linguistic instrument purifying a *designed* verbal language.

Logic gives our linear, verbal language the exactness that is required for mathematics (as a part of that language).
Since Russell[a], the general view is that mathematics can be founded on modern logic. This was only possible after it had been developed in such a way that it could express itself in variables and operators ('symbolic logic').
You can also defend that the old logic has been adapted to mathematics, so that it became part of it.[b]

Because mathematics is capable of modeling the more specific biotic conditions (metabolism, regulation, organization, specialization and production), and even some cultural conditions (information, certainty, affection, identity and influence), I may elaborate the conditions of logic better in the frame of mathematical imagibility (p157).

## § 22 TO KNOW SUPPOSES THE ABILITY TO KNOW

I believe that I have understood enough of a few scientific disciplines, to understand their limitations and to use the design-relevant parts. I am also not afraid to make mistakes. Those who can not make mistakes are unable to do anything. Without historical errors in the DNA we would have remained unicellular.

In chapters 5 to 7 I ventured into other people's territories as a layman, with no more knowledge than a gymnasium from the 60s of the last century and than what I learned from the disciplines I taught (urban design and technical ecology). That knowledge is only supplemented with what is publicly accessible. Truth has no copyrights.
This allows anyone else with such a limited background to check and criticize what I have found.

In order to discover hidden assumptions, programming a computer is a beneficial tool, although its hardware, its language and especially its software can also hide unspoken

a Russell(1903)The Principles of Mathematics(Cambridge)University Press §1 p1.
b The old-fashioned thorough and decent German atlas of Reinhardt;Soeder;Falk(1977)dtv-Atlas zur Mathematik(München)Deutscher Taschenbuch Verlag therefore begins with logic.

assumptions.
If you do not tell a computer everything from the beginning, in the right conditional order, it will not work. As far as possible for me, I mainly reconstructed someone else's territories with computer calculations that led to the same result.

Calculations require explicit assumptions. Then they go their own way. Their outcome does not attract anything of what you want or expect. You have to see how it works in order to understand it.[a] What works is reality, but that does not mean that what works also will work or is 'true' elsewhere. Mathematics works, but I still doubt its hidden assumptions such as the possibility of exact equality and repetition. Everything differs, if not in nature, then in place and therefore in circumstances.

The advantage of a layman's report is that you can leave fewer assumptions unspoken. You can not leave anything out of the secret language of skilled experts with all their learned meanings and assumptions.

Yet it appears that the argument is not longer, but rather shorter.
Probably you go too short as a layman, but there is always a small chance that you will miss professionally ingrained but unnecessary assumptions. Experts who read my efforts smiling, I ask to let me know where I have misbehaved.

Even if I have misunderstood something, rectification allows me to shift the flow of constant doubt, to choose another path in the environment, to expose the surface there. The same sediment is everywhere. I doubt too limited, too superficial or too profound assumptions of language, logic, exact sciences, humanities and of my own.

Science was a beautiful design, but for half a century there has been little design involved if you compare it with the half century before. There are plenty of terrains with dilapidated ruins lying down for new construction on their old foundations or with new piles. Which unspoken suppositions hold us back and which do not?

a For the calculations I only use publicly available simulations in Excel and for symbolic derivations, the freely available computer program Maxima (http://maxima.sourceforge.net/).