



HOKKAIDO UNIVERSITY

Title	Measurement in Berkeley's philosophy : from the viewpoint of the philosophy of space and the philosophy of physics
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Relation	15th Congress of Methodology and Philosophy of Science. Helsinki, 3-8.August 2015 (4.August, C2.1 Philosophy of the Physical Sciences)
Issue Date	2015-08-04
Doc URL	https://hdl.handle.net/2115/59658
Type	conference presentation
File Information	15thCLMPS_20150804.pdf



Measurement in Berkeley's philosophy

-from the viewpoint of the philosophy of space
and the philosophy of physics-

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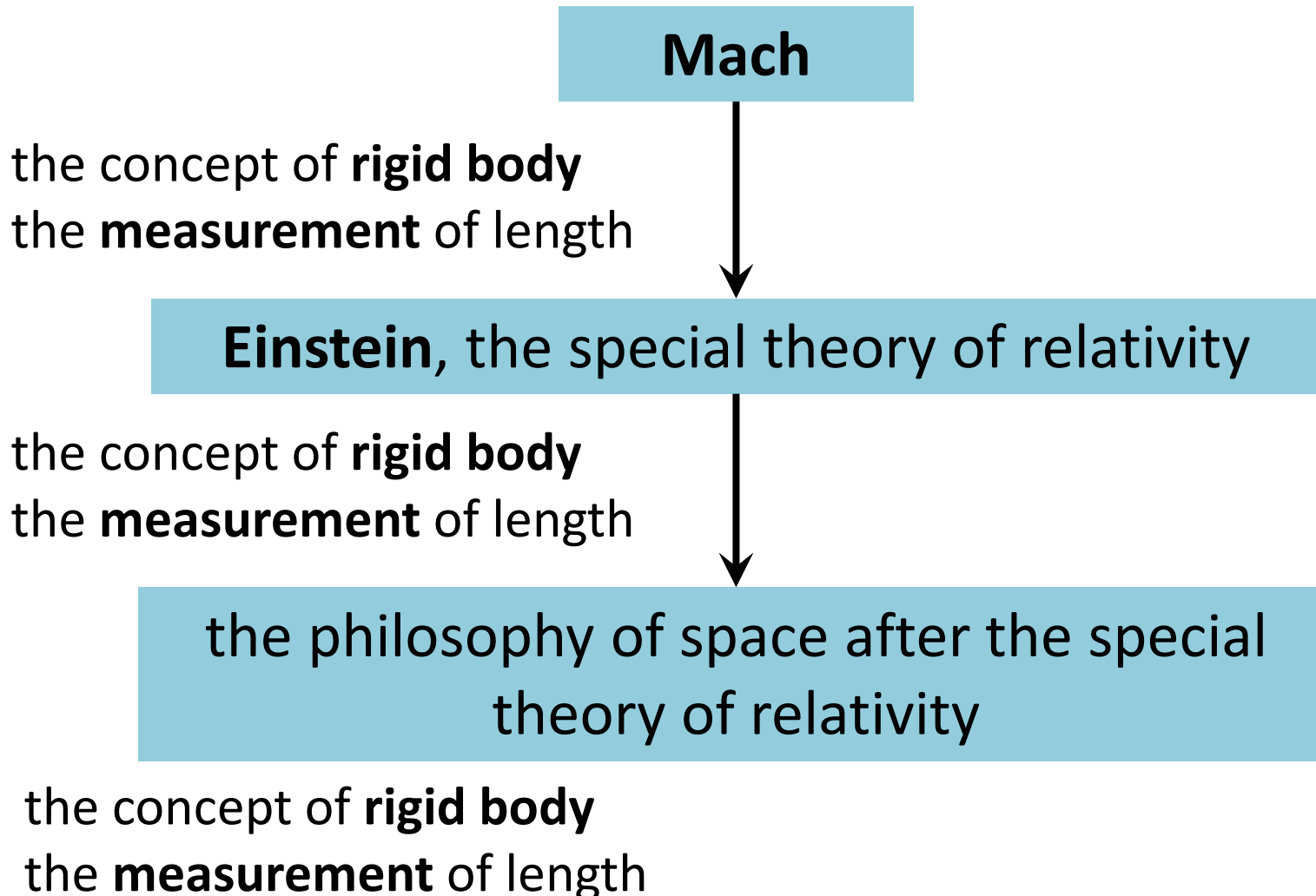
the outline of the presentation

1. The concept of measurement in the philosophy of space and in the philosophy of physics
2. An original point contained in Berkeley's philosophy
3. A problem of physics and an application of the point to the problem

Measurement is considered to be a fundamental topic in the philosophy of space and in the philosophy of physics

- the discovery of non-Euclidian geometry
 - Is geometry a priori, or empirical?
 - a distinction between mathematical geometry and physical geometry
 - the concept of measurement
- the special theory of relativity
 - the concept of rigid body
 - the concept of measurement

Some points relevant to the special theory of relativity is given by **Ernst Mach**



In the context of the philosophy of physics,
Berkeley is generally evaluated as **precursor of
Mach**

Popper, K.R. (1953)

“A note on Berkeley as precursor of Mach”

Brook, R.(1973)

“the kind of radical re-thinking of Newton’s laws of motion which we find in Mach, but not in Berkeley’s De Motu”

the outline of the presentation

1. Measurement in the philosophy of space and in the philosophy of physics
2. An original point contained in Berkeley's philosophy
3. A problem of physics and an application of the point to the problem

phenomenalism

a comparison with Mach's philosophy

Mach

“complexes of sensations make up bodies”(1-13)

“There is ... no sensation to which an external thing,
different from sensation, corresponds.”(AS,ch.14,sec.1)

Berkeley

we give one and the same name to heterogeneous
sensations which are “experienced to coexist with”

“It is a mistake to think the same thing affects both sight and
touch.”(V,sec136)

the concept of the immediately given a comparison with Mach's philosophy

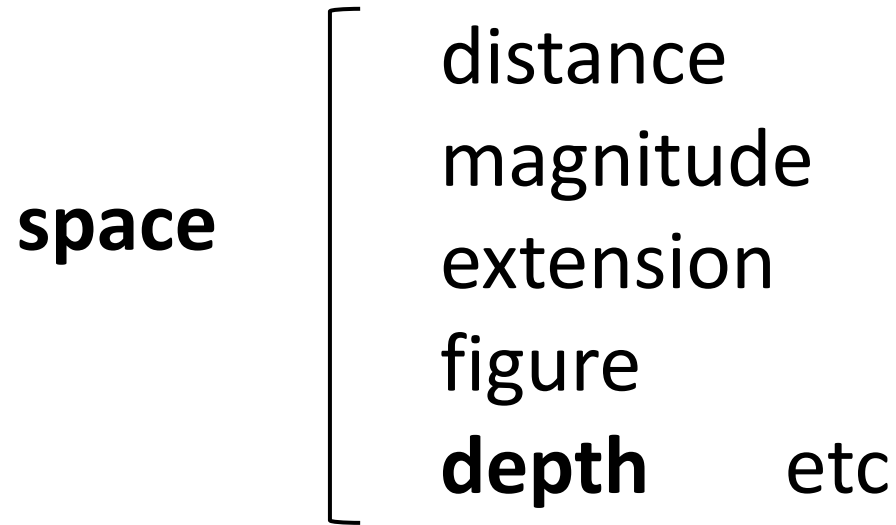
The immediately given

Mach : color, sound, temperature, **space**, time

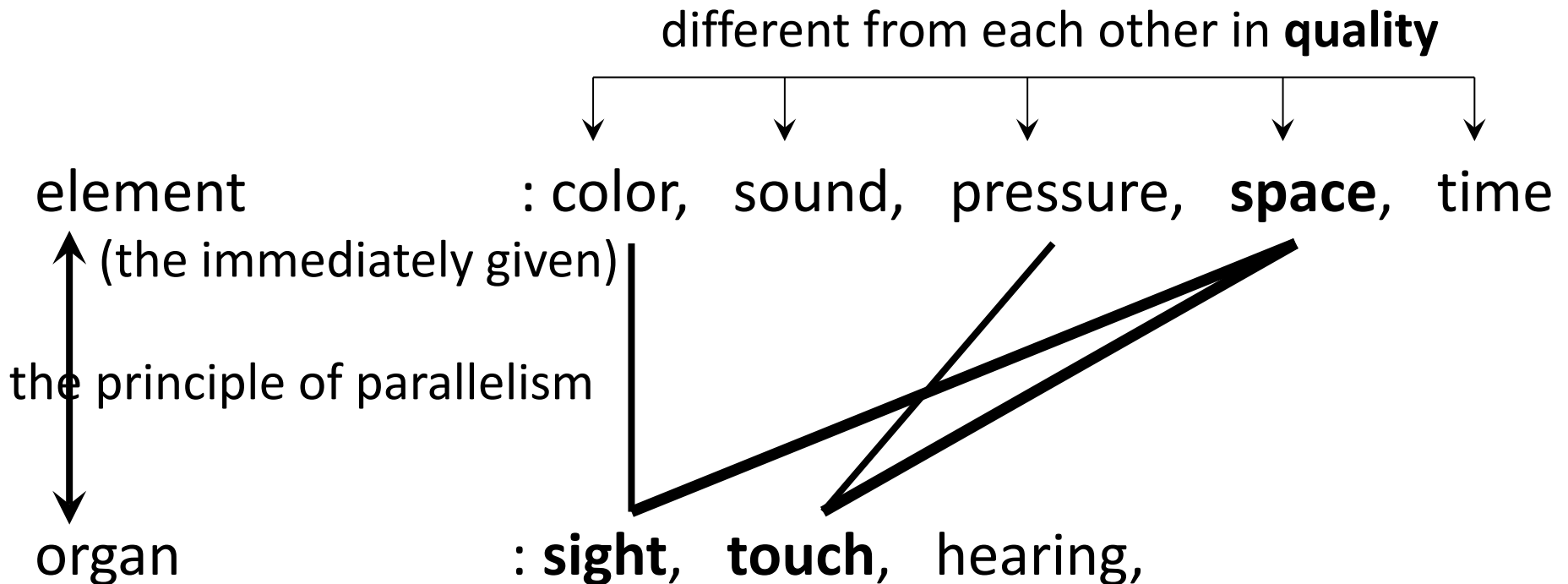
Berkeley : color, sound, temperature, resistance,

They are supposed to be different from each other in **quality**, be heterogeneous.

the spatial concepts in Mach's philosophy



a characteristic of the Mach's philosophy of space



“the sense of sight and the sense of touch involve, so to speak, the same space-sense as a common element”

(AS,ch.7,sec.7)(2)

the spatial concepts in Berkeley's philosophy

space

[point, distance
position, direction
magnitude
extension
figure

a characteristic of the Berkeley's philosophy of space

◆ **independency** of the heterogeneous perceptual spaces

Visible space and tangible space are “specifically distinct”(V,sec.127), and “have an order among themselves”(VV,sec.57)

“The two distinct province of sight and touch should be considered apart”(V,sec.115)

e.g. point/ distance

points (“or minimums”(V,sec.54))

“visible point”(V,sec.112), “tangible point”(V,sec.112)

distance (between two points)

“by the distance between any two points nothing more is meant than the number of intermediate points”(V,sec.112)

visible distance

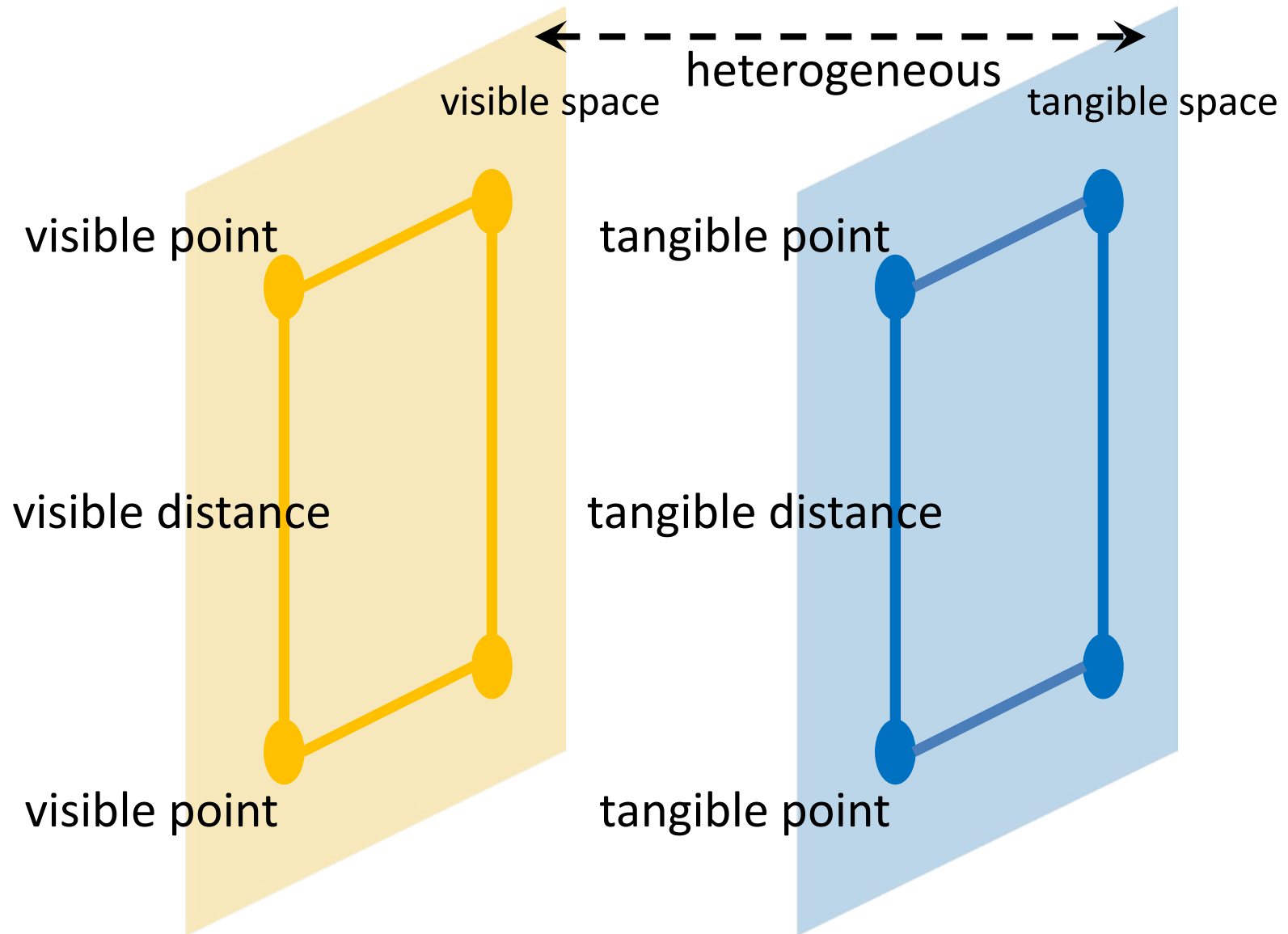
“if the given points are visible the distance between them is marked out by the number of the interjacent visible points.”(V,sec.112)

tangible distance

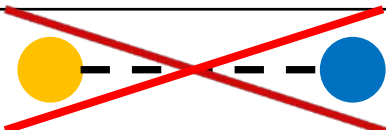
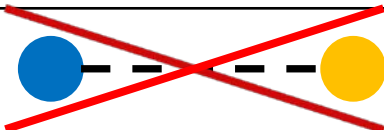
“if the given points are tangible, the distance between them is a line consisting of tangible points”(V,sec.112)

	a visible point 	a tangible point 
a visible point 		
a tangible point 		

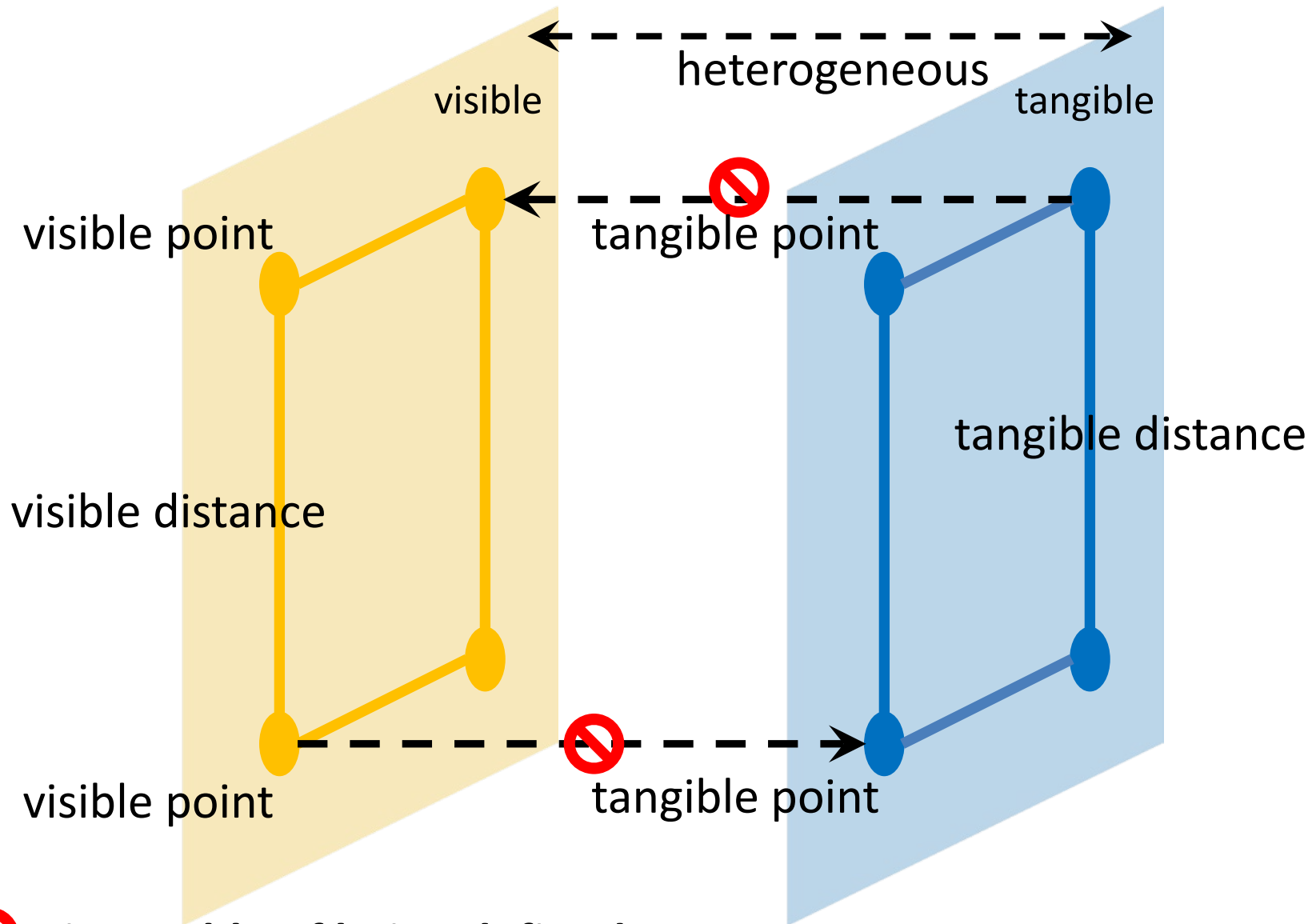
a characteristic of the Berkeley's philosophy of space



“if the given points are one tangible and the other visible, the distance between them doth neither consist of points perceivable by sight nor by touch, i.e. it is utterly inconceivable.” (V,sec.112)

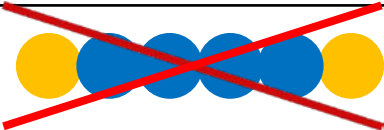
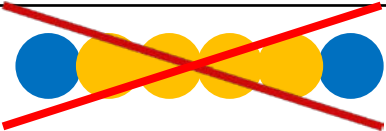
	a visible point 	a tangible point 
a visible point 		
a tangible point 		

a characteristic of the Berkeley's philosophy of space

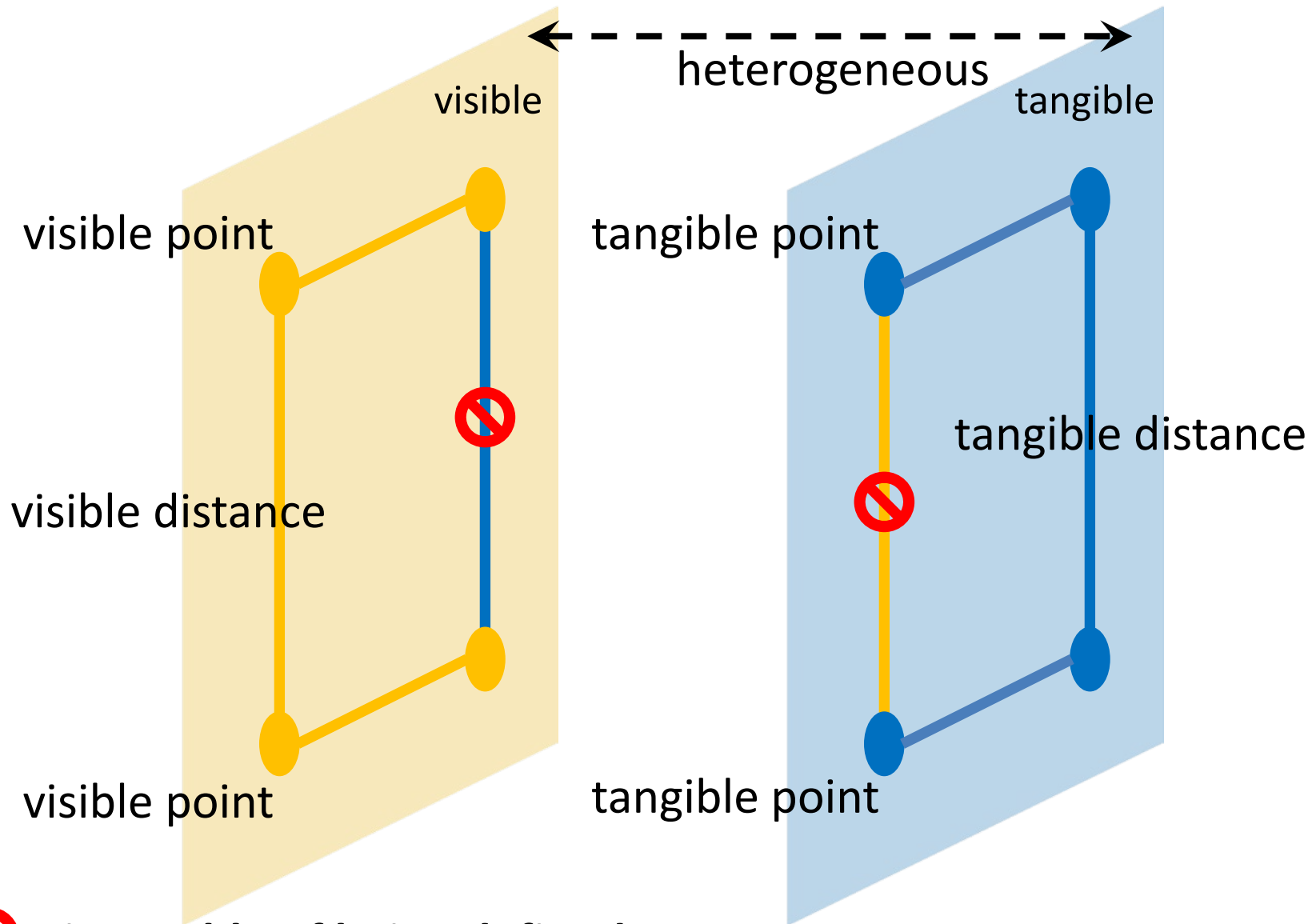


 : incapable of being defined

the following distances will also be denied.

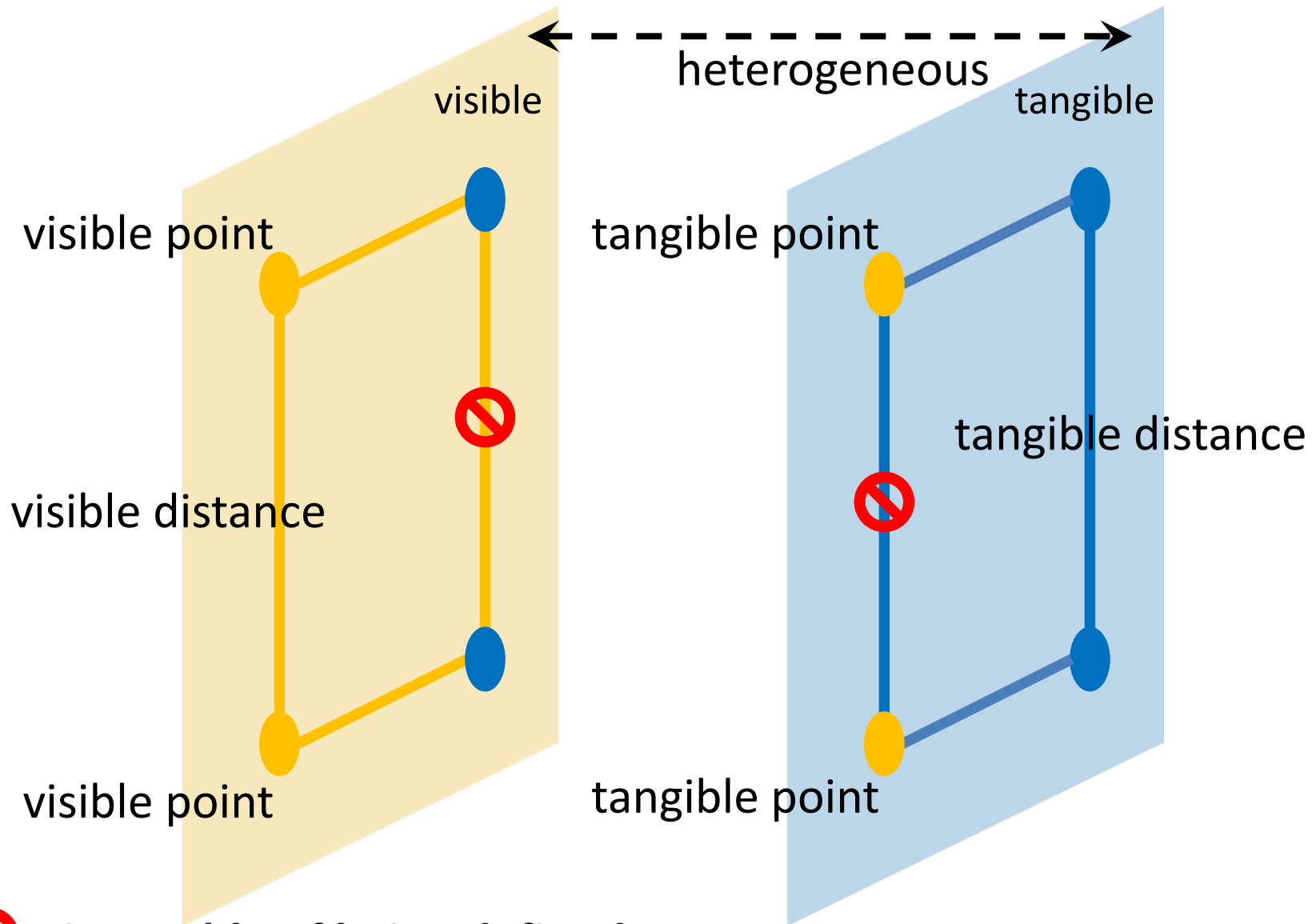
	a visible point 	a tangible point 
a visible point 		
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a characteristic of the Berkeley's philosophy of space



 : incapable of being defined

a characteristic of the Berkeley's philosophy of space



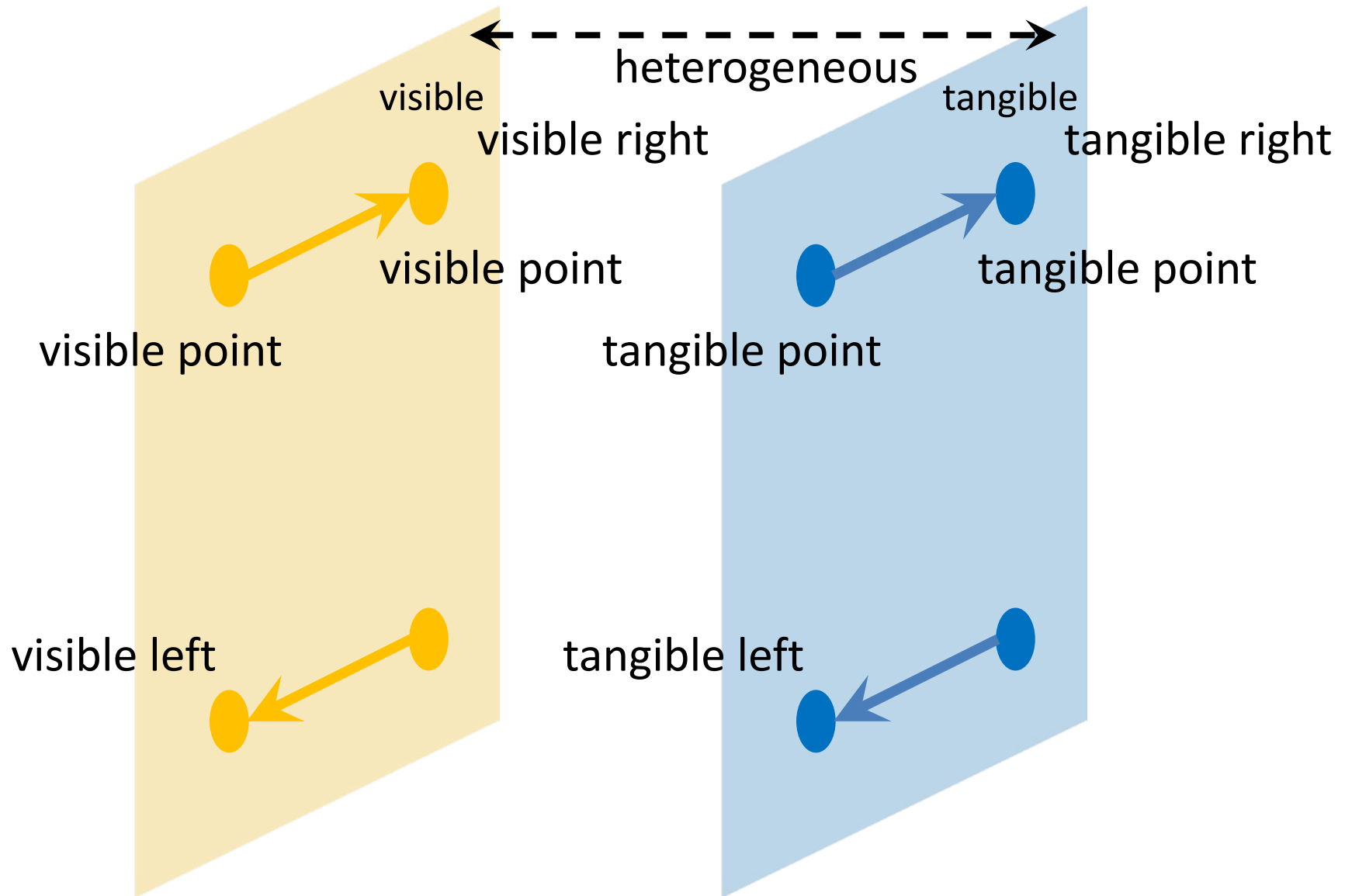
 : incapable of being defined

e.g. position/ direction

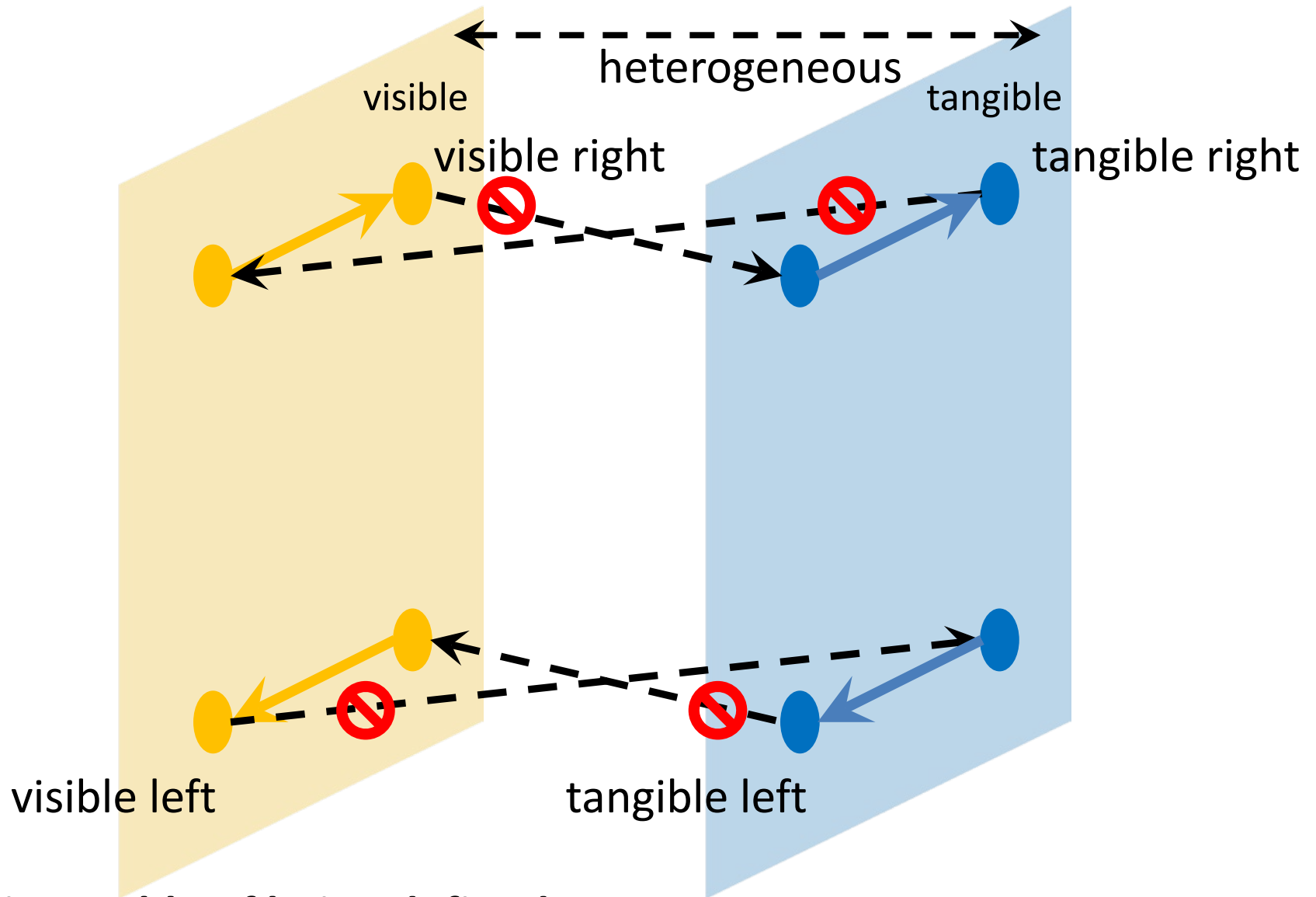
The position of visual point is determined “with relation to”(V,sec.111) another visual point.

- tangible position (of a tangible point with relation to another tangible point)
- visible position (of a visible point with relation to another visible point)
- tangible direction (from a tangible position to another tangible position)
- visible direction (from a visible position to another visible position)

a characteristic of the Berkeley's philosophy of space

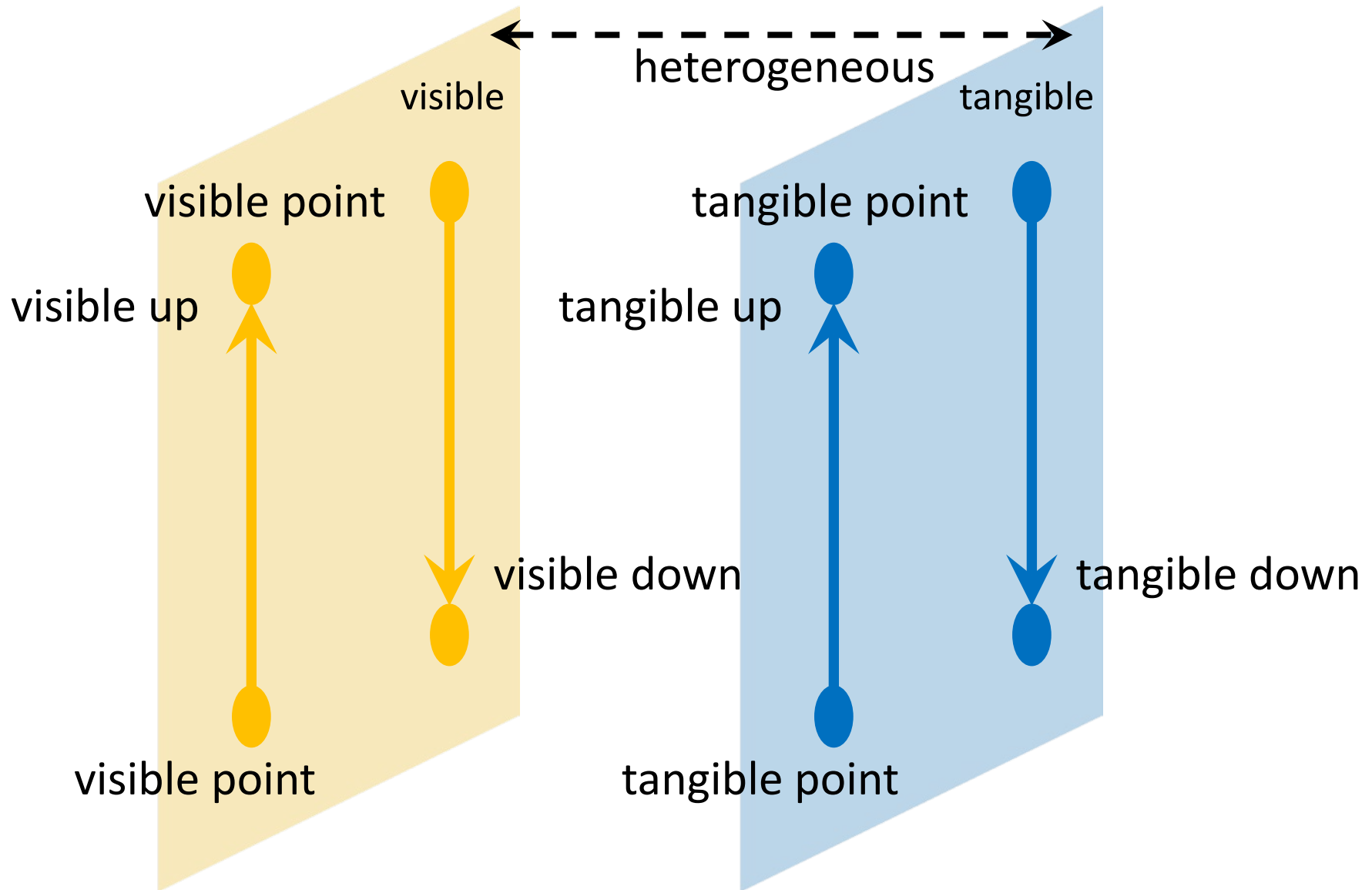


a characteristic of the Berkeley's philosophy of space

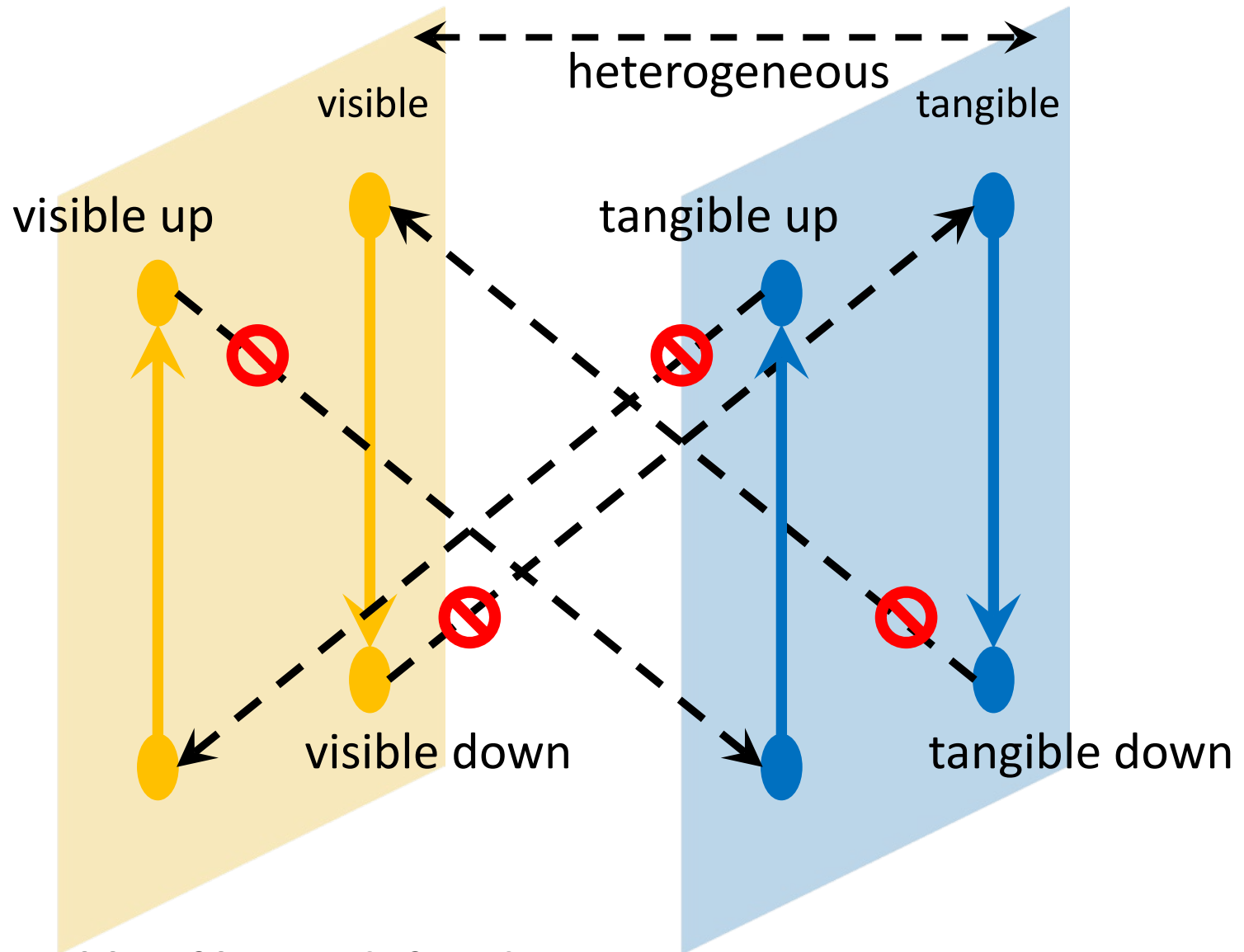


⊘ : incapable of being defined

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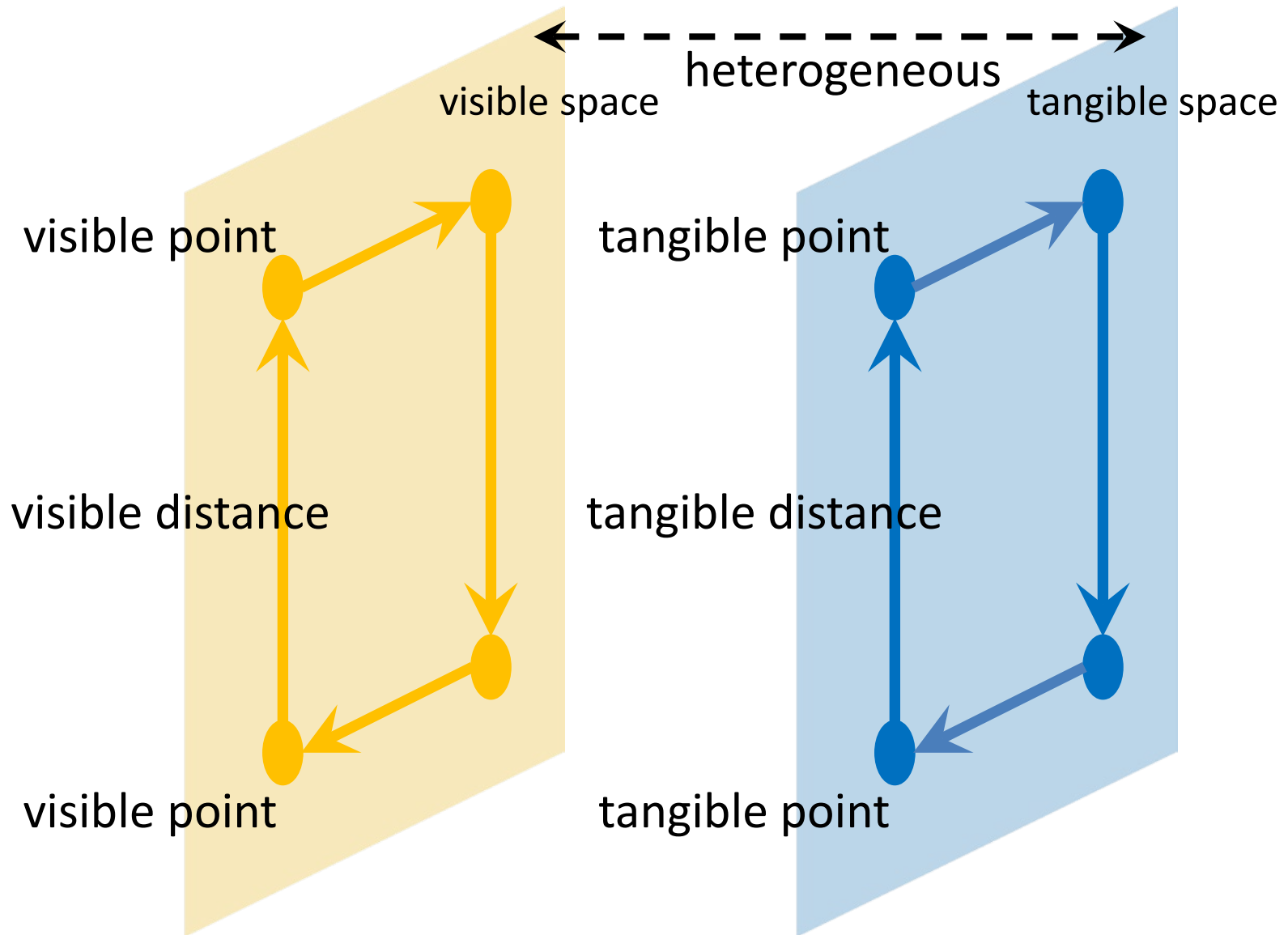


a characteristic of the Berkeley's philosophy of space



 : incapable of being defined

summary



Mach vs. Berkeley

Mach

“the sense of sight and the sense of touch involve, so to speak, the same space-sense as a common element” (AS,ch.7,sec.7)(2)

Berkeley

Spatial relations are altogether determined in each heterogeneous perceptual spaces.

the concept of measurement /Mach

Rigid body

“movable bodies having definite spatial permanency” (KN, ch.21,sec.43), “possess ... impenetrability”,
“the distances between all the parts are preserved”(KN,ch.21,sec.33) “the fact that”(KE,ch24s15)

Measurement

“the application of rigid bodies”(AS,ch.14,sec.23)
“comparison of bodies”(AS,ch.9,sec.7, KE,ch.22,sec.2)
“measurement is experience involving a physical reaction, a superposition-experiment.”(KE,ch.21,sec.20)

According to Mach, measurement is **comparison** of rigid bodies. In particular, it accompanies with the sensation of resistance.

the concept of measurement /Einstein

Rigid body

“two points on a practically rigid body always correspond to the same distance (line-interval), independently of any changes in position to which we may subject the body”

Measurement

“If A and B are two points on a rigid body, ... starting from A, we can mark off the distance S (rod S) time after time until we reach B. The number of these operations required is the numerical measure of the distance AB.
This is the basis of all measurement of length”

The concept of length defined by Einstein seems to, like that defined by Mach, be based on the comparison of tangible distances.

the concept of measurement /Mach & Einstein

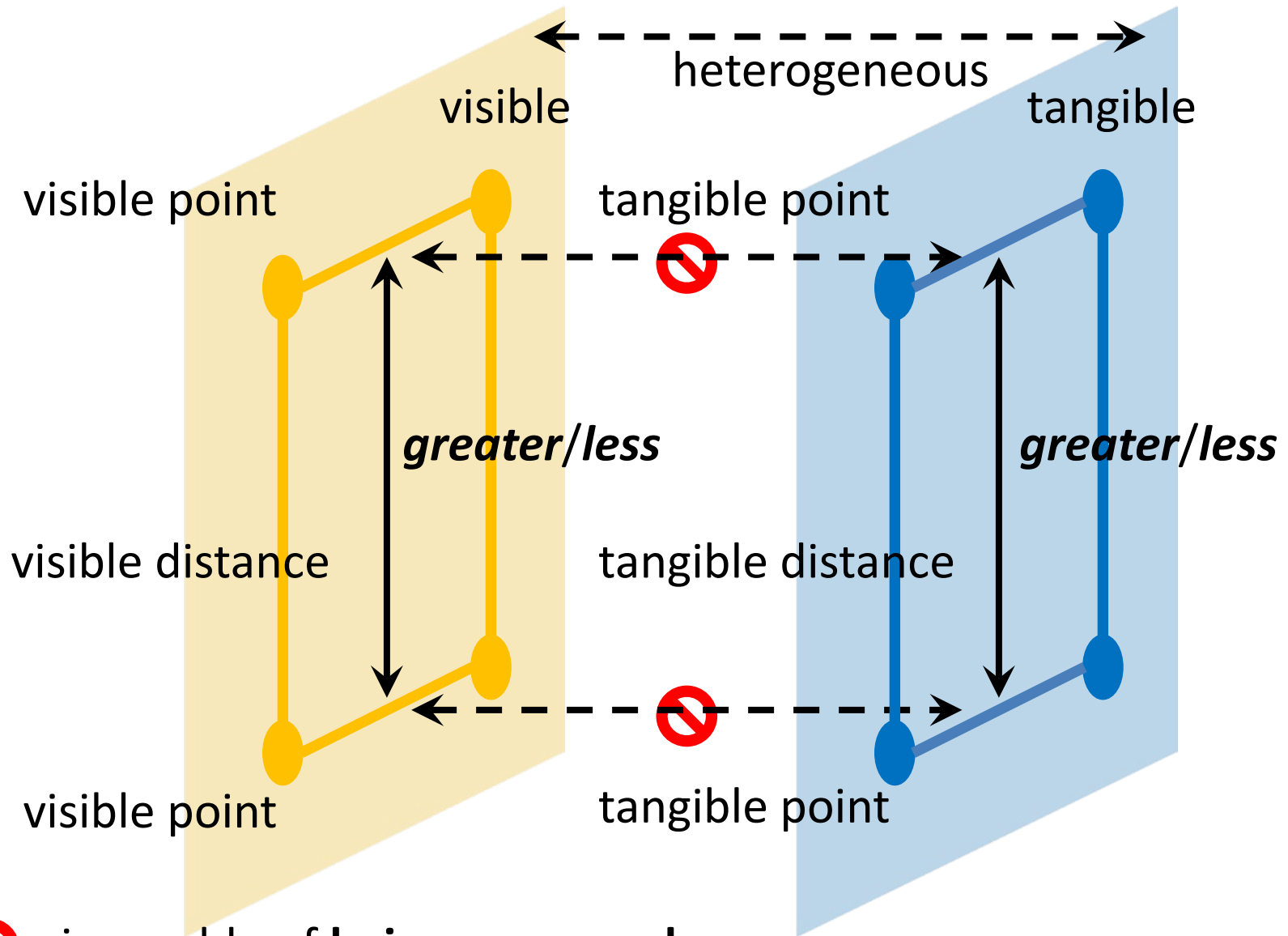
Both Mach and Einstein define measurement as the comparison of rigid bodies.

The point given by Mach is contained in the special theory of relativity.

the concept of measurement (Berkeley)

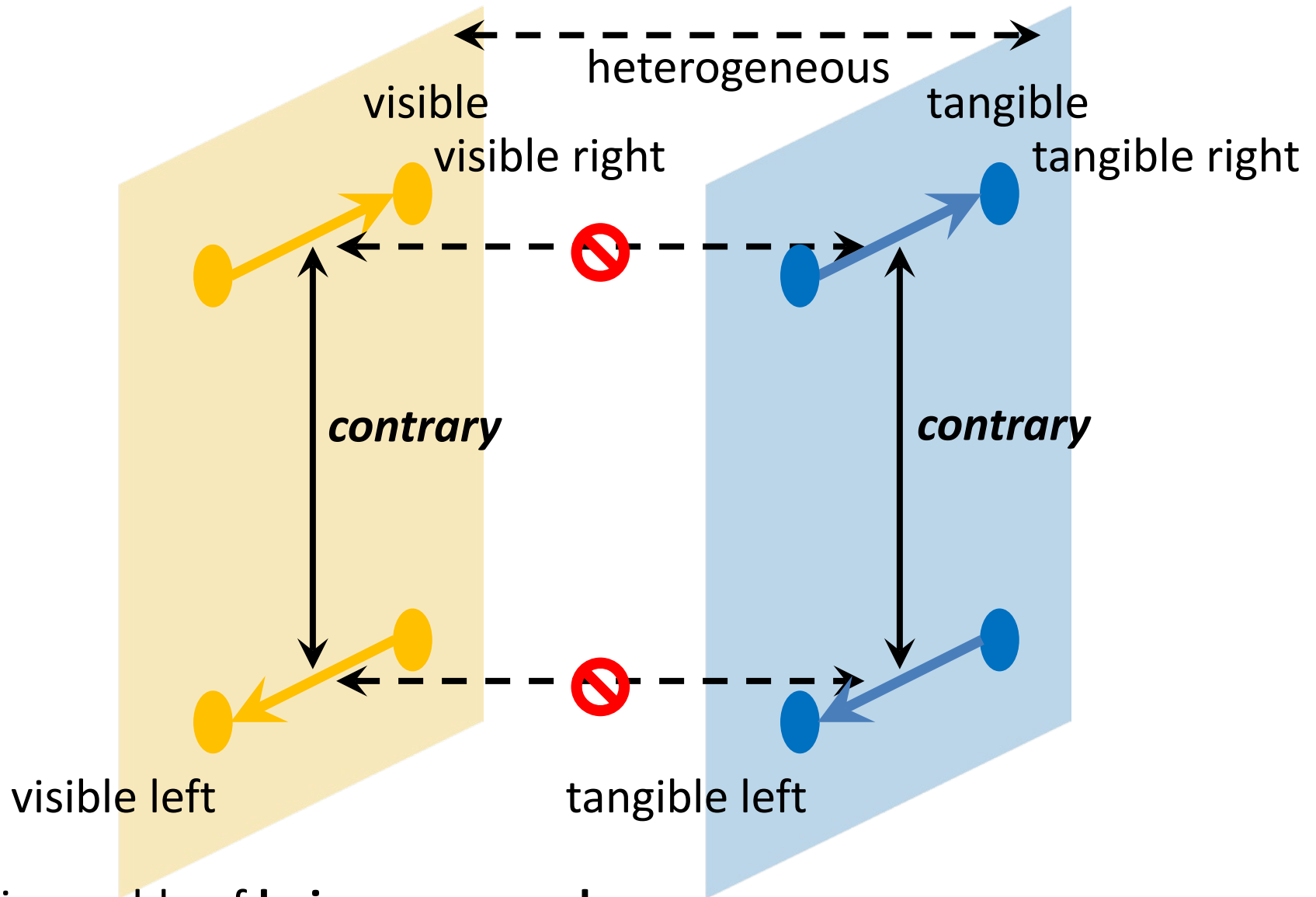
1. We are capable of **comparing homogeneous** things.
We are **incapable of comparing heterogeneous** things.
(V,sec.131)
2. Measurement is **comparison**.
3. Measurement is **not** comparison of two visible distances.
(V,sec.61,156)
4. Measurement is comparison of two tangible distances.
“men measure altogether, by the application of tangible extension to tangible extension.”(V,sec.151)

incapable of comparing heterogeneous things



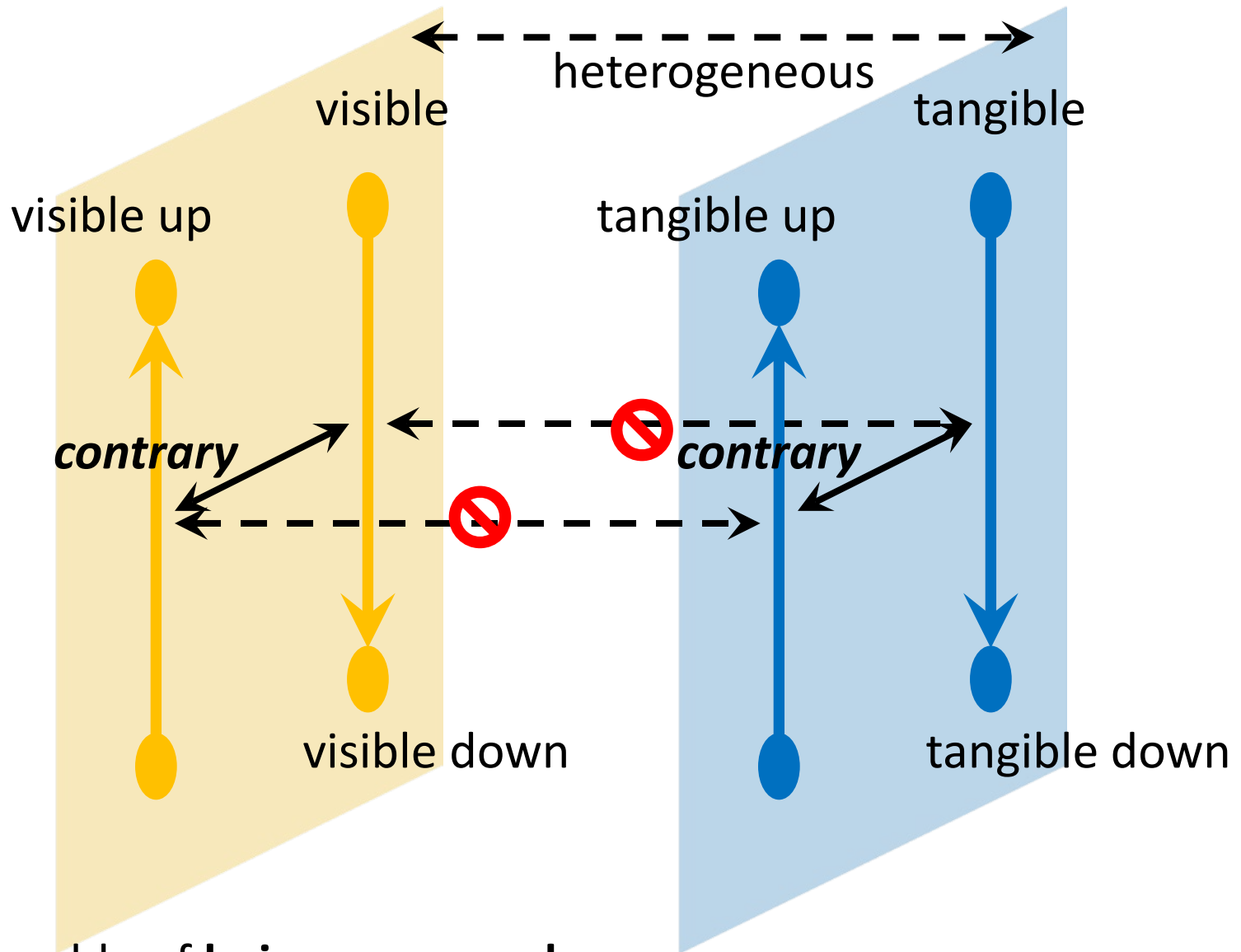
 : incapable of **being compared**

incapable of comparing heterogeneous things



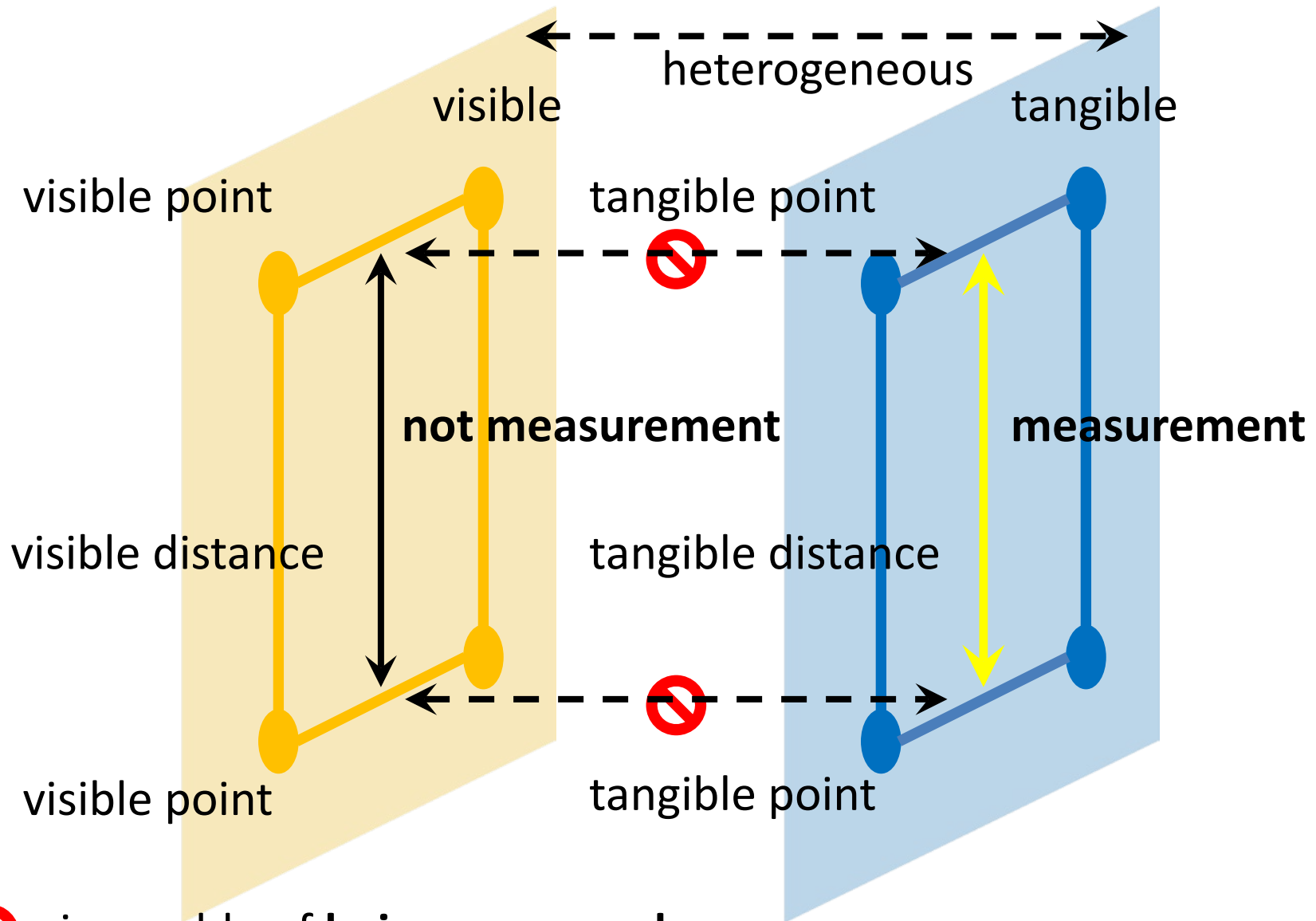
 : incapable of **being compared**

incapable of comparing heterogeneous things



 : incapable of **being compared**

Measurement is comparison of tangible distances



 : incapable of **being compared**

Both Mach and Berkeley have the assertion that measurement is the comparison of tangible distances.

a characteristic of the Berkeley's philosophy of space (measurement)

◆ **coincident character** of the correspondence of the two heterogeneous perceptual spaces

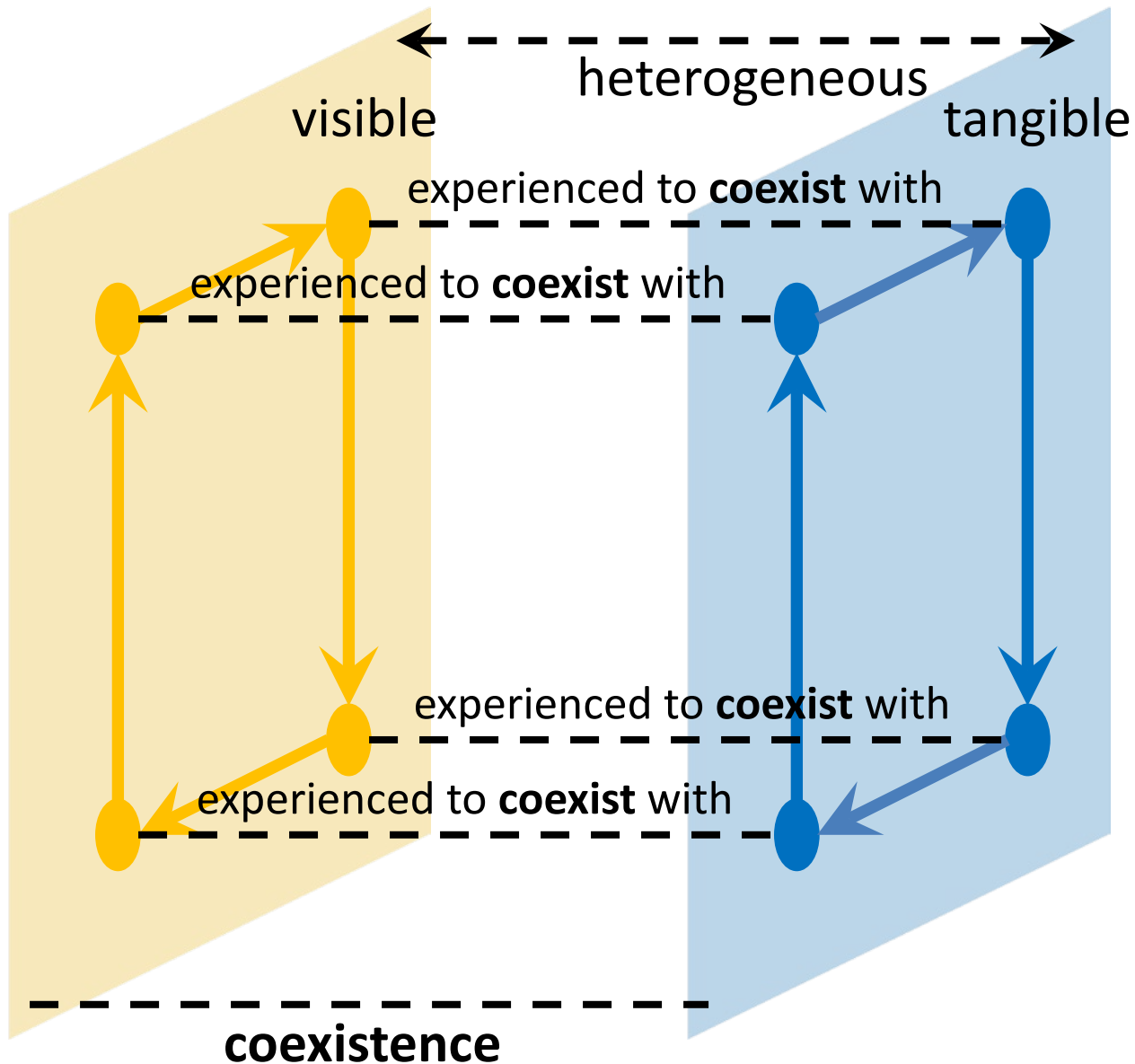
“they might have signified them in a direct contrary manner”

“equally fitted to bring into our minds the idea of small or great”

“just as the words of any language are in their own nature indifferent to signify this or that thing”(V,sec.64)

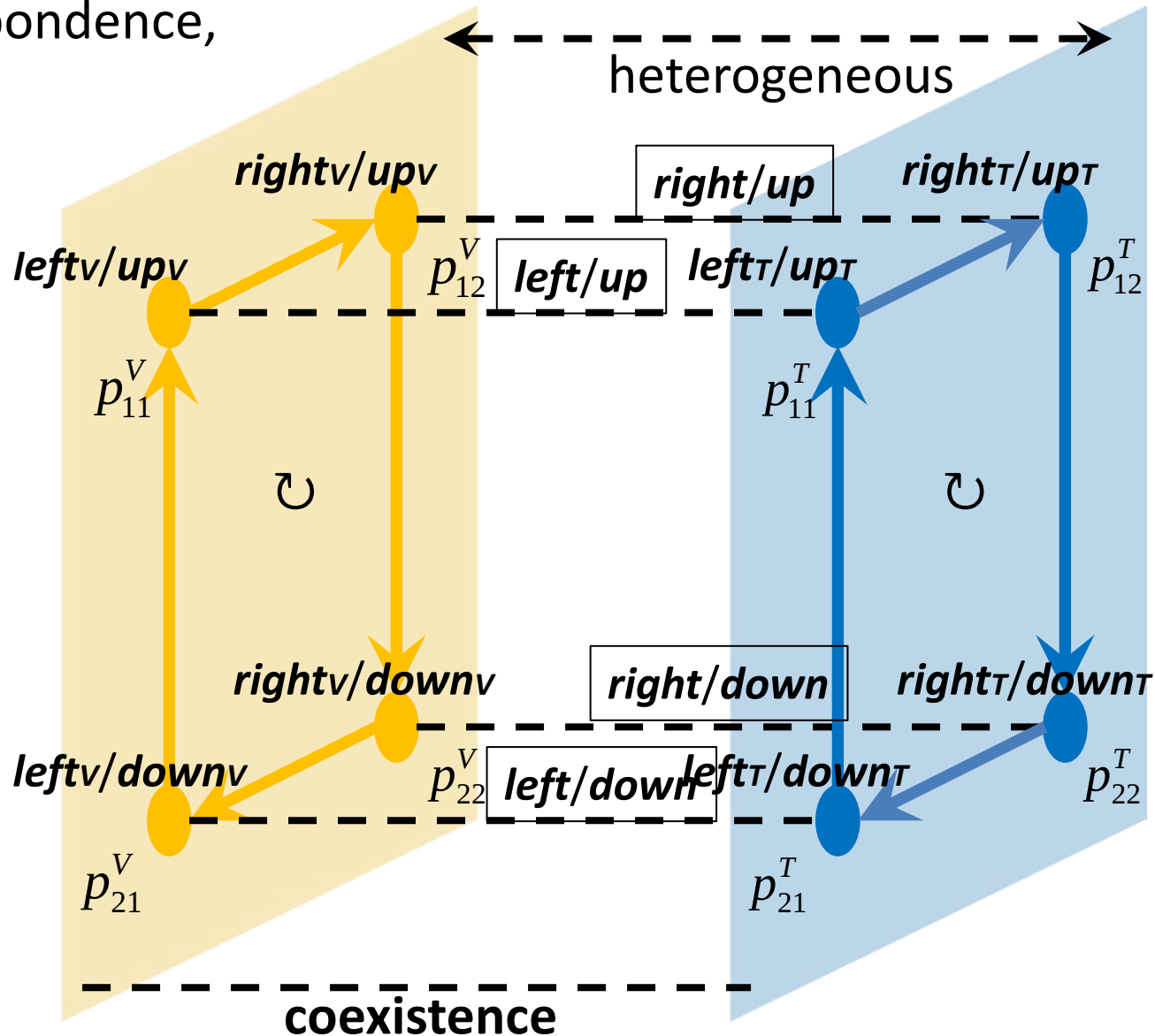
We come to know the correspondence by the **experience** that visible relation and tangible relation **coexist with**.(V,sec.72,110, etc)

The correspondence is known by experience

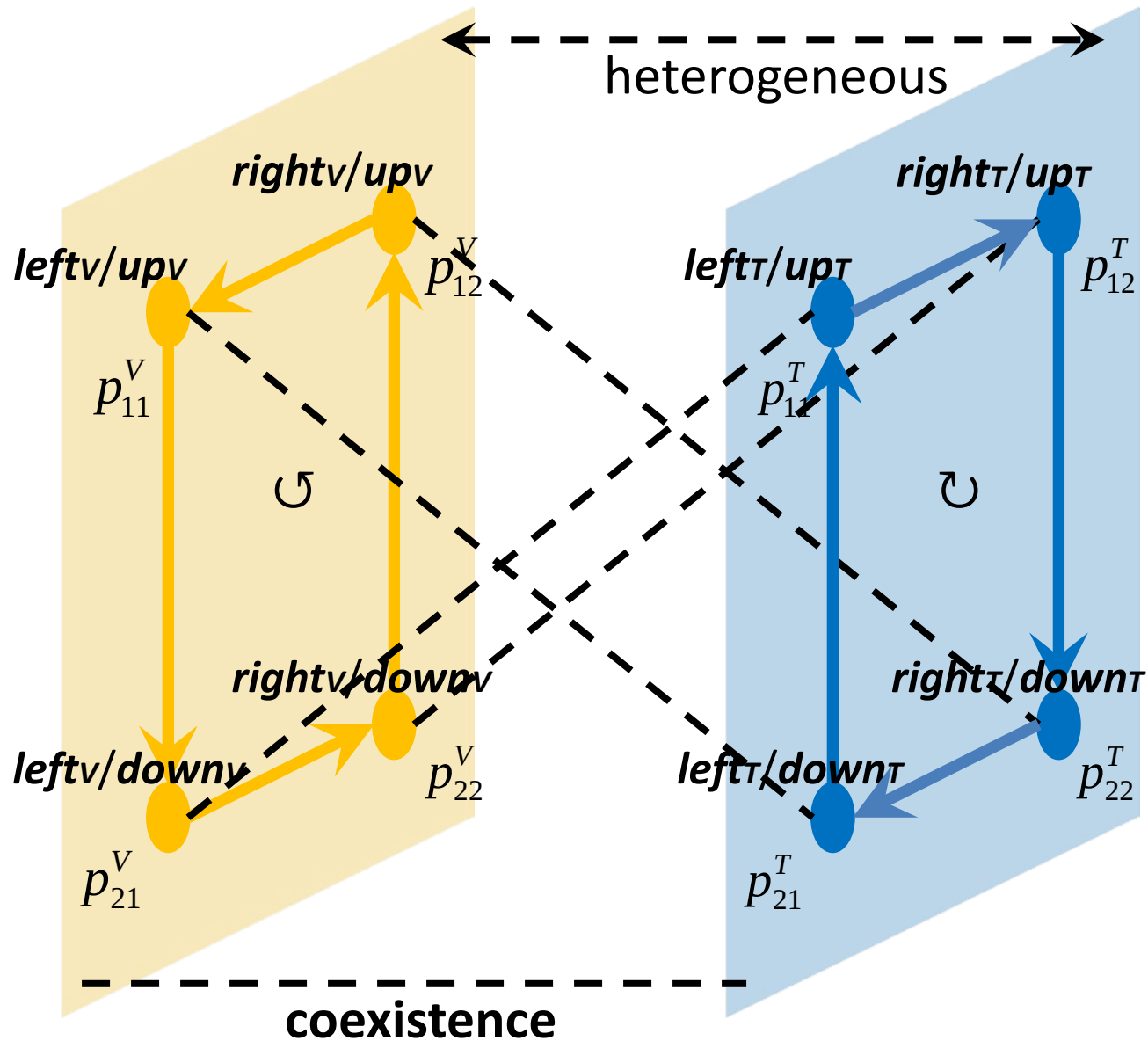


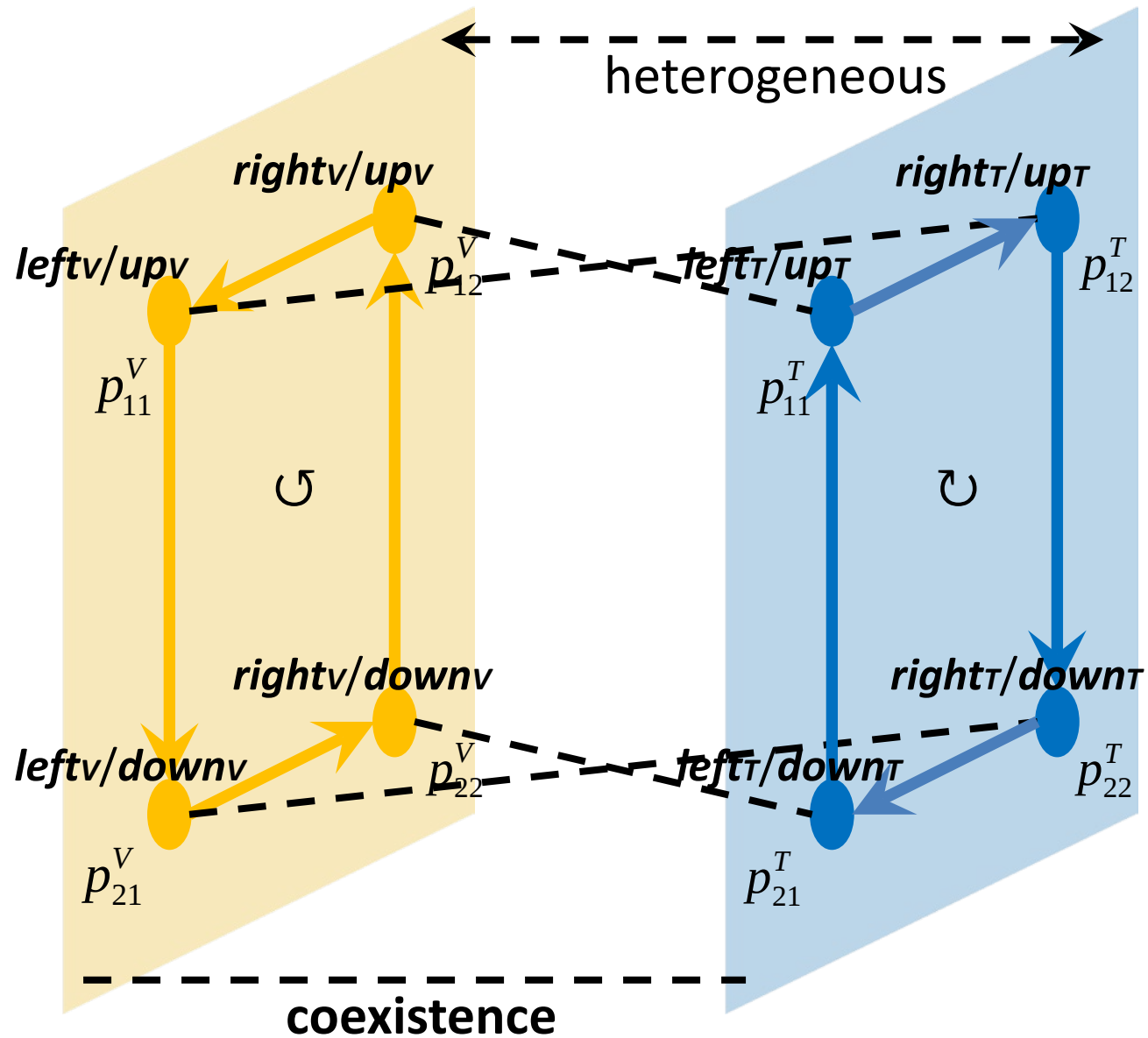
e.g. position/ direction

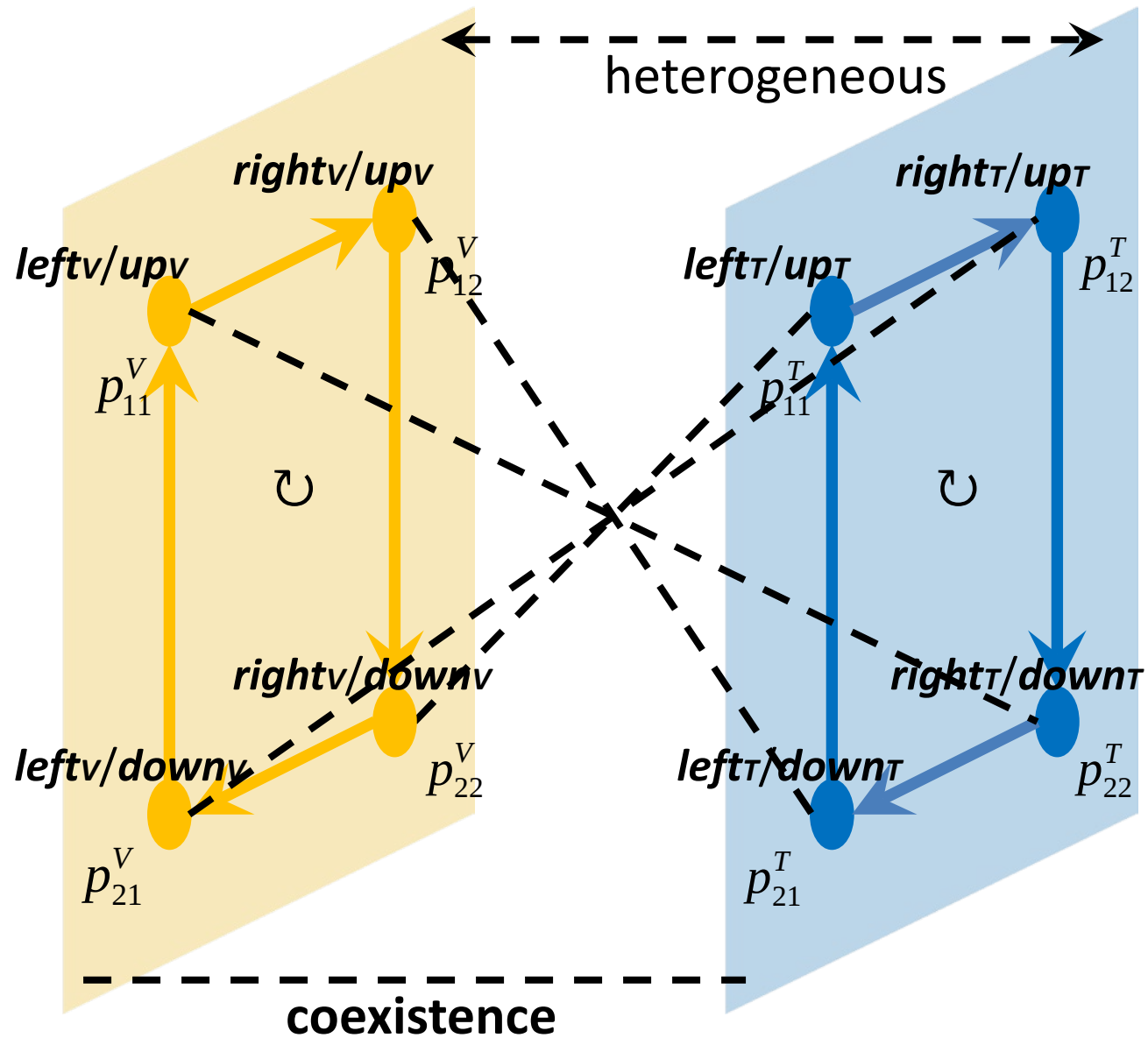
Under the assumption that the following represents the actual correspondence,



the following correspondences would be alternatives.

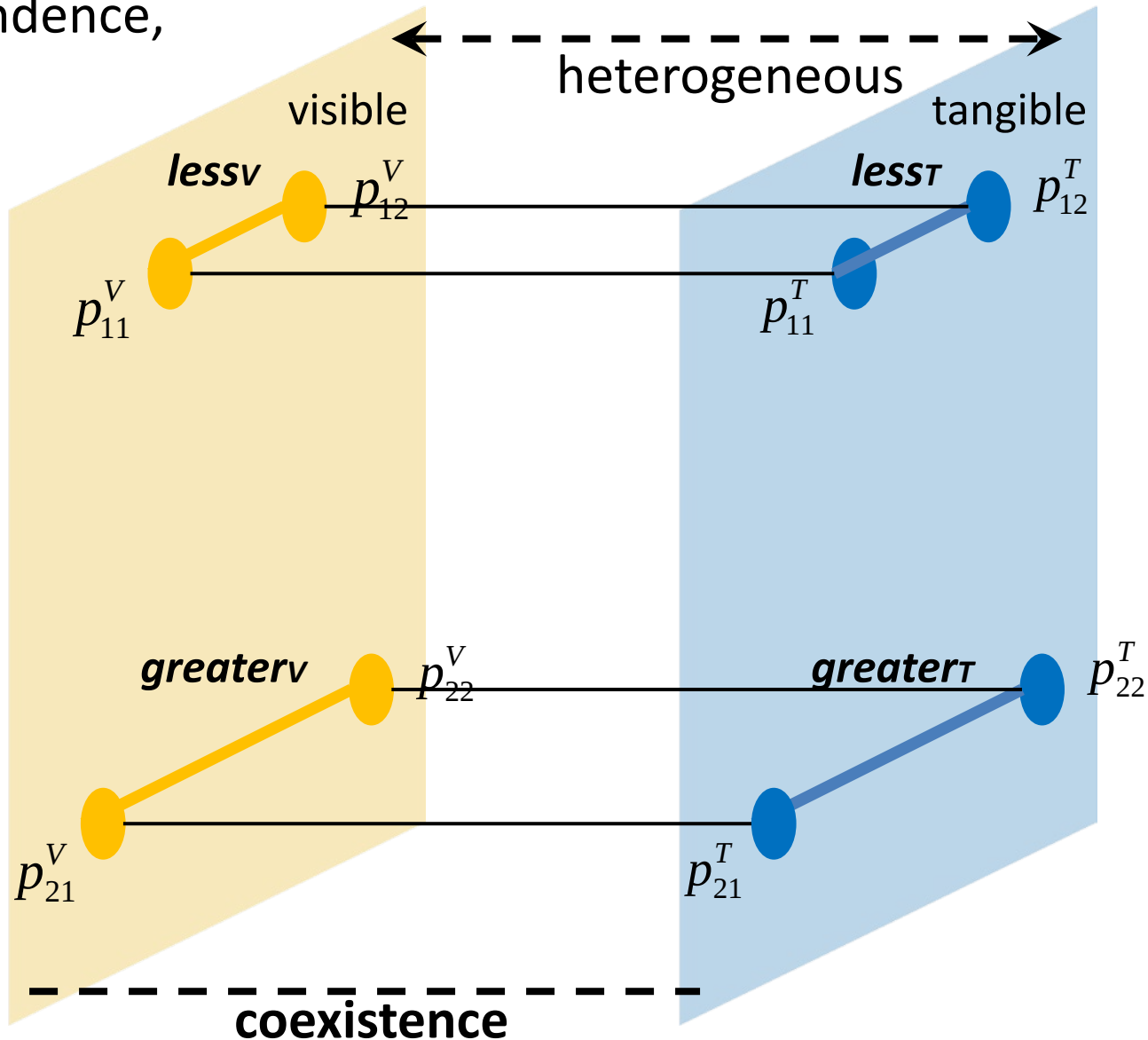




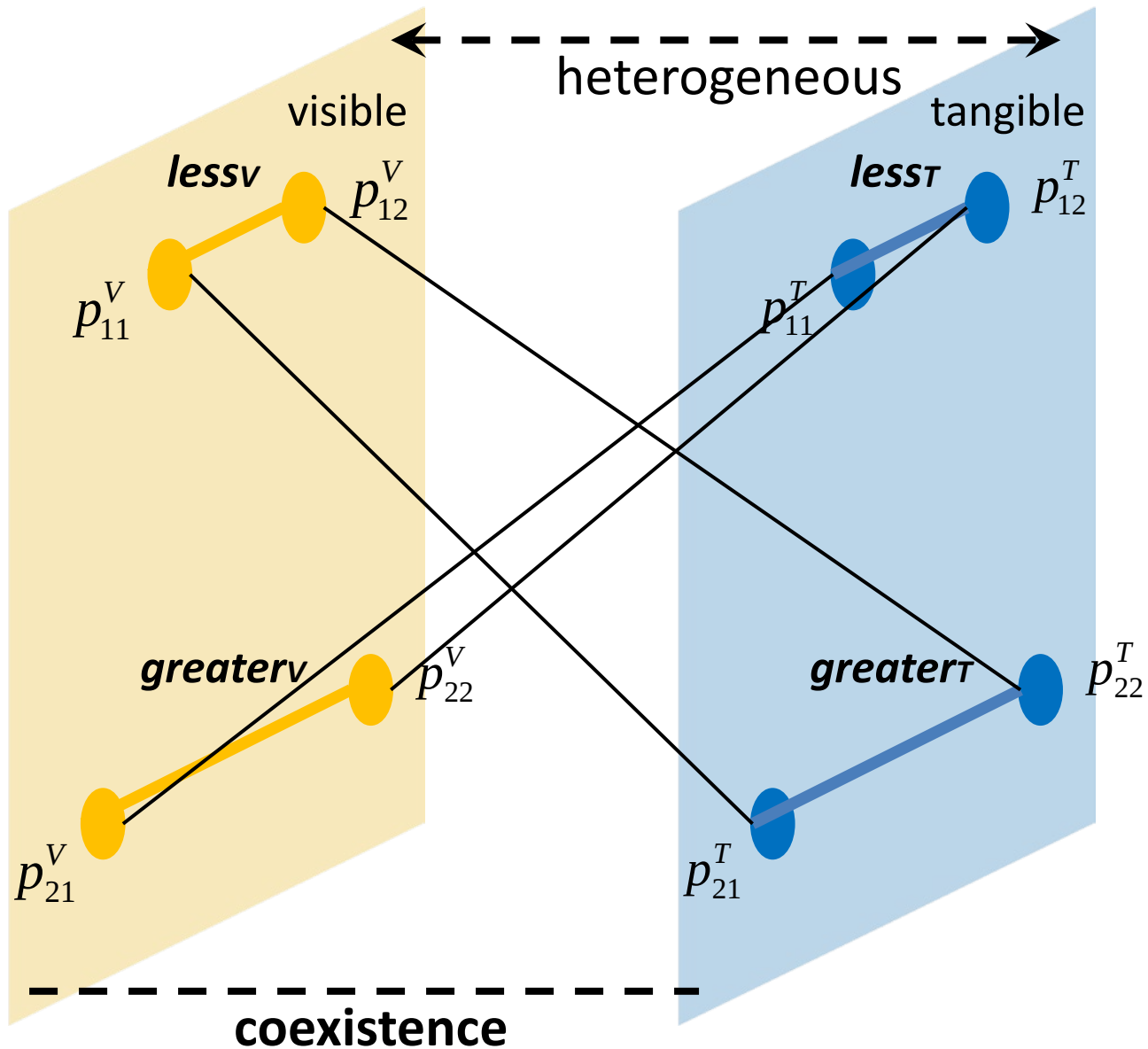


e.g. point/ distance

under the assumption that the following represents the actual correspondence,

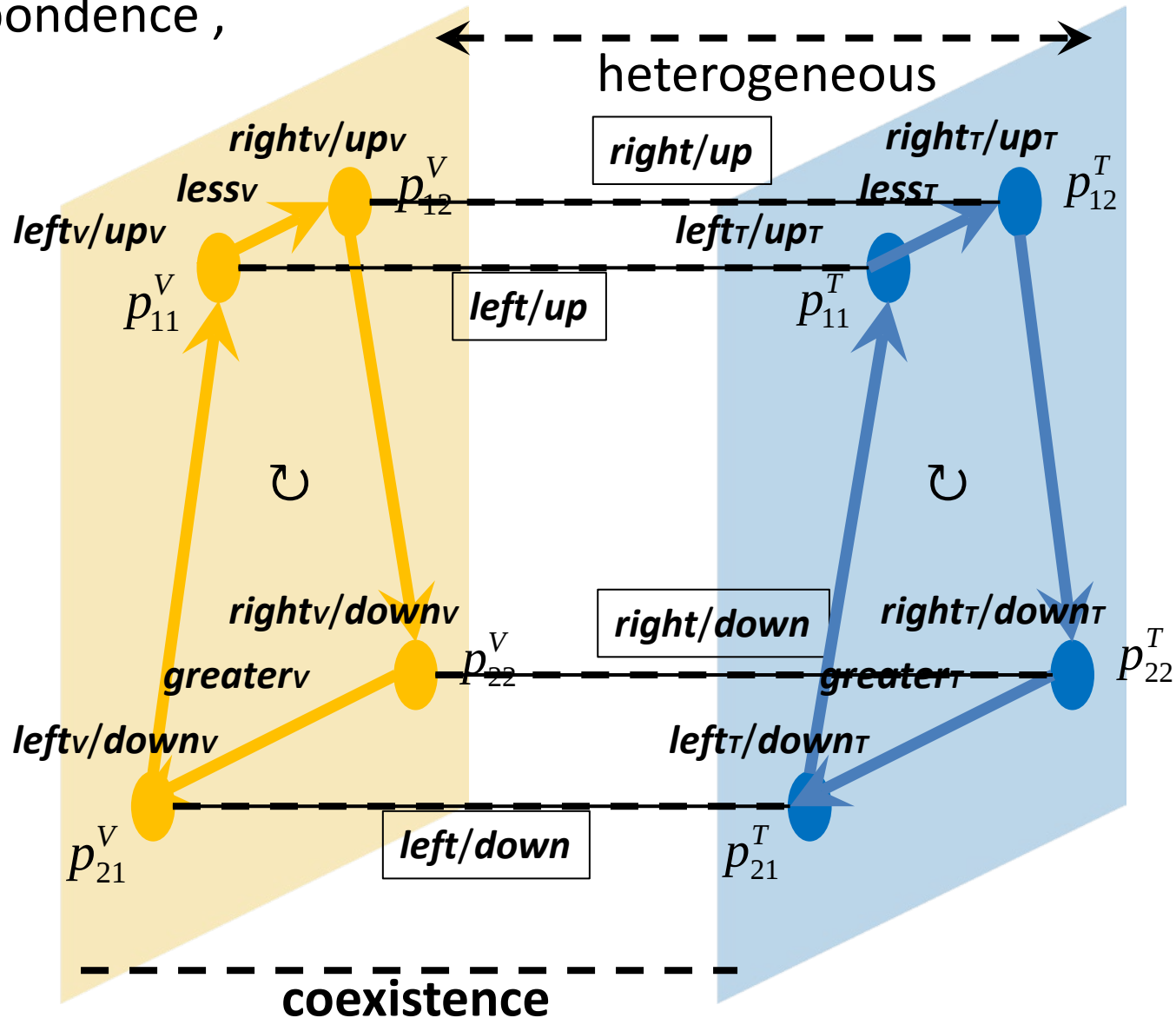


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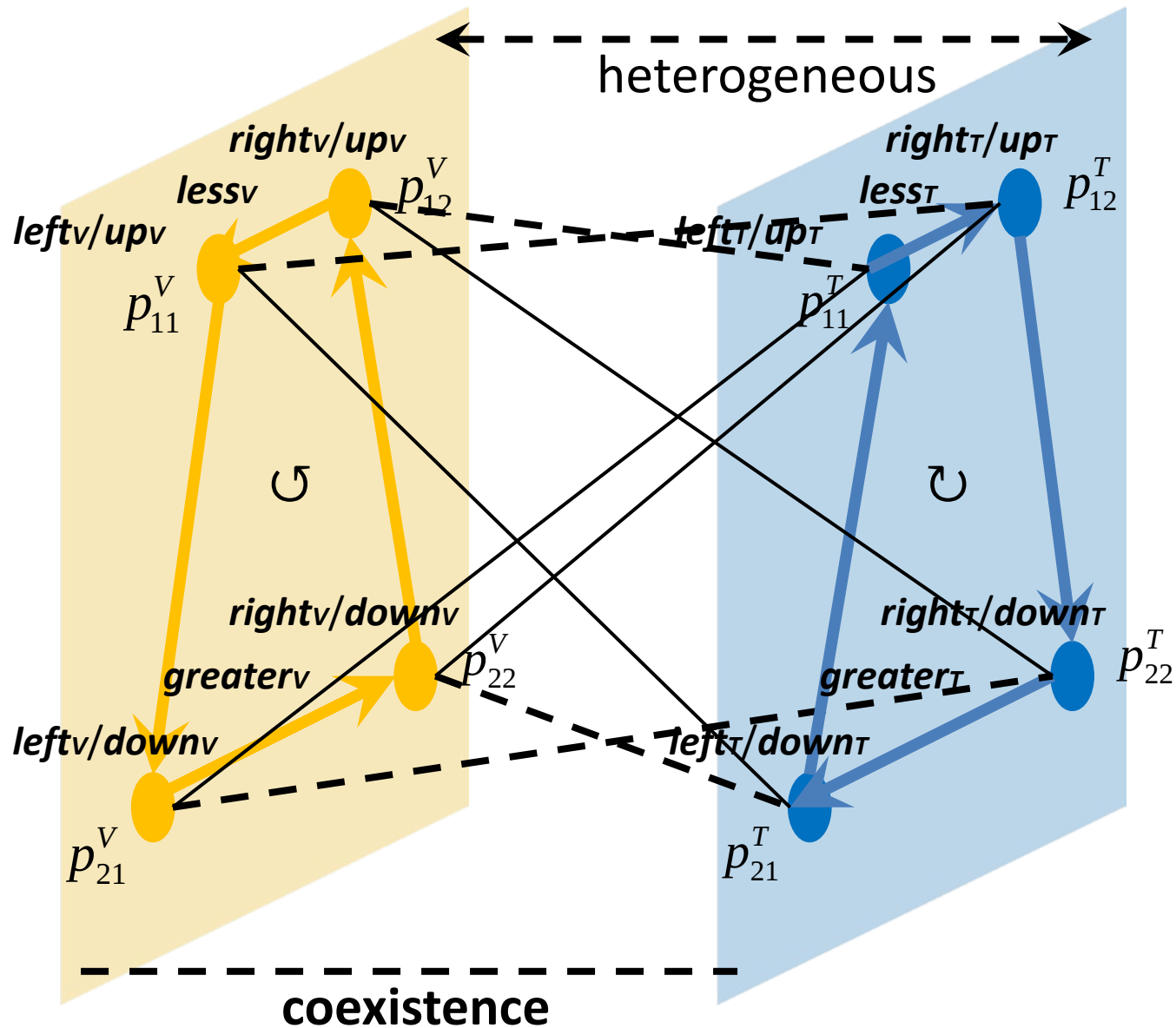


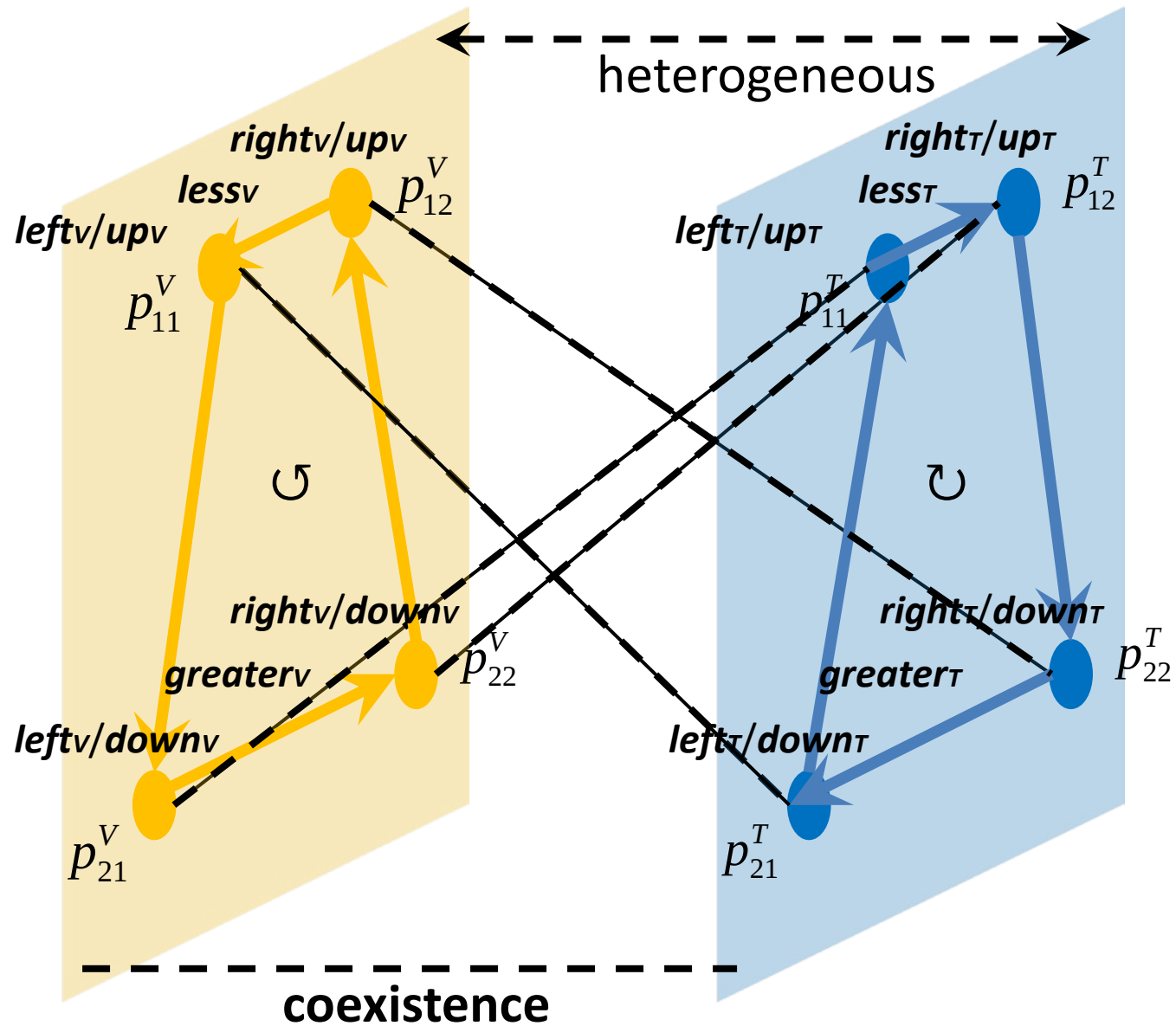
e.g. point/ distance/ position/ direction

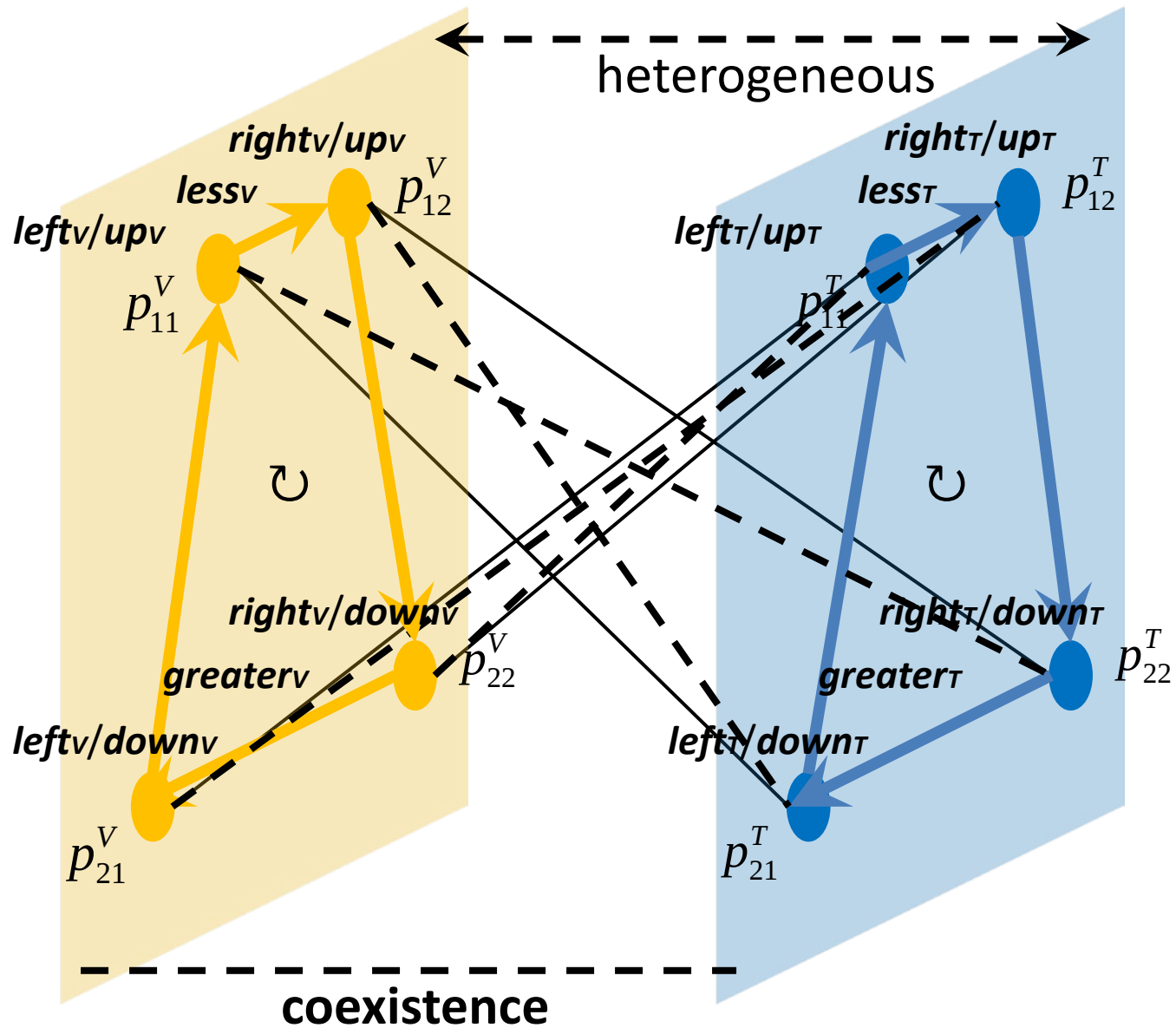
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a characteristic of the Berkeley's philosophy of space (measurement)

◆ **coincident character** of the correspondence of the two heterogeneous perceptual spaces

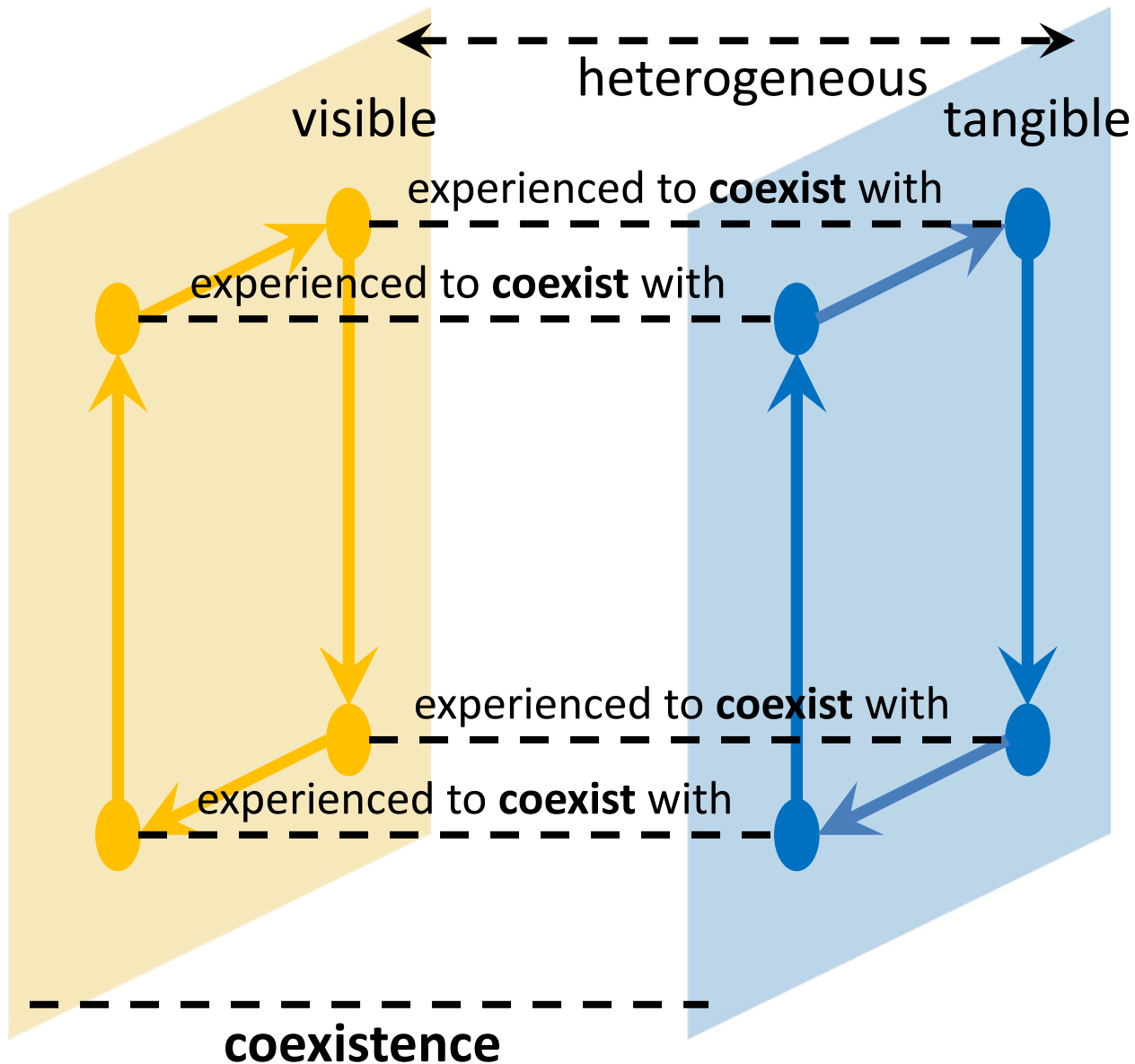
“they might have signified them in a direct contrary manner”

“equally fitted to bring into our minds the idea of small or great”

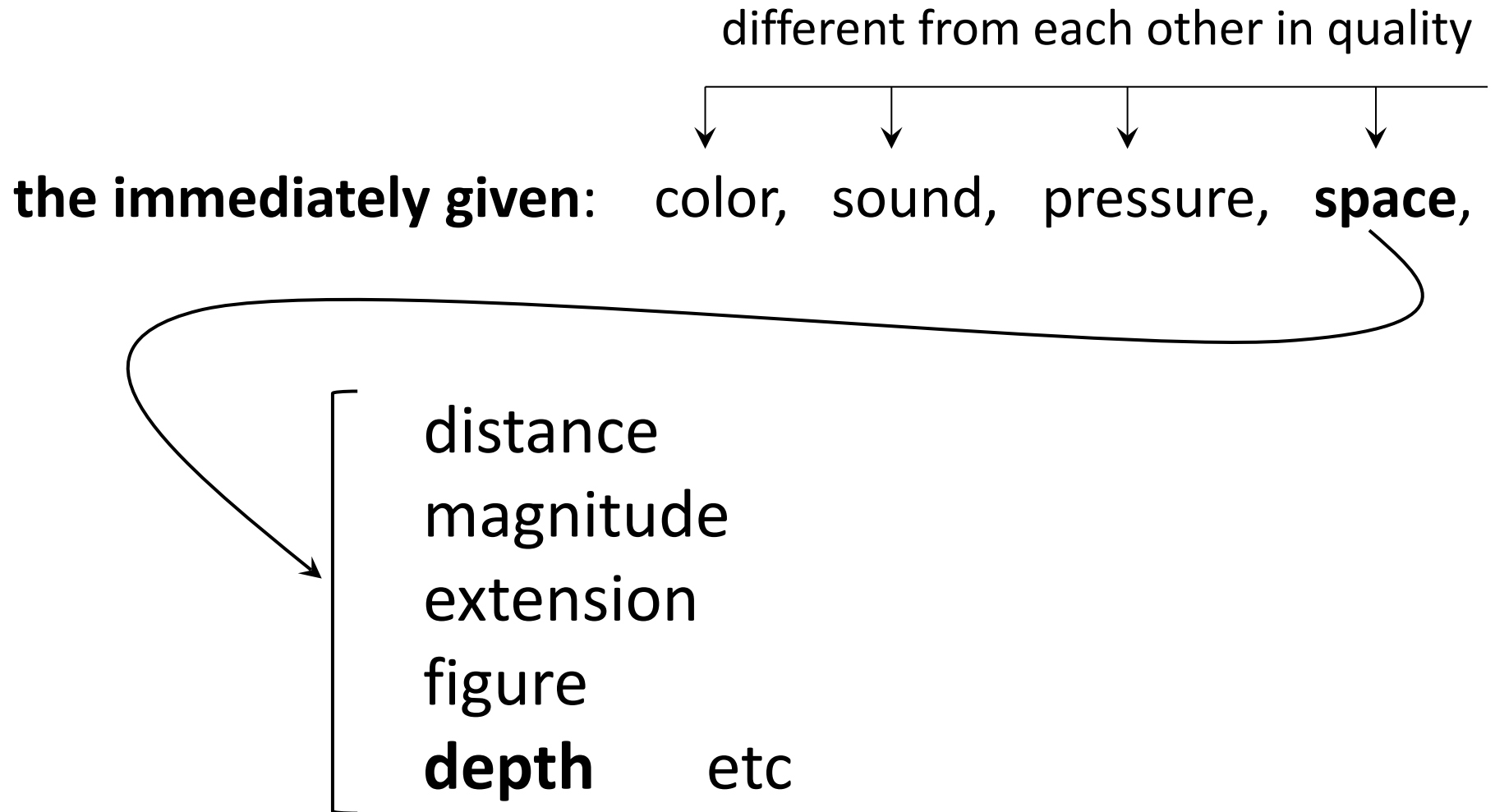
“just as the words of any language are in their own nature indifferent to signify this or that thing”(V,sec.64)

We come to know the correspondence by the **experience** that visible relation and tangible relation **coexist with**.(V,sec.72,110, etc)

The correspondence is known by experience



Mach vs. Berkeley e.g. the concept of **depth**



Mach vs. Berkeley e.g. the concept of **depth**

So called **depth** doesn't seem to be visible distance in Berkeley's sense nor tangible distance in Berkeley's sense.

	a visible point 	a tangible point 
a visible point 		
a tangible point 		

In Berkeley's scheme, depth is what is constructed as a **temporal** distance between two **heterogeneous** points .(P,sec.44)

Depth is **not** the immediately given.

Mach vs. Berkeley e.g. significance of **measurement**

Mach

“mere perception by itself proves to be too much under the influence or physiological circumstances that are not easily controlled”(AS,ch9)

Measurement is needed for the accuracy. (AS,ch9)

Berkeley

Measurement is an act to know the correspondence of two heterogeneous perceptual spaces itself.

the outline of the presentation

1. The concept of measurement in the philosophy of space and in the philosophy of physics
2. An original point contained in Berkeley's philosophy
3. A problem of physics and an application of the point to the problem

Problem

the visibility of the Lorentz contraction, Terrell, J (1959)

“Ever since Einstein presented his special theory of relativity in 1905 there seems to have been a general belief that the Lorentz contraction should be visible to the eye... Einstein’s first paper leaves the impression, perhaps unintentionally, that the contraction due to relativistic motion should be visible.”

“the Lorentz contraction is effectively invisible”

“None of the statements here should be construed as casting any doubt on either the observability or the reality of the Lorentz contraction”

Lorentz contraction

the concept relevant to **the length of the moving rod**
a consequence in **the special theory of relativity**

The mathematical form is
$$L_2 = L_1 \sqrt{1 - \left(\frac{v}{c}\right)^2}$$

, where L_1 and L_2 are considered to be, in any way, length.

Einstein's original argument operation (a)

“imagine its length (the length of the moving rod) to be ascertained by the following two operations”

“(a) The observer moves together with the given measuring-rod and the rod to be measured, and measures the length of the rod directly by superposing the measuring-rod, in just the same way as if all three were at rest”.[]

The operation(a) seems to be measurement in the above sense.

Einstein's original argument operation (b)

“(b) ...the observer ascertains at what points of the stationary system the two ends of the rod to be measured are located at a definite time. The distance between these two points, measured by the measuring-rod already employed, which in this case is at rest, is also a length which may be designated “the length of the rod””.

“the length to be discovered by the operation (b)... differs from ... the length to be discovered by the operation (a)”

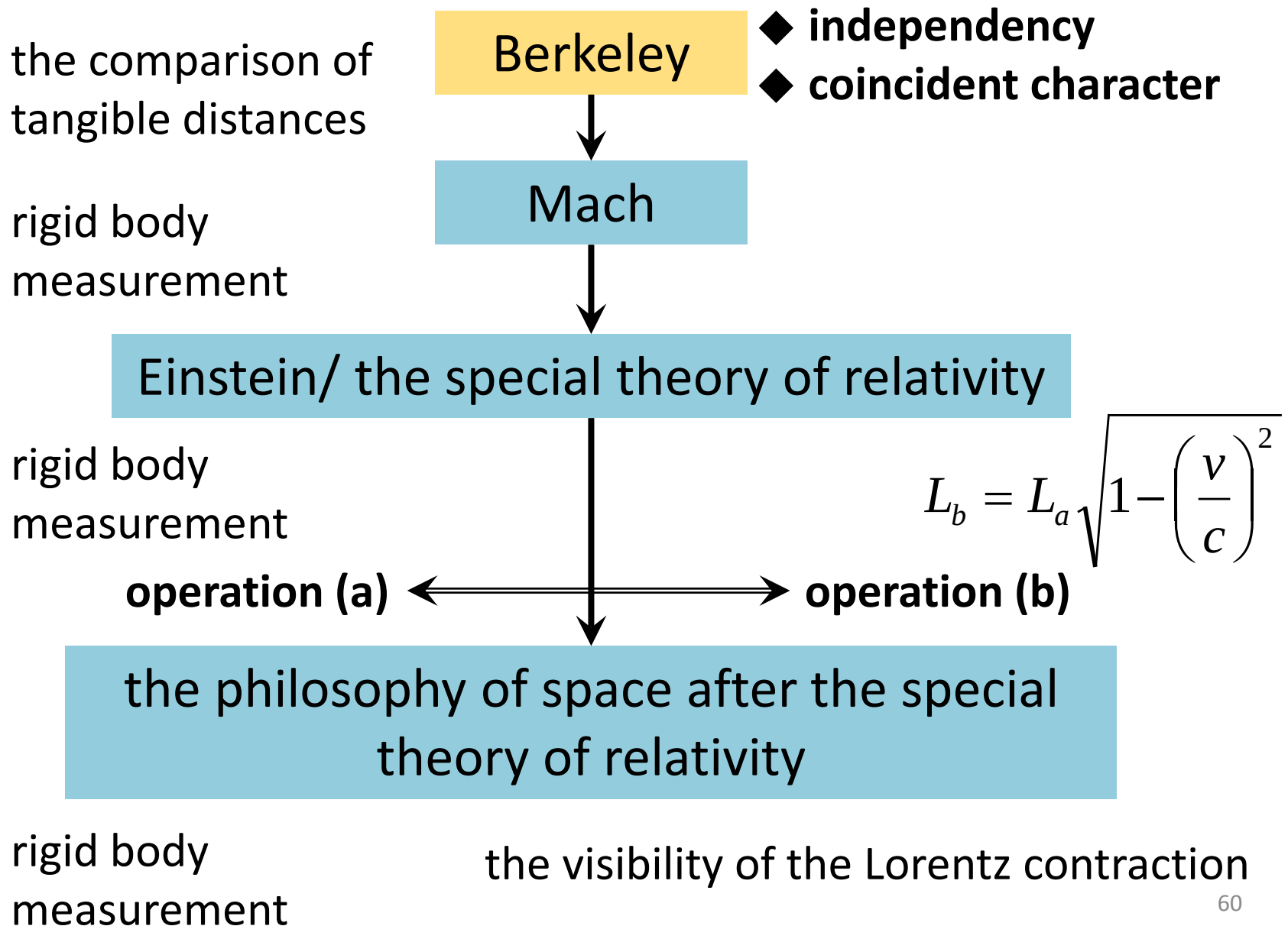
$$L_b = L_a \sqrt{1 - \left(\frac{v}{c}\right)^2}$$

Problem again

the visibility of the Lorentz contraction, Terrell, J (1959)

- Does the Lorentz contraction have **any empirical content**?
- If it does, then what is it?
- What is the concept of length in physics?
- Contraction of what?
- Contraction with respect to what?
- What is the relation between the concept of **length in physics** & the concept of **Lorentz contraction**?

an application of the point to the problem



A treatment of the issue from Berkeley's philosophical perspectives

Is there any alternative answer to the problem?

Berkeley's philosophical perspective

- ◆ **independency** of the heterogeneous perceptual spaces
- ◆ **coincident character** of the correspondence of the heterogeneous perceptual spaces

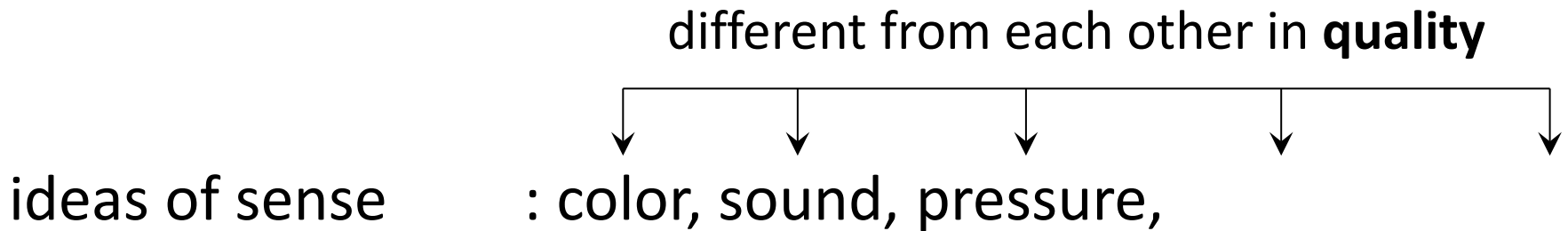
e.g. A visible distance cannot be computed from tangible distances, at least “prior to experience”(V,sec.105).
(V,sec.150, VV,sec.14,31)

method

Is it possible to reconstruct or to axiomatize a space-time theory by means of symbolic logic in the way that reflects Berkeley's point?

presupposed interpretation

Berkeley's "ideas of sense" as **the immediately given**



Berkeley's term "Ideas (of sense)" can be understood as the concept of **the immediately given**.

Berkeley's "ideas of sense" can be seen as **the bases of objective knowledge**.

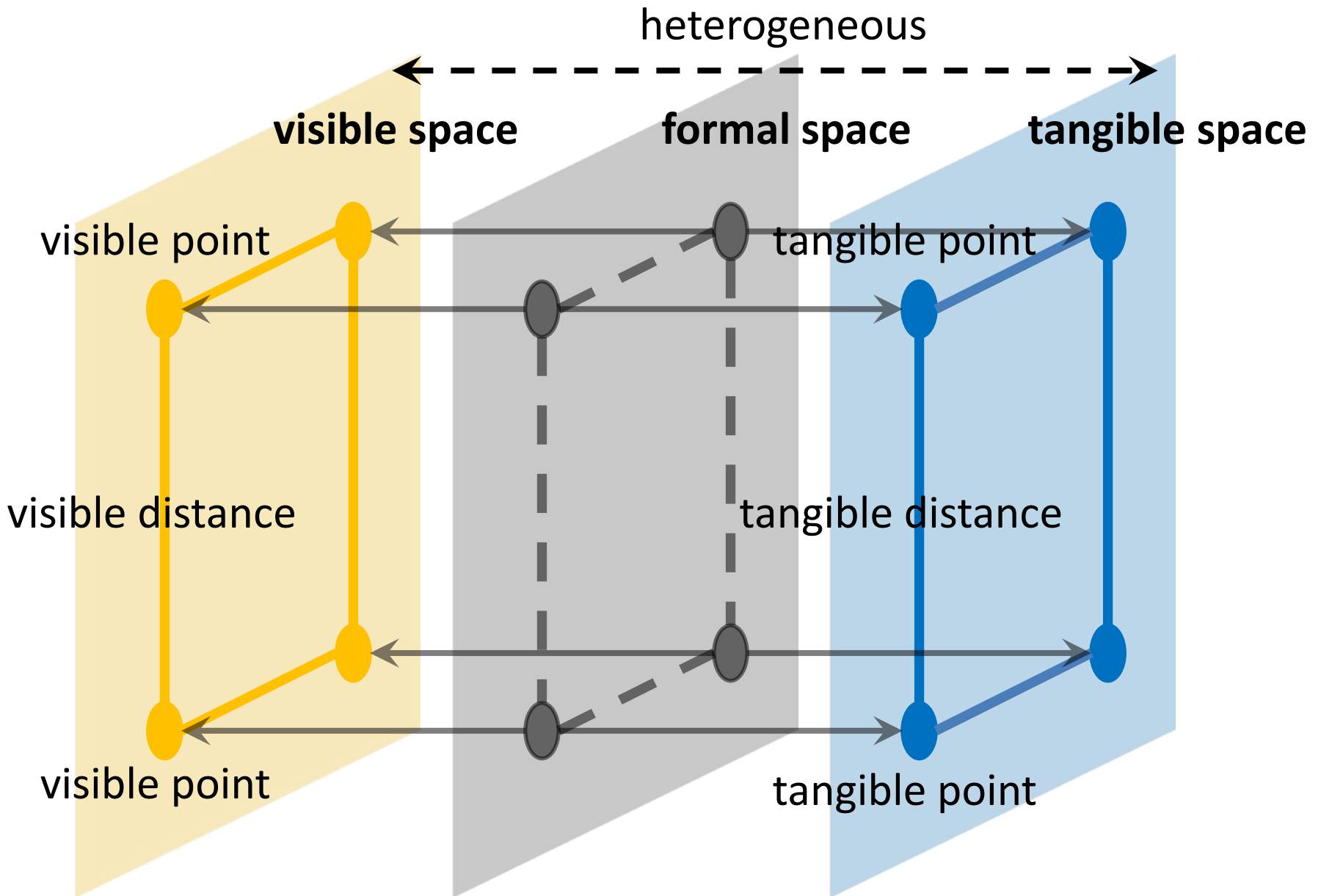
presupposed interpretation

formal kind of knowledge in Berkeley's philosophy

relation

Although Berkeley's philosophy is well known as the philosophical theory that only "idea" and "mind", Berkeley explicitly states that **relation** is an independent province of knowledge.(P,sec.89)

e.g. "between"(V,sec.112),
"greater"(V,sec.54 etc), "less"(V,sec54 etc),
"contrary"(V,sec.93),
"upper"(V,sec.93), "lower"(V,sec.93)
"right"(V,sec.137 etc), "left"(V,sec.137 etc)



tentative development

So far only the determination of the primitives
language

non-logical symbol

1. predicate

equal sign that signifies coexistence =

equal sign that signifies measurement ='

less $>$, greater $<$,

2. constant

visible points $\alpha, \beta, \gamma, \dots$

tangible points $a, b, c, \dots$

Summary

1. Measurement is considered to be a fundamental topic in the philosophy of space and in the philosophy of physics
2. Berkeley's philosophy contains an original point relevant to measurement.
 - ◆ **independency** of the heterogeneous perceptual spaces
 - ◆ **coincident character** of the correspondence of the heterogeneous perceptual spaces
3. A problem of the visibility of the Lorentz contraction and an application of the point to the problem.

Thank you for your kind attention.

Abbreviation

- V : *new theory of vision*
- VV : *theory of vision vindicated and explained*
- P : *principle*
- D : *dialogue between hylas and philonous*
- AS : *analysis of sensation*
- KN : *knowledge and error*

references

- [1]Popper, K. R. “A note on Berkeley as precursor of Mach.” *British Journal for the Philosophy of Science* 4 (1953): 26-36.
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- [7]Einstein, A. “Zur Elektrodynamik bewegter Körper.” *Annalen der Physik* 17 (1905): 891–921.
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