

Innate connection between touch and vision: from hand to eyes

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MOLYNEUX 's QUESTION

Suppose a man born **blind**, and now adult, and taught by his **touch** to distinguish between a cube and a sphere of the same metal, and nearly of the same bigness, so as to tell, when he felt one and the other, which is the cube, which the sphere.

Suppose then the cube and sphere placed on a table, and the blind man be made to see: **whether by his sight, before he touched them**, he could now distinguish and tell which is the globe which the cube? (1)

(1)W. Molyneux, quoted by J. Locke (1694, p 186)

Diderot(1) compared the blind person to a neonate and contends that there is no doubts

« that vision must be very imperfect in an infant that opens eyes for the first time, or in a blind person just after his operation »

(1) Diderot (1749) - La lettre sur les aveugles

According to the empiricist model,

1. the neonate 's experience is confused
2. the senses modalities do not **naturally** communicate.
3. The Molyneux problem receives a negative answer because experience in the tactile modality is not sufficient for learning to perceive in the visual mode.

At the present time, several positive answers to the Molyneux 'question are given by studies in infancy:

1. One-month-old infants visually recognize an object they have previously explored **orally** through its **substance** (Gibson & Walker, 1984) or **texture** (Meltzoff & Borton, 1979).
2. 2-month-old infants are able to visually recognize the **shape** of an object that they have previously manipulated **with their right hand** (Streri, 1987)

As regards Streri (1987) 's experiment,

1. Participants were not newborns
2. For two months, babies may have established some connections between touch and vision.

In consequence, a genuine answer to Molyneux problem have to ask the question whether

- a. Newborns
- b. coordinate information between tactual and visual modalities
- c. in a cross-modal transfer task
- d. from hand to eyes
- e. with objects varying in shape

Concerning the famous Meltzoff 's answer, several problems have to be evoked:

1. Subjects were not newborns
2. Preference for the familiar object has been seriously discussed and this result is opposite to that of Gibson 's experiment
3. Meltzoff 's results have not been replicated (see Maurer, Stager and Mondloch, 1999)
4. Mouthing involves different exploratory procedures from handling: information processing cannot be similar.
5. Texture or substance are material properties and not geometric properties like shape or size.

Prerequisite : Haptic discrimination between shapes by newborns is necessary if we refer to the Molyneux question

Procedures : Haptic habituation without visual control and reaction to novelty

Newborn are able to discriminate between a curvilinear (a cylinder) vs a rectilinear (a prism) shape with both right and left hands.
(see Streri, Lhote, Dutilleul, 2000)



Haptic objects

Cross-modal recognition of shape from hand to eyes
In human newborns (Streri & Gentaz, in press)

Method: intersensory paired-preference procedure (2 phases)

1. A Haptic phase: Infants are given an object to explore manually **without visual control** during a habituation phase
2. A Visual phase: Infants are shown the familiar object paired with a new one.

Subjects: 24 newborns mean age : 62 hours ; range : 16 to 110 h

Objects:

1. Tactual objects: a cylinder 10 mm in diameter and a prism 10 mm triangle base

2. Visual objects: a prism 45 mm triangle base and 100 mm in length. A cylinder 30 mm in diameter and 100 mm in length



Visual objects

Design:

An experimental group of twelve infants (mean age: 55,6h).
“tactual-to-visual modality” group

A baseline group of twelve infants (mean age: 70;5h)
“visual modality” group

Results:

Haptic habituation: all neonates met the habituation criterion
50% decrease from the beginning of habituation

Visual Test : 60 sec of presentation of two objects
simultaneously

1. General Analysis:

Looking times for each object

- « Visual modality » Group: Prism: 46% - Cylinder: 54%

$T(11) = 0.4$; $p > .25$

- « Tactual to visual modality » Group: Novel object: 68% -

Familiar object: 32%

$T(11) = 2.64$, $p < .05$.

Number of looks :

« Visual modality » group: prism : 3.08 – cylinder: 4.08 (NS)

« Tactual to visual modality » group : novel object: 3.58 –
Familiar object: 2.33 – $t(11) = 2.26$; $p < .05$

2. Individual analysis :

« Visual modality » group : 5 neonates looked longer at the
prism

And 6 neonates looked longer at the cylinder; 1 showed no
systematic preference. (NS, test sign).

« Tactual to visual modality » group : 10 looked longer at
the novel object and 2 looked longer at the familiar
($p < .05$; sign test)

In sum, the results showed that the newborns look longer
and more often at the object that they had not previously felt.

Discussion

Newborns are able to transfer shape information from right hand to eyes before they had the opportunity to learn from the pairing of visual and tactual experience.

These results do not support the empiricist philosophical conception and modern connectionist model that sensory modalities cannot communicate in newborns.

This coordination testifies to an early developing ability, largely independent of common experience, to detect abstract amodal, higher-order properties of objects.

This ability have plausibly neural bases. It is a prerequisite scheme of perceptual loops necessary to the development of knowledge in infancy.

Two questions remain unanswered:

1. Is cross-modal transfer from the left hand to eyes evidenced as well as from the right hand? The answer is : no
2. Is reversible transfer from eyes to hands possible ? Is such the case, then the primitive unity of senses would be shown (see future)

And after Birth ?

Previous experiments investigated **reversible cross-modal** transfer of object shape from hand to eyes and from eyes to hand in

- 2-month-old infants when they exhibit low levels of manual activity (Streri, 1987)
- 5-month-old infants when visually guided prehension is developing rapidly. (Streri & Pêcheux, 1986)

Results :

In **2-month-old infants**, visual recognition of the shape of the felt object was again evidenced (from hand to eyes), but not tactual recognition of the seen object (from eyes to hand).

In **5-month-old infants**, the reverse was observed: transfer from vision to touch is evidenced but not from touch to vision

Conclusions:

1. Coordination between touch to vision exists at birth but is not unchanging
2. Transfer is fragile because it depends on the efficiency of information processing of each modality (vision or haptic)

3. Transfer are rarely reversible because the maturation speed of each mode is different

4. But coordination is always present, either from hand or from eyes. From hand, for the Sixth first months of life and from vision, as 6 Months of age.

5. At about 6 months of age, bimodal exploration of an object is possible in infancy. Coordination between senses are reinforced.