

## 04: Can Humans Perceive Causal Interactions?

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‘When we consider these objects with the utmost attention, we find only that one body approaches the other; and that the motion of it precedes that of the other, but without any sensible interval.’ (Hume 1978, p. 77)

‘the account flies in the face of our common-sense conviction that we do perceive causal relations all the time. The experience of perceiving one event following another is really quite different from the experience of perceiving the second event as caused by the first ... the researches of Michotte and Piaget would seem to support our common-sense view’ (Searle 1983, pp. 114-5)

Sometimes ‘a causal impression arises, clear, genuine, and unmistakable, and the idea of cause can be derived from it ... in just the same way as the idea of shape or movement can be derived from the perception of shape or movement.’ (Michotte 1963, p. 270-1)

‘the causal perception is the perception of the work of a mechanical force, just as the impression of the movement of a car is the perception of its displacement in physical space’ (Michotte 1963, p. 228)

‘This causal impression, however, would have been for him [Hume] ... nothing but an illusion

of the senses, as is shown by his views with regard to the feeling of effort. ... [I]t is probable that his [Hume’s] philosophical position would not have been affected in the least.’ (Michotte 1963, p. 256)

‘In a great boulder rolling down the mountain-side and flattening the wooden hut in its path we see an exemplary instance of force ... these mechanical transactions ... are directly observable (or experienceable)’ (Strawson 1992, p. 118)

‘just as the visual system works to recover ... physical structure ... by inferring properties such as 3-D shape, so too does it work to recover ... causal ... structure ... by inferring properties such as causality’ (Scholl & Tremoulet 2000, p. 299)

‘we seem to be as far as ever from deciding whether the hypothesis is true: whether we perceive launchings rather than recognizing them by means of stored patterns in long-term memory.’ (Rips 2011, p. 92)

### 1. How to Get Beyond Intuition?

Consider an encounter with three two-object movements where the delays between movements are 50, 100 and 150ms:

1. The phenomenal difference between the first two encounters is larger than the phenomenal difference between the second two.

2. This difference in differences is a fact in need of explanation.
3. The fact cannot be explained by perceptual experience of objects or their motion.
4. The best explanation for (1) is that we perceptually experience causal interactions.

‘... why it is that in our experiments certain particular conditions were found necessary in order to give rise to a causal impression? They correspond to the different characteristics of reproduction. ... anyone not very familiar with the procedure involved in framing the physical concepts of inertia, energy, conservation of energy, etc., might think that these concepts are simply derived from the data of immediate experience’ (Michotte 1963)

Further questions:

1. How is launching detected? For example, does it involve perceptual processes?
2. Why is a delay of up to around 70ms consistent with the launching effect occurring?

### 2. The Launching Effect and Perceptual Processes

Does the detection of launching involve perceptual processes? Three kinds of evidence indicates that it does ...

1. Apparent motion (Kim et al. 2013)

2. Adaptation? (conflicting evidence: Rolfs et al. (2013) for, Arnold et al. (2015) against).

3. Illusory causal crescents. ‘when there is a launching event beneath the overlap (or underlap event) timed such that the launch occurs at the point of maximum overlap, observers inaccurately report that the overlap is incomplete, suggesting that they see an illusory crescent.’ (Scholl & Nakayama 2004, p. 461)

Why does the illusory causal crescent appear? Scholl and Nakayama suggest a ‘a simple categorical explanation for the Causal Crescents illusion: the visual system, when led by other means to perceive an event as a causal collision, effectively ‘refuses’ to see the two objects as fully overlapped, because of an internalized constraint to the effect that such a spatial arrangement is not physically possible. As a result, a thin crescent of one object remains uncovered by the other one—as would in fact be the case in a straight-on billiard-ball collision where the motion occurs at an angle close to the line of sight.’ (Scholl & Nakayama 2004, p. 466)

‘object perception reflects basic constraints on the motions of physical bodies ...’ (Spelke 1990, p. 51)

‘A single system of knowledge ... appears to underlie object perception and physical reasoning’ (Carey & Spelke 1994, p. 175)

### 3. Object Indexes

#### 3.1. Michotte’s Conjecture

Michotte thought of the launching effect as bound up with the perception of objects and motion.

‘the movement performed by object B appears simultaneously under two different guises: (i) as a movement (belonging to object A), (ii) as a change in relative position (by object B)’ (Michotte 1963, p. 136)

‘the physical movement of the object struck gives rise to a double representation. This movement appears at one and the same time (a) as a continuation of the previous movement of the motor object, and (b) as a change of relative position (a purely spatial withdrawal) of the projectile in relation to the motor object.’ (Michotte 1963, p. 140)

#### 3.2. Object Indexes

In adult humans, there is a system of object indexes which enables them to track potentially moving objects in ongoing actions such as visually tracking or reaching for objects, and which influences how their attention is allocated (Flombaum et al. 2008).

Formally, an object index is ‘a mental token that functions as a pointer to an object’ (Leslie et al. 1998, p. 11). If you imagine using your fingers

to track moving objects, an object index is the mental counterpart of a finger (Pylyshyn 1989, p. 68).

Why believe that object indexes exist in adult humans? One reason is that they can track at least four moving objects simultaneously (Pylyshyn & Storm 1988; there is debate about exactly how many objects can be tracked simultaneously (Alvarez & Franconeri 2007).)

Another reason is the existence of an *object-specific preview benefit*: ‘observers can identify target letters that matched the preview letter from the same object faster than they can identify target letters that matched the preview letter from the other object’ (Krushke & Fragassi 1996, p. 2; see Kahneman et al. 1992).

This system of object indexes does not involve belief or knowledge and may assign indexes to objects in ways that are inconsistent with a subject’s beliefs about the identities of objects (e.g. Mitroff et al. 2005; Mitroff & Alvarez 2007)

#### 3.3. The Principles of Object Perception

cohesion—‘two surface points lie on the same object only if the points are linked by a path of connected surface points’

boundedness—‘two surface points lie on distinct objects only if no path of connected surface points links them’

rigidity—‘objects are interpreted as moving

rigidly if such an interpretation exists’

no action at a distance—‘separated objects are interpreted as moving independently of one another if such an interpretation exists’ (Spelke 1990)

#### 4. Object Indexes and the Launching Effect

*Causal Object Index Conjecture:* Effects associated with the ‘perception of causation’ are consequences of errors (or error-like patterns) in the assignments of object indexes and their phenomenal effects (compare Krushke & Fragassi 1996).

Implications: (i) Where there is perception of causation, there will be errors (or error-like patterns) in the assignments of object indexes. (ii) Factors that can influence how object indexes are assigned or maintained can influence perception of causation.

‘Michotte and his followers worked out many of the factors which mediate the perception of causality, such as the role of absolute and relative speeds, spatial and temporal gaps in the objects’ trajectories, differences in the durations and angles of each object’s trajectory, etc ... ‘This research has generally shown that many different spatiotemporal parameters are critical for perceiving causality, but that featural parameters (eg colors, shapes, sizes) play little or no

role.’ (Scholl & Nakayama 2004, p. 456)

Potential objections to the Causal Object Index Conjecture:

Objection 1. adaptation effects (Rolfs et al. 2013). But see Johnston (2013); Arnold et al. (2015) for questions.

Objection 2. ‘Leslie’s [Pulfrich double-pendulum illusion (Wilson & Robinson 1986; Leslie 1988)] argument suggests that people individuate objects and calculate their causal relations by means of separate mechanisms; thus, we can’t count on causal constraints being part of the object-tracking module. If Leslie is right, there is reason to question Butterfill’s (2009) conjecture that ‘object perception and causal perception are one and the same process’ (Rips 2011, p. 421).

#### 5. The Launching Effect and Metacognition

If the launching effect is a consequence of the operation of a system of object indexes, why does it have phenomenal consequences? One possibility is that conflicts in assigning object indexes give rise to metacognitive feelings of surprise which subjects have learnt to interpret as impressions of causation.

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