GST 112 — Causal Integration

Formal Description

Causal integration occurs when the organisation of components changes the pathways through which physical transfers are produced or accepted. Transfers may become internal to an assembly (transfer internalisation), pass through additional components (transfer mediation), or be prevented or constrained (capability suppression). These changes can alter the expression of existing component capabilities without necessarily establishing an emergent capability. Emergence requires evidence that the maintained organisation establishes a capability unavailable to the participating components independently.

Plain English Explanation

Imagine two devices that can exchange electrical signals. Before they are connected into a larger assembly, a signal passes between two separate devices. Once they are incorporated into one assembly, the same signal can become an internal transfer. The physics of the signal need not change: what changes is the boundary of the assembly and the role of the transfer within it.

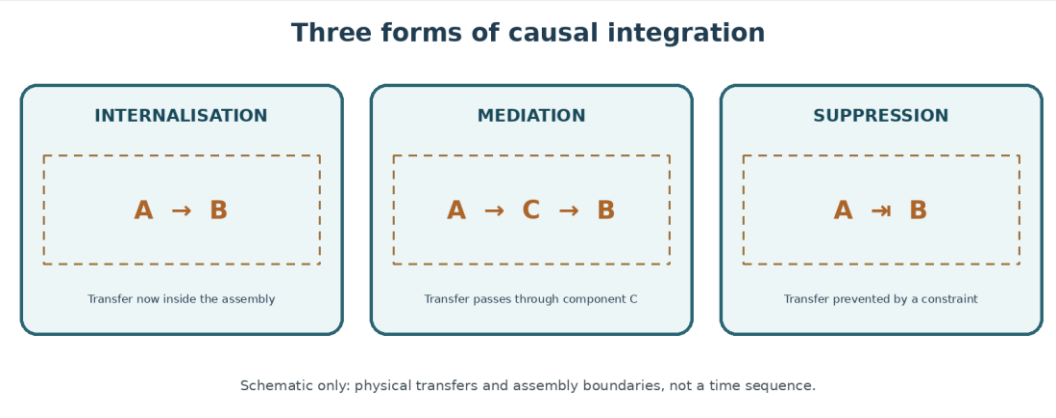
Other changes are possible.

1) Transfer mediation: Consider two people passing a message. Initially, one person speaks directly to the other. Later, they communicate through a third person, who receives the message and passes it on. The communication is now mediated by the third person. The original capability to communicate has not necessarily changed, but the causal pathway through which the message is transferred has.
2) Capability suppression: Consider a rotating shaft that can turn freely when it is separate from a machine. When installed, a locking mechanism prevents it from rotating. The shaft retains its physical capacity to rotate, but the organisation of the machine prevents that capability from being exercised. Its capability is suppressed while the lock is engaged.

Both are examples of causal integration, but they involve different changes. Mediation alters the pathway through which a transfer occurs, whereas suppression prevents or constrains the exercise of an existing capability.

These changes can occur alongside emergence, but they do not, by themselves, demonstrate that emergence has occurred. To identify emergence, we must ask whether the organised components can now produce or accept a transfer that they could not produce or accept independently.

© John A Challoner, 2026.



The diagram illustrates three possible changes in causal relationships within an assembly. The arrows represent physical transfers; the dashed outline represents the assembly boundary. It does not imply that the three changes occur in a sequence.

Examples

Transfer internalisation. Two electronic modules initially exchange a signal across their separate boundaries. When installed within a single instrument, their signal exchange becomes internal to that instrument.

Transfer mediation. In a heating system, a temperature sensor sends a signal to a controller, which in turn sends an electrical command to a heater. The sensor's influence on the heater is mediated by the controller; the controller's operation must also be investigated.

Capability suppression. A machine motor can turn its shaft, but a closed safety circuit prevents it from receiving the electrical input needed to run while a guard is open. The motor's underlying capability need not have disappeared.

In each case, further investigation would be needed to establish whether the complete assembly also possesses a genuinely emergent capability.

Provenance and Links

This module develops the distinction between causal integration and emergence in *A Causal Account of Emergence* (Challoner, 2026). It builds upon *Causal Assembly Theory: Assembly and Disassembly as Causal Processes* (Challoner, 2026), especially the concepts of physical transfer, causal coupling, assembly boundaries and maintained causal capabilities. Related concepts include transfer internalisation, transfer mediation, capability suppression and causal levels.

© John A Challoner, 2026.

Practical Exercise

Consider three cases not used in the examples above.

(a) In a hospital, a patient's test result is passed from a laboratory to a ward through a shared electronic record.
(b) A group of musicians follows a conductor's gestures rather than responding directly to one another.
(c) A bicycle's braking mechanism prevents a wheel from rotating freely.

For each case, identify the participating components and the physical transfers between them, including any physically embodied information. Draw an assembly boundary and decide which transfers are internal and which cross that boundary. Explain whether a transfer is mediated, an existing capability is suppressed, or another change has occurred. Finally, propose what additional evidence would be needed to establish whether the organisation has created a genuinely emergent capability.

© John A Challoner, 2026.