Minimal Traces in Episodic Memory

A case study: the madeleine-memory

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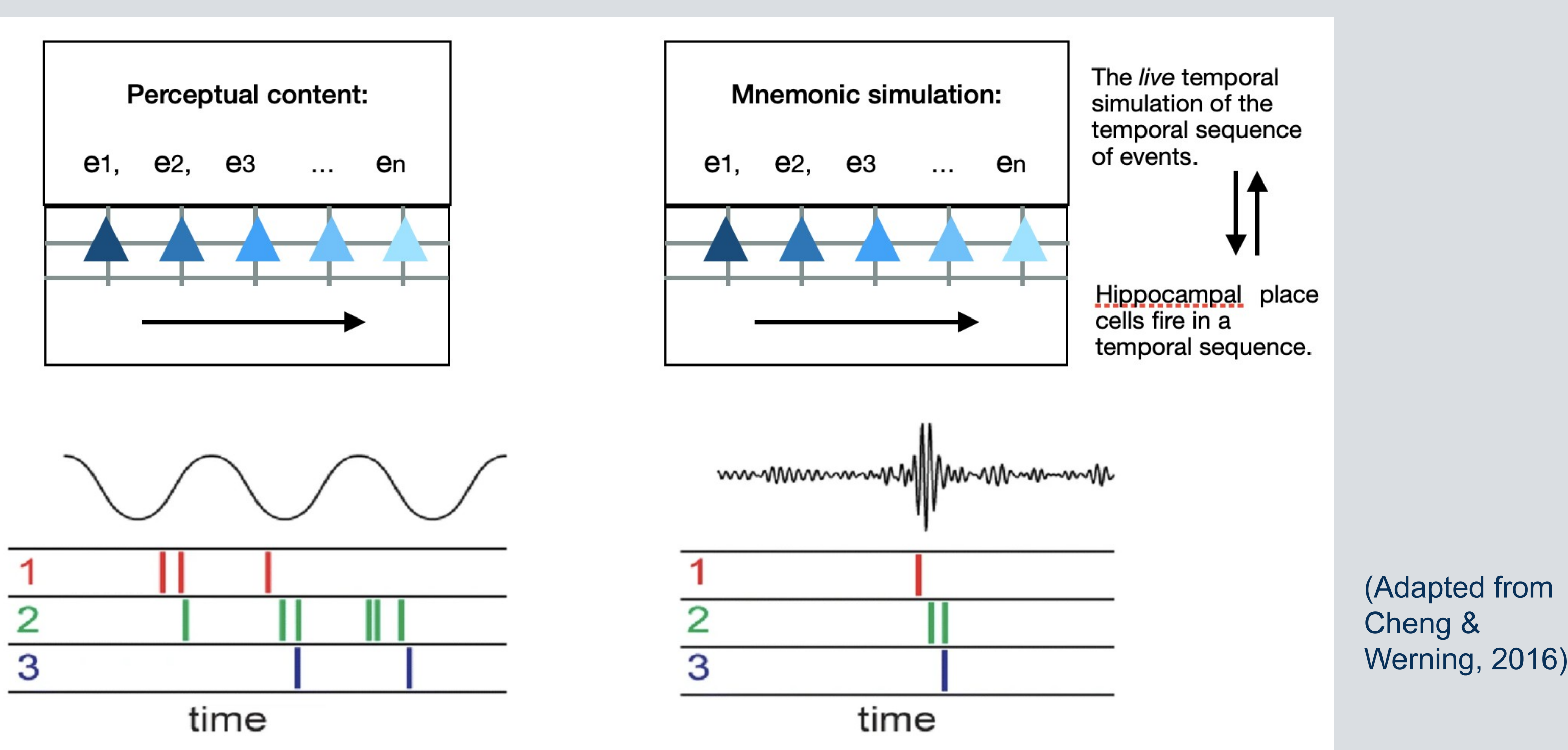### Department of Philosophy - Ruhr University of Bochum

This poster aims to present:
1. episodic memory as a temporal simulation of a sequence of events;
2. the content of episodic memory as a compositional result of a prediction;
3. the madeleine-memory as a case study: both as a live simulation and as a prediction starting from fragmented information;
4. potential future studies on sensory and mnemonic gist.

1. Temporal Sequence in Episodic Memory

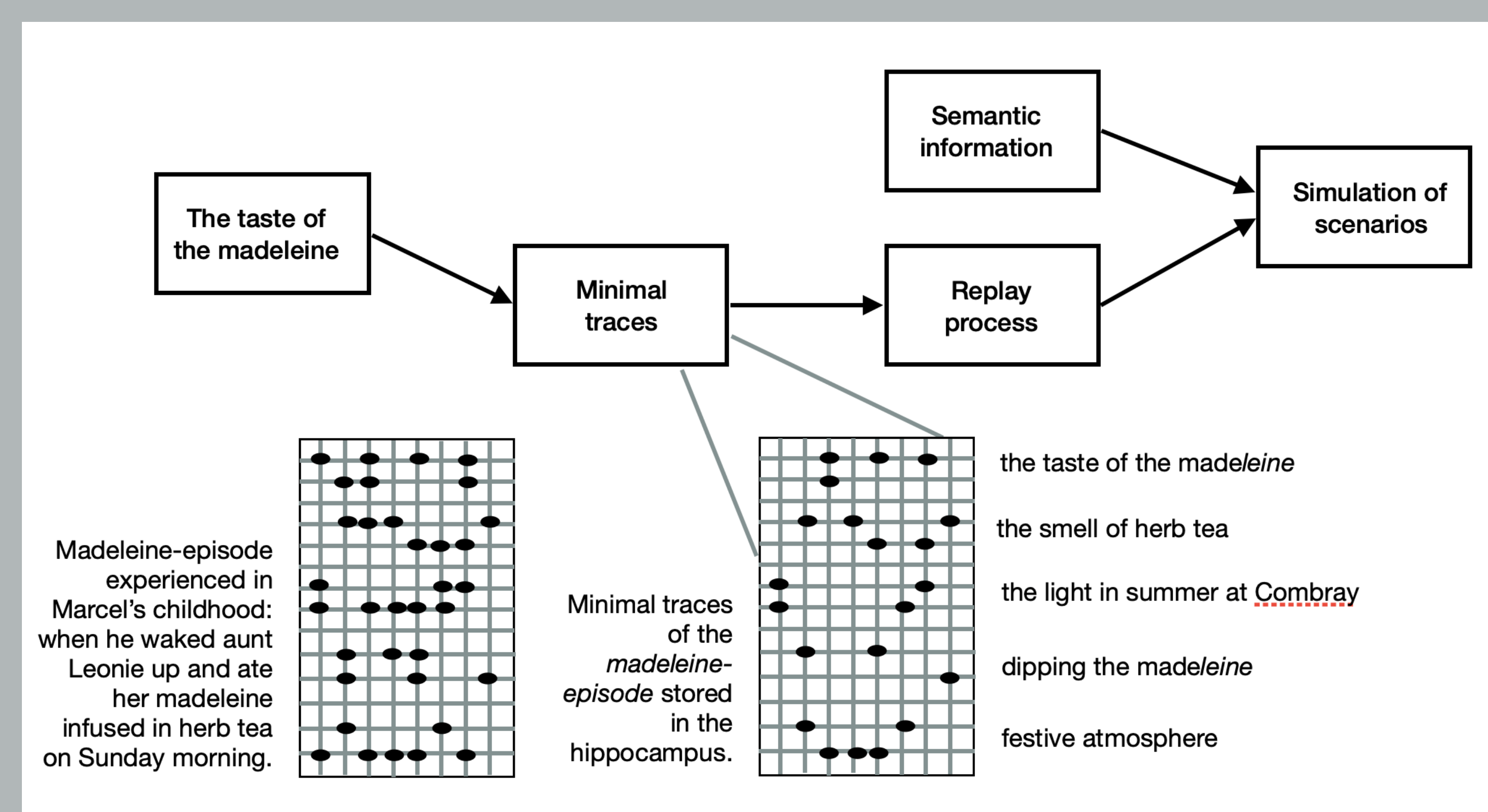Cheng and Werning (2016) proposed a new account, called Sequence Analysis of Episodic Memory.
- The mnemonic content E consists of a temporal succession of events <e1, e2, e3... en>;
- In encoding, the sequence <e1, e2, e3... en> is aligned with sequential firing hippocampal place cells;
- In retrieval, there is a replay of the sequential firing of hippocampal place cells that project into the neocortex;
- A simulation of a scenario is generated by combining informational fragments of the episodic memory trace with statistical semantic information, encoded in the weight of synaptic neocortical connections;
- The neuronal activation patterns so produced may differ from the scenario of the first experience (Cheng, Werning, Suddendorf 2016).

(Adapted from Cheng & Werning, 2016)

2. Predicting the past from Minimal Traces

In analogy to the predictive processing framework of perception, the compositional content of constructed episodic scenarios is the result of a top-down prediction which receives a error-signal from minimal traces - fragmentary neural information without representational content (Werning 2020).
- In perception, the neo-cortex predicts the present on the basis of sparse sensory information - processed in ultra-short-term memory - combining them with the statistical regularities.
- **In remembering, the brain predicts the past**: sparse causal-informational traces - located in hippocampal place cells - are combined with the learned statistical regularities encoded in the weights of neocortical synaptic connections. The neocortex stores those "semantic information on general probabilistic correlation" of the past.
- These statistical correlations are learned throughout a lifetime and stored by the semantic memory: it would be "redundant to store each of the mutual features of the correlations in memory traces".

(From Werning, 2020)

3. A case study: the madeleine-memory

Within phenomenological philosophy, Righetti (submitted) has investigated the role of the bodily dimension in the *madeleine*-memory through the analysis of inner-time consciousness. The phenomena which fall under this evocative notion are the episodic memories that need a bodily stimulus in order to consciously produce their episodic scenario.
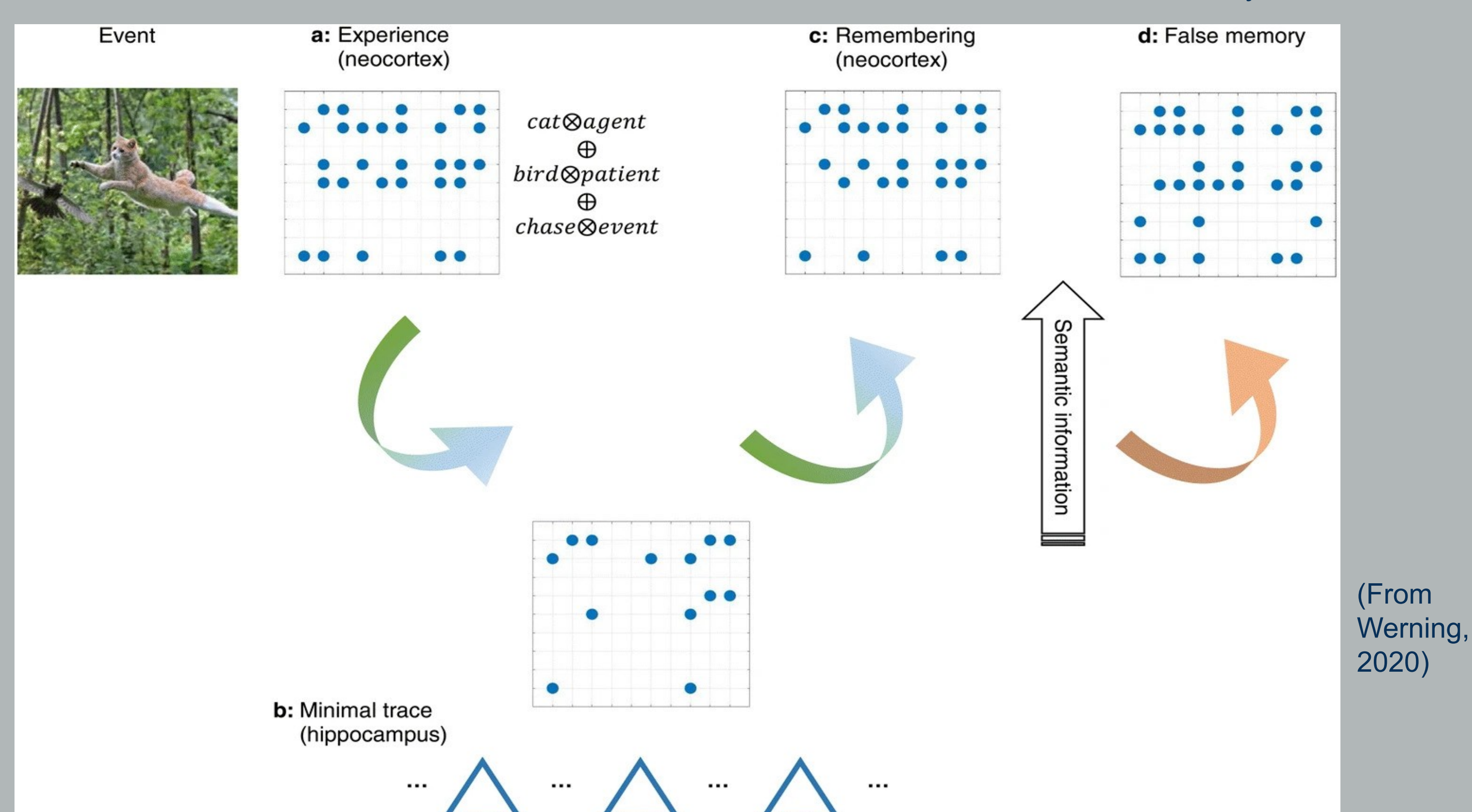- These complex phenomena involve more than only the mere semantic dimension, but rather also the **embodied aspects**, such as actions, emotions and proprioception, of which the subject remains only pre-reflectively aware.
- This results in re-*living* a temporal-endured episodic scenario. The taste of the madeleine activates minimal traces and leads to a prediction of the past based on non-categorial information:
  1) The sensory cue triggers the hippocampal memory traces;
  2) A replay of sequentially firing hippocampal place cells projects into the neocortex. (Werning 2020).
  3) When Marcel (the protagonist) remembers, a simulation of a past scenario is generated, predicting the past episode by combing the minimal trace with semantic information.
- Importantly, in the case of the madeleine-memory, the **minimal memory traces concern also the complex experiences of the** *corps vivant* (Merleau-Ponty, 2012; for instance, the room atmosphere and the emotional attitude).

4. Future research

Comparative analyses between the theory of predictive processing and phenomenology of inner-time consciousness have already shown to be fruitful. In details, Wiese (2017) provides an analysis of the retentional model of temporal consciousness, by combining Grush's trajectory estimation model (TEM) with the features of hierarchical predictive processing models. In addition to the study on the perception of temporal endured objects or events, we propose further investigations on:

- Explaining the difference between remembering and perceiving with regards to phenomenal aspects;
- Investigating the roles of the third- and first-person perspectives in episodic memory; and its difference with perceptive phenomena.

We expect that collaborative research between traces minimalism, the theory of predictive processing and the phenomenology of inner-time consciousness have the potential to lead to new findings in this direction.

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Acknowledgements

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