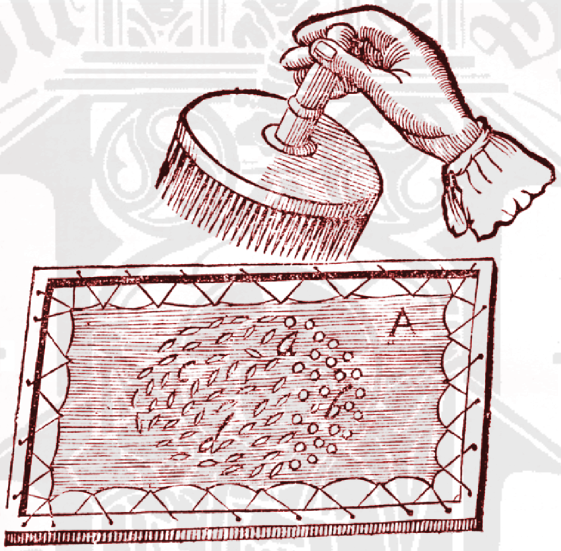
PHYSIKALISCHES KOLLOQUIUM

AM 30. MAI 2022 UM 17 UHR C.T.

IM GROßEN HÖRSAAL

THOUGHT EXPERIMENTS IN BRAIN RESEARCH



Associative memory. Illustration by René Descartes (1596–1650), L'Homme, published 1677

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Our thinking organ is a mind-bogglingly large network that uses electrochemical and molecular procedures to process information. Experimental methods are not yet powerful enough to simultaneously observe all the entangled processes that occur in this organ. And even if the molecular and cellular phenomena underlying a thought could all be recorded existing statistical methods would fail in the task of deducing how the whole thing works from these complex data alone. Theory helps sort out phenomena, understand mechanisms of action, and organize new experiments. Developing a theory that stands up to experimental scrutiny is the most important collective goal of brain research. However, there is currently no generally accepted "brain theory" in this sense, and this is why empirical research is so ramified and diverse. On the way to such a theory, the already known pieces of the puzzle have to be put together in a meaningful way. My thought experiments have exactly that in mind. No new measurements on humans, animals or cell cultures, but an attempt to combine what is known and think ahead. The potential and the problems of a possible new theory then become apparent. In my talk, I will address two central questions of brain research: "Who pulls the strings in the brain?" and "How do thoughts arise in a network?" An empirically based answer to these two questions will undoubtedly occupy legions of brain researchers for several decades to come. Recent developments in the theory of self-organizing dynamical graphs [3-6], however, offer a promising framework for analyzing and understanding the surprisingly high volatility of brain networks observed in long-term experiments with two-photon imaging [1-2].

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[2] Caroni P, Donato F, Muller D. Nature Reviews Neuroscience 13(7): 478-490, 2012
[3] Gallinaro JV, Rotter S. Scientific Reports 8: 3754, 2018
[4] Lu H, Gallinaro J, Rotter S. Network Neuroscience 3(4): 924-943, 2019
[5] Gallinaro J, Gašparović N, Rotter S. PLOS Computational Biology 18(2): e1009836, 2022
[6] Lu H, Gallinaro JV, Normann C, Rotter S, Yalçın I. Cerebral Cortex 32(8): 1574-1592, 2022