Hydrodynamics of writing with ink

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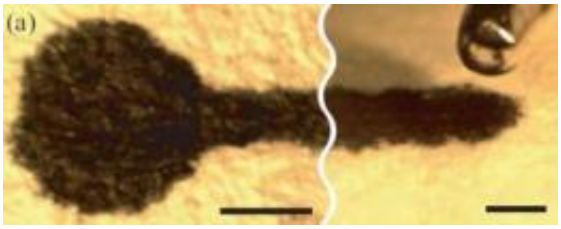

New research is quantifying the dynamics of flowing ink using a combination of experiment and theory. Credit: Jungchul Kim, Myoung-Woon Moon, Kwang-Ryeol Lee, L. Mahadevan, and Ho-Young Kim; *Physical Review Letters* (forthcoming)

For millennia, writing has been the preferred way to convey information and knowledge from one generation to another. We first developed the ability to write on clay tablets with a point, and then settled on a reed pen, as preserved from 3000 BC in Egypt when it was used with papyrus.

This device consisted of a hollow straw that served as an ink reservoir and allowed ink to flow to its tip by capillary action.

A quill pen using a similar mechanism served as the instrument of choice for scholars in medieval times, while modern times have seen the evolution of variants of these early writing instruments to a nib pen, a ballpoint pen, and a roller ball pen. However, the fundamental action of the pen, to deliver liquid ink to an absorbent surface has remained

unchanged for five thousand years.

Writing with ink involves the supply of liquid from a pen on to a porous hydrophilic solid surface, paper.

The resulting line width depends on the pen speed and the physicochemical properties of the ink and of paper. Here we quantify the dynamics of this process using a combination of experiment and theory. Our experiments are carried out using a minimal pen: a long narrow tube that serves as a reservoir of liquid, which can write on a model of paper: a hydrophilic micropillar array.

A minimal theory for the rate of wicking or spreading of the liquid is given by balancing capillary force that drives the liquid flow and viscous force exerted by the substrate. This allows us to quantitatively predict the shape of the front and the width of the line laid out by the pen, the results corroborated by experiments.

More information: Jungchul Kim, Myoung-Woon Moon, Kwang-Ryeol Lee, L. Mahadevan, and Ho-Young Kim, *Physical Review Letters* (forthcoming)

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