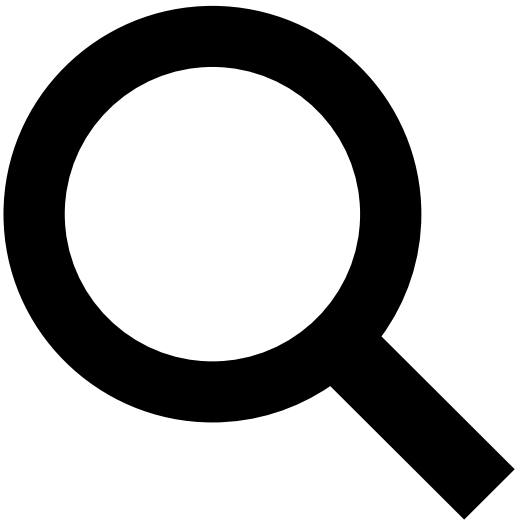
How can we count? Where does our arithmetic capacity come from? A lot of progress has been made on this question, thanks, in no small part, to the work of cognitive scientists like Susan Carey and Stanislas Dehaene. The picture that emerges from this kind of work looks something like this: many animals are equipped with crude but roughly efficient devices that help them estimate quantities. Those devices are ready for use, they require very little in the way of cultural fine-tuning. In addition to that, we can try and track discrete quantities (those expressed by numbers) and make operations on them, but this capacity is woefully limited, and it requires a lot of cultural input to really get off the ground.

This post is not about that theory ; it is about how lovely these theories, and the field as a whole, have become – how subtle, how nuanced, how specific if you compare it with the clumsy nativism and blunt blank-slateism that used to rule over the psychology and philosophy of counting. There was a time when believing in innate constraints on thought meant being a devotee of Immanuel Kant. There was a time, oh you spoiled twenty-first century reader, when you had to prove the most obvious hypotheses against the dogmas of associationism. In thosed days, people thought of cognitive faculties as general competences, unconstrained by anything, independent of modalities, built by general associative learning alone. Yes, ours is a lucky time to read psychology in.

Now, if you are not yet about to send a thank-you email to the closest psychologist of arithmetic in your area, here is a story to nudge you. It involves Francis Galton and his nostrils.



Sir Francis Galton

I just stumbled upon this paper where Francis Galton (genius statistician, Victorian know-it-all, or mad scientist subject to technocratic temptations, depending on where you look at him from) explains how he learnt to count in the olfactory modality, by associating smells with quantities. Never was so deep a faith in the powers of associative learning professed while putting brass tubes into one's nostrils.

"It seems worth while to put a few simple experiments on record, which I made for my own satisfaction a few months ago, in order to assure myself that arithmetic may be performed by the sole medium of imaginary smells, just as by imaginary figures or sounds. I had first to familiarize myself with a variety of scents, for which purpose the following arrangement was provided. Each scent was poured profusely upon cotton wool, loosely packed in a brass tube 8/4 inch in outside diameter, which had a noozle at one side of its ends. The other wide-open end of the brass tube was stopped with a cork. Whenever the tubing is grasped by the hand, a whiff of scented air is forced through the nozzle and passing through the wool becomes impregnated with scent. (…) I begin by breathing out slowly through the nose, to prevent any scent from being prematurely perceived; in the mean time the nozzle is brought below the nostrils. Then I simultaneously give a sudden grasp and a sudden sniff up. A separate apparatus is used for each scent. They are made as alike as possible, and are scarcely distinguishable; nevertheless it is well to operate with the eyes shut. The scents chieffly used were peppermint, camphor, carbolic acid, ammonia and aniseed. I taught myself to associate two whiffs of peppermint with two wiffs of camphor; three of peppermint with one of carbolic acid, and so on. Next, I practised at some small sums in addition; at first with the scents themselves, and afterwards altogether with the imagination of them.

There was not the slightest difficulty in banishing all visual and auditory images from the mind. In this way, without, it is true, becoming very apt at the process, I convinced myself of the possibility of doing sums in simple addition with considerable speed and accuracy solely by means of imaginary scents. Further than this I did not go, so far as addition was concerned. It seemed a serious waste of time to continue the experiments further, because their difficulty and complexity increased. (…) Few persons appreciate the severity of the task imposed on children in making them learn the multiplication table, with its 81 pairs of value each associated with the third value. No wonder they puzzle over it for months, notwithstanding the remarkable receptivity of their fresh brains. I did not attempt multiplication by smell.

Subtraction succeeded as well as addition. I did not go so far as to associate separate scents with the attitudes of mind severally appropriate to subtraction and addition, but determined by my ordinary mental processes which attitude to assume, before isolating myself in the world of scents.

Few experiments were made with taste. Salt, sugar, citric acid, and quinine seemed suitable for the purpose, and there appeared to be little difficulty in carrying on the experiments to a sufficient extent to show that arithmetic by taste was as feasible as arithmetic by smell"

(Psychological Review, 1, pp.61-2 – 1894)

The image of Galton fumbling about for the Peppermint tube, eyes closed, and managing to grasp it, having banished all visual images from his mind all the while, is quite irresistible to me. Notice also the pains he takes to "think" in smell alone, while he knows he will have to revert to his usual thought processes for thinking about addition. I couldn't help daydreaming of a dystopian, psychedelic steampunk Britain where Galton would have every child learn their maths by sniffing test tubes full of patchouli.

Still, this piece poses some interesting questions about arithmetic – in particular the extent to which it is modality-independent. I think most people would agree that it is not rigidly tied to any modality – but still, some modalities, like smell and taste, seem much less fit than others to grasp discrete quantities (this is my intuition ; Galton, obviously, disagreed). We seem to be able to think of numbers independently of vision, audition or touch – but what would happen (pure supposition) if all we had were sensory modalities incapable of representing quantities as discrete? Would we still

retain some rudimentary number sense? Would we be able to acquire one? Could you imagine a species or a culture where arithmetic would depend on smell – and if not, why?

Also, notice the way Galton claims to represent numbers in one modality (smell), but the operations (addition or substraction) in some other, unmentioned way. It seems completely implausible to me, but why exactly?

Ideas, anyone?