

Openness guides discovery



Funding agencies, host institutions and thesis committees require scientists to design elaborate research plans that are expected to guide a project's progress years into the future. But such agendas are at odds with the inherent unpredictability of the scientific discovery process. Indeed, when we look back on our own completed projects, the unanticipated twists and turns are typically what is most noteworthy. We have seen new questions emerge from unexpected findings or from an evolution in our thinking, sometimes even changing a project's entire goal. Insights from other scientists prompted us to look in new directions. Many of our investigations turned out to be fruitless, which forced us to abandon the planned linear process (Fig. 1a) and instead trace back and branch out in alternative directions (Fig. 1b).

In reality, research projects grow through an evolutionary process. Variation – the substrate of evolution – is provided through the emergence of new questions and avenues of investigation. The research team must then choose which directions to pursue, a process akin to natural selection¹. Along with this evolution at the macro-scale, a much more orderly process is required at the micro-scale. Within each step, thoughtful study design leads to robust experiments and analyses. This complementarity between evolution and design best encapsulates the process of discovery: in 'night science' we evolve ideas for the next step, while 'day science' tests them².

A project's evolutionary history is generally obscured in the resulting scientific publication. The publication's function is to justify and communicate the project's main results; it is not a historical account. Instead of recounting all of the project's dried-up branches, publications zoom in on a single lineage in its evolution: the steps that led to the most interesting result (Fig. 1c). Publications typically describe the discovery as it ideally should have happened, reporting only the evidence relevant to the proposed claims³.

While publications create the illusion of a closed and focused development, an attitude of openness is key in the actual making of a discovery. Psychologists use five dimensions to map human personality: extraversion (enthusiasm, assertiveness), agreeableness

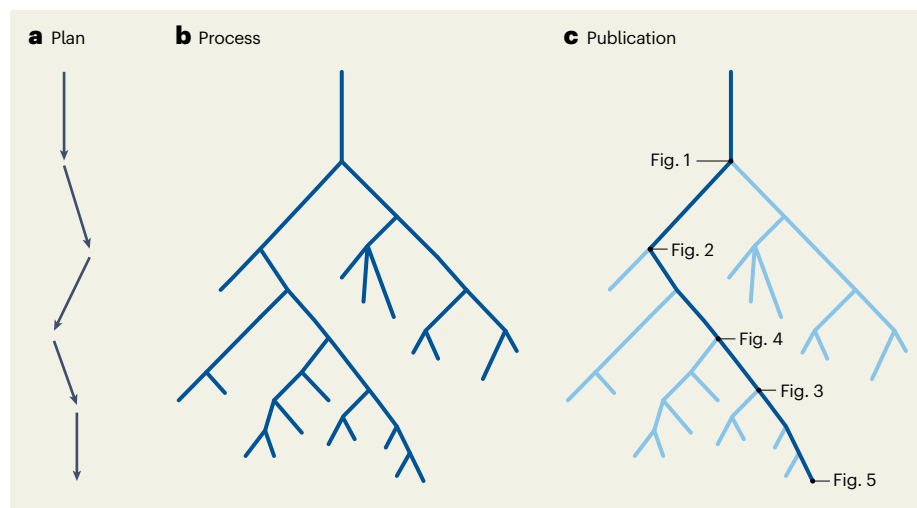


Fig. 1 | Project design and evolution. a, Project plan. b, Actual process. c, Publication.

(compassion, politeness), conscientiousness (industriousness, orderliness), neuroticism (withdrawal, volatility) and openness to experience (openness, intellect)^{4,5}. Of these, only openness is consistently correlated with a wide range of creativity measures⁶. Moreover, openness to experience is associated with increased scientific creativity and research performance^{7,8}. Luckily, openness to experience is not only a personality trait, but also a skill we can cultivate^{9,10}.

Science requires us to be open: we constantly need to follow the data, to branch out in new directions. A need for openness is shared by any creative profession. For example, the novelist Stephen King describes how he focuses on situations rather than preconceived plots, allowing his characters to take the narrative in unexpected directions¹¹. Openness allows creative endeavors to evolve. When one hears new ideas, being open means asking, "How could this idea contribute to the project?" By contrast, secrecy tends to stifle a project's progress.

Every project needs a guide who takes responsibility for navigating its evolution. Collaborating on the project with a trusted co-worker – a science companion – facilitates idea generation and refinement¹². But to expose the project to a variety of perspectives, the guide must engage with a wider range of colleagues, actively seeking out colleagues who might be able to contribute ideas or tools –

not only when the project has hit a roadblock but also when it is going well. Exciting new connections and possibilities often emerge from unexpected places that can be explored when the guide has a 'growth mindset'¹⁰.

To own a project, we need to be open. We do not need to have all the ideas. To let the project evolve, we must shift our focus to the project's perspective. What does the project need? Who else might be able to contribute? A science project is akin to the 'Stone Soup' folk story: a guide comes into a village with little more than a stone and convinces each villager to contribute something to the emerging soup, thereby benefiting everyone involved.

As the project's guide, we decide which ideas to follow and which to set aside. If we are too narrow, the project lacks the freedom to evolve. But if we are too lenient, an excess of competing directions can spiral into chaos. Learning to find the right balance between these extremes is one of the greatest joys in science. To paraphrase Dwight D. Eisenhower's aphorism: in research, planning is indispensable, but detailed plans are useless.

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Competing interests

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