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Preface

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The reasons that drive individuals to develop new technologies and to disseminate them in new products and processes, and the capacity to develop original solutions to technological problems, can be analysed with the concepts typical of individual and social cognitive psychology. Various aspects of cognitive activity address innovation. In particular, the capacity to grasp the latent questions and needs of the market that lies behind the possibility to identify opportunities for new products or services; the means of generating solutions that can respond effectively to the realisation of these new opportunities; problem solving processes in the identification of new procedures that underpin process inventions and new manufacturing techniques; the risk of innovative behaviour and the contexts that can favour a greater or lesser propensity to develop innovative solutions. The best historical example of the two stages of the identification of the problem/opportunity and the generation of a solution is that of Jozsef Biro, the inventor of the ballpoint pen. As a journalist, he considered the fountain pens of the early twentieth century inadequate for his work. As he watched some children in Buenos Aires playing with marbles on the wet tarmac, he noticed that these left a trail on the ground as they rolled. Reasoning by analogy, he had the idea of a sphere that could guide the ink inside a pen. He patented the idea, which was developed and led to the creation of the ballpoint pen. Individual and social cognitive psychology is able to study the various stages of an innovative process. Creativity and problem solving are not the only possible subjects of cognitive analysis, so is the more socio-economic dimension, like the reasons that make a new product an innovation, because they manage to satisfy latent needs; the cognitive mechanisms of comprehension, acceptance and choice of a new product; the propensity to innovate, seen in the light of the representation of the risk and the decision-making activity of the innovating agent, etc. The dynamics of innovation can be explained through the reasoning,

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judgement and decision-making mechanisms of individuals in their position as generators of invention or as consumers of the same. They are the only causal agents of innovation.

We can compare this "enlarged" version of the cognitive explanation of innovation with a "limited" version. Cognitive psychology can help us to understand problem solving activities that set out to adapt a traditional solution to new context. For example, building a railway in a new geographical area or adapting a new metal alloy to the requirements of a car body. It is more difficult for psychology to tackle the empirical analysis of absolute creativity, i.e. thinking of or creating something that had not been thought of or created before, and that represents an innovation. Because these acts are unrepeatable and difficult to monitor in real time, the only sources of information are the diaries, biographies and stories of the inventors. This is the *historical-ideographic* method that has allowed some psychologists, like Howard Gardner, to identify various types of intelligence, by studying famous creative minds like Einstein or Freud, and to characterise creativity as an anomalous idea that tries to impose itself on the prevailing knowledge in a given cognitive domain that is controlled by a given group of peers. There are other important ways of studying creativity. The *psychometric* method tries to extrapolate the personological or intellectual factors linked to creativity from the common man. Correlations have been found with personality traits like independent judgement, the attraction of complexity, aesthetic orientation, interest in new experiences and readiness to accept risk. Finally, the *cognitive* approach, as such, which studies creative capability in problems that are not part of real life, but designed to be submitted to persons in a condition of experimental control. The solution to a problem is developed by breaking it down into two stages: the representation of the problem and its solution. The first stage is crucial for the good outcome of the second. If we represent a problem incorrectly the solution will also be less than optimal. For example, if we add extraneous premises, concentrate on an irrelevant part of the problem or classify it as an example of another, superficially similar type of problem that has a different structure, we risk developing solutions that are not creative, if not misleading. Once the problem has been represented, a solution is found by applying various mental procedures, also known as heuristics, which can speed the process up but can also lead to a dead end. For example, when we are searching for the fastest road to a solution (the "hill climbing" heuristic) we can sometimes end up in a cul-de-sac. For example, by analogy, a mountaineer who wants to climb a mountain using the steepest slopes, but finds himself on a secondary peak. Instead of following a more rational strategy that also envisages some descents, if they help him to reach his goal. "One step forward and two steps back" is occasionally a better choice to reach a solution, but our short-sightedness, lack of vision and mental laziness often hold us back. One characteristic of more innovative thinkers is the way they overcome traditional thought processes by the creative use of analogy. They transfer solutions to problems from other domains to the one they are examining. For example, Charles Darwin was inspired by the analogy of the artificial selection procedures used by British farmers to develop his theory of natural selection. And Herbert Simon et al. referred to the human problem-solving process to develop the first computerised artificial intelligence programs.

The propensity to develop a creative idea and to translate it into inventions and subsequently into productive innovations is an eminently psychological phenomenon, which seems to correspond to a particular functional architecture of the brain. The right hemisphere seems to underpin creative thought in the artistic and scientific field. It governs the neuronal correlations of divergent thought, propensity to risk, curiosity and metaphorical thought. However, the cerebral base alone cannot explain an individual's propensity to develop creativity for technological and innovative purposes. In fact, it has its motivational premises in a number of values and principles contained in our long-term memory and learned through social interaction.