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Introduction

Unveiling the Lady in Black: Modeling and aiding intuition

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ABSTRACT

The cognitive and decision science literature on modeling and aiding intuitions in organizations is rich, but segregated. This special issue offers a sample of that literature, stimulating exchange and inspiring intuitions about intuition. A total of 16 articles bring together diverse approaches, such as naturalistic-decision-making, heuristics-and-biases, dual-processes, ACT-R, CLARION, Brunswikian, and Quantum-Probability-Theory, many of them co-authored by their founders. The articles cover computational models and verbal theories; experimental and observational work; laboratory and naturalistic research. Comprising various domains, such as consulting, investment, law, police, and morality, the articles relate intuition to implicit cognition, emotions, scope insensitivity, expertise, and representative experimental design. In this article, we map intuition across poles such as Enlightenment/Romanticism, reason/emotion, objectivity/subjectivity, inferences/qualia, Taylorism/universal scholarship, System 2/System 1, dichotomies/dialectics, and science/art. We discuss intuitions as inspirations, instincts, inferences, and insights. Finally, we review the contributions to this special issue, placing them into historical, philosophical, and societal contexts.

"Oh lady lend your hand," I cried,
"Oh let me rest here at your side."
"Have faith and trust in me," she said
and filled my heart with life.
"There is no strength in numbers.
Have no such misconception.
But when you need me be assured I won't be far away."
(Lady in Black, Uriah Heep, Songtext)

Die Farben sind Taten des Lichts, Taten und Leiden.
The colors are the deeds of light: what it does and what it endures.
Johann Wolfgang von Goethe (1810), Zur Farbenlehre (Colour Studies), Translation: Miller (2012, p. 106).

The two of us study decision making. When we talk to executives and other senior professionals about decision making, one reaction we often get can be summarized as follows: 'Many of my decisions are based on gut-feelings. Instincts of some sort. Ideally, I know what I need to do, the answer is simply there. For instance, I simply *knew* that we would need to build a new factory. But, I cannot admit that openly. So what do I do? My team and I spend hours to search for facts to back up what I felt I knew all along.' In our experience, typically, it is the middle-management who feels that way. Top executives and managers in family-businesses are more willing to admit that they make decisions based on intuition. But even for them, there are limits to frankness, namely if they can be held accountable at the end of the day in case something goes wrong.

Indeed, the literature, both scientific and popular, is full of anecdotes and stories of people – artists, inventors, engineers, athletes, physicians, managers, mathematicians, teachers, various experts in their respective fields – who report instances where they just knew how to assess a situation, how to decide, how to act, or how to create something. Yet, such "knowing-how" is often hard, if not impossible, to describe and to justify. At the same time, we tend to admire people who seem to have had – in retrospect – good but counterintuitive intuitions, be it in science, business, or in daily life. In short, intuition remains beautifully mysterious; we ambivalently waver between wonder and bewilderment. Most of us encounter – once in a while and more or less secretly – this unknown and elusive, but surprisingly familiar *Lady in Black*.

Intuition, allow us to peak behind your veil! And please take it with a smile if we try to shed some light on you. We know your element is the night and you may not like our torches, beaming

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into the dark – your dark. We apologize. But we are cognitive scientists, we are curious, and we want to learn more about you. At the moment, we do not even know your gender. Do you bear closer resemblance to Michelangelo's beautiful David, or to Leonardo's mysteriously smiling, shadowy Mona Lisa? Maybe you do not even have any gender, even though the two of us would like to believe that you are female – maybe because we trust that there is some wisdom in those languages in which the day is a masculine word (*der Tag*, *le jour*, *el dia*) and the night (*die Nacht*, *la nuit*, *la noche*) is feminine, or simply because we are male, happily married, and deeply admire our better halves. Maybe not seeing you clearly can be described as a mental state of darkness and hence our name for you, Lady in Black, is our own projection into our own darkness. We hope you like the name and we hope you will reward our efforts with our torches by granting us some charming glances from underneath the veil of your mystery.

1. Intuitive and historical accounts of intuition

What is intuition? For us, as researchers, it would be straightforward to screen the answers given in the scientific literature, provide an overview of theoretical accounts of intuition and of methodological approaches to study it, and then to use this overview as a context for the articles that we assembled in this special issue. Had we proceeded this way, this would have been a standard introduction – not much different from other introductions to other special issues or edited books. We started this way, but at some point we felt that something important might be missing: the Lady in Black.

Francis Bacon (1622/1938) provided a roadmap for the human species. *Where do we come from?* Kicked out of Paradise. *Where are we now?* Left alone, standing on our own. *Where do we go?* Unable to return to God's paradise, we only have one option: create our own paradise – the *Novum Atlantis* (which also provided the title of his book). *How to do this?* Torture nature so that it reveals its secrets (an enterprise called science) and use this knowledge (an enterprise called technology) to survive and, eventually, also to have a comfortable life on earth. *Could this program also be applied to intuition?* Tricky. We dig a few knives into it, and once we know its secrets, this knowledge aids us to live and thrive? Alas, what if intuition is not just another "object" – another "it" – out there in nature with organs that could be laid out on a dissection table? Or that could be moved into a brain scanner? Perhaps intuition really is "subject" and "she". And actually, how much can one, possibly, learn when trying to catch intuition in psychological experiments or when attempting to force her into mathematical models?

While scientists walking in Bacon's footsteps may struggle with compelling intuition to reveal *its* secrets, the "ungraspable" may have a closer relationship with artists. To them, *she* actually comes. And there she lends herself to being experienced and transmitted – through paintings and poems, as mediums, for instance. And in contrast to scientists, CEOs and other leaders in society, artists do not need to justify themselves for letting intuition speak in their work, and for how they let her speak.

There is one problem though: The two of us are psychologists, not artists. So back to the dissection table? No. It is important to distinguish between having intuitions on the one hand, and understanding and modeling them on the other. Why should scientists – including those who make intuition their object of study – not also have intuitions? To enhance the chances of having the Lady in Black at our side, as our ghost author when writing the present piece, we tried our best to embrace the mindset of an artist.

Specifically, we did not shy away from reproducing artworks, from weaving metaphors into the text, and from using a style that is quite unusual for a scientific journal – not even from both personalizing and anthropomorphizing the notion of intuition, replacing the "it" with "she" and turning an "object of inquiry" into a "subject". Most importantly, we tried to think out-of-the-box and to adopt a wider perspective. We took towering historical figures, such as Johann Wolfgang von Goethe, the German scientist, poet and writer, or Leonardo da Vinci, the Italian inventor, scientist and painter as stars to look up to and give us direction in our night. There is one difference though: these two were artists and scientists throughout their entire lives – while, for us, the present piece is more like a momentary excursion from the routines of publishing in scientific journals.

Talking about excursions, Goethe is said to have escaped the oppressive rules of courtly life on a trip to Italy where he, after encounters with Italian artwork, received new impulses of utmost importance for his future work, both as scientist and artist. Why don't we do something similar: Make an attempt to escape from our own, isolated, intellectual cave, explore the territory around us, and locate ourselves in broader context? Let us depart on a journey into the *Enlightenment*, *Romanticism*, *Sturm und Drang*, and meet intuition, analysis, science and the contents of this special issue through them.

1.1. Animalistic instincts, divine inspirations and the black-box in the middle

Again, what is intuition? Many would use the term at various, possibly quite diverse occasions. And even though people may have an intuitive understanding of what intuition is, the possible answers they would come up with will certainly show some variance. We would like to structure the following candidate answers by adding another question: "where do our intuitions come from?" Locating objects or concepts, so one might argue in good scientific manner, requires a coordinate system. For the purpose at hand, we would like to draw one that follows from a statement of the Greek philosopher Protagoras (c. 490–c. 420 BC): "*Man is the measure of all things*." Putting us in the middle of our coordinate system, and adopting the convention that animals are below us in a hierarchy spanning from matter to the divine, let us start by looking upwards.

Is intuition a sixth sense, some kind of extrasensory perception, an inner voice through which some supernatural beings – Gods, Angels – speak to us? Note that the Latin word *persona* is composed of *per* and *sonare* – "sounding through". When having intuitions, do we re*sona*te with something that is transcended, that can be conceived as being outside of us, possibly above, and that manages to somehow and mysteriously affect us and to leave some kind of traces or vibrations? According to this conception, a *persona* is a facade, like a theatrical mask as those used in Ancient theatres. In modern terms, one could say that an actor plays a social role or a character, and it is the latter through which the actor, concealed behind the mask, interacts with the world. Take, for instance, Perseus or Dardanos, both sons of Zeus. Without doubt, the Ancient Greek knew what this meant, but how can we, today, make sense of the information that a mythological figure like Perseus or a historical figure like Dardanos is the son of a God? One possibility could be to say that Perseus was more like a *persona*, a mask, and that the real, true and hidden actor, Zeus, was acting through him. Intuition, then, would be Perseus' ability to hear what Zeus wanted him to do, or, to put it another way, Perseus' intuitions were Zeus' orders on how to play on the theatre called human life.

Others may prefer to look in the opposite direction, namely downwards. Is intuition some sort of animalistic instinct – and do animals have intuitions, maybe even better ones than humans? Staying within the animalistic sphere, but allowing this sphere to enter the human kingdom: are intuitions an evolutionary remnant of our reptilian brains, an old but fast track on the neuronal highway? Or are they located in the Freudian unconscious? And how

might these two concepts, the reptilian brain and the Freudian "id", relate to each other?

Note that these two conceptualizations – intuition as an inspiration, an inner voice, possibly of divine origin or as an animalistic instinct – correspond to models of man and to ideas about our origin: the fallen angel versus the dressed ape, respectively. Religiously minded people and Darwinists may resonate with these views, and some engage in intellectual fights with the other party – think of the heated debates, in particular in the U.S., on how evolutionary theory should be taught in schools. Others may be able to integrate them and to embrace both. To challenge all parties a bit, we would like to raise the question of whether or not such conceptions might be just projections, reflecting that there is something we do not know and cannot clearly see? Maybe spatial arrangements do not hold up to scrutiny anyhow: who could say whether our intuitions originate within us, whether they come from outside, and what difference it really makes whether we look upwards or downwards? The conclusion of such a sceptical position might be that intuition is, at the end of the day, nothing more than a catch-all category for everything related to cognition that we cannot explain – bluntly speaking, a label for the black-box.

Wait a minute! Black-box sounds a bit like Lady in Black, doesn't it? We must admit that, being scientists, we feel quite comfortable with adopting a sceptical viewpoint. Scepticism was also Descartes' starting point which later turned out to be the ground on which he built his philosophy. So let us pause for a while, and reflect on the observation that we do not know exactly what intuition is.

1.2. The days of the Enlightenment and the power of analysis

Up to this point, we used many concepts and words that are related to light: day, unveil, night, dark, torches, beaming, reflect, projection, glances, seeing, viewpoint. With black being the absence of light, the black-box and our dear Lady in Black belong to this list as well. We can only see what is in the light, an insight that Berthold Brecht put in the following rhyme: "*Denn die einen sind im Dunkeln; Und die andern sind im Licht; – Und man siehet die im Lichte; Die im Dunkeln sieht man nicht*" (There are some who are in darkness; And the others are in light; – And you see the ones in brightness; Those in darkness drop from sight) (Brecht, 1928/2004). In order to see what is in the dark we need to enlighten it. This holds true for a dark room, but there is also some truth to it at a different level. There is not only sunlight, electric light, or fire light, but, in a metaphorical sense, shedding light on something can also refer to the human capacity to think and to apply reason. Like the physical light, thinking itself seems invisible, but it makes us aware of everything that becomes its object. Using thinking and reasoning to illuminate the world surrounding us was the agenda of the Enlightenment, an era ranging from the 1620s to the 1780s, with famous figures such as René Descartes, John Locke, Baruch Spinoza, Voltaire, David Hume, Immanuel Kant, or Isaac Newton, to name but a few. The Enlightenment's thinkers were in constant intellectual battle with traditional authorities (kings, feudal rulers, and the church) and they emphasized and promoted reason, analysis and individualism.

Let us zoom in on one of their goals and means. Analysis, as a strategy, is ubiquitous and we find it in many domains and disciplines. It amounts to decomposing a larger unit into its pieces, up to the point at which these parts cannot be divided any further. The endpoint of such an endeavor was the in-divisible part, the *individuum* (note that this Latin word is a translation of the Greek *a-tom*). Seen this way, fighting for individualism and the rights of individuals in society and politics (Elias, 1939/1991) and advocating analysis in philosophy and in the sciences are two facets of the same idea.

Fig. 1. Caspar David Friedrich: Man and Women Contemplating the Moon, Alte Nationalgalerie, Berlin, 1835.

Analysis in chemistry means to intentionally separate materials (molecules) into their ingredients or elements (atoms). Analysis in philosophy is a method of presenting complex concepts as compounds of more basic ones. Analysis in decision science means to decompose a decision problem into smaller units: what are the goals, the criteria, the arguments that speak in favor of the various options, the possible consequences, the probabilities of events, the weights that should be attached to certain criteria, and so on. In an historical and often-cited letter, Benjamin Franklin wrote to Joseph Priestly about how he could use an analytic approach to make decisions, possibly the first time that this procedure is explained thoroughly. The idea is to break the complex problem into pieces, put the components, that is the arguments for the two decision options, on a scale to see how they balance out in what Franklin called "moral or prudential algebra" (for the complete letter, see Gigerenzer & Goldstein, 1999, p. 76).

1.3. Hymns to the night: Romanticism, feelings, and the mysterious

The age of the Enlightenment gave way to Romanticism, which originated in Europe at the end of the 18th century and spanned until the 1850s. While figures of the Enlightenment pushed for reasoning and analysis, and wanted to spread the light, so to speak, the Romanticists embraced the twilight and the night. For them, the dark was not a scary place that one should better enlighten with the light that is coming from within, but a place where something else which they found inside could flourish and grow. One of the artists of this period was Caspar David Friedrich (1774–1840). His paintings typically show nature with wide horizons, often foggy, often full moon nights, and they express longing and mystery. This is not nature as an object of scientific analysis, but nature as our origin (note that the Latin root of nature is "to give birth") to which we are mysteriously connected and ache to return to at some point. The paintings of Romanticism do not capture an objective reality, but instead one of subjective and romantic feelings that emerge from the inside, like sentiments that belong to and complement nebulous but awe-inspiring landscapes. Maybe our intuitions can be seen as corresponding to this deeply hidden part within ourselves, possibly originating there? A picture is worth a thousand words: Fig. 1 shows how mysterious the world appears when seen by someone who embraced the mystery within himself. Was Caspar David Friedrich the painter, or was he a *persona* through which our Lady in Black unveiled herself?

The Romantic *Zeitgeist* also left traces in the literature of that time period. Probably one of most representative poems from this era is *Hymns to the Night* by Novalis (1772–1801) – a drawing made out of a few letters that transmit more than a thousand words of intellectual reflections about what the night may mean for us, psychologically. Perhaps our Lady in Black was a hidden co-author back then, in 1800?

> *Before all the wondrous shows of the widespread space around him, what living, sentient thing loves not the all-joyous light – with its colors, its rays and undulations, its gentle omnipresence in the form of the wakening Day? The giant-world of the unresting constellations inhales it as the innermost soul of life, and floats dancing in its blue flood – the sparkling, ever-tranquil stone, the thoughtful, imbibing plant, and the wild, burning multiform beast inhales it – but more than all, the lordly stranger with the sense-filled eyes, the swaying walk, and the sweetly closed, melodious lips. Like a king over earthly nature, it rouses every force to countless transformations, binds and unbinds innumerable alliances, hangs its heavenly form around every earthly substance. – Its presence alone reveals the marvelous splendor of the kingdoms of the world.*
>
> *Aside I turn to the holy, unspeakable, mysterious Night. Afar lies the world – sunk in a deep grave – waste and lonely is its place. In the chords of the bosom blows a deep sadness. I am ready to sink away in drops of dew, and mingle with the ashes. – The distances of memory, the wishes of youth, the dreams of childhood, the brief joys and vain hopes of a whole long life, arise in gray garments, like an evening vapor after the sunset. In other regions the light has pitched its joyous tents. What if it should never return to its children, who wait for it with the faith of innocence?*
>
> *What springs up all at once so sweetly boding in my heart, and stills the soft air of sadness? Dost thou also take a pleasure in us, dark Night? What holdest thou under thy mantle, that with hidden power affects my soul? Precious balm drips from thy hand out of its bundle of poppies. Thou upliftest the heavy-laden wings of the soul. Darkly and inexpressibly are we moved – joy-startled, I see a grave face that, tender and worshipful, inclines toward me, and, amid manifold entangled locks, reveals the youthful loveliness of the Mother. How poor and childish a thing seems to me now the Light – how joyous and welcome the departure of the day – because the Night turns away from thee thy servants, you now strew in the gulfs of space those flashing globes, to proclaim thy omnipotence – thy return – in seasons of thy absence.*
>
> *More heavenly than those glittering stars we hold the eternal eyes which the Night hath opened within us. Farther they see than the palest of those countless hosts – needing no aid from the light, they penetrate the depths of a loving soul – that fills a loftier region with bliss ineffable. Glory to the queen of the world, to the great prophet of the holier worlds, to the guardian of blissful love – she sends thee to me – thou tenderly beloved – the gracious sun of the Night, – now am I awake – for now am I thine and mine – thou hast made me know the Night – made of me a man – consume with spirit-fire my body, that I, turned to finer air, may mingle more closely with thee, and then our bridal night endure forever. (Novalis, 1800/1992; see also http://logopoeia.com/novalis/hymns.html)*

Romanticism was like a contrast program to the Enlightenment, like the other pole of a swinging pendulum. And it was not alone. "*Le cœur a ses raisons que la raison ne connaît.*" ("*The heart has its reasons that reason knows nothing of*" or, in a related formulation,"*we know the truth not only by the reason, but by the heart*".) Even though Blaise Pascal is usually seen as a figure of Rationalism, with this quote, so one might be led to believe (rightly or wrongly) he explicitly limits the realm of reason and rationality. In fact, in Western culture, most people would locate our intuition rather in the heart than in the brain. And even though possibly most people would agree that deliberate reasoning, analysis, and "cold" information processing is something humans do, they would add and insist that there is more to being human.

Take, for instance, *Mr. Spock* of the American *Star Trek* series. He is the personification of rationality; he uses logic to override any emotion in an effort to control his feelings so that they do not control him. Interestingly, he has non-human origins; his father comes from the planet Vulcan. Of course, Mr. Spock and this planet are fictions, but the minds of the scriptwriters are real and they convey a message that reflects and shapes the folk theory of millions of people who have watched this series: Emotions make us human – suppressing them and functioning like a computer would be seen as degradation.

Mr. Spock can be contrasted with another fictitious figure: *Young Werther*, the main character of a drama of Goethe, published in 1774. Werther is full of emotions, feelings, and sentiments. In particular, he is overwhelmed by his love and torment, and is not able to cope with them and to gain control. He cannot distance himself from his inner turbulences with a cold and rational mindset. He lacks what Mr. Spock has and vice versa. In the last act of the drama, he commits suicide – which led to great irritations and disturbances in the society of the time. *The Sorrows of Young Werther* can be situated in the German literacy movement known as *Sturm und Drang* (Storm and Stress) that took place from the late 1760s to the early 1780s. Both this movement and Romanticism were united in that they exalted nature and feelings and sought to overthrow Enlightenment's cult of rationality.

2. Analysis versus intuition today

The eminent figures of the Enlightenment, Romanticism and other epochs are no longer with us, but much of their ideas and artwork found their ways through the centuries and can speak to our thinking and feelings. Even more importantly, they shaped our worldviews, technologies, and institutions. In this sense, we stand on the shoulders of giants – whether we are aware of it or not – and the past is still alive. We will, in what follows, turn to a handful of these echoes of the past.

2.1. The culture of objectivity and the fight against subjectivity

This section heading is inspired by the titles of two publications. In "The culture of objectivity: Quantification, uncertainty, and the evaluation of risk at NASA", Feldman (2004) analyses the events that led to the explosion of the Challenger shuttle on January 28, 1986. Feldman traces the disaster back to a conflict between engineers at Morton Thiokol, the supplier of the shuttle's rocket boosters, and the organizational culture in which these engineers were operating, both at their own company and at NASA. The engineers felt that it was too cold on that morning of January 28 and hence too risky to launch. The problem was that they could not present sufficient data to back up their judgment, simply because there had not been a launch at such an exceptionally low temperature before. The shuttle stood at the ramp, fully tanked, the start had already been delayed, and if they would not start on that day, the window of opportunity would close – in short, stakes and pressure to launch were high. The engineers' seemingly subjective assessments, call them intuitions, did not get enough weight in what Feldman called "the culture of objectivity". The shuttle was launched and exploded after 73 s into flight.

The second part of this section's heading is inspired by "Probabilistic thinking and the fight against subjectivity", a book chapter authored by Gigerenzer (1987); see also Gigerenzer et al. (1989) and Hacking (1990). The culture of objectivity is not only dominant at Morton Thiokol and NASA, but also in science. Gigerenzer adopts an historical point of view and describes its origins in one

specific discipline, namely statistics. Numbers are seemingly objective and transparent. As the "probabilistic revolution" (Gigerenzer et al., 1989) unfolded, they played an ever increasing role not only in science but also in public policy and bureaucracy. The generals around Napoleon, for instance, knew that if they wanted to have something from him, they had to give him numbers. And ever more today, not only scientists, but also governments and multinational companies invest huge efforts in collecting data (and increasingly "Big Data") which, in turn, serve as a basis for decisions, or their justification.

What started in Europe with the Enlightenment (in a way, already earlier with Galilei: *measure what is measurable, and make measurable what is not so*) holds much of the industrialized world with an iron grip. Science, governments, corporations, and other pillars of society are built from fabrics of rationality, analysis, measurement, quantification, formalization, and objectivity. Subjectivity and feelings are a private business, not to interfere in public – at least not openly. And the place for those who do not overtly live up to those ideals is certainly not the middle of society. Conclusions or policy recommendations that cannot be grounded on numbers will have a harder time making an impact, and the engineers at Morton Thiokol were certainly not the first or the last ones to learn this lesson.

Even numbers themselves have problems when they cannot be dressed, on face value, into the garments of objectivity. Then they are scorned upon, and rejected by the majority. Inferential statistics in the social sciences speak testimony of this. Take Bayesian statistics as an example. As Dennis Lindley (1983), one of their leading advocates, writes (pp. 10–11): "*the Bayesian paradigm concerns uncertainty . . . It applies to statistical, repetitive situations . . . But it is also applied to unique situations. We are uncertain about the inflation rate next year, the world's oil reserves, or the possibility of nuclear accidents. All these can be handled by subjective probability*". But rather than also publicly fighting for subjectivity and intuition to have the place they deserve in science, many Bayesians seem to adopt the same hypocritical mind set as those who overtly reject Bayesian statistics as subjective: In their attempt to live up to the ideal of objectivity, those split-brain Bayesians then simply use uninformed (uniform) priors. What an irony! At the end of the day, it may all come down to pride and the questions whether one has the courage to stand up to one's subjectivity, or whether one prefers to hide it. As I. J. Good (cited according to Grosan & Abraham, 2011, p. 202) put it: "*The subjectivist (i.e., Bayesian) states his judgements, whereas the objectivist sweeps them under the carpet by calling assumptions knowledge, and he basks in the glorious objectivity of science.*"

Whenever subjectivity meets statistics, thorny territory is entered. The fight against subjectivity continues when asking which of the many rules and procedures, including the various tools of inferential statistics, should be used to process seemingly objective input. But how many dare to ask in the first place? How many consumers of SPSS, STATA, and psychology textbooks know that there are, at least, three different notions of "level of significance": one developed by early Sir Ronald A. Fisher, a second by the late Fisher, and a third by Jerzy Neyman and Egon Pearson, each of which is markedly different from how most psychologists would define this term today (Gigerenzer & Marewski, 2015)? How many of those who rely on .05 and .01 as seemingly objective criteria actually know that the convention of using these but no other criteria appears to be a pragmatic one? (Fisher only had tables for .05 and .01, most likely because his archenemy, Karl Pearson, was not willing to give him any others.)

Even worse, how many practitioners – judges, doctors, policymakers, or other recipients of statistical information – really understand the numbers they consume: probabilities, survival rates, or risk reductions? Certainly fewer than one might want to hope for – not all beams shining down from the Enlightenment program manage to reach the sphere of the mortals (e.g., Gigerenzer, 2002; Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin, 2007; Hertwig & Hoffrage, 2002). And sometimes, others even intentionally deflect those beams into directions that best suit them: be it industries who use numbers to "prove" the usefulness or harmlessness of their products (e.g., medications, tobacco, pesticides), or governmental institutions which use numbers (e.g., about economic growth, presented prior to elections) to influence citizens' judgment. There are some subjects who manage to hide within the culture of objectivity and who pull the strings from behind the scenes. They do not excuse themselves for being subjective; rather they let their interests guide which statistical model to apply, which representation format to use, and so on. In short, the machinery for compiling and processing numbers is necessarily fueled by subjective judgment. Some pretend they can eliminate all such subjectivity, some others do not even understand the subjectivity in the first place, and yet others abuse it.

2.2. Inferences and qualia

The rational and analytic approach the Enlightenment pushed forward is often combined with an engineering approach, particularly in modern times. This is not just an echo but a loud and resounding thunder, with greetings from Francis Bacon. The idea is that understanding something amounts to being able to construct models of it, which may eventually be implemented in mechanical or electronic devices. This is objectivity and transparency in its purest form: everyone can see the blueprint and will be able to build the same machine; everyone can study a particular software code and will get the same results (probabilistic components in a computer simulation taken aside). Examples for such devices that attempt to simulate the workings of cognition in artificial systems include neural networks and the *ACT-R cognitive architecture* (e.g., Anderson, 2007; ACT-R, which stands for *Adaptive Control of Thought-Rational*, will be introduced in detail below).

We cannot exclude the possibility that the researchers and engineers who construct those systems have intuitions when doing so – we believe and we hope that this was, is, and will be the case. However, we are not aware of any machine, system, model, or representation of the human mind for which the inventor and engineer claimed that his or her creation – sort of an electronic homunculus – has intuitions.

Fair enough: If subjectivity has no place in today's culture of objectivity, why should such creations have subjectivity built in? And how would this be possible at all? Could one build an artificial intelligence system that has intuitions? If we humans have intuitions and machines do not, this may, indeed, make us special and unique. Consider the following dialog between a critic of artificial intelligence and such an engineer of cognition, promoting artificial intelligence. Critic: "Humans are special; they can do things that a machine will never be able to do. For instance, they have intuitions!" Engineer: "Tell me exactly what the difference between man and machine is and I will prove you wrong. Tell me exactly what intuitions are and I will build a machine that has intuitions." Note that there are at least two challenges here. First, specify exactly what intuitions are, and second, build a machine that implements these specifications. Frankly, we do not know which one is the harder part.

We do know, though, that this little dialogue stimulates an interesting question. Are intuitions statistical inferences that the human mind is – at a subconscious level – drawing from data? (We will turn to the mind as intuitive statistician below.) If so, the engineer has a chance; after all, inferential mechanisms can be built into computer code and machines. But what if intuitions are subjective experiences that we have in the twilight? The human mind draws inferences at an unconscious level. This may happen in smart,

fast-and-frugal ways (Gigerenzer, Todd, & the ABC Research Group, 1999; Gigerenzer, 2007; Hertwig, Hoffrage, & the ABC Research Group, 2013), in error-prone, biased, and fallacious ways (Gilovich, Griffin, & Kahneman, 2002; Kahneman, Slovic, & Tversky, 1982), or in yet other ways. The list of descriptions and models is endless – which, in itself is revealing and shows that we do not know exactly, but can only construct models of what is happening in the black box, the home of our dear Lady. When these statistical inferences rise from the night and see the light of the day, that is, when we become consciously aware of them, then we may refer to these experiences as intuitions. They emerge in the twilight – where darkness and light meet each other.

Here our engineer has a problem. Processing data is easy, but what is conscious awareness? Are intuitions *qualia*, like the subjective experience of color that cannot be captured by analytic models of light that merely decompose it into waves of different lengths (Jackson, 1982)? Enlightenment meets Romanticism – the past is still alive and echoes can be heard in the discussions around artificial intelligence and philosophy of mind (Dennett, 1993; Nagel, 1974; Searle, 1992). For sure, reflecting about qualia and conscious awareness sheds a new light on the distinction between objectivity versus subjectivity that we discussed in the last section.

2.3. Taylorism in the organization of science versus holistic worldviews: Places for intuition?

Analysis, objectivity, and quantification come hand in hand with a fourth ideal: specialisation. These four ideals did not always play the role they do today. Aristotle's insights, for instance, are not just inferences he drew based on some statistics that he had collected – he rather had an encompassing view of man and the world. Moreover, even though he is known as a philosopher, he wrote, in fact, about psychology, logic, epistemology, aesthetics, natural sciences, political sciences, economics, and what not. And he was not an exception – many philosophers in ancient times were like him. Or think of Leonardo da Vinci, who might be best known for his Mona Lisa and other paintings, but who was a true polymath, with interests ranging from sculpture and architecture over anatomy, geology, history, astronomy, botany, music, cartography, mathematics to engineering and science. Or consider, three hundred years later, scientist-artist Johann Wolfgang von Goethe: *Dichter und Denker* and *Universalgelehrter* (i.e., "universal scholar") who tried to understand Nature by adopting a generic, universal, and holistic view, in which the parts are not scrutinized in isolation, but in which they remain integrated in encompassing units. Indeed, in one of his most important dramas, Goethe (1808) lets Mephistopheles, the opponent of his main character, Faust, explain the working of modern science: "*Wer will was lebendig's erkennen und beschreiben, Sucht erst den Geist heraus zu treiben, Dann hat er die Theile in seiner Hand, fehlt leider! nur das geistige Band.*" ("*He who would study organic existence, First drives out the soul with rigid persistence; Then the parts in his hand he may hold and class, But the spiritual link is lost, alas!*").

Goethe was very sceptical towards analysis and torturing nature on the dissection table. He was rather convinced that she would only reveal her secrets if we would trust our senses and avoid intersecting hypothetical constructs between us and the observable phenomena.

The golden age of the big Universalists seems long gone. With the passing of time, Mother Philosophy gave birth to many children – disciplines that later became known under their own names. Universalists gave way to specialized experts, affiliated to one of many faculties and disciplines that divided the world into parts and focus on certain areas. *Divide et impera!* Even within a given discipline, specific analytic and pragmatic approaches are adopted. Such divisions – between disciplines and within disciplines – come with their own requirements and dynamics. The pool of knowledge becomes larger, and it becomes more and more difficult to climb and stay on top of it. Indeed, today's experts are all but generalists. Specializing on narrower and narrower domains seems necessary to enable researchers to reach the edge of knowledge in their domain, so they can push its boundaries. It is, perhaps, no surprise that many researchers survive in this system by building their careers on one pet-theory or on a single dependent variable or experimental paradigm. The advantages are, seemingly, obvious: an electric torch which focuses its light shines brighter at a particular spot than a torch with a wide area of diffusion – an observation revealing that and why analysis and Enlightenment are brothers in arms, loosely speaking.

This development can be described as a form of *Taylorism*, that is, efficiency through specialization that allowed the institutions in the modern sciences to become assembly lines for producing both research and student output. And on the student side, at least in Europe, the *studium generale*, or, universities' universal education, has given way to specialization as well: The Masters and Bachelors of the Bologna system produce a steady flow of standardized pieces and spares of the size needed in various domains of society.

Is this the holy land, the *Novum Atlantis*, that Francis Bacon has seen in his prophecy and in which he wanted to lead us, under the flag of science and technology? Is this the ideal of the eminent figures of the Enlightenment, the secularized priests of rationality and analysis? Has Frederick Winslow Taylor seen these consequences in the organization of science and in scientific organizations when he advocated specialization and efficiency? "Oh, poor Lady in Black", one might cry out, "is there a place for you in our modern scientific institutions governed by objectivity, quantification, analysis, and specialization?"

Intuitive is often associated with *holistic*. To the extent that this association does not come out of the blue, the distinction between an analytic and a holistic worldview deserves a closer look. Obviously, the program of the troika (Bacon, Enlightenment, Taylor) grants advantages, but there is no free lunch. Its price-tag is what is lost in the aggregation of the small pieces, in the coordination of the specialists, who focus on analytical depth and thereby forego the holistic big picture in which everything is related to everything. Mephistopheles was right: "But the spiritual link is lost, alas!" (Goethe, 1808).

What is meant by the spiritual link? The Latin *spiritus* means "to breathe", which, in turn, refers to a process that connects inside and outside – subject and object. Grown up and embedded in our culture of objectivity we easily forget about us as subjects and observers (Lehrs, 1985). But in fact, there is no object without subject, and no subject without object. What does it mean to say that a subject sees an object? The light enlightens everything it shines at. We already pointed out that this does not only hold true for the light out there that physicists study, but also for the inner light (call it *thinking*) through which we see the world. Granted, without sunlight or other forms of physical light we cannot see anything. But what if the sun is shining at a particular spot and no one is there to see? How are the light out there and the inner light related to each other?

"*Das Auge hat sein Dasein dem Licht zu danken. Aus gleichgültigen tierischen Hilfsorganen ruft sich das Licht ein Organ hervor, das seinesgleichen werde, und so bildet sich das Auge am Lichte fürs Licht, damit das innere Licht dem äusseren entgegentrete*" Goethe (1810, p. x) "*The eye owes its existence to light. From among the insignificant ancillary organs of the animals light calls forth the organ to become its like, and thus the eye is formed by the light and for the light so that the inner light may emerge to meet the outer light.*" (translation: Miller, 2012, pp. 105–106).

One can adore what one sees out there, in the "all-joyous light" (Novalis) of the day. Moreover, it is relatively easy and straightforward to implement and pursue the program of Francis Bacon, and to use reasoning and analysis to study the things we see during daytime (note that measuring radioactive decay in a dark room and reading off the instruments with the help of electric light during nighttime would not be substantially different). Finally, one could even analyze the physical light and break it into pieces, as Sir Isaac Newton did. Newton, one of the great figures of the Enlightenment, conceived our sunlight as being composed of waves with different lengths. But with these "parts in his hand", to reiterate from the quote of Goethe's Faust, Newton would not be able to tell how the inner light is related to the outer light (Steiner, 1897). We should add that the "scientific-workers" (Fisher, 1956, p. 42) in any of the knowledge production factories in the footsteps of Taylor are not able to answer this question either – we are back to the discussion on qualia, conscious awareness and philosophy of mind.

This is possibly the mystery the Romanticists were after, with their mistrust in the scientific rationalization of nature and their emphasis on the experiencing subject. It is definitely the mystery anthroposophy is all about. Anthroposophy, founded by Rudolf Steiner (1861–1925), is a monistic and holistic philosophy and a spiritual worldview that encompasses man and nature alike, that connects macrocosm and microcosm, and that relates the outer and the inner light. Rudolf Steiner, whose books and lecture series fill 400 volumes and who inaugurated numerous movements in society and arts, tried – and many would argue successfully – to shed light at our night side. The scientific community ignores his work.

2.4. System 1, System 2, and the Lady in Black

The culture of objectivity, analysis, and quantification and the rise of statistics not only had a fundamental impact on society and scientific practices, it also led to new research questions. Soon after the culture of objectivity in form of statistics had entered psychology departments and the methodological toolbox of researchers, some psychologists asked whether not only enlightened statisticians but also naïve participants could count and analyze data. "Naïve" means: without a pen to facilitate counting events, and without any statistical training or instructions on how to process numerical information. In a classic article, entitled *Man as an intuitive statistician*, Peterson and Beach (1967) concluded that people can estimate means and variances fairly well. What is interesting is their use of the term "intuitive". If a person "somehow felt" that 40% of marbles in an urn were blue, then this was, according to Peterson and Beach, an intuitive estimate by an intuitive statistician. Was it the same Lady, who possibly helped Caspar David Friedrich painting landscapes and Novalis writing poems, who helped undergraduates estimating proportions?

The next step was from summarizing data and descriptive statistics to inferences. In a book entitled *Cognition as intuitive statistics*, Gigerenzer and Murray (1987) no longer dealt with means, proportions, or variances but with more complex questions: How do naïve participants intuitively estimate probabilities of data given hypotheses? The converse question, how to intuitively estimate probabilities of hypotheses given data, has also been extensively studied: to what extent is the human mind a Bayesian? From the 1970s on, numerous researchers examined how much help our Lady in Black granted to undergraduates who have been confronted with textbook problems that probed intuitions about statistic, logic, or probability theory. The factory producing all these research outcomes became known as the *heuristics-and-biases program*, spearheaded by Daniel Kahneman and Amos Tversky (e.g., Kahneman et al., 1982). According to this program, people use simplifying heuristics when it comes to probability judgments and these heuristics cause cognitive biases, that is, systematic and predictable deviations from statistics and probability theory.

The heuristic-and-biases program can be seen as a counter-image to the inheritance of the Enlightenment. The philosophers and mathematicians of the Enlightenment stressed rationality, logic, and reasoning. When asked about how probability theory is reflected in mortals, Pierre Simon de Laplace (1814/1951), for instance, was convinced that probability theory is "only common sense reduced to a calculus" (p. 196). Similarly, Jacob Bernoulli wrote, in a letter to Leibniz dated 1703, that the law of large numbers is a rule that "*even the stupidest man knows by some instinct of nature per se and by no previous instruction*."

But they were not psychologists and they did not collect data to check whether this was actually the case. When Kahneman, Tversky and all the scientific workers did exactly this, they found out that the philosophers of the Enlightenment were wrong. In view of this mismatch between *is* and *ought*, it did not take long for labels to be invented. Reponses that are consistent with what the modern priests of the Enlightenment declared as rational are seen as originating from System 2 – and responses that amounted to norm deviations are seen to originate in System 1.

Let us take a closer look at this distinction. In fact, there is a family of so-called *dual-process theories* (e.g., Evans, 2009; Kahneman, 2003; Sloman, 1996; Stanovich & West, 2000) that use these labels with slightly different meanings. For the purpose at hand, it is sufficient to just drop some terms that are used by at least one of the authors writing on dual processes. System 1 is often referred to as intuitive, fast, experiential, implicit, automatic, effortless, irrational, hot cognition, emotional, affective, associative, whereas System 2 is analytic, slow, symbolic, explicit, controlled, effortful, rational, cold cognition, deliberate, rule-based. The characteristics of System 2 obviously read like a portrait of *l'homme éclairé* (the enlightened man). But is System 1 portraying our Lady in Black? One may be tempted, at first glance, to say yes: a response or reaction that comes spontaneously, fast, and intuitively seems to come out of nowhere, that is, out of the dark.

At this point we want to return to Protagoras and his support for our attempt to localize intuitive accounts of intuition. To the extent that intuitive responses are System 1 responses, and vice versa, System 1 closely resembles the animalistic instincts. In fact, many of the attributes often used to characterize System 1 suggest that the functioning of this system is basically built on automatic frequency processing – a capacity shared by both humans (Hasher & Zacks, 1979) and animals (Gallistel, 1990). According to the Darwinian framework, animals and humans are not as distinct as some perceive them to be. Consider Edward Thorndike's law of effect: "Responses that produce a satisfying effect in a particular situation become more likely to occur again in that situation, and responses that produce a discomforting effect become less likely to occur again in that situation" (Gray, 2011, pp. 108–109). This law describes the behavior of cockroaches, pigeons, rats, chimps, toddlers, scientists, and CEOs. Further note that this law requires the ability to process frequencies and to draw inferences – specifically, to process the information how often a particular response in a particular situation led to a particular effect. In fact, not only undergraduates, but also animals seem to be *intuitive statisticians*, and *Animal cognition as intuitive statistics* would also make a good book title. Decades of research in Behaviorism have shown that animals are very sensitive to incentive schemes and that they can learn very quickly and accurately whether the probability of receiving food is higher when the blue or red light is on. In sum, System 2 is the class primus of the Enlightenment, possibly located in the prefrontal cortex, and System 1 is something we share with animals, possibly located in our reptilian brain.

Is there also a place for the Romanticists in the dual-process theories? Where is our Lady in Black as Caspar David Friedrich and

Novalis might have seen her? Should we build her a home in the landscape of psychological theories and call it system 3? Could this home be located in the brain and eventually be gauged and measured with EEG and fMRI studies? We do not think so. She is a personification of the dark side within us. If something pops up from this dark side some may refer to it as intuition. Some of these fast and spontaneous responses may be possible because we are good intuitive statisticians who processed frequencies in the past. In this sense it may be appropriate to say that she lives – and hides – in System 1.

But then we have, once in a while and all of a sudden, also ideas how to restructure thought elements when solving a problem. This may happen to engineers who try, for a long time, to tackle a particular challenge. Or it may happen to authors who think about how to best arrange the arguments and metaphors in a text. And it happened to chimpanzees who tried to get a banana that Wolfgang Koehler fixed at the ceiling of their cage in Tenerife. They had some boxes available in the cage, but they did not have any experience with this situation. They were jumping, crying, they got upset – to no avail. All of a sudden, Sultan (Koehler's smartest chimpanzee) seemed to have an idea, stacked the boxes, climbed up and reached the banana (Köhler, 1963). That was not a System 1 response, and also not pure luck, but obviously a very goal-driven activity. Koehler and his colleague Max Wertheimer used the term *insight* to refer to the joyful experience that accompanies a successful restructuring of "affordances" (to use a term introduced by Gibson, 1977) in a problem space. Usually there is some logic that is inherent in operations and affordances are not arbitrary. If an engineer is able to solve a problem while thinking hard about it and applying the knowledge she learned at the university, most would probably see this as a System 2 activity. But what if this insight comes all of a sudden, seemingly out of nowhere? This "out of nowhere" could eventually also be "out of the night" – literally. If we work on a problem for 30 min, get interrupted or sleep it over for a night, and then continue for 30 min, it is more likely that we find the solution than if we work for 60 min in one piece (Sio & Ormerod, 2009). It seems that our mind is able to make use of such incubation times even on some subconscious level – which relates incubation to intuition. If problem solving, as the Gestalt psychologists have conceptualized it, is a System 2 activity, and if this activity can also continue during night time and leads to insights later on, the Lady in Black seems to be able to also approach us through System 2! And who knows, often the Lady may not need a night during which we sleep, or a period during which experimenters distract their participants with other tasks to control the total time that they spent on problem solving. She may even take the liberty to visit us *during* problem solving. We may, all of a sudden and seemingly out of nowhere, have intuitions while thinking hard, subsequently we validate these intuitions, and after having seen that they contributed to solve the problem we call them insights.

System 1 and system 2 are often discussed and contrasted as dichotomies. Kruglanski and Gigerenzer (2011) questioned this approach and argued that both could be built on the same principles and mechanisms. We posit that there is yet another shared feature: Our Lady in Black is with us everywhere and she does not care how we categorize and label the places where she will whisper to us.

2.5. Dichotomies, definitions, and dialectics

We want to pause here for a while and reflect on where our journey led us so far. Adopting Protagoras' coordinate system, we started with an understanding of intuition that assumed the existence of a Divine sphere and that conceptualized intuitions as inspirations from Gods, Angels, or whomever. Then we looked in the opposite direction and suspected that intuitions may be akin to animalistic instincts. Finally, we looked in the middle, so to speak, and have seen . . . an imponderable black box. We took this observation as a starting point and contrasted light and darkness, Enlightenment and Romanticism, rational and emotional, objectivity and subjectivity, inferences and qualia, analytical and holistic worldviews, Newton and Goethe, System 2 and System 1.

The list of dichotomies just given reflected the path we have taken so far. The following list is a bit more comprehensive and follows a different order. We invite you to read it twice, one time row-wise and one time column-wise. Subsequently, try to add or insert a few more dichotomies. We will tell you below what this exercise is about.

analysis	intuition
bright	dark
white	black
clear	unclear
open	concealed
explicit	implicit
rules	associations
reason	emotions
male	female
controlled	impulsive
steered	automatic
effortful	easy
slow	fast
thought	instinct
human	animal
culture	the wild
educated	ignorant
enlightened	clouded
rational	error-prone
objective	subjective
truth	fantasy
realism	idealism
adult	child
educator	to-be-educated
nudging	to-be-nudged
government	citizen
authority	anarchy
. . .	. . .

Note that each of the three lists of dichotomies – the one we met along the path of the current article, the one provided by dual process theories, and the list for our little exercise – is related to the human sphere, either cognitive or social. To complete the picture, we would like to add, at this point, still another list of dichotomies – one that forms the basis for the Chinese *Taijitu philosophy*.

This philosophy is not about cognition, knowledge, experience, or social affairs, but mainly about the outer world. Yin and Yang are two forces in nature. Yin is characterized as slow, soft, yielding, diffuse, cold, wet, and passive; and is associated with water, earth, the moon, femininity, and nighttime. Yang, by contrast, is fast, hard, solid, focused, hot, dry, and aggressive; and is associated with fire, sky, the sun, masculinity and daytime (Osgood & Richards, 1973). Even though yin and yang seem to oppose each other, they act complementarily or antagonistically. In the well-known *yin-yang* symbol, we do not see two areas that are strictly opposed, rather it seems one originates from and moves into the other, and vice versa. 

In fact, it is easy to see the white area (yang, day) moving into the black one, and the black area (yin, night) moving into the white one, which amounts to seeing the symbol rotating clock-wise. Moreover, the white area contains a seed of black in it, and vice versa. Hence, even though the symbol shows two different principles, it also visualizes that they are intertwined.

At this point, we want to get back to Aristotle and to Goethe. In his *Nicomachean Ethics*, Aristotle does not assume a simple dichotomy between good and bad, or between virtues and vices. Rather, what is good or virtuous is always in constant battle with

two poles. Each virtue is a golden mean between two vices. Being brave, for instance, is the middle-ground between cowardly running away and being rash, reckless and careless. In fact, a continuum spans between the two poles, and hence there are various virtues along this continuum. Being courageous is a virtue, but it is already a bit closer to the pole of being reckless. Being cautious is also a virtue, one that is closer to the pole of being a coward. The same can be said for other virtues, for instance, those between the vices of being greedy and being wasteful.

We find a similar constellation in Goethe's *Theory of Colors* in which something new emerges in the middle ground between two opposing poles. For Goethe, physical colors are not just waves of different lengths, as his analytically-minded intellectual antipode Newton suggests, but "*deeds of light: what it does and what it endures*" (Goethe, 1810; Miller, 2012, p. 106). While for Newton darkness is the absence of light, for Goethe darkness is polar to light and interacts with it. For Newton, the physical colors are already in the light, they are just invisible because they cancel out. For Goethe, in contrast, the light itself is homogenous and *not* composed of colored elements. These colors only emerge if light meets darkness in turbid media such as air, dust or moisture. According to Goethe, yellow is a light which has been dampened by darkness; blue is darkness weakened by light. Daily visible examples are the yellow sun or moon (light dampened by dusty air; the thicker the atmosphere, the more the yellow turns into orange or red), the blue sky (darkness of outer space weakened through dusty air), or the blue oceans (darkness seen through turbid water). An *experimentum crucis* that could determine whether Newton or Goethe is right does not exist, and would not make sense. The two simply focus on different aspects of reality. According to Lehrs (1985), "the theory of Newton and his successors was based on excluding the color-seeing faculty of the eye," and focused, instead, on mathematical models. In contrast, "Goethe founded his theory on the eye's experience of color", which, not surprisingly, was not considered to be hard science. Here they are again, the culture of objectivity and the fight against subjectivity. Qualia had and have no place in the world of physics. While artists find Goethe's approach more useful for their work, the natural sciences teach Newton's theory.

From yang and yin, from light and darkness, back to analysis and intuition. Instead of trying to define intuition, we have so far been playing with metaphors and dichotomies; and we have painted a picture, akin to a painting from *Impressionism* that consists of many little dots. Definitions are marking borders (Latin *definire* means "to set bounds to"). Consistent with an analytic approach, definitions divide and separate. To appreciate an impressionistic painting one needs to go in the opposite direction: not getting closer to inspect the dots in more detail, but stepping back to connect the dots when overseeing them from a distant, holistic point of view. This is what the above exercise was about.

In fact, one can see two pictures, one in the left column in our table above and one in the right. What emerges if these two pictures are compared to each other? How are analysis and intuition related to each other? Are these dichotomies, opposing each other? Or like yin-yang, intertwined and complementing each other? Or like poles with the potential that something new can emerge in the middle, like virtues between vices? Or like light and darkness that, together, have the potential to let colors emerge in the twilight?

Western philosophy and thinking is apparently biased towards analysis. It can be seen as a huge Enlightenment program to gain a better understanding and control of the world, including ourselves. It led to the sciences, and it produced technologies, thereby following Francis Bacon's vision and simultaneously creating and leading us into his Novum Atlantis. It conquered the world. The Aborigines, Australian natives, who live(d) in their *Dreamtime* (or should we call it their 'Age of Intuition'?) did not come to Europe and the U.S., but cell phones found their way to the land down under.

Why should this program halt when it comes to explaining intuition? Moreover, why should this program use methods other than reasoning and analysis – why should it change a winning horse? One may indeed have mixed feelings when scrutinizing intuition with an analytical mindset – feelings that may not be so different from those that small scale societies may have had when they have seen the first white invaders some centuries ago. Isn't theorizing about intuition as perplexing as illuminating a full moon night with strong neon light so that one can see everything more clearly – including why two lovers find such a night so romantic? What do you think of your own intuitions: can they be analyzed, dissected, and decomposed? Every theoretical account tries to shed light on some object, but theoretical accounts of intuition are quite special. They try to shed light on something which may be conceived of as the opposite, namely darkness and mystery. Could it be that these attempts, paradoxically, destroy what they are after? Do such attempts simply chase away our Lady?

On the other hand, if intuition is related to the dark side within us, as we suggested, what is bad about looking into the mirror to also shed some light inside, so to speak? At the forecourt of the Temple of Apollo at Delphi, the adepts could read engraved "γνῶθι σεαυτόν" (*gnothi seauton; know thyself*). We are not surprised that the scriptwriters of Star Trek decided that Mr. Spock – a personification of pure reasoning – is only half-human. At the same time, we are convinced that following what Immanuel Kant described as the motto of the Enlightenment, *sapere aude* (dare to know), is another element of what makes us human.

What we just described corresponds to yang (the light, the white area) moving into the yin (the night, the dark area): analysis and scientific inquiry choosing intuition as their target. But what about the black area as the origin of the white area (in the rotating symbol), and what about the black dot inside? We suggest that no matter how bright the light will shine, the other pole – the darkness – is always present. When considering scientific approaches and theories that try to shed light on our elusive Lady who lives in the dark, the question arises where the light comes from and who inspired those theorists. Could it be that intuition is occasionally helping even the most enlightened scientists, including those who try to unveil her? Or consider decision aids that implement an analytic approach. It all looks very objective, precise and quantitative – at first glance: consequences are quantified on utility scales, and a limited number of criteria are weighted such that the relative importance of these criteria is captured. Everything is crystal-clear and transparent, and the ultimate number crunching can be performed by a computer to determine which option receives the highest score. But where do these utilities and weights come from? They look objective once they are plugged into an excel sheet, but upon closer inspection, it soon becomes clear that our Lady in Black may not be a passive bystander when a decision maker "somehow" comes up with them. For the sake of completeness, what would correspond to the white dot within the dark area? Well, we need to have some conception and understanding of intuition; otherwise we would not be able to talk about it in the first place.

Note that the dialectics between yin and yang and how they interact and influence each other is also reflected in theoretical approaches in psychology – for instance, in Brunswik's (1952) notion of *quasirationality*, which has been further developed in Hammond's *Cognitive Continuum Theory* (Hammond, 1996, 2000, 2010; see also Dhami and Thomson, 2012). The notion of quasirationality points at a combination of analysis and intuition. It is the mode of cognition in the middle-ground between the two extreme poles. Simon (1987) expressed this idea as follows: "intuition is not a process that operates independently of analysis; rather, the two processes are essential complementary components of effective decision-making systems" (Simon, 1987, p. 61).

We will now finish this part of the current article that could have been written as if there was no special issue on *Modeling and Aiding Intuition in Organizational Decision Making*. We adopted a broad perspective and met our dear Lady in Black in various forms. We met her as inspirations, possibly from sources that some might locate outside ourselves. We met her as animalistic instincts that come in form of intuitive statistics. We met her as statistical inferences that can, for instance, be described as stemming from fast-and-frugal heuristics. And finally we met her as insights that we may have when we engage in problem solving or restructuring. The common denominator is this: In each of these forms, something emerges from the dark side within us. What comes out of our darkness interacts with conscious awareness, it becomes an object that can be scrutinized and analyzed, and we may wonder "Where did this idea, this hunch, this gut feeling come from?" The inner light – thinking, reasoning, and rationality – that the eminent figures of the Enlightenment lifted on the throne which was, before, occupied by religious content, shines into the darkness and attempts to understand. We cannot tell exactly where this inner light comes from and why it disappears while sleeping. Sleep is said to be the little brother of death, and we also do not know anything about before and after our life on earth. But we feel that both sides, the inner day and the inner night, belong to us. Enlightenment and Romanticism have been eras in history, but they are more: what was driving their representatives is constituting each of us. Subconscious inspirations, instincts, inferences and insights are not intuitions, but once they leave the dark side within us and we become aware of them, they turn into intuitions. Adopting Goethe's theory of colors, intuitions are like colors that emerge in turbid media, in the sphere of twilight, where light and darkness meet and interact with each other. Intuitions are messengers that enter our all-joyous days, and they remind us of our own origin: the mysterious night side.

3. Pictures at an exhibition

This section headline cites the title of a suite composed by Modest Mussorgsky (1839–1881), an innovator of Russian music in the romantic period. The ten movements of this suite paint, through music, the world of gnomes, of an old castle, catacombs, and they even include a sparkling ballet of unhatched chicks in their shells. Typical for Romanticism, Mussorgsky's creations all play with mystery. In what follows, we will give you a guided tour through the creations that we have collected for our exhibition. These creations are not paintings, poems, or music, but scientific articles. And as you will see, they are everything but mysterious. Yet, much like inspiring paintings, poems, or music, they all invite to intuit and reflect – namely about our Lady in Black.

Who are those whose creations we exhibit? First and foremost, they all are enlightened scientists – individuals, who have attempted to find and to describe, eventually also to model, the traces of our Lady. In addition, many of them are, what one is tempted to call, the tribal elders: half of all articles in this issue have a (co)author who was already at retirement age when composing his or her piece. They include founders of several influential research programs on intuition, four former presidents of the *Society of Judgment and Decision Making* (including the first two), former or current editors of general and specialized psychology journals (e.g., *Psychological Review*, *Judgment and Decision Making*, *Decision*), and even a former student of towering Psychologist Egon Brunswik. And these wise, experienced tribal elders include several whose creations have been, if one believes Google Scholars Citation Counts, explicit topics in about 10,000, or 100,000 other pieces of work – just imagine a painter's, poet's or composer's work would be acknowledged 10,000 times in the work of other painters, poets, and composers: that would be quite unique, wouldn't it?

How did we get those, whose creations we exhibit, on board? First, we contacted a number of individuals who had already, in the past, shared their experiences and encounters with our Lady in Black, and/or of whom we thought they could trigger stimulating avenues for research on intuition. We wanted to influence as little as possible these authors' intuitions, associations as well as their analyses and reflections. They were invited to submit contributions of their own taste – opinion pieces or empirical work, single or co-authored articles – and also to depict or unveil intuition in whatever way they wanted. Those who accepted our invitations include John R. Anderson, Jon Baron, Rex Brown, Jerome Busemeyer, Mandeep Dhami, Kenneth Hammond, Robin Hogarth, Gary Klein, Christian Lebiere, Thorsten Pachur, James Shanteau, Paul Slovic, and Ron Sun. Second, to further increase our chances of obtaining some interesting glimpses at the Lady, we sent an open call for papers to various research communities, newsletters, and mailing lists. Also for those submissions, we tried to offer as much ground for creativity as possible. After inevitable rejections, a few withdrawals, and numerous night-shifts, 16 papers written by a total of 38 different authors were left to be presented.

How did we arrange these 16 contributions in our exhibition? All authors produced their work without knowing much (or anything) about the others' pieces. They also did not know which metaphors we would use in the present article at the entrance gate to this exhibition, in which context and frame we would put their work, and which connections we would see between their articles. Frankly, for a long time we did not know either. In fact, the 16 articles can be classified along many dimensions and hence there are many ways to assign them to different rooms in our exhibition, and many ways to order them in the present guide. We are not able to specify how exactly we finally settled on one of the many possible arrangements, but now that we walk through the five different rooms that we describe in the following five subsections, we feel that they radiate harmony. The Lady in Black, so we believe, is said to like harmony – not only between nature and man, as in Romanticism, but also between reason and feeling. Maybe she helped us a bit?

3.1. Experience, expertise, and environments

The first three contributions to our exhibition are all single-authored by distinguished researchers: Gary Klein, James Shanteau, and Kenneth Hammond. Each of them is, as one of them (J.S.) put it in an email to us, "no longer dependent on new publications for promotions and pay raises. These days, I only publish when I want to, not because I have to." Two of our first three articles do not contain a single data point, and the third contains only a few. Having seen and organized innumerate exhibitions themselves, these authors leaned back, so to speak, and wrote opinion pieces in which they adopted a wide perspective and reflected upon decades of their own but also others' thinking, theorizing, and ways to conduct research.

As another commonality, their articles focus on experience, expertise, and on the natural environment in which experience can be gathered and expertise can develop. The first variation of this theme, we look at, has been composed by Klein (2003): Intuition results from experience. Experience, in turn, produces experts. Given repeated exposure to various situations, these experts learned about the statistical structure of the environment, that is, they learned which *cues* are important and which ones are less so when assessing a situation and when predicting outcomes. The experts learned how these cues inter-correlate, and they learned distinguishing certain configurations of cues – patterns that are meaningful to experts but that novices may not recognize as such (Simon, 1987). This conceptualization also informed the name of Klein's account: the *recognition-primed decision model*. Finally, and most importantly, these experts also learned what the best course of action is for which pattern. Accordingly, Klein defines

"*intuition as the way we translate our experience into action*" (2003, p. iv). Such learning does not necessarily lead to explicit knowledge that can be verbalized, but can result in implicit, tacit knowledge. That is, people with a rich experience base may not necessarily be able to provide reasons for why they judge and decide as they do – instead they have a gut feeling and know intuitively how to act (for a discussion of this distinction between explicit and implicit knowledge, see Chassot, Klöckner, & Wüstenhagen, 2015; see also Sun, 2015). Following this account, the Lady in Black speaks to us through some sort of automatic frequency processing. She detects which cues are relevant and even complex patterns do not really pose a challenge to her. However, she can only be at our side if we have done our homework and made sure that we accumulated what she needs as input: experience, experience, and experience.

Experience leads to expertise (see the writings of Shanteau) and to intuition (see the writings of Klein). These two links translate into a series of methodological imperatives: To study intuition one should not put undergrads on Francis Bacon's dissection table in a sterile laboratory room. One should also not try to study their reflexes while torturing them with textbook problems. Instead, one should observe experts in their natural environments, for instance, firefighters in burning buildings, or pilots in airplane cockpits. Many scholars follow this imperative in the context of what became known as the *Naturalistic Decision Making* program. This program was initiated in 1989 in a conference that took place in Dayton, Ohio, where more than thirty professionals met to share their experience with and to discuss their ideas for studying "cognition in the wild" (this term cites a book title by Hutchins, 1995; for more information on naturalistic decision making, in general, and the Dayton conference, specifically, see Klein, Orasanu, Calderwood, & Zsambok, 1993; Lipshitz, 1993; Orasanu & Connolly, 1993; and www.macrocognition.com).

In his article, Klein (2015) describes the naturalistic decision making approach to intuition and contrasts it with two other frameworks, namely the fast-and-frugal heuristics and the heuristics-and-biases research program. Like the recognition-primed decision model, the fast-and-frugal heuristics program posits that intuition develops through the interaction with the environment. Many of the fast-and-frugal heuristics can be formalized as algorithms, implemented in computer code and examined in computer simulations. Performance is assessed in terms of fit between environmental structure and an actor's goals. In contrast, the majority of heuristics proposed in the context of the heuristics-and-biases program are rather vaguely defined, and performance is assessed against "laws" of logic, probability theory or rational choice theory – not against the person-ecology fit. According to this program, intuitions are seen as a source of deviations, biases, and errors from these laws (see also Kahneman & Klein, 2009). In his article, Klein offers seven suggestions for theory construction and research practice resulting from his synopsis of these three different approaches.

Based on his rich experience from studying experts, Shanteau (2015) focuses on a puzzle that is related to the experience of these experts. If experts in the same field share similar experiences and if intuition is based on experience, then these experts should develop similar intuitions and they should generally find themselves in agreement with each other. Shanteau provides a brief overview of the literature that speaks to this question and concludes that this is, indeed, often the case – but that there are also many studies that report the opposite. He discusses this heterogeneous pattern and explains the variance in terms of differences between the domains in which the experts gathered their experiences and developed their intuitions. Whether intuitions are good and whether experts develop the same intuitions depends not only on the experts themselves, but – to a larger extent – on the environment for which they gained their expertise.

Another author who stresses the importance of the environment is Hammond (2015), albeit, not like Shanteau does. Instead, he focuses on domain-specific differences related to the design of studies. Hammond advocates the methodological imperative that cognitive processes (including intuition) should be studied using a *representative design*. The notion of representative design has been developed by Egon Brunswik as an alternative to systematic design. The latter usually selects, often manipulates – and sometimes even artificially creates – stimuli in order to disentangle the causal influence of several factors that could impact the response of interest. This is what most of us do! Brunswik argued that the set of stimuli used in a study with a systematic design is most often not representative of the set of stimuli in the natural environment – to which people's cognition has adapted. His alternative, representative design, can be implemented by sampling stimuli representatively of the environment, for instance, by randomly sampling (for an overview of representative design, see Dhami, Hertwig, & Hoffrage, 2004). Brunswik's work suggests that the Lady is, well, easy to deceive. If we gain experience in a natural environment but are subsequently brought into an environment which is not representative of our natural environment, the Lady may still speak to us – but we should better not listen as our inferential mechanisms behind which she will conceal will lead us astray (Fiedler & Juslin, 2006).

Many of the researchers contributing to the heuristics-and-biases program do not seem to care about representative design, and some may not even be aware of this concept. However, for researchers from the naturalistic decision making community, interfering with the environment and using artificially created stimuli is not ideal to study intuition. In his paper for this special issue, Hammond adopts a historical perspective and reflects on the origins and receptions of representative design. And who could be a better author for this paper? Hammond was the last living student of Brunswik and in his essay he takes us back to the very beginning of his career – back to the 1940s at the University of California, Berkeley – but then covers six decades of debate centering around the concept of representative design, thereby discussing the work of Gerd Gigerenzer, Daniel Kahneman, Phil Tetlock, and others. Unfortunately, we had to start the previous sentence with "Hammond was". On April 28, 2015, he passed away at a "biblical" age of 98 after a career spanning seven decades of theoretical and empirical contributions to the field of judgment and decision research. The present paper is for sure one among the last (if not *the* last) he has written. We feel extremely glad and honored that we can include it in the present special issue, and we believe he would be delighted as well if he could see the context (i.e., the other papers) in which his essay appears.

3.2. Formal models and cognitive architectures

The previous room in our exhibition assembled pieces that focused on methodological aspects – intuition should either be studied in the same natural environment where it had developed, or with a representative design. The subsequent three pieces illustrate another methodological aspect of studying intuition, namely how to model it.

Most intuition research employs verbal descriptions or *informal* models. The widespread use of verbal descriptions and informal models is also reflected in this special issue: we will see such research in every of our exhibition rooms – with the exception of the current one. In the current section, we will turn to *formal* descriptions of intuition: computational and mathematical models. In doing so, we will not focus on those type of formal models that are, to a large extent, well-known in mainstream intuition research. Instead, we move into a room in our exhibition that displays a class

of models that, though forming part of halls of fame in other areas, deserve attention in intuition-research, too: *cognitive architectures*.

To appreciate what formal models and cognitive architectures are, let us, with the help of one of our authors, briefly caricaturize their antipodes. The following is an extract from an email, written by James Shanteau in the context of the review and production process of his contribution to this special issue.

> "*When I started discussing expertise in the 1970's, it was common to use the concept of schema to explain the development of expertise (and much else in cognitive psychology). When I tried to pin it down, however, I couldn't figure out whether schema referred to a rule, a process, an outcome, or all of the above. I concluded that schema could mean whatever the user wanted it to mean, i.e., an universal explanatory principle.*
>
> *I had a similar experience trying to figure out what situation awareness (SA) meant – a concept first tied to expertise in military settings. For instance, expert pilots could be the best because they have SA. But SA was offered as the explanation of what separates experts from novices. The circularity of the reasoning made it, to me, an empty concept.*
>
> *Intuition is not quite in the same boat as either schema and SA, but it seems dangerously close.*"

Shanteau's lines reflect experiences we made when trying to find descriptions and models of the traces of the Lady in Black in the scientific literature. What, initially, started out as a quest ("How have others described you?"), quickly turned into despair ("Oh dear Lady in Black, who has not tried to turn you into an object of scientific inquisition?!"). Thousands, so it seemed, dedicate their life to trying to hunt "it" down: intuitions. But what exactly is being hunted; that is, what do different authors really mean when they use the term "intuition"? Entering this term in Google Scholar yields, nowadays, more than 1,000,000 hits. Of course, we have not worked our way through all of them, but going through a sample of articles was already enough to support the suspicion that different authors had different concepts in mind, even though they used the same word.

We were reminded of *Rorschach testing* in psychoanalysis: inkblots were shown to people, people generated associations, and these associations were used as data and interpreted by psychologists (who were, albeit on a higher level, hence doing the same: while people interpreted ink plots, psychologists interpreted interpretations). Everyone would see something in these inkblots, just as everyone is able to see something in clouds, or as the ancient Greek were able to see Perseus and other mythical figures in star constellations (note that the names they gave to these star constellations persist today). Likewise, everyone will be able to associate something with "intuition", "gut feeling", or "fast thinking" – which may come dangerously close to the Babylonian confusion in which people speaking different languages could no longer understand each other.

Fuzzy scientific concepts akin to Rorschach inkblots certainly have their merits: associations or even some misunderstandings may trigger new research, and they stimulate creativity. With their low level of precision, informal approaches correspond to the soft yin-element. Not surprisingly, they evoke the yang-element – which comes as formal theories. Let us now go through some of the arguments for the latter (for overviews, see Fum, Del Missier, & Stocco, 2007; Lewandowsky, 1993; Marewski & Olsson, 2009).

Formal theories allow tackling problems where verbal theories tend to fail: (i) verbal theories and their predictions tend to be hard to nail down; (ii) their relative vagueness makes it more difficult to compare them to competing theories and predictions; (iii) verbal theories can be tricky to integrate in common frameworks; (iv) verbal theories can only capture certain levels of complexity. Last but not least, a reason why verbal theories have problems is actually not that the theories are verbal. Rather, it is an argument about a confound: many of those working with verbal theories may lack the programming and mathematical skills required to design and test complex theories. Such lack of expertise lets many verbal theories to be shaped less by reality and more by technology – namely by SPSS and other programs that allow running off-the-shelf analyses (e.g., t-tests, ANOVAs, regressions) on off-the-shelf research designs (e.g., simple factorial experiments).

While informal accounts of intuition are quite popular, the formal approaches are still comparatively rare. Most scientists making the Lady their object of inquiry are, at most, willing to dissect intuition – be it in the lab or the natural world – but they refuse to do more. Why? Is it, perhaps, that the ungraspable becomes even less graspable if one wants to force her into what might look like intellectual chastity belts (equations), or even worse, tortured by iron maidens (computer code)? How can one intuit intuition with something as unintuitive as hundreds of lines of code or mathematical analyses? While formal theories seem like chastity belts and iron maidens for some, for others the verbal theories seem like colorful costumes, worn during experimental shows of magic: sawing-the-women tricks of some sort; some very interesting, some rather boring, and some silly but sexy.

By exaggerating and simplifying features or traits, caricatures can aid perceiving the real thing. In reality, both magic costumes and chastity belts are degrees on a continuum. In fact, many theories are neither solely formal *or* verbal. Glöckner and Betsch's (2008) connectionist model of intuitive decision making, for instance, explicitly rests on both math and verbal assumptions. Indeed, on its own, theorizing at formal or informal levels is neither "good" nor "bad". Clearly, both levels of description have their own merits and, actually, also their own problems. Both can be interesting, informative, and insightful – like the work presented in the first three papers of this special issue, which we hope you enjoy as much as we do. And both can border re-description and tautology. This can happen when a theory does not attempt to model processes. Examples are mathematical equations with free parameters that carry no explanatory value, but that are given quasi-psychological, marketable labels (e.g., "risk aversion"). Examples are also observations (e.g., of behavior) turned into "explanations" for what is being observed – just think of the many fashionable personality traits (e.g., "extraversion") populating the psychological and organization science literature.

Moreover, what is an advantage on some grounds can translate in hurdles on others. To illustrate this point, mathematical or computational precision can aid testing. But dealing with mathematical equations or computer code also requires expertise in the corresponding formalism (e.g., a programming language). And while codes and equations can be shared, they also need to be translated into verbal arguments in journal publications. Informal theories, in contrast, do not require translations. They rely on common (e.g., English) language as their only medium and can, hence, both be easily understood by and communicated to others. And it does not take much to see how enhanced comprehensibility can promote spread, or how communicability can aid usefulness. Just imagine a world where the religious, legal, or administrative texts are available in incomprehensible language only, requiring experts to understand them and to translate them into the language of John Q. Public.

One of us recently had a conversation with an IT consultant. The consultant confessed that his business is, simply speaking, making more money, if more laws and regulations are created, and if these are becoming increasingly complicated. Companies have to adapt to them, and they can do that, so the argument goes, by buying software that implements these regulations. This can be software automatically generating paychecks, deducing taxes, calculating social security benefits, or software creating and updating all pertinent warnings to accompany the products to be sold. The

software simplifies a complex tasks for companies, namely to play within the rules.

In research, a parallel to what the consultant does is the implementation of verbal theories in formal models. Formal models – be it the scientist' theory or the consultant's software – reduce ambiguity and leave less room for interpretations and maneuvers. They shape, control, and valuate outcomes – be it in that they precisely define which states of the world are, actually, in line with a theory, or that they define that world in the first place. They can aid to establish an objectivity of some sort. On the other hand, "holes in the law", can give agents (e.g., companies, scientists) rooms for interpretability and the flexibility that is often necessary when hitting on new, unknown, or complicated problems. Here we meet them again, the two archrivals objectivity and subjectivity, this time they can be best labeled rigidity and flexibility.

The formal approaches we have caricatured above can be lined up on a continuum, marked by two poles: One pole is occupied by models that focus on isolated aspects of cognition (e.g., "intuition") or tasks (e.g., fire-fighting), while the other pole belongs to cognitive architectures. Cognitive architectures are computational (or mathematical) models that strive to integrate multiple components of cognition (e.g., perception, memory, decision making, motor action) into one unified theory. This unified theory then, ideally, interacts with the world (e.g., the statistical structure of the environment) and applies to diverse tasks, domains, and phenomena (e.g., strategy selection, aircraft controlling, mathematical reasoning, intuition, probability matching, forgetting).

One of these unified models is the ACT-R cognitive architecture (e.g., Anderson, 2007). This architecture is central to the first article in this section, co-authored by Thomson, Lebiere, Anderson, and Staszewski (2015). Cast as computer code (available at http://act-r.psy.cmu.edu/), ACT-R is, arguably, the most detailed and most widely used of the architectures around. Other examples of architectures, though not discussed in this issue, include EPIC (Kieras & Meyer, 1997) or SOAR (Newell, 1992). ACT-R has been applied to an array of phenomena in a variety of fields, ranging from probabilistic inference (Schooler & Hertwig, 2005), insight (Anderson, Anderson, Ferris, Fincham, & Jung, 2009), and the learning of mathematics (Ritter, Anderson, Koedinger, & Corbett, 2007) to multi-tasking (Salvucci & Taatgen, 2008). Pointing out that cognitive architectures have played little role in exploring intuitive decision-making processes, Thomson et al. (2015) explain central features of ACT-R, offer reasons for using ACT-R, and discuss how the ACT-R framework might help us better understand intuitive decision making processes. In so doing, they posit that instance-based learning is consistent with the kind of intuitive decision-making processes formulated by Kahneman and Klein (2009). They also conceptualize biases as emerging either from the cognitive architecture, the environment, or the use of strategies which allow adapting to cognitive and environmental constraints.

ACT-R can be called a hybrid architecture. Its symbolic part is a production system; while its sub-symbolic system is cast in terms of parallel processes, which can be summarized by a set of mathematical equations. The next article, an opinion-piece written by Sun (2015), takes us into the universe of another architectural framework: CLARION (*Connectionist Learning with Adaptive Rule Induction ON-line*; e.g., Sun, 2014; Hélie & Sun, 2010; information available at http://www.clarioncognitivearchitecture.com). In his article, Sun offers us a snapshot of dual processes theories – System-1, System-2 and its associates – viewed through the lenses of CLARION. In discussing the work of Evans (e.g., 2009), Kahneman (e.g., 2003), Sloman (e.g., 1996), and others, Sun replaces the distinction between intuitive versus reflective thinking with that of implicit versus explicit processes and raises what he takes to be critical issues with that distinction. For instance, he points out that intuition may not be strictly automatic; it can be consciously controlled and manipulated. He also points out that intuition may be slow, rather than fast. He describes how CLARION might allow for exploring some of the issues he raises. His article closes by sketching out how CLARION might help addressing social and organizational phenomena.

The third article in this series complements the conceptual pieces written by Thomson et al. (2015) and Sun (2015): Juvina, Lebiere, and Gonzalez (2015) provide a detailed example of modeling work in the social domain. Specifically, much of what happens in organizations is some sort of social interaction – be it with clients, suppliers, or colleagues. It is a truism that trust is an important element of successful, repeated interactions. One might argue such trust, in turn, is shaped by evidence – direct and indirect. Direct evidence is one's own observations, while indirect evidence might be, for example, gossip about a person, or information found in social media. Evidence can be used to inform intuitions about the outcomes of likely future interactions (e.g., if you betrayed me once, you may betray me again). At the same time, the more often an interaction takes place, the more opportunities for forming and refining intuitions there are. One can also call this process "learning": acquiring evidence, drawing conclusions based on it, getting feedback on the correctness of the conclusions, and updating. In the long run, expertise can develop. Indeed, expertise – not only about our partners in social interactions, but also more generally – can be thought of as playing out learned intuitions; much like the experienced CEO, politician, or spouse, who has a "gut feeling" of how to react to a business partner, a coalition partner, or the beloved one. Juvina et al. dive into this world of trust, learning, and intuition. Specifically, these authors present an ACT-R model to explain how learning transfers across two games of strategic interaction: the *Prisoner's Dilemma* and *Chicken*. In doing so, Juvina et al. bring together different lines of research. The first is work on intuition and expertise, the second is formal modeling (in their case, with the ACT-R architecture), and the third stream of research they integrate in their paper is behavioral economics.

3.3. Prescription, aiding, and rationality

So far we discussed papers that describe and/or model cognitive processes in general and intuition in particular. We now move into a room with three pictures that have prescription as a theme. By means of an introduction, here are some historical remarks on the relationship between prescriptive and descriptive approaches.

Interestingly, the first formal theory of decision making under risk, *Expected Value Theory*, does not make the distinction between prescription and description, and is instead both at the same time. Pascal and his contemporaries of the 17th century, and also later the philosophers during the Enlightenment, perceived no difference between how *l'homme éclairé* ("the enlightened man") should reason and decide and how he actually did it (Gigerenzer et al., 1989). Observe, by the way, that the enlightened and rational man was, at least at that time, male, whereas intuition, the mysterious Lady in Black, was female (for an historical perspective on the question concerning intuition's gender, see Gigerenzer, 2007). Human reasoning was perceived to follow the rational calculus – a view that is echoed in, for instance, the psychology of Jean Piaget (Piaget & Inhelder, 1969). A more modern version of this view is *rational analysis* (e.g., Anderson, 1991; Oaksford & Chater, 1998) with its conviction that studying what people should do is a good starting point for understanding what they actually do.

In a letter written in 1713, Nicolas Bernoulli, invented and formulated an intriguing problem. We flip a fair coin until it lands on tail. If this happens with the first throw, the win is 2, if it happens at the second throw it will be 4, 8 for the third throw, 16 for the forth, and so on. What would be the fair price to pay the casino for playing this lottery? Everyone could see that following Expected Value

Theory would dictate one to pay an infinitely high price for this ticket – while everyone, including the smartest mathematicians, philosophers, and promoters of Expected Value Theory were only willing to pay relatively low prices. It was an earthquake in the land of rationality. In 1738, Nicolas' cousin, Daniel Bernoulli provided a solution to this problem and published it in the *Commentaries of the Imperial Academy of Science of Saint Petersburg*, hence the name: the *St-Petersburg paradox* (Gigerenzer et al., 1989). The solution was based on a transformation of the objective values. People's subjective values can be modeled as the logarithms of the objective monetary values. Bernoulli's proposal was nothing more and nothing less than the birth of *Expected Utility Theory*. It took another 200 years, during which this theory was not modified, until John von Neumann and Oskar Morgenstern (1944) formulated the axioms of Expected Utility Theory. If probabilities are not known, but need to be subjectively estimated, Expected Utility Theory turns into *Subjective Expected Utility (SEU) theory*. This theory was, and for many today still is, perceived as *the* rational approach to decision making. Being rational means to adhere to all axioms of SEU theory, and, conversely, violating any of them means being irrational.

It did not take long time after von Neumann and Morgenstern (a mathematician and an economist, by the way) had axiomatized SEU theory for psychologists to enter the scene (e.g., Edwards, 1954). They were interested in the question of whether people actually followed SEU theory. The answers were mixed. While Maurice Allais (1953) reported a systematic violation of a central axiom of SEU theory (this violation became known as the *Allais paradox*), Ward Edwards (1954) concluded that people are, by and large, rational. This conclusion was challenged in the late 1970s and the 1980s by the heuristics-and-biases program whose goal was to document and model deviations from SEU theory or from any other normative and rational benchmark.

The heuristics-and-biases program was very productive and influential at two fronts. First, in the academic world it produced an avalanche of studies reporting irrational behavior and decisions – there is the saying that on their way to the Annual meeting of the *Judgment and Decision Making Society* one colleague asks another "What's the bias of today?" Second, and possibly even more important, this program influenced an armada of consultants and teachers (e.g., at business schools), many of them psychologists, who approached companies with a simple message: "Your managers fall prey to all kind of biases and pitfalls. We can inform them about these pitfalls and thereby help them to make better decisions". This message sold very well, opened many doors, and created many jobs (see also Lopes, 1991). Were the proponents of the heuristics-and-biases program able to build bridges between academia and practice? While we anticipate some variance in the answers, we think that the following statement should be uncontroversial: The scientific work provided legitimacy to the consultants, and the consultants provided material, examples, and data to their research colleagues.

"We help you to avoid pitfalls (studied by psychologists) in your managerial decisions" is one door-opener for the consultants. Another could be "we help you to apply prescriptive models of decision theory (developed by mathematicians and economists) to solve your problem". How interested were companies and policy makers in this second offer? With this question, we are exactly where our next contributor, Rex Brown, starts. The author reflects on his attempts, spanning over 40 years, to build bridges between academia on the one hand, and players and organizations in the world of business and politics, often at the highest levels, on the other. He knows both worlds from the inside: He describes himself as alternating between consulting and faculty appointments. From his "practitioner's perspective" he concludes that the "use of quantitative applied decision theory and other formal decision aid has, so far, been surprisingly small given the initial optimism of the 1950s" (Brown, 2015, p. 213). One of the reasons for this lack of appreciation that Brown discusses is organizational constraints: Often, firms and political parties have their own agendas, histories, path-dependencies, cultures, and routines that impede with effective and efficient decision making. In a nutshell, the prescriptive models are great but many organizations are not yet ready for them. The crowd in the street cannot stand the beams originating in the Enlightenment and shining through the centuries and through the models developed by rational and analytically-minded scientists. Another reason for the lack of acceptance boils down to the opposite: the organizations operate in an uncertain world and applied decision theory does not deserve its name since its models are often too remote from the complex realities out there, or its proponents speak jargon and cannot communicate to executives such that those can understand. In a nutshell, the enlightened priests on their mission to bring rationality into this dark world were not able to build the bridge, they have not learned the language of the primitives, and they do not understand what these mortals really need in the wild. Brown (2015) reports various tragic attempts to let the sun of rational thinking shine into the fog and darkness where business and political leaders – and our Lady in Black – are at home. He gives us some insights into such difficulties but he is nevertheless "hopeful that decision-aiding practice and decision science research can, indeed, be integrated into a productive symbiosis where aiders identify their research needs and communicate them to scientists, who respond effectively" (p. 217) and, lucky for us and our readers, he offers various suggestions towards this goal.

Hogarth and Soyer (2015) are concerned with aiding decision makers and with bridging theory and practice as well. Imagine an analyst who needs to communicate probabilistic information to a decision maker, say, to a CEO interested in sales forecasts. That CEO does not necessarily have the best statistical intuitions; she may know little or nothing about, for example, the bias-variance dilemma or the importance of using different data sets to fit and test models (Gigerenzer & Brighton, 2009). How can inevitable uncertainties be best conveyed? One way might be to depict degrees of confidence graphically. Yet, while pictures can convey strong messages, confidence intervals (or other attempts to quantify uncertainty) may not be equally accessible to everyone. Hogarth and Soyer discuss three different ways – decision aids, one could say – of how to inform decision makers about uncertainties in forecasts. They include (1) description, like graphical information displays, (2) simulation, and (3) mixtures of both. In contrast to mere description, simulation is an experience-based approach – akin to problem-based learning and case-based teaching (see e.g., Dietz et al., 2014). The idea is to allow people to experience the involved uncertainties in vivo before making decisions. One way to think of this simulation approach is as aiding decision makers toward developing useful intuitions for themselves through experience, whereas a description approach represents to decision makers the intuitions (or conclusions) drawn by others. Hogarth and Soyer themselves draw an interesting parallel to story-telling: Much like the analyst needs to know what data to present and how to present them in order to convey a message, a story teller needs to know what to say and how to say it to a given audience. Hogarth and Soyer point out that well-crafted stories (and also case-studies, by the way) empower the audience to draw their own conclusions. This approach is in stark contrast to *libertarian paternalism* (Thaler & Sunstein, 2008). Libertarian paternalism does not aim at building intuitions, but, instead, nudges people into what somebody else, a policy maker, has identified as being "good" or "correct" (for a discussion, see Grüne-Yanoff & Hertwig, 2015; and for an extensive discussion on *Educating Intuition*, see Hogarth, 2001).

Story-telling and simulation offer one way to develop intuitions – namely, by experiencing them. The third paper in this series illustrates another way: That intuition is often defined and pinned down

by contrasting it with in-depth analysis and reflection. Most ways to conceive of analysis and reflection, in turn, follow the lead of classic approaches to human rationality: the maximization of expected utility, which typically requires the weighting and adding of relevant information. What happens when classic probability theory is used as a means for grasping rationality? The heuristics-and-biases program gives a resounding answer: People violate various norms. This answer has soon been challenged by shifting the blame from naïve participants to the researchers: the norms were often too narrow, the theoretical accounts of what people were doing instead were too vague and an ecological account was also rarely, if ever, adopted (Gigerenzer, 1991, 1996, 2004; Gigerenzer, Hoffrage, & Kleinbölting, 1991). *Quantum Probability Theory* can be seen as another attempt to challenge the norm, and thereby to rescue the rationality of behavior – just like the St-Petersburg paradox did not lead to declaring all who felt prey to it as irrational. Instead, not the people but the norm was in trouble, and Daniel Bernoulli went back to the drawing board and changed the norm.

Something similar can be said for Quantum Probability Theory. This theory and its potential for understanding intuition is the topic of White, Pothos, and Busemeyer's (2015) article. As these authors point out, what appears to be irrational when seen through the lenses of classic probability theory appears to be rational when seen through the lenses of Quantum Probability Theory. Hence, it all depends on the sort of light that is cast on behavior and judgments and, in turn, which norms are applied to evaluate those. There is an interesting observation that can be made here. Classical probability theory is not very hard to understand, notwithstanding the fact that many experiments seem to suggest that naïve participants violate its norms. As a consequence, it does not take much to declare such deviations – for instance, if someone estimates $p(A) < p(A\&B)$ – as "irrational". From there it is not far to labelling them as "intuitive." In contrast, understanding Quantum Probability Theory is a bit more challenging. It seems that one needs quite a sharpened and sophisticated mind to develop a complex normative framework that, in turn, allows one to present intuitive responses of naïve participants as rational. This observation provokes the following question: If cognition typically thought of as irrational can be turned rational, just through a change of perspective, then what defining features are considered to be intuitive, unreflective cognitions? And what are the implications for research programs that are either built on, or that strongly resonate with, these distinctions, including the heuristics-and-biases framework or System-1-System-2 associates? White, Busemeyer, and Photos inspire us to think about these and related questions.

3.4. Sentencing, valuation, and moral judgments

Being a good researcher can be hard, but operating in an academic institution and assuming various roles also has its challenges. The two of us repeatedly find ourselves in situations in which we feel that we should treat a particular student or colleague in a particular way. The problem is that there are rules for these "cases" and applying them often suggests something else. The term "cases" already reveals the whole conflict.

For many decades, we had a rather influential administrator in our faculty. He was a lawyer. We will refer to him, henceforth, as Lawrence (not his real name). How often did we hear from him "but five years ago, we had a case in which. . ." We felt that this was the wrong approach and that we should not talk about cases, but about people. Cases may be similar, but every person is unique, right? Lawrence turned people into cases by focusing on features that were specified in the rules of our faculty – and he ignored everything else. The argument was then: these cases have *A* in common, so they should all be treated equally. Enforcing rules and equal treatment was his absolute priority. Our first priority was to treat everyone in a fair manner. Often we intuitively felt that for one particular student, with the features *A*, *B* and *C*, the right thing to do would be *X*, and for another one, with features *A*, *B*, and *D*, the right thing would be *Y*. For both students we used common sense and healthy (at least, we would see it so) intuitive and human judgment after we had listened to their stories, often for a long time. Student meetings with Lawrence, in contrast, were typically quite short. After he had learned that these students fell in category *A* (which was legally relevant), the case was clear for him – there was no need to learn about *B*, *C*, and *D*. In a nutshell, Lawrence analyzed cases and thereby based his reasoning on legally relevant features, ignoring everything the law is mute about. We, in contrast, tried to look at the entire situation and apply intuitive common sense – often we did not even know all the subtleties of the law. The clash of frames culminates in the following question: What is more important, the rules or the people?

How would you, dear reader, approach such issues and how would you decide? How would you feel as a student when talking to Lawrence and when talking to us? Do you think the faculty would be better off, in the long run, if it were run by people like Lawrence, or by us?

It seems the pair of archrivals, objectivity and subjectivity, manage to find (and fight) each other everywhere, including when it comes to legal and moral issues, where they appear in the form of objective but rigid rules and subjective but flexible judgments. The arguments and accusations they will elicit from the other side remain the same, across domains: Too analytic, mechanistic, and inhumane versus too intuitive, arbitrary, and unreliable. To see the difference more clearly – and in fact, to this avail we already exaggerated Lawrence's and our stance a little bit – let us look, once more, at caricatures. At the one extreme, courts and administrations will be replaced by software. For every "case", an interface allows to enter the legally relevant information. There would be no interviewer or human being involved in the process of data entry as this could already open the gate for a subjective component – it only has to be ensured that no false information can be fed into the system. The software can then make decisions that are consistent with the law, simply because the law is built into the software and also determined which information has been requested. Systems akin to George Orwell's (1950) *Big Brother* will not only watch our behavior, but also regulate it and be the ultimate judge.

At the other extreme, we have chaos and anarchy. No rules, no order, human judgment all over, eventually even with no, or limited, memory of similar cases. People would use emotions, lies and bribes to manipulate others, decisions would not be reliably made, and in an absence of an objective and neutral institution people will form alliances and find other ways to get what they think they deserve – and most of these ways will have the potential to destabilize society. As Thomas Hobbs (1651) put it in his *Leviathan*, without law and order and strong governments, society will collapse in a war of all against all.

No one, including Lawrence and us, would like to live in any of these extreme worlds. Think of Aristotle's Nicomachean Ethics: each virtue is located between two vices. Hence, the question arises: What is the golden middle? Where exactly should one settle on the continuum between the extremes, and how does one strike a balance?

Our first paper in this series, by Dhami, Belton, and Goodman-Delahunty (2015), is exactly about this middle-ground between intuition and analysis. Following Brunswik (1952) and Hammond (1996), they refer to this middle-ground as quasirationality. In a way, their article is closely related to our repeated discussions with Lawrence. However, these authors do not look at student affairs in an educational program; rather they focus on sentencing in the context of court trials. How should a particular case or person, ideally, be evaluated: by stepping back, abstracting from details, and

applying legal rules in an objective manner, or by getting closer, seeing the specifics and using personal, eventually, intuitive judgment? Dhami et al. look at both the legal system and at the actors in this system. Specifically, they review how sentencing in common law jurisdictions in Australia, in the US, and in England and Wales is regulated and prescribed. As it turns out, none of these legal systems resembles one of our extremes; they all strike the balance between analysis and intuition, albeit with some variation and different tendencies towards the one or the other extreme. Moreover, the authors also study how decision makers – judges, jurors – actually function and decide in these legal environments, thereby addressing the question whether or not there is a place for our Lady in Black in a legal environment.

With the next article – Dickert, Västfjäll, Kleber, and Slovic (2015) – we proceed from values and sentencing to valuation and policy making. The valuation of lives is a thorny issue as the following story illustrates. Being a good mathematician can be hard, but being a good mathematician working for the military secret service during war times has its own challenges. Alan Turing (1912–1954) was not only a good mathematician – he was a genius. And he found his challenges when he got involved in a secret military project whose purpose was to decrypt messages that the Germans sent with their Enigma machines. The Allies could receive all these messages, but without the key they were useless. To cut a long story short, the project was crowned by success and Alan Turing played an eminent, possibly the decisive, role in building a general purpose machine that was able to crack the key – every day, as the key would change every day. Such general purpose machines were later called Turing machines. Today we call them computers.

The larger challenge, however, was yet to come. What to do with the messages they could decipher? Should the British, for instance, prevent those ships from leaving the harbor about which they had learned that the German submarines planned to sink them? Had they done so, the Germans would soon have realized that their encryption method is no longer secret and they would have redesigned it. Turing's work would have been in vain. It was hence crucial for the British to use their intelligence wisely, but in order to do so they had to be smart and cruel at the same time: Save as many lives as possible in the short run but sacrifice as many lives as necessary to keep their success a secret and to save even more in the long run. To implement this strategy, they had to turn people into numbers, just as Lawrence turned them into cases. Tucholsky (1925) told a cynic joke about a diplomat from the Quai d'Orsay (in Paris) who was speaking about the horrors of war: "War? I cannot find that so terrible. The death of a man: that is a catastrophe. One hundred thousand dead: that is a statistic."

But is protecting two ships with 100 passengers each exactly the same as protecting one ship with 200 passengers? How should one distribute resources in humanitarian catastrophes, such as wars, hurricanes, or earthquakes? Should managers, civil servants, politicians and other administrators use Expected Value Theory or Expected Utility Theory to determine which course of action is the best when the goal is to save as many lives as possible? To the extent that every human live should count the same, no matter whether it is one in a group of 1,000 or one in a group of 10,000, it is rational to use expected Value Theory when it comes to valuating large number of lives. A deviation towards Expected Utility Theory would then be classified as irrational. Dickert et al. (2015) dive into the world of policy making, discussing the intuitive valuation of human lives through the lenses of "classic" models of rationality. In doing so, their work can be, perhaps, best situated in the realm of the heuristic-and-biases and related frameworks. They find that valuations of lives are prone to well-documented biases when done intuitively. This result gives rise to a puzzling and disturbing question. Spontaneously, we show some sympathy with intuitive valuations. The Lady in Black as we depicted her is not at all destructive or cruel; rather she seems to be nice, friendly, and someone whom one wants to have at one's side. In contrast, cold bureaucracy and number-crunching computers appear to be inhumane and heartless – and not at all sympathetic. How can it be that such a cold and analytic number cruncher would save more lives than a kind-hearted do-gooder who is proud of valuing human intuitions higher than abstract analyses?

The next paper by Raue, Streicher, Lermer, and Frey (2015) focuses on a topic that is crucial for the two previous papers, even though the term is not mentioned in those: psychological distance. Does it make a difference when decisions are made for a mere number, or a number that comes with a photograph, an acquaintance, a relative, or oneself? Do emotions, moral sentiments, intuitions, and subjectivity enter the room when cold rationality leaves it? Recently, Angela Merkel, currently German Chancellor, was filmed in a "citizen dialogue" with a young refugee girl – a child, speaking perfect German, who had been living with the uncertainty to be deported from Germany after having lived there for four years. Merkel tried to explain the girl the rationale of German immigrant policies – initially in a cold, analytic, almost bureaucratic discourse that contrasted with the tender emotions, vulnerabilities, and dreams of a better life that the girl transmitted. At the close of the interview, in speaking to the girl Merkel said something like this: "politics is sometimes harsh. . .as you are standing now in front of me. . .. then you are an extremely sympathetic human. . ." The moderator suggested Merkel to recall the girl's face when talking about a possible new procedure in German immigrant laws. Finally, the girl started crying, and Merkel walked up to her to caress her (www.youtube.com/watch?v=UIjXkg33EDA). As of writing this article, rumors are that the girl will not be deported.

Clearly, "psychological distance" matters, not only in policy making and politics, but also for cognition and behavior. And here she is again, the Lady in Black. This time, she comes to us with *Construal-Level Theory* (Trope & Liberman, 2010). This theory assumes that only the present (e.g., time, beings, objects) lend themselves to direct experience. In contrast, the future, other people, different locations are mentally farther away. To illustrate, what scares you more: dying of the same sudden cancer-related death a close relative very recently felt victim to, or being executed by a robot twenty years from now? Raue et al. (2015) lead us to ask how the level of construal influences and interplays with decision making. Their answer: Depending on how close or distant something or someone appears, concrete personal plans for tomorrow, hopes for our beloved ones' near futures, or fantasies of a brave new world differ in nontrivial ways. They focus on risks, such as dying of a disease. Their findings from three studies – with students, physicians, and managers – "support the notion that both novices and professionals are influenced by perceived psychological distance when making decisions under risk" (Raue et al., p. 262). The authors also lead us, the editors of this special issue, to ask another question. Could it be that we had the idea of organizing and editing this issue only because our own work is relatively far away from the epicenter of intuition-research? Maybe it was exactly this distance that led us to underestimate the complexities and hence triggered our decision to dare and to start.

Back to the thorny world of human morality. The last paper in this section, by Baron, Scott, Fincher, and Metz (2015), allows us to intuit possible answers to the question how can it be that cold and analytic number crunchers would do, in numeric terms, more good (e.g., save more lives) than kind-hearted do-gooder. It is frequently argued, so Baron et al. point out, that overcoming prohibitions (e.g., Do not kill!) and utilitarian appreciations of overall consequences (e.g., letting a ship with a 100 passengers to be torpedoed to save one with 200 passengers) requires overriding intuitive responses. Put differently, reflection creates distance and cold reasons allow seeing the "bigger picture", illuminating those complex

aspects of a multi-faceted dilemma that intuition leaves in the dark. But is this answer really doing justice to our Lady in Black, or is it, though beautifully simple, too simple, perhaps even simplistic? Diving into the world of careful nitty-gritty experimental research, in five studies Baron et al. invite us to critically reflect upon this and related propositions. They examine individual differences, which they measured in a panel of about 1200 participants, and leave us wondering under what circumstance reflective thinking can really be thought of as overriding intuition as opposed to people relying on intuition simply because they do not reflect sufficiently upon a problem.

3.5. Intuition in the wild

We now move into the last room of our exhibition. The common theme of the pieces in this room is that they all focus on the distinction between analysis, deliberation, or ratio on one side, and implicit or intuitive decision processes on the other – the bright side and the dark side. All of them are purely experimental papers, and none of them engage in modeling. Instead, they all describe behavior and leave it there. None of them interferes with the environment, manipulates or selects stimuli. The authors' approach was to simply ask research participants about situations that naturally occur in their daily lives. All three papers are linked to experience and expertise in the sense that participants were familiar with the domains, situations, and type of decisions. In fact, they all could have been included in the first exhibition room in which we placed Klein, Shanteau and Hammond. We still decided to have two rooms, one for those "elder statesmen" who adopted an aerial point of view and who contributed programmatic papers, and one for the last triple of pieces from our "ethnologists" who collected fresh data in the wild.

Chassot et al. (2015) take us in the domain of investment decisions of financial and energy experts. These experts operate in markets, they sit on millions of dollars, and they need to decide in which energy to invest. The authors focus on two forms of energy: gas and solar energy. The stakes are high, returns on investments are measurable (albeit only ex post!), and the markets are competitive. To the extent that enlightened investors who use ratio and analysis achieve better outcomes than romantic poets who make such decisions based on hunches and gut feelings during full moon nights, one should expect that there is no place for our Lady in such a world.

Would it make sense to ask those experts how they arrive at their decisions? If you think so, we invite you to reread the very first paragraph of the present article. But how could one look into the darkness here if directly asking is problematic? The authors had an intuition how to shed a light at the unconscious of their financial and energy experts. In a way, they followed the footsteps of Sigmund Freud. But times have changed – they did not place people on the couch but in front of a computer screen. Their research question was whether unconscious attitudes toward renewable versus non-renewable energy sources influenced investment behavior. To measure such unconscious attitudes, Chassot et al. (2015) administered the *Implicit Association Test*. Note that Freud and many other psychoanalysts also used associations in their work, but they elicited and analyzed them in many sessions over many weeks. As we already said, *tempora muntur* (times change). Today's lives may be a bit more hectic compared to those 100 years ago, and accordingly – and equipped with modern technology that did not exist back then – the present authors probed their experts' associations and measured reaction times in the range of milliseconds. One of the main results they report is a correlation between implicit associations and investment in solar energy. This finding is even more interesting when contrasted with another one: explicit associations did not at all correlate with investment behavior. It seems our Lady in Black is able to operate in a domain that looks, at first glance, quite hostile for her with its charts, reports, and analyses. And, consistent with her nature, she manages to stay in the dark and to hide, even from those whom she affects.

Like our previous authors, Brown and Daus (2015) focus on experts' job-related behavior, and they look into another aspect of the Freudian id that is often considered to be related to intuition. Specifically, they attempt to penetrate more deeply into the cave of those implicit, mysterious, aspects of cognition that shape and influence reason and that nurtured the fire that consumed Goethe's *Young Werther*: emotions.

These authors studied police officers, that is, those in society who are there to enforce the supremacy of rules, society-built rationality, and objectivity. Do police officers succeed where Werther failed? Are they able to control their emotions, in particular, their anger? But this is not the only variable of interest. Brown and Daus also measured police-officers' inclination for intuitive decision making, and, on a separate scale, their inclination for deliberative thinking. As one of the relationships among these three predictor variables, the authors found that police officers' ability to control affect is positively correlated with their rational decision making style. As their dependent variables, the authors focused on the policer officers' inclination to issue a speed ticket and to discharge a weapon. One of the findings – when explaining such job-relevant behavior in terms of the predictor variable – was that "high intuitive-decision-making style had a stronger relationship with action when police officers felt a stronger propensity to control their anger" (p. 300).

The last article, by Pachur and Spaar (2015), ends this special issue where this introduction started. We reported what many executives admitted to us, namely that they quite often rely on their intuitions. Pachur and Spaar asked their participants, mostly students, for *which* decisions they use them. Specifically, the authors selected six domains – choosing a mate, dress, restaurant, doctor, electronics, and vacation place – and examined, for each of these domains separately, to what extend the participants prefer an intuitive (i.e., spontaneous, affect-based) and to what extent they prefer a deliberative (i.e., effortful, planned, and analytic) decision style. In a way, their article is very closely related to the one by Shanteau (2015). They both focus on domain-specific differences. But the research question is different. Shanteau scrutinizes the performance of experts and relates it to properties of the environments. He finds that experts perform better and are more consistent in domains in which cues are positively correlated. He looked at outcomes and performance, but does not report any data that would speak to the question whether the experts actually used intuition. Pachur and Spaar fill exactly this gap. Granted, they do not model how people decide and whether they actually use intuition or analysis, but they probed people's intuitions about this question. They basically asked their participants, for each of the six domains separately, how loud they cried "*Oh lady lend your hand, oh let me rest here at your side (Uriah Heep)*" and to what extent they felt that she was not *"far away"* and *"filled my heart with life."* The preferences participants reported for intuition and for deliberation showed considerable variability across the domains. In addition, domain-specific preferences for intuition were consistently correlated with self-rated expertise in making decisions in the respective domain – a finding that is entirely compatible with Klein (2003). Do repeated encounters with the Lady in a particular domain boost self-rated expertise and possibly also confidence? Or does repeated exposure to similar situations allow us to activate our cognitive autopilot and, while getting a bit sleepy in this mode and entering her kingdom, we feel that she is at our side?

4. Acknowledgements and epilogue

In closing, we want to express our gratitude to all the contributing authors of this special issue. We feel very much honored to have you on board. We would also like to thank JARMAC's editor-in-chief, Ron Fisher, for giving this project a home in this journal and for his support throughout the entire period, as well as the editorial staff at the publisher, especially Ann Barajas, Jill Shepherd, and Thiyagarajan Sivakumar, who have been extremely cooperative and helpful. Furthermore, we especially want to thank the numerous reviewers for their thoughtful comments and feedback, greatly contributing to this project. Moreover, we would like to thank Guillaume Blanc, Cvetomir Dimov, Sebastian Hafenbrädl, and Justin Olds for helpful comments on previous versions of the current article, as well as Matthieu Legeret for helping us with the references. Special thanks go to numerous authors who provided feedback on our summaries of their articles (and, for some, also on other sections), and to the Swiss National Science Foundation for supporting the research framework in which this special issue is embedded (e.g., SNF 100014–140503/1, 100014–146702). Thanks also go to those authors who considered this special issue as outlet for their work, but who have not been included in the final set, be it because we rejected the submission or because it was withdrawn after we had asked for more than deliverable. In either case, we hope you were able to revise your manuscript such that you could find another outlet for it.

Finally, we would like to thank our dear companion, the mysterious Lady in Black. She was our muse. In writing this introduction, we often felt like having been kissed by her. The kisses were passionate. We received some while we were thinking about how to connect things or which metaphor would fit best. No matter whether these ideas came during day time or during night time (when large parts have been written), they seemingly came out of nowhere, out of some dark corners, remote of our conscious awareness, and we felt she was at our sides. But often it also happened that they came over night – literally, while we have been sleeping in bed with closed eyes – and we woke up with a new idea that we hastened to note down before it would vanish.

Each of us felt like being two authors simultaneously who worked in tandem. One was the rational and analytic scientist whose element is the day and the light, who wanted to produce a well-structured, clear, understandable piece, and who carefully scrutinized the ideas, the flow, and the arguments. The other was a *persona* who, mysteriously, received ideas like kisses and who could truthfully say "*I don't know how she found me; for in darkness I was walking*" (Uriah Heep). Some of these sparkling ideas that came from our night-side and that sent vibrant shivers through our bodies and brains have been highly appreciated by the analytic co-author. Others were rejected. Sometimes these new ideas were easy to integrate; sometimes they messed up the old structure and led us to trash many pages of already polished text. Sometimes it seemed the analytic co-author had the lead; sometimes it seemed the Lady contributed more and deserved first-authorship. In fact, things were even more complex as we wrote this piece together and it happened more than once that some intuitions or sparkling ideas that one of us had turned out to be a challenge for a section that the other one of us had just completed. Having been gone through all these complexities, we hope we managed to connect the various ideas and metaphors in a text with a clear structure, and we hope this text has the potential to unfold some sort of living within you, dear reader. We would be delighted if you happen to read the text before you go to bed, and feel, when waking up the next morning, like having been visited by our dear friend, the Lady in Black.

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