

Illuminating the Neuroscience of Decision-making Through the Dark Night of John of the Cross

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Abstract. In this publication, we will use the principal concepts of John of the Cross, the famous mystic of the XVIth century, as a framework to go over, in a non-reductionist way, three challenges in contemporary neuroscience of decision-making. Firstly, the dark night and the purgative paths will be related to discontinuity in decision-making. Secondly, the passive and active paths will be associated to brain plasticity, architecture, and levels of decision. Thirdly, the illumination, which can be felt when a solution is reached, has to do with positive emotions and can be inspired by the science of love of John of the Cross. We shall lastly conclude by emphasizing the usefulness of his work to illuminate the neuroscience of decision-making.

Keywords: conversion, illumination, purgative path, science of love, unlearning, virtues.

Introduction

To undergo behavioral or cognitive changes, to decide, humans must go through five main steps (Figure 1; Savioz 2021). The initiation step involves the phrasing of the question or of the problem to be solved. Following there is a deliberation step, when different responses are assessed. This step is characterized by higher stress levels related to uncertainty, indecisiveness, or the inability to solve the problem. This will momentarily result in intense intellectual activity or exploratory behaviors. Subsequently, there is a breaking step when one response is chosen. At that moment a climax is reached, comparable to a breathtaking panoramic view after a long mountain hike. Other metaphors have been commonly used to describe this phenomenon of illumination or intuition more precisely. Mechanical metaphors mentioning a combination of elements, such as a key with a specific lock (e.g., Changeux and Connes 1992, 117), correspond to a discovery. A unique key must be found for a specific lock. Fluid metaphors involving a fusion of elements, for instance a log and a flame (Maritain 1963, 741–743),¹ correspond to an invention, one must create or modify a key in order for it to fit the lock. Beyond their limitations, these representations suggest the existence of functional levels at the breaking step. If you cannot find a solution, you must invent one. Lastly, in the two final steps, the implementation and completion steps, the suggested response is evaluated and may lead to an adequate solution.

Even though the overall process of decision-making has been well described by neuroscientists, such as Glimcher (2003) and Peters, McEwen and Friston (2017), key aspects of the deliberation and breaking steps remain largely an enigma.

- 1) The deliberation and the breaking steps are closely linked together, in a continuum. However, the whole decision process appears to be a paradox, as there is also a discontinuity. Indeed, during the pro-

¹ See also John of the Cross (Spiritual Canticle, Stanza XXII, 3; Dark Night, Book II, chap. X, 1).

cess, preconceptions are discarded, motivation must be reinforced, and emotions mastered.

- 2) The existence of functional levels is commonly accepted. For instance, the economist and Nobel laureate 2002, Daniel Kahneman (2011) talks about an instinctive, emotional, and rapid decision-making mode occurring automatically, however with errors, and a slow mode, needing high efforts and attention. One can also think of Alexander Grothendieck, one of the greatest mathematicians of the 20th century. He described the process of dreaming/discovery with three levels, the carnal, the mental and the spiritual level (Grothendieck 1987). However, so far, no consensus has been reached regarding the identity and number of such levels.
- 3) Finally, the process of decision-making has features that challenge experimental and theoretical scientific approaches, thus making it difficult to explain their mechanisms. Already, at the deliberation step, when the individual is confronted by the unforeseen or the unknown, “time” or “duration” appear to be distorted. Additionally, the decision is indescribable and, in some cases, appears to have been made without logic. Unconscious mechanisms predominate until a choice is made.

In the present article we are interested in the general process of decision-making regarding an example of conversion, as described by John of the Cross, or of an important life decision, and not in all steps involved. We are dealing with important and rare choices, such as to convert or not, to opt between moral paths, survival strategies or theories, rather than with minor or day-to-day decision-making, which can participate as building blocks in the whole process. John of the Cross reflected at length on the phenomenon of conversion and proposed a precise, refutable model, which sheds light on the three enigmas raised. Our intention is not to force his explanations onto contemporary neuroscientific data, but to illustrate how his work can be used as a framework to unfold current neuroscientific knowledge regarding the mentioned enigmas. Particularly, how it provides a non-reductionist interpretation of the neuroscience of decision-making, emphasizing the existence of several steps and levels.

After a brief recall of the life and work of John of the Cross, we will talk about each enigma in the next three chapters. The continuity/discontinuity of the deliberation and breaking steps can be illuminated by his concepts of the purgative path and of the dark night, which must be seen as means for facilitating decision-making, not as decision-making itself. Our understanding of the functional levels can be enlightened by the concepts of the active and passive aspects of this path. Lastly, illumination itself deserves to be considered from his notion of the “science of love”. We shall lastly conclude by highlighting how the non-reductionist perspective of John of the Cross contributes to our understanding of decision-making.

1. Life and work of St John of the Cross in brief

Juan de Yepes Álvarez, known as John of the Cross, lived in Spain from 1542 to 1591, in the Renaissance and Reformation time. As a reformer of the Carmelite Order, a follower of Teresa of Avila, he was held captive in Toledo in a dark tiny cell for nine months, between 1577 and 1578, by monks who did not share his conception of life in monasteries. While he humbly accepted his situation, he later acquired the certainty that he was on the wrong track and decided to escape. Jean-Pie Lapierre, an editor who commented on his work, said: “This prison which he leaves as one molts, is it there that John of the Cross was lit by the flame of love, lit and burned? Everything leads to believe it” (Lapierre 1984, 14). The poem he sketched in the prison later led him to phrase a doctrine on the pursuit of perfection, which required going first through, what he called, a “dark night”: the darkness or emptiness in oneself favors the illumination or transformation of oneself. He wrote four texts between 1584 and 1587. These writings speak about the ascent of a “secret staircase” or of a “mystical ladder” associated with a dark night,² forming a purgative path of gradual renunciation (Figure 1). A void is created enabling to purify, rest and strengthen one’s soul until union with God.³ The first text, *The Ascent of Mount*

² John of the Cross (Dark Night, Book II, chap. XVII, 1).

³ John of the Cross (Dark Night, Book II, chap. XXIV, 3).

Carmel, describes the active purgative path. It is a conversion path requiring to make adequate choices, sometimes difficult ones, about life. John of the Cross compared it to climbing a mountain. The second text, *The Dark Night of the Soul*, addresses the passive purgative path, preparing the hu-

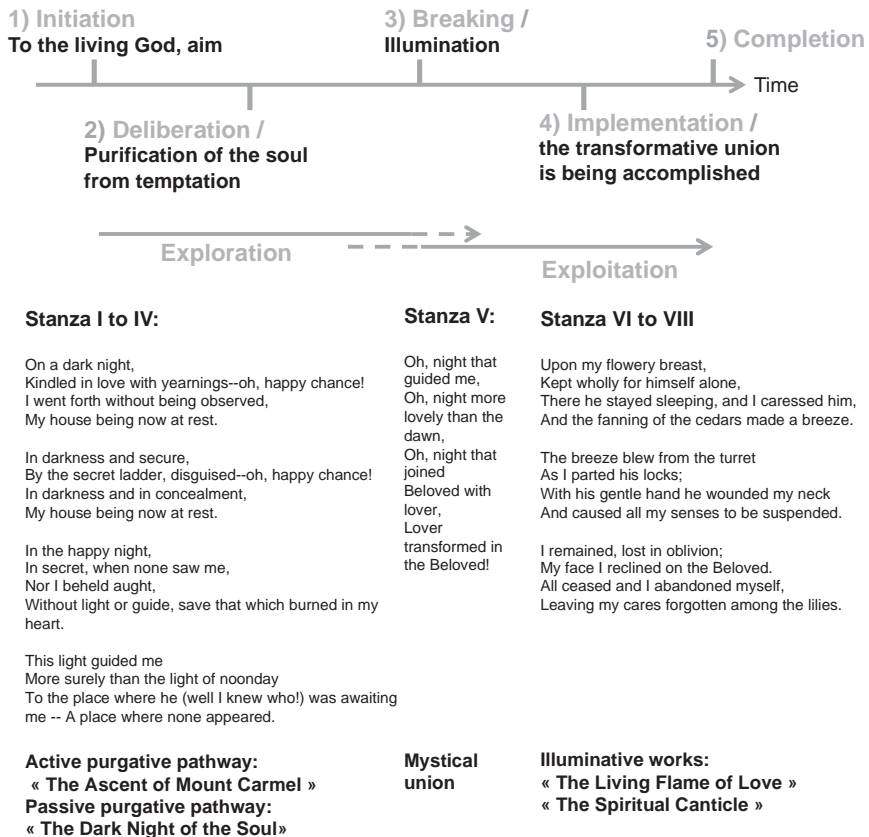


Figure 1. Comparison between the progression of the soul towards conversion/illumination according to John of the Cross (in black) and the model of decision-making in five stages and two movements, exploration, and exploitation (in grey; Savioz 2021)

Source: The progression described by John of the Cross follows the VIII stanzas of the poem stated in the books *The Ascent of Mount Carmel* and *The Dark Night of the Soul*.

man soul to be receptive of grace. This path is parallel to the active path. Once the dark night has been illuminated, the union of the soul with God, also called union of love, is reached. The last two texts, *The Living Flame of Love* and *The Spiritual Canticle*, describe the illuminative path following this mystical union. It is also called a transforming union, meaning that people will devote themselves entirely to their quest. Overall, John of the Cross describes a “science of love”.

2. The purgative path, the dark night and discontinuity

A more precise description of the purgative path, with its ladder or levels and the dark night, will be presented. This will allow us to approach the phenomenon of continuity/discontinuity of decision-making and to understand how to avoid wrong choices. In a second part, these concepts will be applied to the neurobiological data in order to show how they contribute to a non-reductionist vision of the phenomenon of decision-making.

2.1. The purgative path

The purgative path consists in climbing a “secret ladder”, i.e., a psychological or interior staircase.⁴ According to John of the Cross’s anthropology, this ladder is structured. A human being is composed of a body with senses, and a spirit with three main powers: understanding, memory and will.⁵ The path gradually leads to the purification of the self for temptations or sins.⁶ Concretely, it is a question of entering several dark nights (Table 1).

Thus, to progress, the path of conversion firstly requires to enter a night of the senses, i.e., to distance ourselves from the external senses⁷ and passions.⁸ To get to the second level, the spiritual level, it is necessary to immerse oneself in the night of the spirit, i.e., to first enter a night

⁴ John of the Cross (Ascent, Book II, chap. I, 1).

⁵ John of the Cross (Ascent, Book II, chap. VI; Book III, chap. XVI); John of the Cross (Dark Night, Book II, chap. XXI).

⁶ John of the Cross (Ascent, Book I, chap. VIII, 4).

⁷ John of the Cross (Ascent, Book I, chap. XIII).

⁸ John of the Cross (Ascent, Book I, chap. V)

of understanding. This means freeing oneself from one's imagination, fantasy, internal senses,⁹ and supernatural knowledge.¹⁰ Furthermore, it is necessary to enter a dark night of memory and will,¹¹ favoring the passage between levels. Finally, a third level can be reached where "at times the soul remains as it were in a great forgetfulness, so that it knows not where it has been or what it has done, nor is it aware of the passage of time".¹² This level is, unlike the others, timeless. Additionally, it can be irrational and ineffable.¹³ It is better explained by poems than by prose, by anagogy than literally, by mystical language than by philosophical explanations (Maritain 1963, 648–649, 658–659). Indeed, for the mystic, the transformative union with God means "resignation and detachment from everything".¹⁴

Overall, to make an important decision, such as in a conversion, the purgative path has to free the person from his sensual or animal dimension, from the spiritual or rational dimension to, at best, get close to a celestial dimension: "We may say with truth that, that which was sensual becomes spiritual, and that which was animal becomes rational; and even that the soul is journeying from a human life to a portion which is angelical; and that, instead of being temporal and human, it becomes celestial and divine".¹⁵

The doctrine of the dark night is a doctrine of void. Today we would call this, avoiding distractors. This approach to dive into the dark night has the advantage of pursuing the intended goal, not taking any detours, either by getting lost or, even worse, taking erroneous paths and never succeeding. Various harms, such as wandering of memory, are prevented by the same token.¹⁶ It is a question of choosing a path of perfection by avoiding the "way of the lost spirit" which is too attached to earthly

⁹ John of the Cross (Ascent, Book II, chap. XII).

¹⁰ John of the Cross (Ascent, Book II, chap. XXVI). Supernatural knowledge, i.e., visions, revelations, inner words, and spiritual feelings.

¹¹ John of the Cross (Ascent, Book III, chap. I).

¹² John of the Cross (Ascent, Book II, chap. XIV, 10).

¹³ John of the Cross (Dark Night, Book II, chap. XXIII, 10).

¹⁴ John of the Cross (Ascent, Book II, chap. V, 8).

¹⁵ John of the Cross (Ascent, Book III, chap. XXVI, 3).

¹⁶ John of the Cross (Ascent, Book III, e.g., chap. XXII and XXV).

goods and the «way of the imperfect spirit» which remains linked to his interests. Emptying the soul will favor access to the “liberty of spirit”¹⁷ which enables to think of the unthinkable.

Table 1. Functional levels according to John of the Cross^o

<u>Anthropological level</u>	<u>Dark night, powers and union</u>	<u>Virtues</u>
Sensual and animal level	Night of senses (The non-self as a problem)	Soul distantiates from external senses, passions (spiritual deadly sins) and associated particular reasonings or natural knowledge
Spiritual and rational level	Night of the understanding (The human self as a problem)	Soul distantiates from the internal senses (imagination and fantasy), simple general or supernatural knowledge (visions, revelations, inner words, spiritual feelings) – FAITH
	Night of memory and will (The human self as a problem)	Soul distantiates from memories and will – HOPE and CHARITY
Celestial, and timeless level <i>A moment of eternity</i>	Union of love (The others, the All-other)	Soul guided by the «heart» reaches the mystical union

^o John of the Cross describes in *The Ascent of Mount Carmel* three main levels, i.e., the night of the senses, the night of the understanding, memory and will and finally the supernatural level, comparable to the top of Mount Carmel and requiring the union of love and mystical knowledge. The first level is predominant at the deliberation step of the model of decision-making (Figure 1), while the second level is more focused on the moment of rupture or decision-making. Lastly, the third level, the transforming union, projects into the future by integrating the past. More than the others, it gives timelessness to a decision of break in life. The theological virtues, faith, hope and charity, enable to move to the third level. Note that the “All-other” is God.

The phenomenon of discontinuity in conversion is linked to the metaphor of the dark night from the model of John of the Cross. It appears to correspond to an objective reality, which can proportionally deploy itself in order to solve the problem. Indeed, the metaphor of the dark night is commonly evoked in relation to decision-making or ruptures of life. The biologist François Jacob reached at least the first level when he made his discovery, unconsciously recombining different genetical data in a logical explanation while looking at a movie in a dark cinema (Jacob 1987). The writer Emmanuel Schmitt reached the second level when he lost himself

¹⁷ John of the Cross (Ascent, Book III, chap. XXIII, 6); Maritain (1963, pp. 658–661).

at night, in the Hoggar desert, and became spiritual (Schmitt 2015). Finally, a possible example of the third level would be the famous mystical experience of Blaise Pascal, his “night of fire”. At that level, the limits of the reality or of the individual are reached. One is particularly faced with a difficult decision, either because of a lack of information or because of the presence of contrary or plausible truths. If the choice to be made is unavoidable, then it is equivalent to a jump in the dark. Moreover, if the choice cannot be done randomly because of the potentially deleterious consequences it would entail, then it becomes problematic. Knowledge and reason must be transcended by selflessness, empathy, or wisdom (Maritain 1963, 693–694).

2.2. Neuroscience of the purgative path

The model of John of the Cross should encourage scientists to be wary of any simplified vision of decision-making, i.e., when discontinuity is reduced to only one night or the first level. Rather, there are various forms of it, from day-to-day decision-making to conversion.

The dark night can be partly linked to the deliberation step, to the physiological processes of unlearning, or re-learning (Pagani and Merlo 2019). Unlearning is related to intense stressful situations. Fear and despair activate the amygdala and, via glucocorticoids, the hypothalamus-pituitary-adrenal stress system, as well as the adrenergic system. Chronic stress can lead to depression, and hippocampal shrinkage, as is the case in Alzheimer disease (McEwen 2012) resulting in avoidance of decisions.

However, if not too intense or if momentary, a stressful situation at the deliberation step might enable the breaking step (McEwen 2012). This is the case, at the first level, when the “night of the senses” is reached by filtering stressful stimuli out, such as in sensory deprivation, in meditation, or by escaping a stressful environment. Indeed, the unconscious learning by classical conditioning diminishes as stimulus-stimulus association decreases. Under such conditions, the decreased release of acetylcholine might increase cortico-cortical and hippocampo-cortical information processing (e.g., Hasselmo and Giocomo 2006). Additionally, it might also lead to the automatic resolution of a problem by allowing

thoughts to be reorganized or changed. At that first level, the neocortical network of attention might be inactivated, contrarily to the default-mode network, associated with daydreaming (Buckner and DiNicola 2019) and sleep-onset (Lacaux et al. 2021). This network, instrumental to creativity, would participate in the exploration of a variety of competitive cognitive strategies, including behavioral ones, facilitating decision-making.

Interferences of cortical information processing, leading to uncontrolled imagination, fantasy, hallucination, or delusion – the internal senses of John of the Cross – might also result from the low levels of neurotransmitters, such as acetylcholine or dopamine. John of the Cross saw the necessity of entering the nights of the understanding, the memory, and the will, i.e., a second functional level, to limit such phenomena. Nowadays, following scientists such as Hilgard (1980), we would rather evoke the “mental trilogy”, i.e., emotions instead of comprehension/understanding, cognition instead of memory and a rational mind, and motivation instead of will¹⁸. At this second level, unlearning or inhibiting learning helps to master one’s feelings, to update one’s knowledge by forgetting outdated memories, and to control desires. The dark night of the mental trilogy is supposed to enable an ordered exploration of feelings, ideas and desires resulting in a decision that has to do more with a quasi *de novo* creation rather than a discovery, occurring more likely at a first level.

A third level can be reached when no satisfactory solution is found at the first two levels. In such a scenario, no solution seems sufficiently rational. Thus, one has not only to accommodate his mind but also to open it. Unlearning at this level could mean, for example, forgiving oneself for wrong decisions, rather than simply forgetting them. This requires the use of reason in combination with wisdom, selflessness – John of the Cross would speak about love (Table 1) –, and strategies going beyond neurobiological ones, i.e., cultural, and social strategies, whilst applying ethical rules.

¹⁸ The underlying neural networks mainly involve the amygdala and the insula; the neocortex and the hippocampus; and the striatum with the nucleus accumbens, respectively.

3. The passive and active aspects of the purgative path, and the virtues

It is now a question of better understanding the functional levels of decision-making by focusing on the passive and active aspects of the purgative path of John of the Cross. In a second part, we explain how they contribute to underline a non-reductionist perspective of neuroscientific data, that is to say, in this case, a non-deterministic vision of the phenomenon of decision-making.

3.1. The passive and active paths, and virtues

The description of the purgative path given in the previous chapter partly corresponds to the active path. This path uses virtues in association with human mental powers, i.e., the understanding, the memory, and the will, in order to facilitate choices and achieve goals. The powers can go through the dark nights by relying, according to John of the Cross, on virtues of faith, hope and charity, respectively.¹⁹ By opting for the dark night, with the help of these virtues, a selection takes place, avoiding various errors in decision-making, such as excess or wrongdoing in making choices in the pursuit of power, fortune, and pride to succeed.²⁰

In contrast, the passive path results from the fact that the ability of human beings to progress does not primarily depend on their will. It is rather given to them.²¹ A passive path enabling filtering or selection of sensory inputs exists simply because the senses correspond to a “strait gate”.²² However, the path taken thereafter is widening, enabling contemplation or an open mind not distracted by the sensory inputs.²³

For John of the Cross, both paths are necessary and complementary. However, to reach the union of love, the soul must adopt a passive atti-

¹⁹ John of the Cross (Ascent, Book II, chap. VI).

²⁰ John of the Cross (Dark Night, Book II, chap. XXI).

²¹ John of the Cross (Dark Night, Book I, chap. IX, 7).

²² John of the Cross (Dark Night, Book I, chap. XI, 4).

²³ The passive path has the advantage of enabling God to communicate with us while we are tempted (John of the Cross, Dark Night, Book II, chap. XXIII, 2–3).

tude, whereas an active attitude can possibly be an obstacle.²⁴ Hence, in our words, *de novo* creation or invention might be favored by the passive path, more than by the active path alone.

3.2. Neurosciences of the passive and active paths

The passive and active paths can be related to the brain organization, in association with the three functional levels.

Whereas, at the first level, the senses are responsible for a passive selection of sensory inputs (Figure 2), at the second level, the loop networks including the striatum, as well as the amygdala, are involved in motivation and emotions, and participate in the active selection of adequate or virtuous choices or behaviors (Savioz 2021). The motivational loop can be instrumentally conditioned: by trial and error, a person learns to make adequate choices. Conditioning can also be unlearned to promote virtuous attitudes. That is to say, not being too emotional but thoughtful and voluntary enough (Table 1). During the life history of each person, the prefrontal cortex gradually learns to control negative emotions (Smith 2018).

Finally, at the third level, the supramodal neocortical structures, which are characterized by the highest synaptic plasticity, enable undistracted and passive thinking, contributing to decision-making. They consist mainly of the hippocampus and the associative cortices, forming an intentional loop (Freeman 1999; Kozma, 2016). These regions are mainly indirectly stimulated by sensory inputs and can therefore work independently of the stimuli. Consequently, they cannot be conditioned by sensory inputs and can unfold thoughts despite sensory distractions. Novel ideas or solutions can emerge to consciousness. In turn, as a “top-down” information flow, they will be able to influence the sensory inputs, as in active perception, and produce adequate responses in a proactive and not reactive manner, as in goal-directed behaviors (Figure 2). This flow is, for example, activated when a person with a motor disability directs his wheelchair

²⁴ An active attitude of the “soul would be directly quenching the spirituality which God infuses through these imaginary apprehensions...” (John of the Cross, Ascent, Book III, chap. XIII, 4).

by thought via specialized devices (Bastos-Filho et al 2014). In pathologies such as Alzheimer, where significant synaptic losses occur, especially in the supramodal cortices (Savioz et al 2009), the passive path is impaired, resulting in a diminished capacity to make important decisions.

Overall, the passive path of John of the Cross, related to synaptic plasticity and neural network architectures, implies that the decision-making process cannot be entirely conditioned and that therefore, a deterministic explanation will not suffice to understand it.

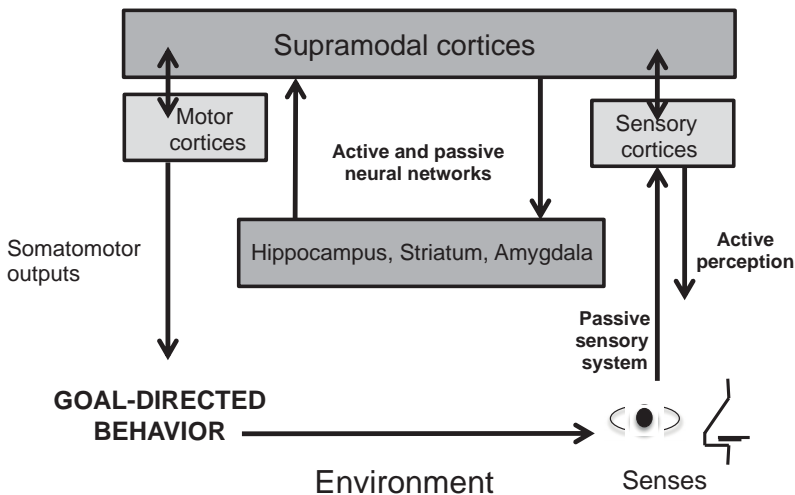


Figure 2. Sensory and motor cortices (light grey) develop earlier than supramodal cortices (dark grey). These last cortices can work independently from sensory inputs, are the most plastic and process the most information. Myelination in these areas happens later. They are capable of top-down information flow and form with the hippocampus, an intentional loop. They are also the most vulnerable in aging and Alzheimer's disease. They cannot be conditioned directly and can therefore be linked to the passive path of John of the Cross. On the contrary, loop networks, involving the striatum and the amygdala can learn by conditioning. One actively learns to make decisions by controlling emotions (amygdala...) and motivation (striatum, cortex)

Source: Figure modified from Savioz (2021).

4. The illumination

Once a decision is made, there is a moment of illumination and the initiation of the transformative path. We will now focus on this moment and explain its relation with the “science of love” of John of the Cross. How such a perspective can be applied to a neuroscience, interested in the phenomenon of illumination, will be discussed.

4.1. The illumination or the point of rupture

For John of the Cross, the moment of illumination is a moment of union of love with God, emerging after having avoided bad decisions and temptations. It is much broader than a deterministic and physicalist point of view where stress is replaced during discontinuity by the pleasure of having found a solution. John of the Cross recognized that graces can be obtained at this stage: beauty, enjoying the sweetness of love, and wisdom or divine science.²⁵ However, this is not the endpoint, as a decision can be followed by other ones that will require an extended effort.²⁶

Thus, for John of the Cross, climbing the ladder of the purgative path “is the science of love”.²⁷ After union, the path will widen considerably, love becoming total and peace settling in. As an owl in the light is dazzled,²⁸ falling in love or a decision make us speechless or can alter our perception of time. This is not about giving an ontological explanation of the vanishing of time, but rather a psychological one. Time is not abolished but life is henceforth forever marked by the choice made.

At the third level, one needs mystical knowledge, that is an intelligence of heart. It goes further than deductive reasoning and sometimes even than the principle of non-contradiction. It also enables one to avoid being trapped by the urgency or impatience, and to consider the long term. John of the Cross gave an example when talking about the disciples

²⁵ John of the Cross (Spiritual Canticle, Stanza XXXVI, 1).

²⁶ John of the Cross (Spiritual Canticle, Stanza XXVI, 2–3); John of the Cross (Dark Night, Book II, chap. XIX–XX).

²⁷ John of the Cross (Dark Night, Book II, chap. XVIII, 5).

²⁸ John of the Cross (Dark Night, Book II, chap. V, 3).

of Emmaus²⁹. They were blinded by their sadness and could not imagine an alternative to their rational explanation, Jesus, whom they believed to be the deliverer of Israel, was dead. Over time, the memory of past events and Christ's announcements opened their hearts, allowing them to recognize the presence of Christ among them. They chose the unthinkable only after ruling out all other options.

At higher levels of choices, love for an ideal also plays a role. Intention must be considered and not anymore just pleasures, interests or psychological, economic, or social gains, such as reputation. It seems inconceivable to grasp, for example, the life of self-giving of Saint John of the Cross while ignoring his aims: "Such is he that loves God; he seeks neither gain nor reward, but only to lose all, even himself, according to God's will; this is what such a one counts gain".³⁰

4.2. Neurosciences of the illumination and of the point of rupture

Inspired by the "science of love" of John of the Cross, we can opt for a neuroscientific perspective that is not limited to instincts, pleasure, and conditioning. If on the first level of the decision-making process, illumination might have to do with achieving pleasures comparable to those of a sexual nature, on the second level, it might refer to the feeling of joy observed in passionate love; and on the third level to mystical ecstasy related to unconditional love, a love in favor, not of a specific person, but of all people.

At the first level, endorphins, and the hormone oxytocin are involved. At the second level, brain networks of motivation and emotions are largely interrelated to the brain network of decision-making. According to Bartels and Zeki (2000), the deactivation of the right prefrontal, parietal, and middle temporal cortices of amorous subjects was related to joy and, in the amygdala, to decreased sadness and fear. At the third level, neuroimaging studies of unconditional or altruistic love showed an activation of many brain regions (Beauregard and Paquette 2006; Beauregard et al

²⁹ John of the Cross (Ascent, Book II, chap. XIX, 9); Lc (24, 13–35).

³⁰ John of the Cross (Spiritual Canticle, Stanza XXIX, 7).

2009). Some of them were also activated during passionate love, such as regions of the striatum.

Depending on the level of choice, a person might be guided by immediate (for instance, in neuroeconomics, short-term financial gains) or deferred pleasures. The frontal and parietal activities which select for the long term, can moderate the motivation, associated with the dopaminergic system, which aims for the short term (McClure et al 2004). At the third level, we can say that an intelligence of heart comes to the front. At that level, the body works united with the conscious “mind”. It was shown, for example, that higher resting heart rate variability reflects a stronger strength of the medial prefrontal cortex – amygdala interaction in human adults, indicating successful emotional regulation (Sasaki et al 2016). This supports a neurovisceral integration perspective (e.g., Thayer, Mather and Koenig 2021).

Overall, current research in neuroscience of happiness shows that a distinction can be made, despite overlaps, between brain networks of hedonia, at a first level, and the motivational brain regions, potentially involved in eudaimonia (good spirit), or happiness, associated with cognitive appraisals of life meaning and engagement, at a second and third level (Kringelbach and Berridge 2009). However, this field of research, and even more so the domain associating happiness and decision-making is still in its beginning stages. Consequently, caution is needed when oversimplifying associations between brain regions, functional levels, and illumination, particularly when resulting from neuroimaging studies. Nevertheless, the existence of functional levels contributes to the avoidance of an approach that is too reductionist regarding the phenomenon of illumination.

Conclusion

In the present article, we were interested in the work of John of the Cross as a framework to unfold present neuroscientific knowledge with respect to three enigmas regarding decision-making, i.e., in short, discontinuity, functional levels and particular features culminating in the illumina-

tion. We wanted to show how the non-reductionist perspective of John of the Cross allows a critical point of view on the neuroscience of decision-making.

Indeed, it appears that, since there are usually several dark nights participating in the purgative path with numerous possible neurobiological implementations (stress, unlearning...), it is necessary to avoid reducing the discontinuity observed in decision-making to a single night or to the first level, especially when we are preoccupied with important life choices. The physicalist perspective appears to be sufficient to explain what happens when unconscious choices are made at a first functional level. One has however to distance oneself from reductive physicalism and biologism, as from the first level on, form and information already play an important role. A decision does not only depend on brain changes, but also on the logic and content of thoughts which are interrelated according to their own rules.

Furthermore, the passive and active aspects of the purgative path of John of the Cross enlighten our understanding of functional levels. Mainly, it was observed that, due to the existence of the passive path, partly related to the synaptic plasticity of neural networks, decision-making cannot be fully conditioned, thus ruling out deterministic models as explanations.

Lastly, it is worth considering illumination itself from the notion of “science of love” of John of the Cross. It has been noted that, depending on the level of decision-making, it is either related more to pleasure, passionate love, or unconditional love. It is also possible to establish links between these levels of love and the duration of a decision.

Overall, we have seen that human beings are either passively confronted with dark nights, or can actively seek out such nights and even increase or decrease their intensities to reach a solution. Moreover, the clearer is not explained by the darker. An appropriate level of darkness is a condition to reach illumination. The solution is not given by the darkness but by the person who goes through a dark night. However, to fully understand the decision-making process, neuroscientists will still need to explain all the features of illumination that John of the Cross men-

tioned, such as the vanishing of time. There remains the possibility that they will discover that the closer they get to the breaking step, the more illumination will appear as an unfathomable black hole.

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