FREE WILL AND DECISION MAKING IN AESTHETIC AND MORAL JUDGMENTS

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Sommario: 1. *The dominant view on human freedom*. 2. *Criticisms to the assumptions derived from Libet's results*. 3. *Functional brain imaging during aesthetic judgment*. 4. *Neurophysiology of moral judgment*. 5. *Conclusive considerations*.

As each of us knows by introspection of one's own thoughts and feelings, human beings possess the unique capability of conscious and rational evaluation of alternatives. This is the basis for all conscious decisions in everyday life as well as in specific situations, like those in which we ought to make choices that will have long-lasting effects on our lives. Our feeling during conscious decisions is dominated by the certainty of being completely free. For example, we feel free when we decide to perform even very simple movements and also when we judge if a picture is beautiful, neutral or ugly. Even more, we feel free to decide our conduct in moral dilemmas, in which it is critical to assign a global judgment of right or wrong to possible alternatives in which we risk to harm other individuals.

1. The dominant view on human freedom

The freedom of the human will has been challenged by the revolutionary results of Benjamin Libet.[1] In a brain region, known to be involved in the programming and execution of movements, Libet and his research team found a neural activation well before the appearance of the conscious awareness of the decision to act. Therefore, if the brain starts the generation of the motor command before the subject consciously decides, then the decision is not conscious. Instead, the brain decides, and only afterwards it generates the mental state corresponding to the feeling of the conscious decision. In this conception, our freedom is a mere illusion. With an unfounded generalization of this concept to every human decision, it could be assumed that our brain

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[1] B. Libet, C. A. Gleason, E. W. Wright, D. K. Pearl (1983), *Time of conscious intention to act in relation to onset of cerebral activity (readiness-potential). The unconscious initiation of a freely voluntary act*, «Brain», vol. cvi, pp. 623-642.

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always decides for us, and only when the decision has already been taken we feel to be the author of the choice. This lack of freedom of the will has been arbitrarily extended to every kind of decision, including aesthetic and moral judgments. In conclusion, in this view we are never free, because our brain decides for us and at the same time it creates the illusion that our conscious self is the real author of our choice. But, since the brain is completely determined by physical laws, actually there is no free subject at all. The whole universe is completely subjected to physical laws, which are sufficient to explain everything, including, in the future, also human mental activity.

2. Criticisms to the assumptions derived from Libet's results

The aforementioned assumptions, especially the generalizations and the wishful thinking about what science will explain in the future, are not the only possible interpretation of the results of Libet and colleagues. Since the main topic of this article concerns human judgments, here I only summarize the main criticisms to Libet's experiments, which are described in more detail elsewhere.[2]

1. In Libet's experiments, the timing of the first conscious will to move was retrospectively reported by the subject after the end of the movement. Therefore, the timing of brain activity was a physical time, recorded as an electrical signal. However, the timing of the awareness of the will to move was a mental time. From several other observations, it is clear that the mental time is not in register with the physical one, especially when it regards a comparison with a self-generated behaviour. For example, in the stopped clock illusion (chronostasis) the time in which we are blind while we are shifting our gaze from one point of the visual scene to another is filled back with the image of the ending point.[3] As a consequence, we are not aware of the time gap between the two images. Another example is the temporal attraction of the perceived times of actions and their presumed effects. In this time illusion, the interval between a voluntary action and a delayed sensory stimulation is perceived with a duration shorter than the physically measured elapsed time.[4]

2. A second line of criticism to the interpretation of Libet's findings is based on the fact that the real meaning of the electrical activity which precedes the awareness of the will to move is still undefined.[5] The early brain activation is

[2] F. Tempia (manuscript in preparation), in *Proceedings of stoq iii Project Workshop*, Roma.

[3] K. Yarrow, P. Haggard, R. Heal, P. Brown, J. C. Rothwell (2001), *Illusory perceptions of space and time preserve cross-saccadic perceptual continuity*, «Nature», vol. cdxiv, pp. 302-305.

[4] P. Haggard, S. Clark, J. Kalogera, (2002), *Voluntary action and conscious awareness,* «Nature Neuroscience», vol. v, pp. 382-385.

[5] H. Shibasaki, M. Hallett (2006), *What is the Bereitschaftspotential?*, «Clinical Neurophysiology», vol. cxvii, pp. 2341-2356.

reported in a cerebral region defined as the 'precentral cortex', which includes the primary motor area but also premotor regions. The latter areas display an activity, which is correlated with the execution of voluntary movements, but also with the sole intention or ideation to move without any motor consequence. In my opinion, it is plausible that the early electrical brain activation before a voluntary movement is simply related to the abstract ideation of moving without any decision of whether to execute such idea or to desist from the action. Until the area related to the execution instead of the ideation of movement will be better defined, it remains possible that the brain activity which precedes the awareness of the will is not downstream relative to the decision to move, but is still in a phase when the decision has not yet been taken.

3. The third type of criticism is that, in the experiments by Libet and colleagues, the kind of voluntary movement under investigation was an extremely simple one, such as the flexion of a finger to press a button. Movements of this type in everyday life are usually performed almost automatically, in the context of a more complex behaviour, which is driven by a conscious intention. As a consequence, the paradigm of Libet's experiments, chosen because it can be easily assigned to a precise time point, is not a suitable example for an intentional movement driven by a conscious decision. For this reason, I find it more interesting to extend the study of conscious decision making to aspects which are exclusive of human free thinking, like aesthetic and moral judgments.

3. Functional brain imaging during aesthetic judgment

Humans are the only living beings that appreciate beauty as an abstract category, even separated from any utilitarian purpose. The judgment whether a picture is beautiful or ugly is a decision, which is not possible without a conscious evaluation. This is in contrast with the first stages of processing of visual signals, from which visual perception originates in an automatic fashion, which cannot be modified by a conscious effort. We can voluntarily close our eyelids or we can stare at a certain spot or we can focus our attention to a detail of the visual scene, but we cannot decide to obtain a different perception of an object. In this respect, it is interesting to note that the perception of an object is a real recognition of its meaning. In conditions of poor lighting, it is possible to see an object, which remains as an undefined mass until it is recognized and assigned to a specific category, like for example a satchel or a knapsack or a wastepaper basket. Before the recognition, the object is just a darker or a lighter area in the visual field. The definite vision arrives suddenly, as a visual understanding of the object, but not through a conscious effort. Our feeling is that the recognition occurs automatically, by brain centers that are continuously active independently from our will. This is well documented through illusions, which are false perceptions, that resvet from a misinterpretation of a visual object. Therefore, the first stages of processing of visual signals are not under voluntary control, except for the focusing of attention, which can selectively enhance the analysis by visual centers of a particular object or a specific feature. The fact that we cannot voluntarily change the processing of images does not mean that the results remain subconscious, under the level of consciousness. In fact, a visual perception is a conscious experience, although it is the result of a complex signal processing of which we are unaware.

At present it is unclear which is the first neural structure where conscious visual perception arises. There is general agreement about the lack of conscious perception associated with visual signal processing in the retina and about the central role of the thalamo-cortical system in consciousness. The thalamo-cortical system is composed of the thalamus, which is a series of nuclei localised in the depth of the brain, around the third cerebral ventricle; and by the cerebral cortex, which has reciprocal connections with thalamic nuclei. Since such connections run in both directions – from thalamus to cortex and vice versa – they are often referred to as thalamo-cortical loop. For this reason, it is difficult to dissect the localisation of functions between these two structures: a damage to either the thalamus or to the cortex disrupts the activity of the whole loop. Besides these two structures there is a third series of deep nuclei, called the basal ganglia, which are mainly located close to the lateral cerebral ventricles. Basal ganglia participate in unidirectional loops, receiving signals from the cortex, sending their output information to thalamic nuclei, which eventually project back to the cortex. Although their role is not completely defined, the basal ganglia are maintained to serve a purpose of stabilisation of cortical activity. Again, due to their location inside a loop, it is difficult to distinguish their precise contribution to conscious functions, in which the cerebral cortex is obviously involved.

Both the thalamic nuclei and the basal ganglia present with an orderly structure, in which each specific subdivision of cortical areas is connected to a selective corresponding thalamic nucleus and a well defined compartment of a basal ganglia nucleus. This complex fractionation of circuits is also present at the level of cortical areas: every cortical division possesses extensive connections with many other areas, although not in a random fashion but with well identifiable projections. This regional specificity of connections is also reflected in the temporal coherence of spontaneous fluctuations of the cortical activity, measured by functional imaging techniques.[6] Cortical areas related to vision constitute one of such functional connectivity systems, in which synchronous activity fluctuations are present even in basal resting conditions and under light anaesthesia.[7]

[6] M. D. Fox, M. E. Raichle (2007), *Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging,* «Nature Reviews Neuroscience», vol. viii, pp. 700-711.

[7] J. L. Vincent, G. H. Patel, M. D. Fox, A. Z. Snyder, J. T. Baker, D. C. Van Es-

Because of the complexity of brain architecture, both at the structural level of the connections and at the functional level of synchronicity of activity oscillations, it has been and it is still extremely difficult to better define which are the neural structures, which are most directly correlated to and necessary for any kind of conscious experience. This problem is referred to as the search of neural correlates of consciousness (NCC).[8] Some authors, in order to simplify the terms of the NCC investigation, have tried to study, as example of conscious experience, visual perception. Although no solution has been found so far, even for this very simple form of consciousness, an interesting framework to face this problem is the one proposed by Crick and Koch[9] (for an update see Tononi and Koch[10]). These authors propose that the activation of the occipital cortical areas directly related to the processing of visual signals is not enough to enable conscious perception. In order to experience a perception, it would be necessary to wait the spread of activation to the frontal lobe and then back to the occipital cortex. At present there is no experimental demonstration of the validity of such a hypothesis.

From the introduction above, concerning the problems of visual processing and of visual conscious perception, it is now possible to leap to the pattern of activation of the cerebral cortex during aesthetic judgements. In this case, the conditions engage much more than vision, because an evaluation and a decision are also involved. It is important to note that, with the technique utilized for most studies of functional localization of brain activity, called functional magnetic resonance imaging (fMRI), the rate of oxygen consumption (blood oxygen level dependent signal: BOLD signal) is measured over the whole cerebral cortex. Oxygen utilization rate in the central nervous system is very high compared with other tissues and organs, accounting for about 20% of the total body energy for an organ, which weights only about 2% relative to the body mass. This high rate of caloric expenditure is nearly the same in resting conditions, when the brain in not engaged in any task and with the eyes closed and in the absence of other sensory stimuli, compared with situations in which some cortical areas are performing operations related to a sensory, behavioral or cognitive tasks. For example, during a heavy mental task (e.g. solving arith-

SEN, J. M. ZEMPEL, L. H. SNYDER, M. CORBETTA, M. E. RAICHLE (2007), *Intrinsic functional architecture in the anaesthetized monkey brain,* «Nature», vol. CDXLVII, pp. 83-86.

[8] J. R. SEARLE (2000), *Consciousness,* «Annual Reviews Neuroscience», vol. XXIII, pp. 557-578; KOCH C (2004), *The Quest for Consciousness: A Neuroscientific Approach*, Englewood, Roberts & Co.; BLOCK N (2005), *Two neural correlates of consciousness,* «Trends in Cognitive Sciences», vol. IX, pp. 46-52.

[9] F. CRICK, C. KOCH (2003), *A framework for consciousness,* «Nature Neuroscience», vol. VI, pp. 119-126.

[10] G. TONONI, C. KOCH (2008) *The neural correlates of consciousness: an update,* «Annals of the New York Academy of Sciences», vol. MCXXIV, pp. 239-261.

metic problems), there is no significant change in total brain blood flow or oxygen consumption.[11] With the extremely sensitive functional imaging techniques, which has became available in the last few decades, it is possible to detect tiny changes in localised brain areas. Such increases of blood flow or glucose utilization, related to the activation of a cerebral area, are changes of less than 5-10% relative to the basal rate, resulting in even smaller changes in oxygen consumption usually ranging 1-5% of the basal rate.[12] It is remarkable that in 1878 an Italian physiologist (Angelo Mosso, University of Torino) first described a functional change of brain circulation restricted to a cortical area (the right prefrontal cortex) during mental arithmetic calculations.[13] Mosso exploited a bony defect of the subject's skull, which allowed him to directly observe pulsations in brain arteries. In conclusion of this brief appraisal of the functional imaging technique, we must keep in mind that, whenever a brain area is shown to 'activate' in relation to a specific task, such 'activation' is not a switching on of a machinery that was inactive, but a tiny increase of a background activity, which was very high also at resting, idle conditions.

A first fMRI study in the search of the neural correlates of the experience of beauty was performed by Kawabata and Zeki.[14] In this study, the subjects viewed four categories of paintings (a portrait, a landscape, a still life, an abstract composition), which they previously classified as beautiful, neutral or ugly. Obviously, the cerebral areas related to the analysis of visual signals showed an increase of activity. In addition, specific activations were observed in correlation with the category of the painting. For example, the cortical area of face recognition was more activated for portraits, while cortical areas related to the processing of spatial aspects were activated more intensely in the case of landscapes. However, the aim of this research was to uncover the areas, in which the activation was related to the subjective aesthetic judgment of beauty. For this purpose, brain activity was compared in the cases of beautiful versus neutral and, to increase the contrast between the conditions, of beautiful versus ugly. In both cases there was no distinction between the four categories of paintings. In the latter condition – comparison of beautiful ver-

[11] L. Sokoloff, R. Mangold, R. L. Wechsler, C. Kenney, S. S. Kety (1955), *The effect of mental arithmetic on cerebral circulation and metabolism*, «Journal of Clinical Investigation», vol. xxxiv, pp. 1101-1108.

[12] M. E. Raichle, M. A. Mintun (2006), *Brain work and brain imaging,* «Annual Reviews Neuroscience», vol. xxix, pp. 449-476; M. D. Fox, Raichle (2007), *Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging,* «Nature Reviews Neuroscience», vol. viii, pp. 700-711.

[13] A. Mosso (1881), *Ueber den Kreislauf des Blutes im Menschlichen Gehirn*, Leipzig, Verlag von Veit & Co.

[14] H. Kawabata, S. Zeki (2004), *Neural correlates of beauty*, «Journal of Neurophysiology», vol. xci, pp. 1699-1705.

sus ugly – an activation of the medial orbitofrontal cortex was detected. However, in this case the comparison is between two distinct judgements – beautiful vs. ugly – so that each of them could in principle be associated with the activation or deactivation of different cerebral areas. The crucial comparison is therefore between beautiful and neutral pictures. In this case, the cerebral activation included the orbitofrontal cortex, the anterior cingulate cortex and the posterior parietal cortex. Kawabata and Zeki[15] interpret this result as an engagement of areas involved in emotional states which derive a concept of human aesthetic perception as a primitive feeling related to emotion and reward. A detailed criticism to this conclusion can be found in Tempia,[16] where it is argued that the results by Kawabata and Zeki are instead consistent with the activation of cerebral areas involved in rational evaluation.

The activation of the orbitofrontal cortex was confirmed by Jacobsen and colleagues,[17] although the precise area involved was localized to Brodmanns's area (BA) 11 by Kawabata and Zeki[18] while it was identified as the nearby BA10 by the latter report.[19] The orbitofrontal cortex is engaged during decision making.[20] Especially its anterior portion, corresponding to BA10, was shown to enable contingent interposition of alternatives of mental tasks or behavioral plans.[21] Therefore, the activation of the orbitofrontal cortex in aesthetic judgement has to be related to the decisional nature of the underlying process, requiring the simultaneous evaluation of the 'beautiful/not beautiful' alternative. Jacobsen and colleagues [22] interpret the activation of BA10 as related to the explicit processing or introspective evaluation of internal mental states, such as one's own thoughts and feelings.

In addition to the BA10, Jacobsen and colleagues[23] also observed a bilateral activation of the BA45/47 and the left temporal pole. The former has

[15] *Ibidem.*

[16] F. Tempia (2008), *Attività cerebrale, percezione visiva e giudizio estetico.* in *La natura dell'uomo. Neuroscienze e filosofia a confronto*, a cura di Grassi P, Aguti A, Milano, Vita e Pensiero, pp. 55-63.

[17] T. Jacobsen, R. I. Schubotz, L. Höfel, D. Y. von Cramon (2006), *Brain correlates of aesthetic judgment of beauty*, «NeuroImage», vol. xxix, pp. 276-285.

[18] H. Kawabata, S. Zeki (2004), *Neural correlates of beauty*, «Journal of Neurophysiology», vol. xci, pp. 1699-1705.

[19] T. Jacobsen, R. I. Schubotz, L. Höfel, D. Y. von Cramon (2006), *Brain correlates of aesthetic judgment of beauty*, «NeuroImage», vol. xxix, pp. 276-285.

[20] E. Koechlin, A. Hyafil (2007), *Anterior prefrontal function and the limits of human decision-making,* «Science», vol. cccxviii, pp. 594-598; D. Lee, M. F. Rushworth, M. E. Walton, M. Watanabe, M. Sakagami (2007), *Functional specialization of the primate frontal cortex during decision making,* «Journal of Neuroscience», vol. xxvii, pp. 8170-8173.

[21] E. Koechlin, A. Hyafil A (2007), *Anterior prefrontal function and the limits of human decision-making,* «Science», vol. cccxviii, pp. 594-598.

[22] T. Jacobsen, R. I. Schubotz, L. Höfel, D. Y. von Cramon (2006), *Brain correlates of aesthetic judgment of beauty*, «NeuroImage», vol. xxix, pp. 276-285.

[23] *Ibidem.*

been shown to be related to evaluative tasks in contrast to either semantic or episodic judgments, suggesting that it reflects a constructive on line process rather than a controlled activation of memory representation. Jacobsen and colleagues[24] suggest that the recruitment of area BA10, BA45/47, anterior cingulate, and left temporal pole in the aesthetic evaluative judgment depends upon the intentional nature of the processes, in contrast to implicit evaluation. They conclude that «the aesthetic judgments of beauty trigger activation in a brain network that generally underlies evaluative judgments, and hence share neural substrate with, e.g., social and moral judgements».

The conclusions of Jacobsen and colleagues[25] are also consistent with the findings obtained by techniques, which, at variance with fMRI, allow a precise temporal resolution of the neural activation. In a study utilizing magnetoencefalography, Cela-Conde and colleagues[26] reported, in the left dorso-lateral pre-frontal cortex (DLPFC), an activation with a long latency in the range of 400-1000 ms. Such latency is in contrast to earlier and more automatic stages of visual processing (e.g. the visual cortex displayed activation at 130 ms), in accordance with explicit intentional processing. In addition, this study clearly shows that the dorsal aspect of the prefrontal cortex is involved in aesthetic perception. This is an important observation, because the DLPFC is involved in functions like monitoring the abstract properties of a sensory stimulus and encoding the state of the environment, in order to choose between multiple possibilities.[27] Even more interestingly, the DLPFC is considered involved in rational judgments related to decision making which is in agreement with an intentional nature of the aesthetic judgment.

Höfel and Jacobsen[28] confirmed this conclusion through the use of electroencephalography (EEG), which is another technique with a high temporal resolution. In this study, they show that a late component of the EEG wave, specifically related to intentional evaluation, is selectively present even during pure aesthetic contemplation. Such EEG wave consists of a lateralized late positivity (in a time window of 500-770 ms after stimulus onset) recorded in

[24] *Ibidem.* [25] *Ibidem.*

[26] C. J. Cela-Conde, G. Marty, F. Maestú, T. Ortiz, E. Munar, A. Fernández, M. Roca, J. Rosselló, F. Quesney (2004), *Activation of the prefrontal cortex in the human visual aesthetic perception,* «Proceedings of the National Academy of Sciences of the United States of America», vol. CI, pp. 6321-6325.

[27] D. Lee, M. F. Rushworth, M. E. Walton, M. Watanabe, M. Sakagami (2007), *Functional specialization of the primate frontal cortex during decision making*, «Journal of Neuroscience», vol. XXVII, pp. 8170-8173.

[28] L. Höfel, T. Jacobsen (2007), *Electrophysiological indices of processing aesthetics: Spontaneous or intentional processes?,* «International Journal of Psychophysiology», vol. LXV, pp. 20-31.

the central region of the scalp. Höfel and Jacobsen,[29] on the basis of their results and of previous knowledge, conclude that the lateralized late positivity reflects the processes of evaluative categorization: its relation to aesthetic contemplation is to be related to the intention to evaluate the aesthetic value of the patterns, even in the absence of aesthetic judgments. Moreover, their results show that the lateralized late positivity reflects a sub-process involved in both intentional aesthetic contemplation and aesthetic judgment of the pictures, while an earlier frontocentral wave reflects a sub-process specifically related to aesthetic judgement. The final conclusion of Höfel and Jacobsen[30] is that «aesthetic appreciation of beauty appears to require intention and is not spontaneous in character».

Taken together, the neurophysiological data indicate that the human aesthetic experience, both as simple contemplation and also as judgment derived from a decision between alternatives, requires intention of the subject and is completely different in nature from the earlier automatic processing of visual signals. Moreover, the activation of the orbitofrontal cortex during aesthetic judgments is in agreement with a process of decision making on the basis of both rational and emotional components. In fact, the orbitofrontal cortex is related to explicit processing and introspective evaluation of internal mental states. Even more interesting is the late activation of the DLPFC, which is related to rational thinking and explicit evaluation in the formation of judgments. From these considerations, it can be hypothesized that the fact that humans exclusively are capable of aesthetic appreciation is related to a 'qualitatively' higher intentional and rational control of mental states.

4. Neurophysiology of moral judgment

Among living beings, human experience and behaviour are unique since they are guided by judgments of what is right or fair in contrast to what is wrong or unfair. Moral evaluations and judgments are based on moral cognition and ethical reasoning, in which rational aspects interact with emotional and motivational mechanisms to produce moral thoughts and choices.[31] Alterations of moral behaviour are present following lesion to one of several brain regions. The most critical areas of cerebral cortex involved in moral decision making are the prefrontal cortex and the temporal lobe (for a review see: Moll and colleagues[32]). Patients with damage to a prefrontal area known as

[29] *Ibidem.* [30] *Ibidem.*

[31] J. Moll, R. DE Oliveira-Souza, R. Zahn (2008), *The neural basis of moral cognition: sentiments, concepts, and values*, «Annals of the New York Academy of Sciences», vol. mcxxiv, pp. 161-180.

[32] J. Moll, R. Zahn, R. de Oliveira-Souza, F. Krueger, J. Grafman (2005), *Opinion: the neural basis of human moral cognition,* «Nature Reviews Neuroscience», vol. vi, pp. 799-809.

the ventro-medial pre-frontal cortex (VMPFC) exhibit markedly reduced social emotions and an abnormally utilitarian pattern of moral judgments in high conflict scenarios.[33] On this basis, the VMPFC is considered as an area coding for the emotional relevance of the situation and its activation would lead to a dominance of emotional aspects in implicit moral choices. This area is set in opposition to the dorso-lateral pre-frontal cortex (DLPFC), which is necessary for 'cold blooded' utilitarian choices based on explicit abstract rational reasoning. The DLPFC is considered involved in executive control, goal maintenance and the inhibition of prepotent responses.[34] Some fMRI studies support this theory. Studies aimed at identifying the brain regions which are activated during moral evaluations with different emotional/rational content, presented the subjects with moral dilemmas, which are problems that entail dissonant choices of comparable motivational strength. One example is the trolley dilemma:[35] «A runaway trolley is headed for five people who will be killed if it proceeds on its present course. The only way to save them is to hit a switch that will turn the trolley onto an alternate set of tracks where it will kill one person instead of five. Should you turn the trolley in order to save five people at the expense of one?» Most people say yes. This kind of dilemma is defined as 'impersonal', because it involves the deflection of an existing threat. In contrast, a moral dilemma defined as 'personal' is the footbridge dilemma:[36] «As before, a trolley threatens to kill five people. You are standing next to a large stranger on a footbridge spanning the tracks, in between the oncoming trolley and the helpless five. This time, the only way to save them is to push this stranger off the bridge, onto the tracks below. He will die if you do this, but his body will stop the trolley from reaching the others. Should you save the five others by pushing this stranger to his death?» Most people say no. In the latter case, the subject would be the agent directly causing the death of the stranger by personally pushing him onto the tracks. Greene and colleagues[37] hypothesized that in this case the subject feels more personally involved and experiences a sense of 'agency' because the action springs more directly from the agent's will. In such situations, they hypothesized that brain regions involved in emotion will be activated more intensely. In fact, with

[33] M. KOENIGS, L. YOUNG, R. ADOLPHS, D. TRANEL, F. CUSHMAN, M. HAUSER, A. DAMASIO (2007), *Damage to the prefrontal cortex increases utilitarian moral judgements,* «Nature», vol. CDXLVI, pp. 908-911.

[34] E. K. MILLER, J. D. COHEN (2001), *An integrative theory of prefrontal cortex function,* «Annual Reviews Neuroscience», vol. XXIV, pp.167-202.

[35] J. J. THOMSON (1986), *Rights, restitution, and risk: essays, in moral theory,* Cambridge, MA, Harvard University Press.

[36] *Ibidem.*

[37] J. D. GREENE, R. B. SOMMERVILLE, L. E. NYSTROM, J. M. DARLEY, J. D. COHEN (2001), *An fMRI investigation of emotional engagement in moral judgment,* «Science», vol. CCXCIII, pp. 2105-2108.

fMRI, Greene and colleagues[38] described a greater activity for personal, as compared with impersonal, moral judgment in brain areas known to be associated with emotion, including VMPFC and the superior temporal sulcus. In a more recent report, Greene and colleagues[39] studied brain activation associated with moral dilemmas that bring cognitive and emotional factors into more balanced tension. One example is the crying baby dilemma: «Enemy soldiers have taken over your village. They have order to kill all the remaining civilians. You and some of your townspeople have sought refuge in the cellar of a large house. Outside, you hear the voices of soldiers who have come to search the house for valuables. Your baby begins to cry loudly. You cover his mouth to block the sound. If you remove your hand from his mouth, his crying will summon the attention of the soldiers who will kill you, your child and the others hiding out in the cellar. To save yourself and the others, you must smother your child to death. Is it appropriate for you to smother your child in order to save yourself and the other townspeople?» This is a personal moral dilemma and, in addition, it is a difficult one. Participants tend to answer slowly and they exhibit no consensus in their judgments. The reason why this dilemma is difficult is that the strong negative emotional response of the idea of killing one's own baby is set in competition with the abstract cognition that, relative to the alternative in which everybody are killed by the soldiers, there is nothing to loose and several lives to gain in smothering the child. During difficult moral judgments, relative to easy ones, there was a greater activation of DLPFC (BA10/46) and inferior parietal lobes including the superior temporal sulcus. In addition, there was activation of the anterior cingulate cortex (ACC), which is known to be associated with cognitive conflict. In the same report,[40] utilitarian moral judgments (accepting a moral violation), compared with nonutilitarian moral judgments (prohibiting a personal moral violation), were found to be associated with a greater activation of DLPFC and the right inferior parietal lobe (BA40). This result is interpreted as a dominance of abstract reasoning in utilitarian choices. The conclusion of Greene and colleagues[41] is that the personal, emotional pondering is linked to the activity of cortical areas, like VMPFC, involved in emotional processing. In contrast, areas like DLPFC deploy cognitive control. In this view, the outcome of the moral evaluation arises from the competition between emotional and cognitive brain areas: when the former ones win, the judgment is in favour of personal elements, while a victory of cognitive areas overrides

[38] *Ibidem*.

[39] J. D. Greene, L. E. Nystrom, A. D. Engell, J. M. Darley, J. D. Cohen (2004), *The neural basis of cognitive conflict and control in moral judgment*, «Neuron», vol. XLIV, pp. 389-400.

[40] *Ibidem*.

[41] *Ibidem*.

emotional responses generating an utilitarian judgment[42] (see also Young and Koenigs[43]).

Similar, but not identical, results were found by another research group.[44] In the comparison of moral versus non-moral scenarios, the areas with a specifically greater activation were the medial frontal gyrus and the frontopolar region (within BA10), the posterior superior temporal sulcus/inferior parietal lobe (BA19/39), and the left rostral DLPFC (BA9/46). However, in this study the areas more associated with cognition (like DLPFC) displayed a greater activation in scenarios in which action and inaction result in the same amount of harm, while areas more associated with emotion (like the orbitofrontal cortex) were more activated for conflicts between goals of minimizing harm and for those involving intentional harm. Schaich Borg and colleagues[45] conclude that «morality is not represented in one place in the brain, but instead is mediated by multiple networks». Furthermore, they conclude that «emotional activation in the paralimbic system is not associated with an increased frequency of judgments that something is morally wrong».[46] Taken together, the results of Schaich Borg and colleagues[47] are in line with the theory of Greene and colleagues,[48] but with the difference that the same areas involved in morality undergo a grossly similar activation with all paradigms, with only minor differences in specific scenarios, which engage some areas slightly more than others. The impression derived from the results of this study is that the greater involvement of cognitive or emotional areas could be simply correlated with the different types of evaluation, which require either more cognitive or more motivational/emotional processing of the elements.

Even though the theory of Greene and colleagues, derived from their results, apparently explains many experimental observations, other lines of research provide data, which do not fit into this conception of competition between emotional and cognitive cortical areas. In line with a role of VMPFC in emotional choices, damage to this area causes a more utilitarian moral con-

[42] *Ibidem.*

[43] L. Young, M. Koenigs (2007), *Investigating emotion in moral cognition: a review of evidence from functional neuroimaging and neuropsychology,* «British Medical Bulletin», vol. LXXXIV, pp. 69-79.

[44] J. Schaich Borg, C. Hynes, J. Van Horn, S. Grafton, W. Sinnott-ArmstronG (2006), *Consequences, action, and intention as factors in moral judgments: an fMRI investigation,* «Journal of Cognitive Neuroscience», vol. XVIII, pp. 803-817.

[45] *Ibidem.*

[46] *Ibidem.*

[47] *Ibidem.*

[48] J. D. Greene, L. E. Nystro, A. D. Engell, J. M. Darley, J. D. Cohen (2004), *The neural basis of cognitive conflict and control in moral judgment*, «Neuron», vol. XLIV, pp. 389-400.

[49] M. Koenigs, L. Young, R. Adolphs, D. Tranel, F. Cushman, M. Hauser, A. Damasio (2007), *Damage to the prefrontal cortex increases utilitarian moral judgements,* «Nature», vol. CDXLVI, pp. 908-911.

duct.[49] However, in a different test, called 'ultimatum game', the same kind of patients with VMPFC lesion, behave in a more emotional fashion.[50] In the aforementioned theory this result would mean that VMPFC is related to cognitive control and inhibition of emotional responses, which is exactly the opposite of the conclusions of Greene and colleagues. In the ultimatum game two players have one opportunity to split a sum of money: the proposer offers a portion of the money to the other player, who can accept or reject the offer. In the latter case both players get nothing. Low offers are usually rejected, because they are felt as unfair and therefore they are thought to elicit an emotional reaction. Patients with VMPFC lesion display a higher rejection rate than control subjects, behaving in a more irrational and emotional manner.

On the other hand, DLPFC was considered involved in cognitive control, favouring utilitarian choices.[51] However, when the function of this area is reversibly disrupted by transcranial magnetic stimulation, the acceptance of intentionally unfair offers is facilitated,[52] which is a more rational behaviour. Thus, the inactivation of a 'rational' area with this paradigm favours a more rational choice. This is exactly the opposite of what is expected by the model of competition between emotional and cognitive cerebral areas.

These discrepancies are better explained by a recent theory proposed by Moll and colleagues.[53] According to their theory, «competing representations of behavioural choices cannot be split into cognitive and emotional ones. Instead, the competition will occur among *cognitive-emotional* alternatives… In this view, rational or purely cognitive choices cannot be considered as *real* choices because they lack motivational power».[54] Therefore, all morally relevant experiences are considered as cognitive-emotional association complexes. Cognition and emotion, instead of being in competition, are continuously integrated during the moral decision making. Moral cognition emerges from the integration of content and context dependent representations in corti-

[50] M. Koenigs, D. Tranel (2007) *Irrational economic decision-making after ventromedial prefrontal damage: evidence from the Ultimatum Game*, «Journal of Neuroscience», vol. XXVII, pp. 951-956.

[51] J. D. Greene, L. E. Nystrom, A. D. Engell, J. M. Darley, J. D. Cohen (2004), *The neural basis of cognitive conflict and control in moral judgment*, «Neuron», vol. XLIV, pp. 389-400.

[52] D. Knoch, A. Pascual-Leone, K. Meyer, V. Treyer, E. Fehr (2006), *Diminishing reciprocal fairness by disrupting the right prefrontal cortex,* «Science», vol. CCCXIV, pp. 829-832.

[53] J. Moll, R. Zahn, R. de Oliveira-Souza, F. Krueger, J. Grafman (2005), *Opinion: the neural basis of human moral cognition,* «Nature Reviews Neuroscience», vol. VI, pp. 799-809.

[54] J. Moll, R. DE Oliveira-Souza, R. Zahn (2008), *The neural basis of moral cognition: sentiments, concepts, and values*, «Annals of the New York Academy of Sciences», vol. MCXXIV, pp. 161-180.

cal-limbic networks.[55] The elements and mechanisms involved possess three distinct components.

The first component is context-dependent and it consists of a structured knowledge of events. In everyday life, people continuously integrate contextual elements when assessing the behaviour of others and when appreciating their own actions in a given situation. It depends on the representations of events and event sequences in the prefrontal cortex. Over-learned event sequences, like routine tasks, are stored in the medial and posterior portions of the prefrontal cortex. Less predictable event sequences are represented in the DLPFC. The anterior portions of the prefrontal cortex, including the frontopolar cortex, are more involved in long-term goals and multi-stage complexes of events, important for making plans and thinking about the future. Social and emotional event knowledge is represented in the VMPFC.

The second and third components are context independent. The second component concerns social perceptual and functional features. Social perceptual features are based on the interpretation of facial expressions such as gaze, prosody, body posture and gestures. These features are encoded in the posterior temporal lobe, in the region of the superior temporal sulcus, which has been implicated in the impaired social decoding observed in autism. Social functional properties are extracted from different social situations and they depend upon the anterior temporal lobe, which has been implicated in semantic dementia. Patients with this syndrome show impairments in naming human actions. In addition, an abnormal activity in this area was found in psychopathic individuals.

The third component consists of the 'central motive states', represented by the motivational and emotional aspects of moral cognition. Central motive states are distinct from basic emotions, like fear or disgust, which emerge from the binding of context representations (e.g. the perception of a feared object or situation) with the central motive states (e.g. undirected anxiety). Several structures belonging to the limbic system exert a powerful influence on behaviour through its connections with the prefrontal cortex and other cerebral regions. In this view, the more cognitive forms of information processed in cortical areas are integrated with limbic signals representing the emotional and motivational aspects. Therefore, it would be inappropriate to divide cortical areas between cognitive versus emotional ones, because every area which is involved in moral cognition performs cognitive elaborations and also receives motive signals, which are integrated during information processing.

In contrast to a competition between a rational and an emotional choice,

[55] J. Moll, R. Zahn, R. de Oliveira-Souza, F. Krueger, J. Grafman (2005), *Opinion: the neural basis of human moral cognition,* «Nature Reviews Neuroscience», vol. VI, pp. 799-809.

as in the theory of Greene and colleagues,[56] supported by the authors of lesions studies,[57] according to Moll and colleagues [58] all alternatives possess a mixed cognitive-emotional content, as illustrated by the following examples. «Should I opt for killing one innocent to save five other lives and forever suffer the angst of being a murderer, or opt for abstaining to do so and be responsible for causing the death of five people, thus committing a terrible act of omission? Should I indulge in tax evasion and thus be able to send my kid to a good school? In our view, rational or purely cognitive choices cannot be considered as *real* choices because they lack motivational power».[59]

The theory of competition between rational and emotional brain areas[60] would render our choices as a victory either of the rational brain or of the emotional brain. This view seems to originate from an oversimplification of the alternatives encountered in real life. I find more plausible the theory of Moll and colleagues, which maintains that during moral evaluations there is an activation of several cortical areas, involved in different aspects of computation and correlated with different elements of conscious thinking, but with the integration, in each of them, of purely rational together with motivational and emotional aspects. The fact that moral decisions are never based on the activation of a single cerebral area, but that the evaluation and choice processes involve the activation of multiple areas is in line with the concept that conscious decisions arise from an evaluation, which is at least in part explicit and rational. However, the concept of rationality requires an extension both in general terms and also in cases where it is applied to cerebral areas. Human rationality cannot be equated to pure, 'cold blooded' explicit evalu-

[56] J. D. Greene, L. E. Nystrom, A. D. Engell, J. M. Darley, J. D. Cohen (2004), *The neural basis of cognitive conflict and control in moral judgment*, «Neuron», vol. xliv, pp. 389-400.

[57] A. R. Damasio (1994), *Descartes' error: emotion, reason, and the human brain*, New York, Penguin; L. Young, M. Koenigs (2007), *Investigating emotion in moral cognition: a review of evidence from functional neuroimaging and neuropsychology,* «British Medical Bulletin», vol. lxxxiv, pp. 69-79.

[58] J. Moll, R. DE Oliveira-Souza, R. Zahn (2008), *The neural basis of moral cognition: sentiments, concepts, and values*, «Annals of the New York Academy of Sciences», vol. mcxxiv, pp. 161-180; J. Moll, R. Zahn, R. de Oliveira-Souza, F. Krueger, J. Grafman (2005), *Opinion: the neural basis of human moral cognition,* «Nature Reviews Neuroscience», vol. vi, pp. 799-809.

[59] J. Moll, R. DE Oliveira-Souza, R. Zahn (2008), *The neural basis of moral cognition: sentiments, concepts, and values*, «Annals of the New York Academy of Sciences», vol. mcxxiv, pp. 161-180

[60] J. D. Greene, L. E. Nystrom, A. D. Engell, J. M. Darley, J. D. Cohen (2004), *The neural basis of cognitive conflict and control in moral judgment*, «Neuron», vol. xliv, pp. 389-400; L. Young, M. Koenigs (2007), *Investigating emotion in moral cognition: a review of evidence from functional neuroimaging and neuropsychology,* «British Medical Bulletin», vol. lxxxiv, pp. 69-79.

ations, and equally wrong is the conception that our decisions are dictated by unconscious or subconscious processes. The concept of rationality, which can be gathered from these studies, incorporates purely rational elements with indissociable motivational/emotional aspects. Both types of elements are consciously evaluated with the involvement of cerebral areas where they are jointly processed. However, the processing of several distinct aspects is performed in parallel by separate areas, although the consciousness of this process is unitary.

5. Conclusive considerations

From the above review of neurophysiological data, it results clear that the basis of our aesthetic and moral judgments consists of the presence of conscious rational and motivational/emotional appraising associated with the activation of several cerebral areas. A mechanistic view of this process would state that such brain activity is the only determinant of every decision. It should be noted that a statement of this kind must censor any possible action of conscious mental activity in this process. Our conscious experience would be a mere and useless product of our brain, without any role in any function, including judgements and decision making. This view has been called 'epiphenomenalism', because it considers mental activity as an epiphenomenon, which is a by-product of brain activity without any causal role in its processes. It is imaginable that such conception could derive from a reductive and superficial evaluation of neurophysiological data, like the temporal sequence of brain activation, which is followed instead of being preceded by the conscious will in Libet's experiments. The consequences of the observations of Libet and colleagues has been criticized in the first part of this essay and in more detail elsewhere.[61]

At this point, let's try to figure out all the elements and processes involved in decisions related to situations more similar to real life, like aesthetic or moral judgements. In the brain, the different elements involved are processed in parallel by several cerebral areas. Such processing can be associated with the conscious experience of mental events like explicit/verbal reasoning, certain motivations/emotions, and drives of unidentifiable origin. What is most important is that these mental events are pieces of conscious experience. What is also very important is that the overall conscious experience is clearly unitary. Some of these mental events occur involuntarily, without any effort and also without the possibility to avoid them. This is especially true for the more basic, instinctual drives, and partially true for motivations. However, these elements

[61] F. Tempia (manuscript in preparation), in *Proceedings of STOQ III Project Workshop*, Roma.

of mental activity, each of them with one or more identifiable cerebral activity correlates, are blended with higher or lower degrees of explicit reasoning. Our conscious experience is that our own reasoning is not the collection of a set of separate reasoning subjects, one for each cerebral area associated with explicit processing. Rather, we experience a unity of our subjective reasoning. In conclusion, brain activity in distinct cerebral areas is not alone in any conscious experience or in any conscious decision. From the definition, which is more than a definition because it corresponds to our experience, there are no cases in which conscious decisions are taken in the absence of mental activity. Neurological states, in which consciousness is absent but some behaviour is still observed, have been described, but the absence of consciousness obliges us to classify them as non-conscious behaviours. This is a different type of executive activity exerted by brain centers: automatic, even if sometimes complex, behaviours without consciousness. Therefore, in every conscious decision, consciousness itself is one of the players, and it cannot be considered as a secondary one. Activation of brain areas and consciousness are the real actors of the judgments. Experiments of the type 'what comes first' do not apply to the investigation of brain-mind activity, because the very fact of their correlation means that they occur simultaneously. Moreover, such correlated brain-mind activity is not a punctual, short-lasting event, but it can consciously proceed until the subject finds a satisfactory conclusion and a decision is definitely taken. This search of the final decision is a long-lasting process, at least compared with the time course of brain signals. It is important to note that there is no obvious time limitation to the conscious evaluation process. In fact, in some 'difficult' moral dilemmas the subject thinks for minutes before giving a response. In these cases, the subject can be little confident of the rightness and definitiveness of her judgment. In other words, the decision is felt as provisional, with possible reappraisal, resuming the reasoning acted by the correlated brain-mind activity.

In animals, especially in primates, it is recognized that decision making involves, as in humans, processing of motivational/emotional elements with rational information.[62] However, compared with humans, the other primates have limited rational capabilities. In particular, explicit reasoning requiring language is exclusive to humans. Therefore, even if some 'quantitative' differences can be described, like the number of items which can be processed together or kept in the working memory, the salient feature of human reasoning is the explicit nature of the evaluation processes. Such operations are not linked to a specific time lapse of data processing, but they are 'open ended'

[62] M. Sakagami M. Watanabe (2007), *Integration of cognitive and motivational information in the primate lateral prefrontal cortex,* «Annals of the New York Academy of Sciences», vol. MCIV, pp. 89-107.

activities exerted by the mind-brain of the conscious subject. The fact that the decision or judgment process can indefinitely continue, or pause, and be resumed in the course of a conscious process, negates any mechanistic explanations. In other terms, the fact that the outcome of human conscious reasoning is not determined by the integration of the pieces of information involved, leaves space for the freedom of the subject to consciously direct the process and decide the final result. The conclusion of the section about aesthetic judgment, that humans possess a 'qualitatively' higher intentional and rational control of mental states, refers to such a freedom of the outcome of decision processes. Therefore, human decisions and judgments in situations relevant in real life are free and cannot be considered as constrained by the physical brain activity alone. In fact, the brain is never alone during conscious thinking. In conclusion, the real subject of reasoning is not the sole brain but it is equally not the sole mind, but it is the '*conscious brain*' with inseparable physical and mental aspects.

Abstract: *Before simple voluntary movements, the activation of a specific region of the cerebral cortex precedes the conscious intention to move. This is currently considered as a demonstration that the decision to act is not free, but that the brain decides and thereafter generates the illusion of the will. Besides other criticisms, this type of movement is known to be mostly automatic. More complex decisions like aesthetic or moral judgments are a better paradigm to address the problem of the neural correlates for human choices and the freedom of the will. Aesthetic judgments are correlated with an activation of cerebral areas, which are connected to rational decision-making and are also involved also in other kinds of evaluations. Moreover, the timing of cortical activation shows that aesthetic judgment requires explicit and intentional reasoning. Moral judgments are correlated with the activation of cerebral areas, in which specific rational and motivational/emotional elements are processed. The subject performing such an evaluation is the conscious self, who proceeds without a predetermined time limit, until he finds a satisfactory decision. The conscious and explicit nature of the evaluation suggests that the final decision cannot be mechanistically determined by the physical laws governing brain and body function.*