NEUROSCIENCE OF ETHICS: THE STATE OF ART AND THE PROMISES FOR THE FUTURE[1]

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ABSTRACT

It is widely know that neuroscience research can lead humankind to understand and combat many illnesses or conditions that cause untold suffering around the world such as dementia, Alzheimer's, depression or stress and can also lead us to achieve considerable improvements in memory, learning abilities, executive functions, moods and in many others areas related to cognition and emotion. In this article I will be focusing specifically on the research related to the neuroscience of ethics. The neuroscience of ethics is an area of neuroethics that is concerned with the understanding of the brains mechanism that are involved in moral cognition and in our ethical (or anti-ethical) decisions, and I propose here to expand this concept a little further, defining neuroscience of ethics as the field concerned to the understanding of the brain mechanisms of all main behaviours related to ethics and morality. In this article I identify a set of neuroscience studies that have been published in the last 10 years and that are relevant for ethics, shedding light on behaviours such as altruism, generosity, self-confidence, trust , altruistic punishment, violence, lying and prejudice, all of them connected somehow to morality. I then discuss how the understanding of each one of these behaviours can benefit society and how we can use this research to help humankind to improve moral standards and promote general happiness.

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1 Imaging and stimulating the brain

Adina Roskies[2] divided neuroethics in two areas: ethics of neuroscience and neuroscience of ethics. She then predicted that although the neuroscience of ethics was less developed than the ethics of neuroscience it would be the area with truly profound implications for the way ethics is approached in the 21st century and would blossom in the coming years. How right she was!

Today there are two main sets of technologies currently used to map the human brain [3]: the non invasive brain imaging and no invasive brain stimulation. There are many non invasive brain imaging technologies, but the most commonly used at the moment are magnetic resonance imaging (fMRI) and positron emission tomography (PET), whilst in the field of non invasive brain stimulation technologies there are basically two technologies: transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS). The main difference is that

whereas brain imaging technologies measure the activation generated by the brain during cognitive processing, non-invasive brain stimulation *induces* changes in brain activation. In fact depending on the TMS stimulation parameters activation in the cortex can be increased or reduced and in practice, TMS can influence (either improve or diminish, depending on the parameters and target region) many brain functions, including directing physical movement, visual perception, memory, reaction time, speech and mood [4], and there are even studies that provide evidence for the short-term efficacy of rTMS in depression treatments [5].

More than anything, however, the studies using fMRI, PET, TMS and tDCS are starting to shed light on the brain mechanisms that underline ethics and behaviour related to moral and ethics. The studies at the moment are only preliminary , but already there are very important results which I will discus now, sugesting already that the future of this field is highly promising.

2 Imaging and stimulating the brain: self-interest and altruistic punishment

In the field of altruism many studies using PET and fMri are helping to understand the brain mechanisms involving this behaviour. In one of these studies[6] the authors use PET to try to identify the neural basis of the altruistic punishment of defectors. They formulate the hypothesis that altruistic punishment provides relief or satisfaction to the punisher, activating reward-related brain regions. They found that the caudate plays a decisive role in altruistic punishment. According to the authors caudate activation is particularly interesting because this brain region has been implicated in making decisions or taking actions that are motivated by anticipated reward and the prominent role of the caudate in altruistic punishment was supported by the fact that those subjects who exhibit stronger caudate activation spend more money on punishing defectors. They then provide an explanation for this correlation, which is that caudate activation reflects the anticipated satisfaction from punishing defectors. In another study involving altruistic punishment the authors engaged male and female volunteers in an economic game, in which two players played fairly or unfairly, and then measured brain activity with fMRI while these same volunteers observed the players receiving pain. They found that both sexes exhibited empathy-related activation in pain-related brain areas (front-insular and anterior cingulated cortices) towards fair players. However, these empathy-related responses were significantly reduced in males when observing an unfair person receiving pain. This effect was accompanied by increased

activation in reward-related areas, correlated with an expressed desire for revenge. They then concluded that in men empathic responses are shaped by valuation of other people's social behaviour to such an extent that they empathise with fair opponents while favouring the physical punishment of unfair opponents[7].

TMS has been also used in order to understand human reactions to perceived unfair or "cheating" behaviour and even self-interest, prejudice and morality. Knoch[8]for example, uses TMS in a ultimatum game study (a game where people are given some money to share with another person and they can give to the other person as much as they want, but if the respondent does not accept the offer, neither of them will earn anything) that disruption of the right, but not the left, dorsolateral prefrontal cortex (DLPFC) by low-frequency repetitive transcranial magnetic stimulation substantially reduces the subjects' willingness to reject their partners' intentionally unfair offers, which suggests that subjects are less able to resist the economic temptation to accept these offers. This implies that after disruption of DLPFC people tend to have a more "self-interested" behaviour, giving less importance in their actions to what is perceived as fair. It suggests, as well, that future researches could focus on stimulation instead of disruption of the DLPFC, that could produce the opposite effect, i.e., could increase people's susceptibilities to issues of fairness. This study opens a huge door in the studies of akrasia (weakness of will) and morality, especially considering that despite acting in a more self–interested (or maybe greedy) way, avoiding altruistic punishment, people still judge the offers as unfair.

3 Imaging and stimulating the brain: prejudice

There are also important studies related to the neural features of prejudice, especially racism. In one study[9] the authors used fmri to explore the neural substracts involved in the unconscious evaluation of black and white faces among black and white groups, particularly focusing on the amygdala cerebral, known to play a key role in emotions and evaluation. They found correlation between the activation of amygdala with two indirect measures of race evaluation, but not with the direct expression of race attitudes, while these patterns were not observed in the evaluation of familiar black or white faces. These results show that race difference correlate with different degrees of amygdala activation. In short the study suggests that the white group presents more activation of the amygdala when evaluating black faces than when

they evaluate white faces, but this difference is not present when the black faces are known to them. In the experiment, the region where there was more activation for negative evaluations was the left-superior amygdale, a region of special interest, according to the authors, as this is also activated when viewing faces that have frightening expressions. Their study is of particular interest because in a sense it confirms that race prejudice repeatidly operates subliminally, with people expressing prejudice even though they are not conscious of it, revealing how much has to be done still in society to eliminate race prejudice. This was confirmed in another study using fMRI[10] where all participants disagreed with the prejudiced statements, and agreed with the non prejudiced statements, and reported having motivation to respond without bias. Yet, on average, participants showed automatic negative associations towards black relative to white faces. In a recent study[11] using fMRI the authors also found evidence that there are distinct brain mechanisms to what they called superficial (automatic) and individuated judgement. Their studies also supported a long tradition of studies stating. that the processing of a superficial judgment is routed via amygdala, a neural region specialized for primarily automatic processing[12]. They describe the study as providing evidence that the amygdala is recruited to produce knowledge about other's internal characteristics from the most minimal superficial information (i.e., the face), providing then a neural correlate of our everyday superficial judgments of others.

In a study with children who have Williams Syndrome (WS), where social fear is not present and people are very friendly and approachable to strangers, the authors found that children with WS lack racial stereotyping, although they retain gender stereotyping, suggesting that mechanisms for the emergence of gender versus racial bias are neurogenetically dissociable[13]. According to the authors this is probably the first indication of the absence of racial stereotyping in a human group and that mechanisms underlying different forms of stereotypes are not uniform. They speculate (being necessary fMRI research to corroborate the suggestion) that decreased amygdale activity reduces implicit race bias in WS through diminished signalling of the social threat associated with a race out-group.

4 Detecting lies and telling the truth

Another important field of application to brain imaging and brain stimulation techniques

is the field of lies and truth, and ultimately, the field of Justice. The truth has been for centuries one of the main philosophical questions. In Plato's Apology[14] where he describes Socrates defence in court where he is judged for the crime of corrupting the youth and not believing in gods, the whole speech involves the issue of truth . Kant said that there is no right to tell lies ,even for benevolence , concluding that there is no exception for human beings obligation to tell the truth[15].In real life, however, people deceive and lie, and so a reliable "lie detection" mechanism would be a holy grail for use by courts and by the police, avoiding a recurrent problem in Justice where we know that many times guilty people are free to commit more and more crimes because it can not be proved that they have perpetrated the crimes that they have comited, and vice versa innocent people are in prison because they were thought to have committed crimes that they have never practiced. At the moment, however, there is no reliable technology to detect lies, despite the fact that in the United States, defence related agencies have dedicated significant funds to the development of new lie-detection strategies for eventual use in criminal and terrorist investigations[16].There is, however, internet advertisements on "brain fingerprinting"[17] and already this has been used in courts in the USA, even though the scientific community points out that most of the relevant data related to this technology is not published in peer review literature, making impossible to scientifically check the validity of the method[18]. According to Illes and Greely [19] there are other companies offering fMRI-based lie detection services, as No-lie MRI and CEPHOS. These two companies base their technologies in peer-reviewed articles which give these products much more credibility than the brain fingerprinting P-300 technology. Illes and Greely ,however, criticise any attempt to apply this research to the real world without more research being carried out. According to them there are good reasons to doubt that these experiments did, in fact, prove that one can detect real world lies through fMRI, and among them they cite: a) the fact that there are very few articles focused on the issue of determining whether or not single individuals are lying, being that the research focused much more in discovering areas of brain activation during the process; b) the lack of replication results for other research teams ; c) the lack of diversity of tested subjects d) the possibility of the subjects using countermeasures to fake the results and e) the fact that the number of cortical areas activating in these lying and deception tests include many areas, such as anterior prefrontal area, ventromedial prefrontal area, dorsolateral prefrontal area, parahippocampal areas, anterior cingulate, left posterior cingulate, temporal and subcortical caudate, right precuneous, left

cerebellum, insula, putamen, caudate, thalamus, and regions of temporal cortex.. According to Illes and Greely the activation of many of these regions is known to be correlated with a wide range of cognitive behaviors, including memory, self-monitoring, conscious self-awareness, planning and executive function, and emotion and this diversity casts some doubt on the accuracy of any particular method of lie detection. Illes and Greely then make a call for regulation of the use of the lie–detection technology in court and trials claiming that it is necessary to prevent the use of unreliable technologies, and to develop fully detailed information about the limits of accuracy of even reliable lie detection.

In the meantime there are, however, many studies using fMRI and TMS that show progress in the task of discovering the brain mechanism underlining the process of telling the truth, lying and deceiving. In one of these studies[20] the authors found that different patterns of brain activation arise when people tell lies and when they tell the truth, and the type of lie modulates these patterns, in a way that the generation of various types of lies engages different combinations of general-purpose cognitive processes which may provide reliable neural signatures for various types of lies. In another study[21] the authors conclude that it is implausible to think that there is a single and simple ‘‘deception network’’ to be discovered. Instead, it is likely that deceptive behaviour results from a systematic combination of cognitive processes.

In many studies the authors claim that they are able to identify certain patterns of activity characteristic of lying, even though they are not able to detect within individuals consistent activation patterns. In one of these studies[22] they found that on two versions of a simple lying task, normal subjects exhibited consistent behavioural and functional anatomical responses. When lying their response times were significantly increased and there was reliable activation within specific regions of prefrontal cortex. The brain region implicated in both versions of their lying task was bilateral Brodmann area 47. In another study[23] the authors found that besides the fact that there are cognitive differences between deception and truth and that they have neural correlates detectable by fMRI, they also found that ACC (anterior cingulate cortex) and SFG(superior frontal gyrus) are components of the basic neural circuitry for deception.

In another experiment [24] the authors use tDCS in order to manipulate the production of deceptive responses and they found evidence that focal changes in the excitability of the human brain can experimentally influence lie production, altering the speed and efficiency of lying responses. In this experiment the authors tested two kinds of lies: denying a fact that really

happened and producing a false response about an event that did not happen and they found that the two types of lies tested respond differentially to stimulation delivered over the DLPFC which suggests that the two kind of lies have distinct neural mechanisms. They point out that the task that they administered provides a model for two sub processes associated with deception, namely, inhibition of truthful responses (a process present even when the participant is instructed to lie) and producing a lie "pretending to know" or "pretending not to know." Some of the studies are more ambitious and claim that they are able to detect deception at the individual level. In one of these studies the authors aimed at use fMRI to detect deception[25] at an individual level the authors used (fMRI) to show that specific regions were reproducibly activated when subjects deceived. Subjects participated in a mock crime stealing either a ring or a watch. While undergoing an fMRI, the subjects denied taking either object, thus telling the truth with some responses, and lying with others. The authors claim they were then able to correctly differentiate truthful from deceptive responses, correctly identifying the object stolen in 90 % of the subjects.

It all seems to suggest that even if it is true that at the moment we don't have a 100% reliable technology for detecting lies, the advance of research in this field will inevitably lead to this, even though it is impossible to predict when. The advent of a reliable lie-detection technology can have a huge impact on law and security. If the technology starts to be accepted as evidence in court, or even as a instrument to be used by police in interrogations, we will certainly have a much more fair criminal justice system, with the offenders being punished and avoiding forever innocents being jailed for crimes that they haven't commited. This could be a wonderful new world in terms of Justice, but we have to be prepared for it, regulating the use of lie-detection technology in order to make the most of it and avoiding misuse and abuse.

5 Serotonine and violence

In USA, where moms looking for sperm donors for their future babies have easy access to informations about the donors, it is said that more than anything else, what they are interested in knowing is information about the character of the possible donator, whether or not he is a "nice guy". To be a good person, seems to be the most important trait for the majority of the soon to be parents and what they care most for their kids. This shows something important about people's aspirations and desires in terms of personality. We all know that education is

fundamental in the process of formatting someone's personality, but what about other factors? What are the chemical-biological factors involved in certain kinds of desirable or undesirable, good or bad behaviour?

Serotonin (5-HT) is a neurotransmissor whose deficiency has for a long time been associated with depression, and also to irritability and aggression in primates and humans. In an important study on macaque rhesus[26] the authors found , confirming what has been previously documented by them that social differences between closely-related species are correlated with serotonin activity, as species that show relatively high rates of severe aggression (as rhesus macaques) also tend to have low concentrations of cerebrospinal fluid (CSF) of 5-hydroxyindoleacetic acid (5-HIAA) , as pigtailed macaques). The authors reported that rhesus macaques, with low CSF 5-HIAA exhibited more serious forms of aggressive behaviour. In another article[27] it was found in a intra-species study that rhesus monkeys with low CSF serotonin metabolite levels show more spontaneous aggression toward others of the same species, receive more wounds, and die at a younger age, while those with high CSF serotonin metabolite levels show greater proximity to and grooming of peers and have a greater number of neighbours living nearby. It was also reported [28] that in monkeys, the dysfunctional aggression and impulsive behaviours associated with lowered serotonergic function are accompanied by social dysfunction, poor social integration within the group, and lower social status.

As we can see the effects of low levels of serotonin on monkeys can be devastating in terms of their survival and social interactions. Low serotonin levels on some monkeys negatively affect not only the others in the group, but also themselves, who are more frequently injured and die early. So it is important to understand all the mechanisms that affect the levels of serotonin, and not surprisingly it seems also to be affected by the environment. In the article[29]authors report several studies demonstrating that monkeys removed from their mother at birth and reared in a nursery with age-matched peers exhibit chronically low CSF 5-HIAA concentrations that are evident by late infancy and continue into adolescence and adulthood. It was also pointed out in another article [30] that the stressful experience of maternal separation has robust and long-term consequences for the serotonin system in rhesus monkeys. This early-life trauma also causes anxiety related and depression-related behaviours associated with deficient social adaptation and interaction throughout life .

If that is so in monkeys, how would be in humans? A clinical study[31] on psychiatric patients suggests that low brain serotonin activity may be related to psychiatric disorders involving hostile affect and aggressive behaviour. The authors cites studies that relates to people with a history of impulsive violent behaviour (e.g., arsonists, violent criminals, people who die by violent methods of suicide) with low CSF serotonin metabolite levels and also cites studies which relate to some patients with violent histories (for example, with antisocial personality disorder) show signs of compromised brain serotonin function[32]. In another article[33] it is pointed out that reduced CSF 5-HIAA has been found in aggressive psychiatric patients victims of suicide by violent means , impulsive violent offenders and impulsive fire setters rather than in non impulsive violent offenders.

In another article[34] the authors state that the relationship between serotonin and violence in men has been established in multiple studies. The authors carried out an intensive review of the literature in this field and they found that extensive literature dating back to the 1960s provides evidence of an association between animal aggression and reduced serotonergic function.Serotonergic function was a marker and predictor of both violence and suicide in various populations. They point out however, that not all aggressive behaviours were associated with decreased serotonin function. These aggressive behaviours were often maladaptive in some ways, whether impulsive, emotionally driven, or socially dysfunctional. Impulse control, emotional regulation, and social functioning appear to be important qualifiers of the violent behaviour associated with serotonin dysfunction. The authors in this study conclude that there is a complex relationship between serotonin and aggression with various factors contributing. They point out that serotonin influences psychological and social factors, and psychological and social factors influence serotonin.

It is very likely that there are many factors involved in violent behaviour, such as social and psychological factors, the chemistry in the brain and genes. Davidson and als [35] suggest that impulsive, affective aggression may be the product of a failure of emotion regulation and that individuals predisposed to aggression and violence have an abnormality in the central circuitry responsible for adaptive behavioural strategies. For them impulsive aggression and violence, irrespective of the immediate cause, reflect abnormalities in the emotion regulation circuitry of the brain. In another article[36] the authors point out that clinical studies have supported the link between variants of *5-HTT* (the transporter protein of serotonine) *and* disorders in the regulation

of emotion. They emphasise that serotonergic signalling pathways integrate not only basic physiological functions, but also elementary tasks of sensory processing, cognition, emotion regulation and motor activity and as it shapes various brain systems during development, it sets the stage for functions that regulate emotions throughout life. It is also a crucial modulator of emotional behaviour including anxiety and stress responses, impulsivity and aggression. They then pointed out that with the development of imaging techniques it was possible to have the first report of an association between 5-HTT genotype and excitability of the prefrontal cortex, which implies a relationship between cognitive processing and *5-HTT* function in humans. The author also stressed that biosocial genomics now allows us to explore the nature of genetic variation between humans and its influence on individual differences, as well as the relative impact of genetic and environmental factors involved in cognition, emotion and behaviour.

6 Serotonine and genes: fear and fairness

In a recent study [37] the effects of a functional polymorphism in the regulatory region (5-HTTLPR) of the human 5-HT transporter (5-HTT) gene on observational fear condition, risk taking and susceptibility to framing in decision making under uncertainty, as well as multidimensional anxiety in healthy volunteers, was investigated. They found that in comparison to the homozygote for the long version of 5-HTTLPR, the carriers of the short version display enhanced observational fear condition, reduced financial risk taking and increased susceptibility to framing in economic decision making as well as reduced autonomic control over the heart. The authors then have identified social evaluation, physical threat and daily routines as the dimensions of trait anxiety that are specifically influenced by 5-HTTLPR. They concluded that these effects of 5-HTTLPR support the developing view that complex social–emotional and cognitive functions are significantly influenced by genetic variations.

The influence of serotonin is now beginning to be studied in even more complex behaviours related to fairness. In two recent studies[38] the role of serotonine in people's behaviour in the ultimatum game[39] was investigated. Investigating the effects of manipulating 5-HT function on rejection behaviour in the Ultimatum Game using tryptophan depletion (ATD) procedure to temporarily lower 5-HT levels, it was found that compared with placebo, ATD significantly increased rejection rates of unfair offers; they tended to reject low offers more

frequently. The author then concluded that temporarily lowering 5-HT levels increased retaliation to perceived unfairness without affecting mood or fairness judgment. In another study[40] the authors found that the mean platelet serotonin level was significantly lower in participants who reject unfair offers than in those who accept, suggesting that low platelet serotonin may serve as a reliable biomarker to identify people who are more likely to reject unfair ultimatum offers and that the serotonergic system may play an important role in the UG rejection behaviour. Another co-lateral finding of this study, that the authors classify as interesting is that samples taken from individuals who made unfair offers showed a slight, but significant, reduction of mean platelet serotonin levels compared with those who made fair offers. The authors do not discuss this second finding but it seems very important in terms of ethical behaviour. The two results taken together, i.e., that people with lower levels of platelet serotonin are less likely to reject unfair offers and also are more likely to make unfair offers, if confirmed, it could shed light on our understanding of the role of serotonin in relation to fairness and self-interest. It could suggest that people with low levels of platelet serotonin will tend to behave in a more greedy or selfish way than other people when they are in a position of power (in the case of the UG, people in the position of making offers), at the same time they will be retaliating against those who do not behave fairly with them, when they are in a receiving position (in the UG, people receiving the offers). This behaviour is very close to the so-called opportunistic behaviour that surges when people want to receive the benefits of cooperation but refuse to cooperate and is very relevant in terms of ethics, since it suggests a kind of "incoherent" behaviour, breaching the famous golden rule (do unto others as they would do to you).

All these studies show that serotonin can be involved not only in the mechanism of depression and also in some kinds of violent behaviour but also in more complex social interactions involving economical and even ethical attitudes. There are even recent studies suggesting that serotonine could promote prosocial behaviour by enhancing harm aversion, a sentiment that affects both moral judgement and moral behaviour.[41] The discovery of the precise mechanisms of serotonin and its interactions with the environment would be crucial to future developments not only of treatments for depression and stress, but also to help people who present symptoms of violent behaviour and maybe it could also help people who are extremely selfish and anti-ethical to change their attitudes. We are here in the field of moral enhancement, where another key substance, oxytocin, could be proved to have a crucial importance .

7 Oxytocine : self-confidence and trust

Oxytocin is a peptide of nine amino acids (a nonapeptide). The findings from studies of humans parallel those from animal studies and point to the role of oxytocin in stress response and in enhancing social affiliation, even though the underlying mechanisms are not yet well understood[42]. It is possible that oxytocine might be involved in number of clinical disorders involving social deficits and/or disrupted attachment including autism, and social phobia. In relation to autism, for example, after the neuroscience studies identified oxytocine as playing a key role in social behaviour, it was conducted a recent study[43] and the authors found the first evidence that oxytocin nasal spray improves emotion recognition in young people diagnosed with autism spectrum disorders, suggesting the potential of oxytocin nasal spray as a treatment to improve social communication and interaction in these group.

In the article *Oxytocine Modulates Neural Circuitry for Social Cognition and Fear in Humans* [44] the authors show that human amygdala function is strongly modulated by oxytocin.They have used fmri to image amygdala activation by fear-inducing visual stimuli in healthy males and found that, compared with placebo, oxytocin significantly depressed amygdala activation , being the effect more pronounced for faces (socially relevant stimuli) than scenes. They point out that their results indicate a neural mechanism for the effects of oxytocin in social cognition in the human brain and provide a methodology and rationale for exploring therapeutic strategies in disorders in which abnormal amygdala function has been implicated, such as social phobia. In another study [45] involving facial expressions the authors also compared a group who were given oxytocine with a placebo group, and they concluded that reduction of amygdale activity to positive and negative stimuli might reflect reduced uncertainty about the predictive value of a social stimulus and thereby facilitates social approach behaviour.

There are also studies which suggest that certain doses of oxytocine can momentenously increase self-confidence. In one of these studies[46] the authors reported that in their study with people diagnosed with social anxiety disorder (SAD), a psychiatric disorder whose key characteristic is an excessive fear of negative evaluation by others and overly negative self-representations, the administration of oxytocin has improved mental representations of self, following exposure therapy, even though these effects may be either short term or situation specific. This is in line with another study [47] where the authors report that a single dose of

intranasal administered oxytocin is sufficient to enhance the experience of attachment security. According to the authors oxytocin seems to induce a *momentary* state of mind change in which subjects classified as insecure shift to higher rankings of attachment security, being that attachment security is characterized as the individuals confidence to rely on attachment figures to achieve care, safety, and protection and, when alone, to have access to internalized attachment relationships.

These two studies taken together suggest that oxytocine might be involved in the mechanisms of self-confidence in human beings and there are others who suggest that oxytocine could also be involved in the mechanism of trusting people. In one of these studies[48] the authors developed what they called the trust game and the risk game. In the trust game two subjects interacting anonymously play either the role of an investor or a trustee. The investor has to transfer a certain amount of money to the trustee account, and if the trustee transfers certain amount of the money back they will both make a profit. However, the trustee has the option of not returning the money to the investor and in this case the investor would be worst off than if he had not trusted at all. They also developed the risk game, in which the investor faced the same choices as in the trust game but in which a random mechanism, not the trustee's decision, determined the investor's risk. The random mechanism in the risk experiment replicated the trustees' decisions in the trust experiment. Therefore, the investors faced exactly the same risk as in the trust experiment; however, their transfer decisions were not embedded in a social interaction because there were no trustees in the risk experiment. They then formed two groups; to one group was administrated nasal oxytocine and to the other group was given a placebo and they found that in the trust experiment oxytocin increased investors' trust considerably. The investors' average transfer was 17% higher in the oxytocin group and 45% of the subjects in the oxytocin group showed the maximal trust level against only 21% in the placebo group, while in the risk experiment the behaviour did not differ between the oxytocin and the placebo groups. The authors have also found that the differences between the oxytocin group in the trust experiment and the oxytocin group in the risk experiment were highly significant suggesting that oxytocin specifically affects trust in interpersonal interactions. They pointed out that their findings may be particularly important in the treatment of social phobia that is characterised by social deficits, including persistent fear and avoidance of social interactions. They emphasize, however, the danger of misusing the finding, for example, inducing trusting behaviours that

selfish actors could exploit. It is important that the authors called attention to this point because despite the fact that these studies are extremely important and could be used to make people's life better, helping to find future treatments for certain illness or syndromes that interfere and impair people's social abilities, we are in a field that could easily be used for the bad, not for the good, for example, inducing in the future over approachable behaviour for people that could be easily mislead for some others with bad intentions, facilitating hijackings, rapes, robberies and even more sophisticated forms of deceiving such as inducing people to make high risk investments. The Dodo bird, an extinct species (probably because it was over approachable and fearless of humans and other animals) remains as an warning of what is possible to happen with a species, and a warning also of what is possible to happen intra-species, where over approachable people, specially children, could leave them vulnerable to malicious people.

8 Oxytocine: generosity, altruism and greediness

The role of oxytocine in human behaviour has been also tested in a variety of economic games like the Dictator Game, The Ultimatum Game and others. In one of these experiments[49], the gene encoding the related oxytocin receptor (OXTR) was tested for association with the Dictator Game [50] and a related paradigm, the Social Values Orientation (SVO) task. They found association between the gene region and both DG and SVO, being the most significant association observed with rs 1042778. They concluded that common variance in the oxytocin receptor gene underlie individual differences in prosocial behaviour. In another study [51] participants were infused with 40 IU oxytocin (OT) or placebo whilst participating in the Dictator game and the Ultimatum game. The result was that offers of the OT group in the UT game were 80% more generous than those who a placebo was given , but it has no impact on offers in the DG (contrary to the previous study where this correlation was found). The authors interpreted it as suggesting that OT increases generosity and empathy and explain the no-increase in the DG as meaning that OT had more impact in generosity than in altruism.

Certainly the two studies strongly suggest that there is an important positive association between OT and generosity. The authors of the first article, however, notice the discrepancy between the two studies (OT interfering in the DG in one study and not in the other) suggesting that maybe the resolution of these apparent discrepant results awaits a combined

pharmacogenetic strategy where subjects playing the Dictator Game could be also stratified by genotype. However, it seems to me that it still remains inexplicable as to why OT didn't have impact in the offers in the DG in the second study, because if they really do become more generous under the effect of OT, we could expect this increase in generosity not only when the others participant can retaliate, but also when they can not. This is extremely relevant for the studies of morality because if it is confirmed later that oxytocine increases generosity only in the UG a possible interpretation would be that this generosity increase is self-interested and could be meaning nothing else than a strategy to be more efficient in the game, avoiding the game-partner punishment of not accepting the offer and causing the person who made the offer not to gain anything as well. On the other hand, if it is confirmed that oxytocine increases generosity in both games (including then the DG where there is no possibility of retaliation and punishment) then it would be a strong indication that oxytocine is involved in the mechanisms that operate when people are less self-interested and more altruistic.

9 The future of ethics and the ethics of the future

All these studies show an important path for the studies of morality (and the lack of) and attitudes connected to morality such as selfishness, altruism, prejudice, fair-play and punishment. We are now starting to understand what the brains mechanisms connected to these behaviours are, even though it seems we are still in the stone–age in terms of what is now known. The future is however extremely promising. The scenario where we could induce a more moral and cooperative behaviour in people through brain stimulation or even pharmaceuticals is still a long way off, and it also raises moral questions in itself, such as whether or not is morally permissible for us to morally enhance ourselves by any means[52]. However, there is no doubt that if we do understand the neural process underpinning moral-related behaviours it could help us not only to understand better how people make moral decisions and act morally, but it could also be used in future to benefit people who want to act in more altruistic, friendly, generous, reliable and tolerant ways. I will now make a brief analysis of how research on morality could evolve and each moral–related behaviour could contribute to a more friendly and ethical society in future.

Altruism - Altruism basically means to help someone without any expectative of recompense or gain. Altruistic behaviour is probably one of the main behaviours related to morality, as the essence of moral acts, at least in the view of authors such as Kant, it is precisely to act solely out of respect for the so called moral law [53](I ought never to act in such a way that I could also will that my maxime should become a univesal law) i.e., to act in a way that can be universalized and is not based in self-interest. Kant makes a distinction between to act from duty and to act in conformity with duty, being only the first kind of acts considered moral. The basic difference is that only when we act morally (from the motive of duty) we really act altruistically, as in the second case (acting in conformity with duty) despite the fact that we do the right thing, we could still be doing that out of some interest and at the moment that we don't have the interest anymore, we would not be doing the right thing any longer. For example, if the reason why we give back to the owner a wallet full of money that we found in the streets is the expectative of recompense, at the moment that we know that we will not have the recompense, we would not return the wallet. So, despite the fact that, apparently, the person who returned the wallet because she thought that it was her duty to do that and the one who returned it because he/she expected a recompense are altruistic, actually only the first one was, as the second person was waiting for a recompense, and if she knew that she would not be recompensed she would not given the money back.

The imaging techniques can shed light on our understanding of possible differences in the neuromechanisms underlying the two kinds of attitudes, helping us to better understand altruism and how (and if) we make true altruistic decisions and act accordingly to these decisions. The importance of altruism for humankind is huge. The impact exists not only in the microcosms, with altruistic people cooperating and contributing for the good of community in small actions (such as returning the lost wallet to the owners with no expectations) and helping those who are in need, but also in the macrocosms where true altruism is an important factor in influencing people to do their jobs properly or avoiding people to be corrupt in countries (especially in the underdeveloped countries) where the mechanism of recompense and especially punishment do not work properly. If people have the opportunity of committing small and/or big contraventions and are certain that they will not be punished, then the only thing that will stop them is a certain dose of true altruism and morality.

Generosity - Generosity means a certain liberality in giving, and it is a highly desirable behaviour. It is in general out of generosity that people help those in need, donate to charities, in sum, give money or time for others and for the sake of others. The opposite of it, in a certain sense, is greediness: an excessive desire of possessing and an incapacity of sharing things with others. Greediness was immortalised forever in literature by Charles Dickens with the character Scrooge in "A Christmas Carol". Greediness led Scrooge to live a miserable life, becoming rich but living a solitaire and unhappy life

Greediness is closely connected to lack of benevolence and lack of benevolence is certainly an ethical problem. Benevolence is one of what Kant called "wide duties" (in opposition to strict duties) i.e., we have the moral obligation of help others, even though the extension of this obligation remains open, namely, we do not have the obligation to help everybody at every moment. In the utilitarianism, the obligation of helping others is much stricter, as we have always to promote the bigger happiness to the higher possible number of people.

The understanding of the neural mechanisms underpinning generosity can be very useful, for example, in marketing, making publicity more efficient in terms of stimulating people to contribute to charities and campaigns designated to collect money for good causes. The possibility of misuse is, however, always present, since that this comprehension can be used to stimulate people to make donations for causes which are not that noble, or can even be used to exploit people's generosity, but then the problem is not related to research in generosity but related with the laws and regulations that have ben put into practice to avoid any abuse or misuse of future discoveries.

Trust , self-confidence and fear - To trust in others, and to be confident about ourselves is closely connected with inter-personal fear. Here what Aristotle said in terms of the feeling of fear in general[54] , pointing out that the virtue (courage) is the middle point where fear is felt in the right measure, while too much fear characterizes cowardiness , and lack of fear temerity, being both vices, can be applied to this special category of fear, that is, fear of others. In relation to interpersonal fear it also seems to be the case that excessive fear could lead to serious difficulties in approaching and relating to others people, and the absence of fear, on the other hand, could lead to a over approachable behaviour that could lead malicious people to take advantage of this openness (especially children). The studies using fMRI and studies using oxytocine are starting to

shed lights on the brain mechanisms involved in trusting or distrusting people and ourselves. These studies can lead in the future to discoveries and even possible treatments in relation to social syndromes and even autism.

Altruistic punishment – Altruistic punishment means punishing people who do not cooperate, even if this punishment is costly. Altruistic punishment is well exemplified in games like the UG, when the responders do not accept unfair offers in order to punish the person who made the offer, even knowing that in doing so they will loose the money that was transferred to them. Altruistic punishment, even though costly for the punisher is beneficial to society because it increases cooperation and avoids "free-riders" (the opportunistic that want benefit from the group but refuse to cooperate) .[55] The benefits of altruistic punishment are clear: avoiding the free riders, who do not earn anything anymore because of altruistic punishment, they will be forced to cooperate and when cooperation increases society as a whole benefits from it. The missing link in this chain is why would people practice altruistic punishment as it is beneficial for society but is costly for the individual (or individuals) who practice it. However, Fehr [56] from his studies using fmri provides a clue for this, showing that altruistic punishment provides relief or satisfaction to the punisher, activating reward-related brain regions, which is also a very interesting result because it suggests that altruistic punishment, psychologically speaking, is self-interested.

Altruistic punishment seems to be connected to high levels of cooperation in human society and it seems to be necessary to keep these levels of cooperation. However in another study [57]the authors conclude that cooperation is only maintained if conditions for altruistic punishment are relatively favourable: low cost for the punisher and high impact on the punished. These results are highly important because we could infer that if a society is able to keep this conditions(satisfactory punishing the no-cooperators at low cost to the punishers) this society would be able to reach high levels of cooperation, which is desirable not only in terms of ethics, but it also impacts economy , development and quality of life. A society where people cooperate is a society where more people are willing to contribute with the group, paying the taxes that will revert to health, education and security for everybody. A more cooperative society is one where the richer are actually concerned with the welfare of the poor and are willing to contribute to eradicate poverty. At the same time, given the high level of punishment for the free-riders (and consequently the punishment of corruption and all kinds of crimes) corruption in all levels and

crime should also diminish. At the poorer end of the chain, this scenario diminishes exclusion, and the excluded then will also have more incentive to cooperate, leading to a virtuous circle of cooperation and ethical behaviour.

Violence – The figures for violence are very high around the world, and they are frightened, for instance, when we look at Brazil. Whilst around 20.000 people a year died in Iraq, since the beginning of the Iraq war, it is around 45.000 people who are murdered in Brazil [58]. Murder is a huge health problem, being especially devastating for those between 15-24 years of age[59].

Being that violence is such a serious problem, it is difficult not to see the huge benefits that research on the brain mechanisms of violence and the role of serotonin on violent behaviour could bring. Contrarily to what some people think, the research in this area does not make us blind for the environmental and social causes of violence, but on the contrary, it is a very important tool to be used in order to tackle the problem. Here it is important to avoid any reductionist approach, avoiding both the social reductionism, that only blame social causes for the violence problem , and the medical reductionism, that only see physiological causes. In building the integrated approach, where we can see all the causes of violence: social, cultural physiological, neurological and others, we will be able to try to combat the problem with much more efficacy. It could be simplistic to think of a future scenario where a serotonin injection could "cure" violent people, but on the other hand it would be naive to think that serotonin and brain stimulation should not be used as one more tool by people who have certain kinds of violent behaviour and want to change it. The ethical challenge here would be to preserve people's free will, balancing the respect for individuals who refuse to be treated with the social interest of not having their security threatened.

Prejudice - We all know how maligne prejudice is, being race prejudice, gender prejudice, sex orientation prejudice, or any other. Prejudice attitudes are a sub class of immoral attitudes and it accounts for a huge amount of suffering around the world, victimising people in many ways. Allport, in his scale of prejudice[60] , shows that in the end of the prejudice chain starting with verbal abuse there are extermination and ultimately genocide.

The studies that are being carried out on the brain circuits of prejudice suggest that race prejudice can be extremely subtle, operating unconsciously on people, and confirming what in a sense people already know, that prejudice can be seriously dangerous precisely because it

sometimes is not explicit and people even do not admit the existence of it, but end up acting in a prejudiced way. It is also important to confirm what the studies with William Syndrome people are suggesting, that the brain mechanisms operating in race prejudice and gender are distinct. It would also be important to extend these studies to areas such as gay prejudice, but at least in my review up to this moment I was not able to find a single study related to this kind of prejudice.

The advance of the studies on the brain circuits of prejudice can lead to important discoveries about how they operate and these findings can help people to live less prejudiced lives, with immediate impacts on diminishing discrimination and improving tolerance in our society.

Lying – The studies on what happens in the brain when we lie and when we tell the truth are one of the most promising and fascinating in fields related to neuroscience of ethics, and probably also the one that receives more funding worldwide, as it has immediate impact on security. As I have said, even though there is not yet a "lie-detection machine" that is 100% reliable on detecting lies, some devises are being used and sold and it is not science fiction to predict that in medium term there will be a reliable technology available in this area.

The use of "lie-detection machine" immediately poses some problems related to possible misuses, such as those concerning related to privacy, and also raises interesting ethical and legal questions such as "do we have the right to lie?" or "do we have the right of not being tested to know if we are lying or not"? These are certainly questions that ethicists and solicitors will have to answer in the future, but at the moment it seems very clear the benefits that such technology, once available, could bring. One huge benefit would be its use in court, since many innocent people could ask for the use of the technology in order to prove that they are not guilty, leading to their release. The opposite is also true. Many dangerous criminals are free because it could not be proved that they have committed crimes, and such a device could provide the proof. Policeman could use the device in investigations and certainly this could bring much more security for society as a whole. The impact of this in the Justice and criminal system would be huge, but there is no doubt that it would be an impact for good, considering the imense problems of crime and violence that we face in society, with terrorism being a major threat in Europe and USA and internal crimes and violence being a huge problem in Brazil and other latin-american countries. It is clear that security problems have to be tackled immediately and we can not solely rely on a "lie-detection machine" in order to do that, but certainly a device like this would be extremely

useful in terms of police investigation and use in court, and could be one more instrument to be used in order to build a more secure and peaceful society with immediate impact in quality of life.

To conclude I will say that the door is open for neuroscience of ethics to lead us along a path that is highly promising for the studies of ethics, morality and all the behaviours related to it. Neuroscience of ethics has arrived to stay and if we want a better future, improving the moral standards of humankind and building a world where people live longer and better, being more and more free, happier and more ethical, it is time to pay more attention to it.

10 Notes

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