A unique view at the phenomenon of social unrest based on marketing and neurobiological evidence

Olivier Mesly
University of Québec in Outaouais (UQO)

ABSTRACT

In the last two years and across the globe, a number of social unrests have occurred, including in North Africa, Greece, and Québec (Canada). The common ground of these unrests is the feeling by the crowd protesters that they have been treated unfairly; they feel abused by a system that is larger than they are. This paper focuses on the spring 2012 Québec student movement which was initially based on a hike in tuition fees which, in all respects, could not compare with the conditions that people in North Africa or Greece experienced. The paper shows that anger, under certain conditions, leads to chaos. To arrive at this conclusion, a multidisciplinary qualitative and quantitative research was conducted. The paper concludes by asserting that social unrest can be somewhat controlled by better management of anger expressed by citizens.

Key words: perceived predation; Mesly model; anger; hypothalamus, impulsivity.

INTRODUCTION

In the spring of 2012, students across the province of Québec (Canada) started to protest a tuition hike that was to see an increment of roughly 50 cents a day or some $ 1625 per annum by the end of a five-year period. This government's measure had been announced during the previous 2008 election and the government had been elected with a majority. The hike still placed Québec students far below the average of what other students in other provinces in Canada pay[1]. Yet, the protest movement increased, gained considerable momentum, and even lead to a riot during a government meeting outside of Montréal on May 6, 2012. Eventually, the students got support from teachers unions, political parties and foreign groups and thousands took to the streets, evening after evening.

The present paper is organized as follows. First, we present the result of a qualitative study that was done from February to July 2012 by conducting ten unstructured interviews with people that felt intimately concerned with the situation, primarily university and college teachers as well as university students.

We then proceed to explain how anger, which appears to be the main sentiment expressed by the participants, can be explained from a neurobiological point of view. This is important because anger and predation are fundamentally different. The Québec government was certainly seen as a financial predator by its opponents but their reaction was that of anger, not of predation. Adopting such an approach using neurobiological evidence and economics is not out of the ordinary and may serve our goal of shedding light on the recent Québec movement. Indeed, "Neuroeconomics merges methods from neuroscience and economics to better understand how the human brain generates decisions in economic and social contexts." (Fehr *et al.,* 2005, p. 346).

Armed with this understanding, we examine data retrieved from two databases, one including 19 functional groups (n=834) which have experienced different levels of disagreements over the last four years, and a database of n=300 dating back to 2008. We attempt to find correlates between the measures of predator/prey compiled within these databases with the anger expressed by the students. We show that social anger contains a real potential of leading to social chaos. We also make a connection between this tendency towards chaos and social networks.

Finally, we conclude by pointing out that social anger must be prevented or else carefully managed in order to eliminate the potential for social unrest, as this leads to significant social costs that in the end worsen the economical situation for everyone. As an example, the unrest in Québec during the six months leading to the summer had cost millions of dollars in police and anti-riot intervention.

Preliminary assessment – a qualitative study

We conducted ten unstructured interviews with professors and students[2]. Although we initially had prepared for semi-structured interviews, it soon became clear that the respondents were far too emotional so that we let them talked *ad lib*. We compared their comments to

[1] For example, a student in medecine pays some $2000/annum in Québec; roughly eight times more in Ontario.
[2] Ten cases is recommended for this kind of study (Rispal, 2002, p. 90).

what was reported in the news[3]. The word "anger" kept reoccurring over and over again. The word "anger" or similar concepts occur more than 54% of the time, pinpointing the fact that indeed this is the driving sentiment.

In one case, a University professor who had fully supported the student movement testified to the fact that he himself was "attacked" by some protestors, as there were quite a number of violent incidents. Some of the protestors had turned blind and perceived about anyone as a threat, he explained. Studies have shown that a similar phenomenon occurs among animals: "

… chimpanzees attack allies that do not support them in third party conflicts, and queen naked mole rats will attack workers that they judge to be lazy" (Seymour, Singer, & Dolan, 2007 p. 306).

A Cegep (college) teacher explained that the situation had cost her a summer otherwise dedicated to holidays with her kids. Her classes were substantially delayed, and final exams and corrections were to happen during the course of her vacation. She didn't hold any grudge against the students because according to her, the students (who identify themselves with a red square) needed to be treated fairly. She, as did another professor, expressed the fact that the government had been rude in his refusal to meet with the protesters.

One student wrote[4]: "Although I support the red square movement, I do not agree at all with acts of violence. I am opposed to the tuition hike but remain respectful of everyone's ideals." This student was referring to the fact that many protests had turned violent indeed and that some people had encouraged or else refused to condemn violence against people or belongings.

All in all, the protesters by and large felt that the tuition hike was abusive; they felt preys to a political party which, in their own views, had taken a unilateral measure without seeking their opinion. In the past, about every tuition hike in Canada, the US, Great Britain or France had generated in student unrest. As such, the student unrest in Québec was not a novelty, neither was its level of anger and violence. What was more surprising was that compared with other students in Canada, the US or Great Britain, the Québec tuition fees are quite moderate, even after the planned hike. How can a 50 cents a day additional expense can make such a big difference on students who each have i-pods, i-pads, i-phones, cars, vacations, and who enjoy partying with little restraint? Something was triggering the anger and the result was moderate social chaos. This is what we try to answer next.

Predation and anger – two behavioral patterns closely linked yet quite far apart

Financial predation refers to the fact that individuals with the necessary power and acumen take full advantage of people who trusted them, stealing their assets, by surprise (Mesly, 2012).

For predation to exist, there must be five mandatory structural components: a predator (the Québec government according to the protestors); a prey (the "red square" students); a tool (the new law to instill tuition hike and Bill 78, which followed suit to contain student

[3] Andy Blatchford of the The Canadian Press (May 28, 2002: Quebec unrest generates more than 3,000 news reports in 77 countries: analysis reports that "The analysis found that in the last two weeks 39 per cent of what was written about Montreal, from around the world, included at least one of the following expressions: "massive arrests," "riots" and "violence."

[4] Our translation from French.

violence); an "injury" (loss of financial well-being for the students, at least from their point of view); and finally a surprise element. Even though the protestors seem to qualify the Québec government as a financial predator of some sort, two of the above components require that this epithet be moderated. First, it is hardly realistic to believe that a 50 cents a day increase would somehow harm the financial capacity of students[5]. Second, there were no real surprises because the hike had been announced and the government duly elected.

As such, even though the protestors vehemently contested the government, they were not in a position to label it as a financial predator. Their rationale rather turned into one whereby they first emphasized their position as a prey. From this perspective, the recent Québec protest cannot be seen as a pure predator-prey dynamic because the structural elements of predation are somewhat weak. Nevertheless, our qualitative study clearly points to a similar dynamic, that of anger (anger and predation are two hostile behaviors).

To understand anger, it is worth examining it from a neurobiological point of view. In the next section, we will use a definition of anger to help us mining a database that measured predator and prey values on 834 participants and another database that measured cooperation and dependency on n=300.

What is anger?

According to Reimann and Zimbardo (2011, p. 175): "Anger entails physiological arousal (e.g., increased heart rate, blood pressure...) and preparation for verbal and physical aggression."

At the core of human archaic brain lies a structured that all mammalians possess: the hypothalamus. It is crucial to understanding behaviors such as anger because, as pointed out by Squire *et al*. (2003, p. 897): "Almost every major subdivision of the neuraxis, or central nervous system (CNS) communicates with the hypothalamus and is subject to its influence". It is a remarkable brain structure because of the degree of coordinated behavior it can produce despite its small size (the size of an almond in humans) (Gregg and Siegel, 2001, p. 97). The hypothalamus has a number of unique features (See fig. 1 and Annex A, Appendix).

From a structural point of view, it has participated to the evolution of predatory capability (primacy in evolution) among mammals. This means that there is a potential in humans to respond to threat (such as a tuition hike) in a somewhat aggressive manner. It has remained archaic (some other structures evolved in time; e.g. the cortex for higher brain power) and is unconscious. This means that strong reactions such as anger can be expressed without full cognitive control. Thirdly, it is autonomous and works hand-in-hand with the autonomic nervous system (ANS) which controls heart beat, sleep patterns and so forth. As such, it is sensitive to external cues. Fourth, it has complexity and multiplicity, that is, it is equipped although in a rudimentary form to react to threats from perceived predators from the three perspectives that form attitude: emotional, rational (cognitive), and behavioral. Fifth, it has flexibility in its communication with the body (it communicates through hormones and neurons, it produces its own so-called pleasure chemical – Nitric Oxyde NO, etc.), and is based on a two-speed system (a slow and a fast one: ex.: neuromediators/modulators (fast) *vs.* neuropeptids (slow)). We shall see that the speed feature is particularly important in differentiating anger from predation because it entails the concept of impulsivity. Finally, it is

[5] The government assumes an average student income of some $12,000 a year when calculating loans and bursaries.

networked with the body through a loop system that helps control internal homeostasis according to internal set points (this also will become important later on in this paper).

From a functional point of view, the hypothalamus is in a survival-mode. It participates in the body's visceral and most fundamental activities: (a) blood flow (cardiac, renal function etc.); (b) energy metabolism (body temperature, food, water, sleep); (c) reproductive functions (sex, pregnancy, lactation); d) growth (McCullough *et al*., 2007); and (e) responses to threats (stress hormones, sympathetic-parasympathetic tone, etc.). A fee hike strongly perceived as a threat will trigger some reaction from the structural and functional parts that define the hypothalamus. The tuition increase represented a form of resource impediment for students (albeit quite minimal) which would explain the manifestation of anger: in the animal kingdom, withdrawal or loss of necessary food resources triggers the hypothalamic-pituitray-adrenalin axis – HPA (Woody and Szechtman, 2011) leading to potential aggression. The fact that the government proceeded without much prior additional warning may also be an excitatory element: in animals, imminent threat leads to active defensive reactions (Mobbs *et al.* 2009).

Indeed, and this is its second functional characteristic, the hypothalamus is responsive. Most notably, it is equipped with four basic behavioral patterns that relate directly or indirectly to perceived predation: 1) maintenance of functioning homeostasis; 2) defensive rage, also called "sham rage" (Bear *et al.* 1996, p. 446) through the ventromedial hypothalamus. On this subject, Siegel and Sapru (2011, p. 215) note: "…the *medial* hypothalamus …provides a mechanism that modulates feeding, generates affective processes, such as rage behavior, in animal and people…"; 3) escape; and 4) predation aggression (*lateral* hypothalamus)[6].

As can be seen, therefore, from the hypothalamus point of view, predation and anger are indeed different. Rage would be a primitive form of anger, directly related to a sense of unfairness. Hence, we suspect that the Québec protesting students fall into the rage/anger behavioral pattern. What triggered this rage/anger was not a financial predatory attack *per se* but an irritant; indeed, a large number of studies of cats (which are excellent subjects for this kind of study because their reactions are quite noticeable – e.g. pilosity erection) shows that irritants do indeed cause defensive rage (Siegel and Victoroff, 2009).

Another functional characteristic of the hypothalamus is that it is sequential. For example, it regulates hours of sleep. As Squire *et al.* (2003, p. 897) explain: "…hypothalamic structures are thus able to recruit a sequence of motor acts that appear in logical order."

Fourth, the hypothalamus is driven by pleasure and pain. One can see how the student protest has transformed over a couple of months from gestures of anger and self-victimization to nightly social events whereby people started to hit pans in the street in order to make the demonstration as festive as possible.

It can be seen that what the students were feeling was anger; anger is lodged in the hypothalamic structure of the brain, which, through its various structural and functional

[6] We suspect the right lateral nucleus of the hypothalamus might be a stronger center of predatory actions than its left counter-part. This because the right hemisphere has an important role in a variety of functions such as pro-social behaviors, agreeableness and "maintenance of positive social relationships, cooperation and attention to social norms" (Hecht, 2011, p. 4), fear processing (including cortisol control) and inhibitory capabilities in regard to affective, behavioral and cognitive processes.

characteristics, may help explain how the student protest evolved and became so emotionally-loaded.

Defensive aggression

Defensive aggression, at the extreme, is expressed by rage but it can find a more moderate expression in anger. Defensive aggression (rage) is indeed vastly different than what is referred to as instrumental aggression (predation). Animals that experience rage will hiss, lunge and attack (Adams, 2006). Québec students in a similar fashion opted for evening of pan drumming in the streets. Predators display their teeth and bite and attack. Students (except for a small group that proved to be well-organized thugs) do not have the tools: they are not armed against the police or anti-riot forces; they don't have the law in their favor. Gregg and Siegel (2001, p. 93) describe the difference between the two types of aggression with more details: affective (defensive) aggression is impulsive, overt and unplanned in nature; predatory aggression is planned, goal-directed, emotionless, hidden (sneaky) and not preceeded by autonomic arousal (e.g. increase in heart rate).

As seen, defensive aggression originates from a different part of the hypothalamus than predation (medial *versus* lateral hypothalamus). In both cases (rage and predation), levels of testosterone (T) and cortisol (CRT) play a role. Indeed, what is referred to as T-to-CRT ratio is a key marker for proness to social aggression (Terburg *et al. ,* 2009). It is known to produce defensive aggression if the level of serotonin[7] is low, but it will produce instrumental aggression if the level of serotonin is high (Montoya *et al.,* 2012). What differentiates anger and aggression is therefore, in part, the level of serotonin – See fig. 2 (Appendix).

Predation goes through the HPA axis; rage through the HPG axis. We will see that there is more to this but for now, let's focus on the three chemical components that appear in fig. 2.

Testosterone is a steroid hormone (produced through the hypothalamic-pituitary-gonadal axis – HPG) and is strongly associated with aggressive, anti-social behavior and sensation seeking[8] (Stenstrom and Saad, 2011). As explained by Reidy *et al.* (2011, p. 520): "Testosterone inhibits the function of the HPA axis and associated autonomic systems, reducing sensitivity to punishment. In contrast, cortisol is thought to increase sensitivity to fear through suppression of the hypothalamic-pituitary-gonadal (HPG) axis […]"

Cortisol is a steroid hormone that is strongly associated with social withdrawal and a reduction in the activity of the immune system; it is initiated by the hypothalamus in response to stress (through the hypothalamic-pituitary-adrenal axis – HPA). A high T/CRT ratio means, in essence, a high propensity for aggression (either defensive or predatory) and a low tendency towards socialization. The HPA and HPG axes are antagonistic (with the fast-acting neurotransmitter GABA[9] serving as the agent in reciprocal inhibitory connections) , so that the ratio tends to be very high or very low depending on the level of perceived threat (Viau, 2002).

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[7] Serotonin is a neuromodulator found in the neighbourhood of the neurons (but not in the synapses) of the central nervous system (CNS) (approx. 10%) where it regulates mood, appetite and sleep. The balance of it (90%) is found in the enterochromaffin cells in the alimentary canal (gut) where it regulates intestinal movement. One can see how rage, therefore, can take people by the "gut".

[8] Many protesters who spoke on evening news clearly expressed their propensity towards sensation seeking such as crowd gathering and in some cases, violence.

[9] It travels within the synapses only.

Serotonin is strongly associated with impulsivity in both animals and humans (Ueda *et al*., 1999). Low levels of fast-acting serotonin produce high impulsivity, lower fear and anxiety (Woody and Szecthman, 2011) and provoke hyper responsiveness by inhibiting prefrontal control[10]). High levels of serotonin encourage moral and prosocial behavior, a fact that implies more prefrontal cortex activity (Verbeke *et al.,* 2011). The determining factor (at least in part) between rage and predatory aggression is therefore impulsivity. This is why a high T/CRT ratio with low serotonin levels leads to defensive aggression (rage): rage is not calculative, and it is not targeted. For example, a cat artificially stimulated to produce defensive rage will bite anything that is beside it. Similarly, some Québec protestors even attacked people that supported them; they kept changing their targets of complaints regularly, with the focus being first student fees, then social democracy, then banks and corruption and so forth. Aversive (defensive) aggression has an immediate goal: to reduce or eliminate the threat stimulus, that is, the tension caused by the environment. In the case of the student protest, eliminating the government in the Québec context was hardly conceivable; hence there was here a critical criterion for the creation of chaos that is, the absence of self-regulatory systems.

A high T/CRT ratio with (in part) high serotonin levels leads to predatory aggression: this is characterized by highly-focused activities and strategies (Meloy, 1997). Therefore, what differentiates defensive from instrumental aggression is time, expressed as fast (impulsive) *versus* slow (predatory).

Interestingly, aggression is not accompanied by punishment sensitivity but is strongly motivated by reward; this explains why Québec students have constantly challenged the authorities, refused to obey the laws (e.g. they refused to give their marching itinerary, to provide access to university sites despite court orders, etc.).

It must also be noted that the large majority of protesting students were (and still are) from so-called soft sciences: literature, politics, geography, history, arts, etc[11]. Very few business or engineering departments got involved indeed. This majority of students are prone to make less use of the calculative prefrontal cortex and, given the average age of the students, to be prone to impulsivity.

[10] Which itself acts on the amygdala-hypothalamus-PAG network. PAG= periaqueductal gray matter.
[11] They are estimated at 170,000 students out of the 400,000 Québec students.

The role of oxytocin

Even though rage and predatory behavior is thought to be determined by the difference in serotonin, we suggest that what really makes the difference is impulsivity. Impulsivity is a function of serotonin levels but also from another chemical, the neuropeptide hormone oxytocin, frequently and erroneously referred to as the "trust"/"love", which is produced by the posterior pituitary gland under the control of the hypothalamus (Siegel and Pradu, 2011, p. 215). Attachment in the sense of responding to dependency is facilitated by the release of oxytocin, which has been found to be involved for example in the nurturing of mothers towards their infants (Purves *et al*., 2004, p. 486). As such, oxytocin is related in the present paper to dependency, not to trust or love. Attachment (dependency) requires times and thus ranks low on impulsivity potential. In the particular case of the Québec protest, the exact term should surely be dependency rather than attachment, in the sense that the students depend on the government to provide bursaries and loans towards completion of university degrees.

From this perspective, our definition of impulsivity makes sense[12]. Someone who is prosocial but has a very low level of dependency will likely display little impulsivity because there is no sense of urgency (his life is not threatened as he is independent); however, someone who is rejected (who doesn't find cooperation with others) but who highly depends on them sees his life threatened and so will likely respond very rapidly and strongly to a stimulus. He will be highly impulsive. This is the situation that occurred in Québec: the students felt rejected by the government which initially refused to meet with them, yet they depended heavily on it as their education, bursaries and loans are under his control. Hence, the making of the situation in Québec is one of high impulsivity.

The hormone-based serotonin (5-HT) to oxytocin (OXT) ratio, less known than the steroid-based T/CRT ratio, seems to be the real measure of impulsivity. Both hormones somewhat act in the same direction: low levels of serotonin means low levels of sociability (thus potentially high impulsivity) and low levels of oxytocin are expected to produce little sense of attachment/dependency (thus potentially high impulsivity); yet their ratio produce extreme behavior as in the Québec case[13]. Hence, we propose the following model (table 1, Appendix)**[14]**.

For a given level of oxytocin, the person with low serotonin will withdraw from a relationship that is perceived as threatening or where he feels rejected; on the opposite, the person with high levels of serotonin will stay within the relationship (freeze) but show little reactivity.

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[12] We did not have a measure of impulsivity according to standard psychometric tests (such as Barratt) in our two databases (n=834 and n=300).

[13] To measure impulsitivity by a ratio (serotonin/oxytocin) rather than by a simple measure (serotonin) seems logical with respect to human functioning. Only through the on-going play between mutually inhibiting molecules or ions can the dynamic of behavior occur, and this is true for all of human behavior (for example, the autonomic nervous sytem is separated in the sympathetic and parasympathetic systems, with one being activating and the other one being antagonistic; the neuron electrical transmission functions also on the basis of changes in electric charge in and outside of the axon).

[14] Testosterone (T) and Cortisol (CRT) (along with arginine vasopressin) are typically associated with avoidance behavior and distrust, while serotonin (5-HT) and oxytocin (OXT) (along with estrogen and dopamine) are typically associated with approach behavior and trust (Riedl and Javor, 2012, p. 73)

For the Québec students to have so consistently and stubbornly insisted in negotiating with the government is showing dependence in it, while not admitting the reality that their strategy was maladapted; for example, they consistently defied the law while by the same token (and unsuccessfully) going to Court to make sure their perceived rights were respected or laws they didn't agree with got nullified. The fact that the government systematically refused to entertain discussions with the protesters also had for effect of lowering the capacity for social contacts requested by these protesters. For the students, feeling rejected while being highly dependent meant high impulsivity.

As it turns out, the available data consisting of 834 participants that have filled out the Mesly questionnaire (Mesly, 2010) over a four year span (2008-2012) is much related to these neurobiological measures and can be assumed to serve as proxies, as follows (see table 2).

Neurobiological evidence seems to support the fact that we can measure rage by using constructs (predator, prey, cooperation, dependency) that are available in the two databases of n=834 and n=300. For the rage scenario, this would entail a high Predator/Prey ratio given a low Cooperation/Dependence ratio. The neurobiological equivalent of these constructs T, CRT, 5-HT and OXT do indeed play a role in fear context (that is, when real or perceived threat is considered) and are inter-related: individuals displaying higher trust disposition (Increased OXT), for example, have less social-stress induced cortisol (Riedl and Javor, 2012).

All in all, the qualitative investigation that was performed as well as analyses of the protestors' behaviors based on neurobiological information strongly indicates that anger is the main emotion driving the recent Québec protest. It is not predation, and realistically, it is not financial predation on the part of the government.

A look at databases of n=834 participants and n=300

Equipped with the understanding of rage behavior by the Québec students, we moved next to try to find evidence between rage and chaos, as the student movement eventually evolved in dramatic fashion towards chaotic events which left many injured[15] and millions of dollars in damages. Fortunately, our databases contain a measure called predator/prey ratio, which could be a proxy for the T/CRT ratio. The n=300 database contains a measure of cooperation and dependency, which serves as proxy for 5-HT/OXT.

A number of findings came about when examining these databases (n=834 and n=300), which are reviewed thereafter.

The law of perceived predation

The first important finding is that the law of perceived predation (Mesly, 2010) is indeed corroborated through neurobiological evidence. This probably means that we can use, with all scientific precaution, the predator/prey measure to approximate the neurobiological facet of anger. Indeed, a research using images of angry faces shown to participants that were asked to evaluate them on a number of parameters and that was performed by Todorov and Engell in 2008 resulted in the following principal component analysis (table 3, Appendix).

[15] One student even lost an eye.

This is much in line with the factorial analysis performed on each of the 19 groups in the database and on the entire 834 participants as a whole (Table 4). This exemplifies the law of perceived predation: as soon as predator is equal or smaller than prey, the values of trust, cooperation, equilibrium (a sense of win-win) and atmosphere go down. The reverse is true. The Québec students probably felt very much preys when the government decided to impose (unilaterally in their view) tuition hike; they soon reacted with defensive rage by boosting their predator profile and lowering their prey sentiment, while doing so very explosively indeed.

Finding impulsivity – Cluster analysis

We needed to verify that the measure of trust on the database of n=834 did not act as a proxy for dependence. A cluster analysis reveals that trust and cooperation work hand-in-hand and cannot help in asserting whether a situation is explosive (loaded with impulsivity) or not (Table 5 and Annex C, Appendix).

Observation 1:

The class with a high predatory/prey ratio (which is indicative of hostility) shows a cooperation/trust ratio of 1, which is not indicative of impulsivity. Indeed, the right measure for impulsivity seems to be cooperation/ dependency and not cooperation/trust.

We proceeded to retrieve a database dating back to 2008 with n=300 in which all four constructs of relevance (predator, prey, cooperation and dependence) were measured[16]. We performed a number of cluster analyses testing for the most-eloquent scenario. The best output came as follows (Table 6).

This group of n=300 was composed of people who participated voluntarily in a social activity in the Eastern Townships (Québec).

***Observation 2*:**

It would have been very unlikely to find any traces of anger (higher predator/prey with low cooperation/dependence) because any unhappy individual would have likely left the group. What is noticeable though is the fact that two classes of individuals are obtained that fit well into the general four-behavioral model summarized in table 1. It is thus normal not to find people who are angry, fleeing or else "frozen" (uninterested) as these people would have left the group from the onset.

Observation 3:

Only a small percentage of individuals[17] (5/300= 2%) fall into the potential predator category (high predator/prey ratio with relatively high coop/dependence ratio) which again is quite expected given the voluntary setting. The result shows however that indeed our

[16] Dependence was measured with two questions only, which makes it a somewhat weak evaluation of dependence, yeti t served our purpose for the present paper: 1) I feel obligated to collaborate with this person; 2) I cannot avoid dealing with him in the present context.

[17] This is a normal percentage (see Mesly, 2012).

measuring system employing two ratios (predator/prey and cooperation/dependence) seems to make sense and can be used to assess anger.

Observation 4:

As with many other databases, the constant k_{om} is found with the predator/prey ratio; k_{om} is established at 1.3 for the large majority of participants. It can be inferred that this sample population of n=300 is representative of the average population.

Observation 5:

Interestingly, the corresponding cooperation/dependence ratio is similar, at 1.22. All in all, a predator/prey ratio (a proxy for self-confidence) given a cooperation/dependence ratio (a proxy for impulsivity) seems to relate to individuals characterized as stable under attachment theory (see table 5). All in all, we felt confident that the measure of rage as being the ratio of the predator/prey construct given low measure on the ratio of the constructs cooperation/dependence could be used. Knowing that the hypothalamus controls homeostasis by testing set points (for example, set points for hunger, thirst, sleep, etc.) the next step was to determine if the predator/prey ratio goes through set points itself, as this could indicate at what thresholds anger develops. This is what we do next.

Finding chaos

For the 19 groups or 834 names in the first database, the predator and preys values are put in Annex D. Of interest though is the fact that set points were found, as follows (table 7). Group observations showed that where the value of *k* is at 4.7 or under 1, participants tended to quit the relationship (if they have the choice) resulting in high turnover.

Observation 3:

Interestingly, this scale is very similar that of a logistic map found in chaos theory with respect to population facing the options of reproduction or starvation[18]. In this theory (May, 1976), time is a key factor (just like in the theory of predation, as a predator is defined by its capacity to take its prey by surprise, that is, to act faster than the prey). The behaviour of logistic map curve resulting from variations in the value of *r* in the basic function $x_{n+1} = r\ x_n\ (1-x_n)$ are remarkably similar to human behaviors observed among the 19 groups (with *r* being the equivalent of our constant *k*) for values ranging between 0 and the Feigenbaum constant (4.669)[19]. The chaos curve's own behaviors results from variations in the value of *k (= r)* in the logistical map function and is thus related to uncontrolled anger, as follows:

[18] With reproduction and starvation being core activities related to the hypothalamus, and, of course, the utility of predation.

[19] The formula implies a dynamic system: "The future states of a dynamic system are a function of its present sate, as modified by its own activities…" (Lewis, 2005, p. 173).

$$\text{Anger}_{n+1} = k\ \text{anger}_n\ (1\text{-anger}_n)$$

assuming a low cooperation/dependency ratio.
(equation 1)

Past research has shown that the value of *k* is typically at a constant 1.3[20] (see Mesly, 2010 to 2012), which is also a stable value in a logistical map function. One should not be surprised that human behavior follows some mathematical order. Red blood cell reproduction, for example, has been found to obey a mathematical function (Mackey and Glass, 1977).

The logistical map function suggests the existence of loops, which is exactly what happens in the brain, and this at two levels: first, while there is efferent circuitry from the hypothalamus to the pituitary gland, there is no afferent circuit coming to the hypothalamus from the pituitary gland; as such, the hormones secreted by the pituitary glands must go through the entire body before sending back information to the hypothalamus, in particular through the tegmentum. Second, so-called Renshaw loops at the motor neuron level imply some immediate feedback once the neurotransmitter acetylcholine is produced in order to modulate muscle action and avoid over-reactions. Hence, the body is equipped with loops that help explaining the embedding of *k* (the predator/prey ratio) in a logistic map function.

The circumstances characterizing the Québec riots are: 1) lack of control by the government (many protests were simply not squashed and the law was applied rather softly); 2) fast conveying of information through social networks; 3) a constrained (closed) system (Québec schools form the majority of French-speaking educational institutions in North America); and 4) extreme sensitivity to initial conditions (the payment of established tuition fees), a defining characteristic of deterministic chaos (May 1995). Given these circumstances which very closely meet the requirements ofdynamic systems, the inevitable outcome of the anger rise among students was chaos, which is exactly what was witnessed evening after evening for months on end.

The role of social networks

There is little questioning that what helped the Québec protesters to mobilize and act quite drastically (for example by blocking entry to universities despite court orders) was and remains the presence of social network. An expression of this social network could be π since a social network functions much like a circle (circle of friends, of contacts). Hence, and purely theoretically, we could replace the value of the k_{om} at 1.3 by the function:

$$k_{om} = 1 + 1/\pi$$

(equation 2)

Putting equation 1 and 2 together, we obtain:

[20] For a dyadic relationship to last and be fucntional, one must feel about 30% more predator than prey: he must not be in a position where he feels vulnerable (predator value ≤ prey value on the Mesly (2010) scale. This is referred to as the constant k_{om}.

$$\text{Social Chaos}_{n+1} = f(\text{anger}_{n+1}) \text{ with anger}_{n+1} = (1+ 1/\pi)\ \text{anger}_n\ (1\text{-anger}_n)$$

(equation 3)

This reads in the following manner: social chaos in the future is a function of networking capabilities and current anger as it has accumulated over time. This may explain why many governments that face social unrest are quick to try eliminating the use of social networks. They fuel social anger and increase the capacity to mobilize.

Thus, a qualitative study as well as neurobiological evidence supported by key findings retrieved from two databases lead us to conclude that the Québec social unrest is not an act of war entailing predatory attacks, but rather a manifestation of defensive rage. This anger had no way to go but to evolve into chaos as predicted by the values of *k* embedded in a deterministic chaos function.

CONCLUSION

This paper's objective was to better understand how the Québec protest quickly degenerated; it is one of many examples of social unrests that have plagued the world in recent years. Our first goal was to determine the exact nature of the underlying sentiment driving the protest. Judging from the content unstructured interviews and from media coverage, it became clear that anger was the main driver. An analysis of anger from a neurobiological point of view allowed us to make a link with existing databases which had measured, among other constructs, the predatory/prey ratio which turned out to be a proxy for the testosterone-cortisol ratio, as well as the cooperation/dependence ratio, a likely expression of impulsivity (a proxy for the serotonin/oxytocin ratio). We saw the link between T/CRT and impulsivity, which we expressed by the ratio 5-HT/OXT. We also saw that the hypothalamus is the center of anger and that it has a number of structural and functional characteristics that explain anger.

We were then able to examine how the predator/prey ratio behaved given what had been observed in the 19 groups that composed the first database (n=834) assuming low impulsivity. Although it remains to be more scientifically proven, there exists an indication that *k* (the predator/prey ratio) reaches certain set points, just like from a neurobiological point of view, behaviors are coordinated around set points by the hypothalamus[21]. Looking at the pattern of these set points, we remarked that it matched quite closely a logistical map function, which is a function of deterministic chaos. Indeed, the protests in Québec turned into chaos; there was indeed a real possibility that given the conditions that were set (such as a close system), social anger would degenerate into chaos according to a logistical map function, to which *k* relates.

Since the value of k_{om}, known as the predator/prey constant as it remains consistent in functional groups, is of 1.3 (that is, one wants to feel 30% more strengths than weaknesses at any given time during a dyadic exchange), we proposed that this function can be translated into a function that includes a social network effect, expressed by π.

[21] These set points are innate or determined by learned association (Amaral, 2002).

Our analysis remains vastly theoretical and demands more research; yet, many aspects of it point towards the fact that anger, given certain conditions, leads to deterministic chaos, and that this chaos is a function of the capacity of protesters to network, that is, to organize their movement. A net product of deterministic chaos is rapidly declining predictability (Bednekoff and Lima, 1998), hence the importance for governments to get a grip on rising social unrest and on anger, especially coming from more volatile individuals such as university students engaged in soft science programs.

The important lesson from this analysis is that social unrests must be dealt with as soon as they emerge as the inevitable presence of social networks serves as a strong catalyst to drive them towards chaos. Networking capabilities can no longer be discounted: chaos is around the corner whenever social anger meets the right conditions.

REFERENCES

Adams, D.B. (2006). Brain mechanisms of aggressive behavior: An up-dated review. *Neuroscience and Biobehavioral Reviews 30, 304-318.*

Alvarez, R.P., Biggs, A., Chen, G., Pine, D.S. and Grillon, C. (2008). Contextual Fear Conditioning in Humans: Cortical-Hippocampal and Amygdala Contributions. The Journal of Neuroscience 11 (June), 6211-6219.

Amaral, D.G. (2002). The Primate Amygdala and the Neurobiology of Social Behavior: Implications for Understanding Social Anxiety. *Biological Psychiatry 51,* 11-17.

Barratt, E.S. (1993). Impulsivity: Integrating cognitive, behavioral, biological and environmental data. In W.G. McCowan, J.L. Johnson, 2194 Afr. J. Bus. Manage. and M.B. Shure (Eds.), *The impulsive client: Theory, research, and treatment.* Washington, DC: Am. Psychol. Assoc., pp. 39–56.

Bear, M.F., Connors, B.W., and Paradiso, M.A. (1996). Neuroscience – exploring the brain. Williams & Wilkins: MA (PA, USA).

Bednekoff, P.A., and Lima, S.L.: Randomness, chaos, and confusion in the study of anti-predator vigilance. *Trends in Ecological Evolution 13*, 284–287.

Berridge, K.C. (2004). Motivation concepts in behavioral neuroscience. *Physiology and Behavior 81,* 179-209.

Blatchford, A. (May 28, 2002) *Quebec unrest generates more than 3,000 news reports in 77 countries.* The Canadian Press.

Di Scala, G., Schmitt, P. and Karli, P. (1984). Flight induced by infusion of bicuculline methiodide into periventricular structures. *Brain Research 309,* 199-208.

Fehr, E., Fishbacher, U. And Kosfeld, M. (2005). Neuroeconomics Foundations of Trust and Social Preferences: Initial Evidence. *Neuroscientific foundations of economic decision-making 95*(2), 346-351.

Gregg, T.R. and and Siegel, A. (2001). Brain structures and neurotransmitters regulating aggression in cats: implications for human aggression. *Progress in Neuro-Psychopharmacology and biological Psychiatry 25,* 91-140.

Hassanain, M., Zalcman, S., Bahtt, S. And Siegel, A. (2003). Interleukin-1β in the hypothalamus potentiates feline defensive rage: role of serotonin-2 receptors. *Neuroscience 120,* 227-233.

Hecht, D. (2011). An inter-hemispheric imbalance in the psychopath's brain.

Personality and Individual Differences 51, 3-10.

Lewis, M.D. (2005). Bridging emotion theory and neurobiology through dynamic systems modeling. *Behavioral and Brain Sciences 28,* 169-245.

Mackey, M. C. and Glass. L. (1977). Oscillation and chaos in physiological control systems. Science, 197, 287-289.

May, R. M. (1976). Simple mathematical models with very complicated dynamics. *Nature 261*(5560): 459–467.

May, R.M. (1995). Necessity and change: deterministic chaos in ecology and evolution. *Bulletin of the American Mathematical Society 32*(3), 291-308.

McCullough, M.E., Brandon, A., Orsulak, P., and Akers, L. (2007). Rumination, Fear, and Cortisol: An In Vivo Study of Interpersonal Transgressions. *Health Psychology 26*(1), 126-132.

Meloy, J.R. (1997). Predatory violence during mass murder. *Journal of Forensic Sciences 42,* 326-329.

Mesly, O. (2010). *Voyage au cœur de la prédation entre vendeurs et acheteurs- une nouvelle théorie en vente et marketing*. Université de Sherbrooke, Canada.

Mesly, O. and Lévy-Mangin, J.-P. (2012a). The narrow range of perceived predation – a 19 group study. *Forthcoming.*

Mobbs, D., Marchant, J.L., Hassabis, D., Saymour, B., Tan, G., Gray. M., Petrovic, P., Dolan, R.J., and Frith, C.D. (2009). From Threat to Fear: The Neural Organization of Defensive Fear Systems in Humans. *The Journal of Neuroscience 29*(39), 12236-12243.

Montoya, E.R., Terburg, D., Bos, P.A. and van Honk, J. (2012). Testosterone, cortisol and serotonin as key regulators of social aggression: A review and theoretical perspective. *Motivation and Emotion 36,* 65-73.

Mikulincer, M. & Shaver, P. R. (2007). *Attachment in Adulthood-Structure, Dynamics, and Change.* New York: The Guilford Press.

Purves, D., Augustine, G.J., Fitzpatrick, D., Hall, W.C., LaManta, A.-S., McNamara, J.O. and Williams, S.M. editors (2004). *Neuroscience, 3rd edition*. Massachussetts: Sinaver Associates Inc. Publishers.

Reidy, D.E., Shelley-Tremblay, J.F., and Lilienfeld, S.O. (2011). Psychopathy, reactive aggression, and precarious proclamations: A review of behavioral, cognitive, and biological research. *Aggression and Violent Behavior16,* 512-524.

Reimann, M. and Zimbardo, P.G. (2011). The Dark Side of Social Encounters: Prospects for a Neuroscience of Human Evil. The Journal of Neuroscience, Psychology, and Economics 4(3), 174-180.

Riedl, R. and Javor, A. (2012). The Biology of Trust: Integrating Evidence From Genetics, Endocrinology, and Functional Brain Imaging. *The Journal of Neuroscience, Psychology, and Economics 5*(2), 63-91.

Rispal, M. (2002). *La méthode des cas. Application à la recherche en gestion.* De Boeck Université, Bruxelles.

Seymour, B.; Singer, T.; and Dolan, R. (2007). The neurobiology of punishment. Nature reviews. Neuroscience 8(4), 300-311.

Siegel, A. and Sapru, H.N., (2011). *Essential Neuroscience, 2nd edition*. Baltimore: The point: Wolters Klumer, Lippincott; Williams & Wilkins.

Siegel, A. and Victoroff, J. (2009). Understanding human aggression: New insights

from neuroscience. *International Journal of Law and Psychiatry 32,* 209-215.

Squire, L.R., Bloom, F.E., McConnell, S.K., Roberts, J.L., Spitzer, N.C. Zigmond, M.J. editors. Fundamental Neuroscience, 2nd edition. Academic Press (Elsevier Science).

Stenstrom, E. And Saad, G. (2011). Testosterone, Financial Risk-Taking, and Pathological Gambling. Journal *of Neuroscience, Psychology, and Economics 4*(4), 254-266.

Terburg, D., Morgan, B. And van Honk, J. (2009). The testosterone-cortisol ratio: A hormonal marker for proness to social aggression. *International Journal of Law and Psychiatry 32,* 216-223.

Todorov, A and Engell, A.D. (2008). The role of the amygdala in implicit evaluation of emotionally neutral faces. *Scan 3,* 303-312.

Ueda, S., Isizuya-Oka, A., Nishimura, A. And Takeuchi, Y. (1999). Hypothalamic aggression area under serotonergic control in mouse-killing behaviour of rats. *International Journal of Neuropsychopharmacology 2,* 255-261.

Verbeke, W.J.M.I., Riedtdjik, W.J.R., van den Berg, W.E., Dietvorst, R.C., Worm, L. and Bagozzi, R.P. (2011). The Making of the Machiavellian Brain: A Structural MRI Analysis. *The Journal of Neuroscience, Psychology, and Economics 4*(4), 205-216.

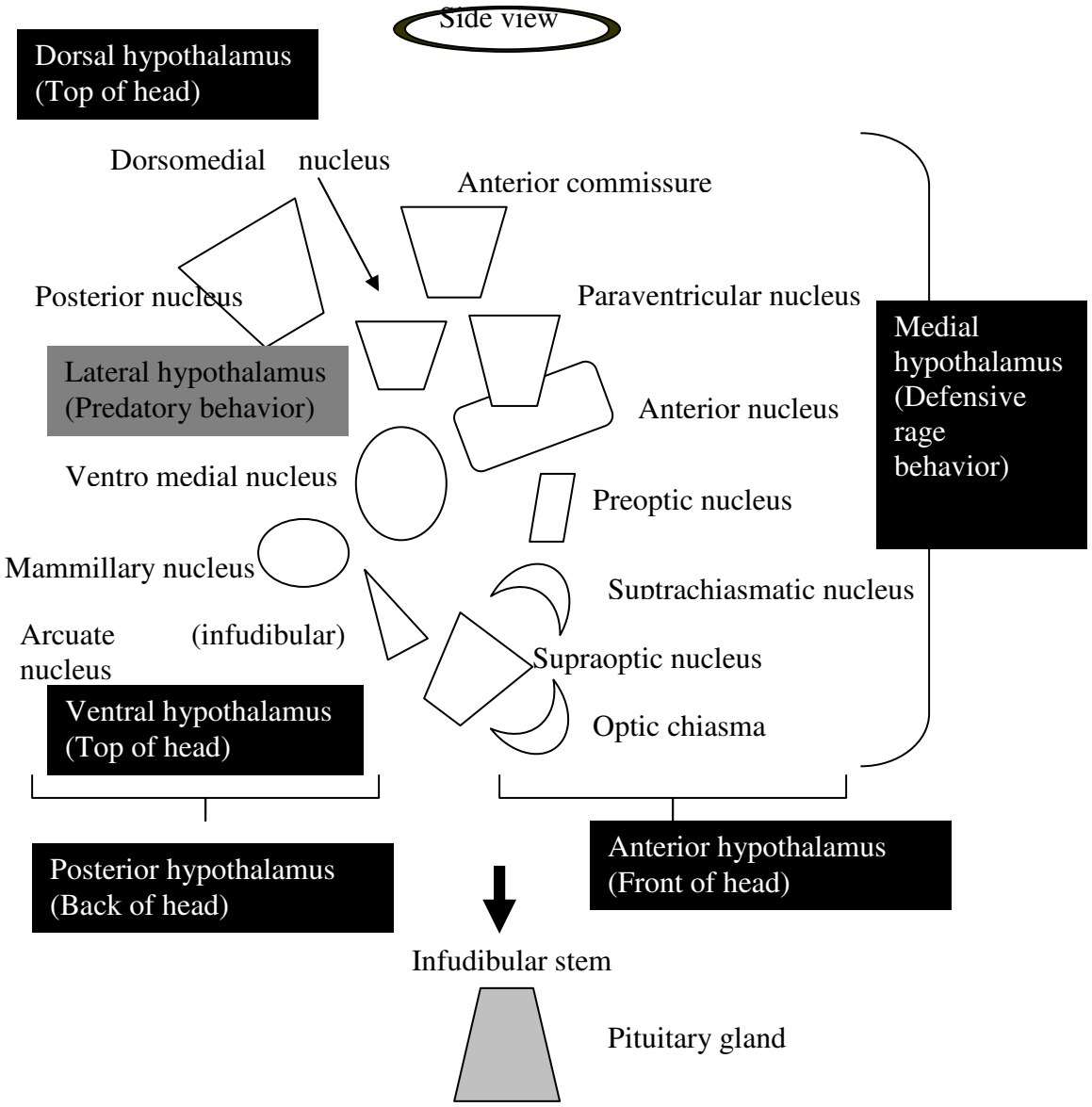
Viau, V. (2002). Functional cross-talk between the hypothalamic-pituitary-gonadal and -adrenal axes. *Journal of Neuroendocrinology 14,* 506-513.

Woody, E.Z. and Szechtman, H. (2011). Adaptation to potential threat: The evolution, neurobiology, and psychopathology of the security motivation system. *Neuroscience and Biobehavioral Reviews 35,* 1019-1033.

APPENDIX

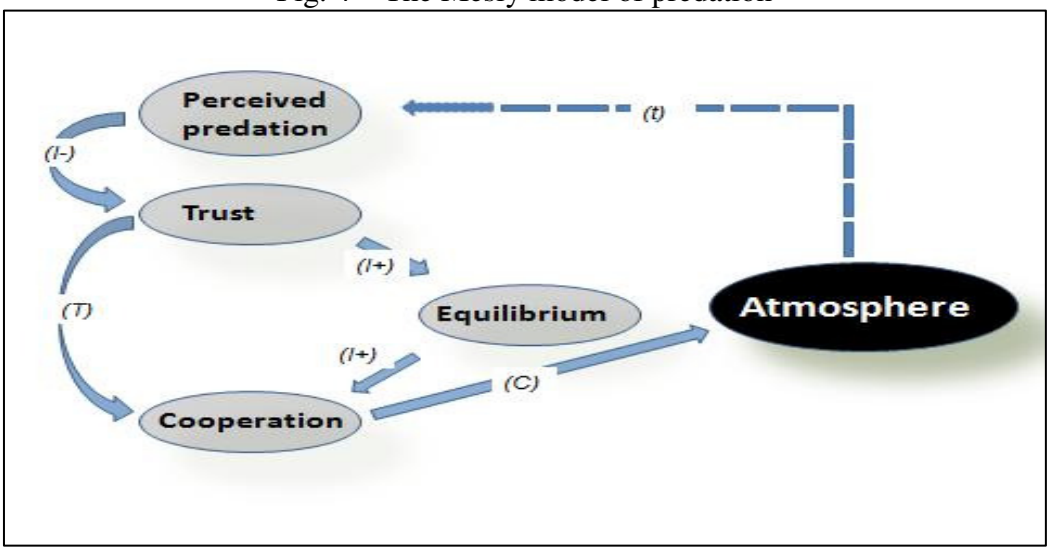
Annex A

Figure 3 –The hypothalamus and its parts (one side only; in fact, the hypothalamus has two sides)



Annex B

Fig. 4 – The Mesly model of predation



Legend: I: influence negative (-I) or positive (+I); T: time; C: causal; t: loop time

Annex C: Tables of interpretation

Construct	Value	Type	Emotional involvement	Type of commitment
For Trust and cooperation	4 to 5	Transactional	Little	Almost indifferent
	5 to 6	Relational	Moderate	Trust-driven
	6 to 7	Interpersonal	High	Blind trust
Construct	**Value**	**Zone**	**Likely Emotion**	**Outcome**
For predator or prey	4 and above	Conflict	Hostility	Strenuous
	2 to 4	Normal	Amicable	Lasting
For the Predator /Prey ratio	Above 1.8	Conflict	Hostility	Strenuous
	1.2 to 1.8	Normal	Amicable	Lasting
	Below 1.2	Conflict	Hostility	Strenuous

Annex D: Perceived predation measures across 19 groups (n=834)

Table 8 – Measures of perceived predation across the 19 groups

Perceived predation Values for the 19 groups (rounded numbers)								
Year	Group (n)	Predator	Min	Max	Prey	Min	Max	Pre/Pro Ratio
2008	G1=35	3.6	1.0	5.2	3.0	1.0	5.0	1.4
	G2=28	2.5	1.8	3.6	2.3	1.2	3.4	1.2
2009	G3=26	5.9	2.3	7.0	4.3	1.7	7.0	1.5
	G4=57	3.5	1.4	6.6	3.0	1.2	5.2	1.3
	G5=27	3.2	1.5	5.0	2.8	1.8	5.0	1.2
	G6=32	3.4	1.2	5.6	2.9	1.2	5.9	1.2
	G7=75	3.8	1.0	6.4	3.0	1.0	5.6	0.8
	G8=78	3.4	1.0	7.0	2.7	1.0	4.5	1.3
	G9=73	4.1	1.0	7.0	3.5	1.0	7.0	1.8
2010	G10=184	4.8	1.0	7.0	3.8	1.0	7.0	1.9
	G11=13	4.2	1.2	5.6	4.7	2.7	6.4	0.9
2011	G12=26	3.3	2.4	4.4	2.9	1.2	4.6	1.3
	G13=24	3.8	2.4	5.4	3.0	1.0	4.8	1.4
	G14=25	3.7	1.6	6.6	3.1	1.4	4.4	1.2
	G15=26	3.4	2.0	4.6	2.1	1.0	3.8	1.8
	G16=24	4.5	3.2	5.8	3.3	1.8	5.0	1.4
	G17=25	4.5	2.2	6.4	3.3	1.6	5.6	1.4
2012	G18=28	4.0	2.6	6.6	3.2	1.8	5.0	1.3
	G19=28	3.5	2.0	5.4	3.0	1.6	5.0	1.2
T	**834**	4.0	1.0	7.0	3.2	1.0	7.0	1.23

Tables and figures

Fig. 1 – Structural and functional variables of the hypothalamus

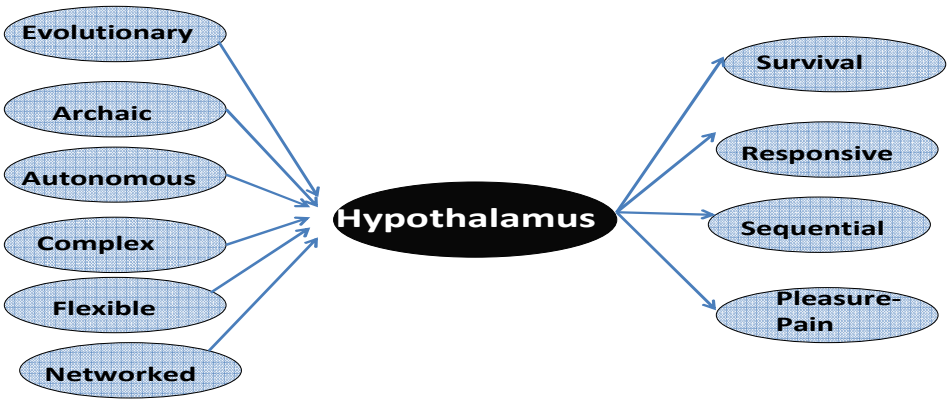
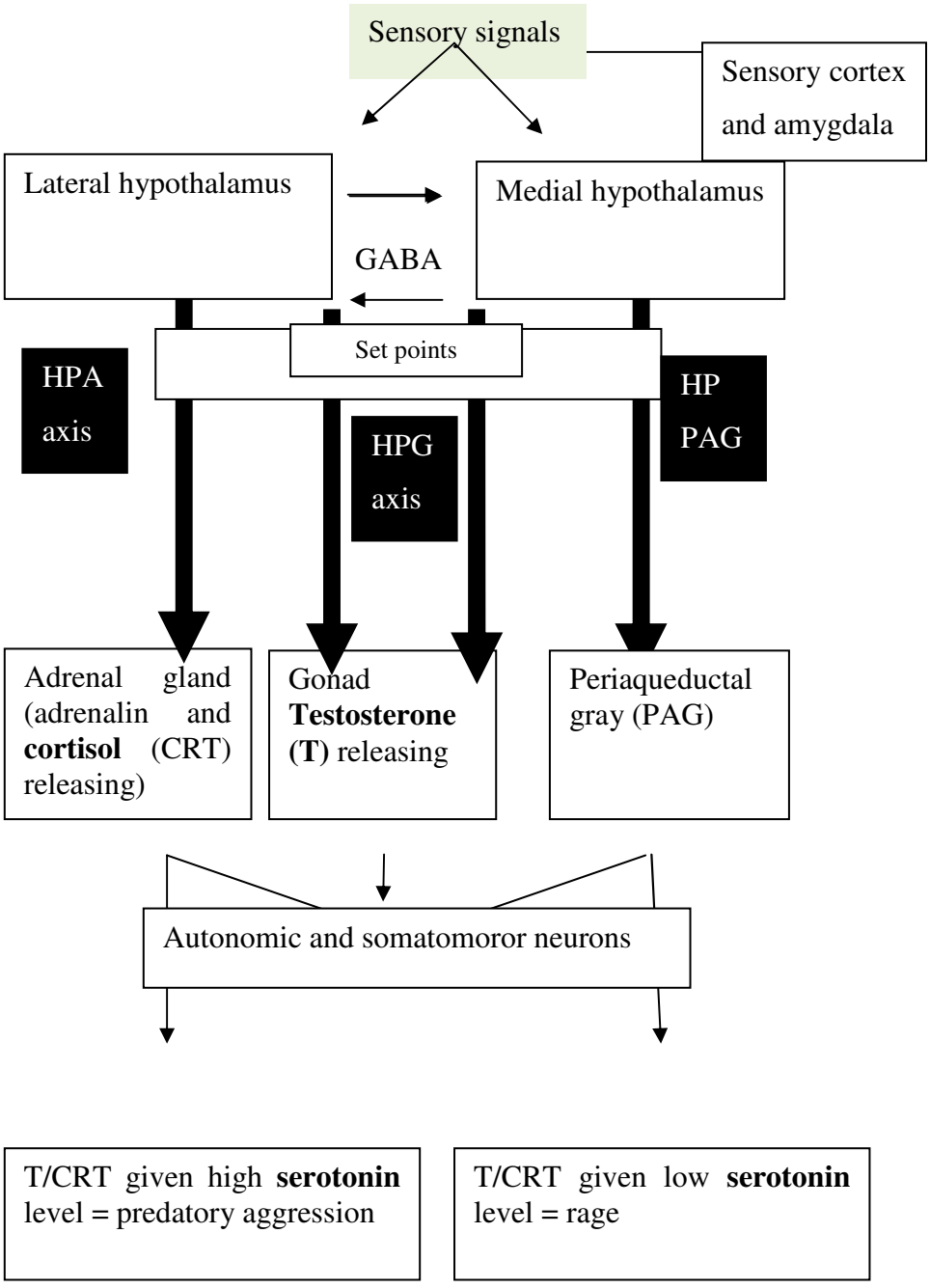


Figure 2 – a simplified version of the rage and predatory dynamic[22]



[22] The amygdala plays a central role in emotions such as trust and attachment, in socialization and in the expression of contextual fear and danger avoidance (Alvarez et al., 2008; Amaral, 2002). The anterior, cortical, medial and basomedial amygdala are related to defensive rage but not to predatory attack; the central, lateral and basolateral amygdala are related to predatory aggression but not to defensive rage (Gregg and Siegel, 2001, p. 96). This means that while the amygdala plays a role in aggression, the nature of this aggression depends on which part of the amygdala it originates from. As pointed out by Siegel and Sapru (2011, p. 449), attachment, socialization and rationalization participate in some way in instrumental aggression and rage.

Based on Siegel and Victoroff (2009), Gregg and Siegel (2001), Berridge (2004), Terburg et al. (2009) and Hassanain et al. (2003).

Table 1 – A model for the four core hypothalamic responses to threats[23]

	High (T/CRT) (steroids)	Low (T/CRT) (steroids)	
Low impulsivity (Slow)	Predation	Freeze	High (5-HT/OXT) (hormones)
High impulsivity (Fast)	**Rage**	Flight (escape[24])	Low (5-HT/OXT) (hormones)

Table 2 – Databases in relation to neurobiological information about anger

Measured in the databases	Neurobiological equivalent
Predator	Testosterone (T)
Prey	Cortisol (CRT)
Cooperation	Serotonin (5-HT)
Dependence (partly measured in the n=300 database)	Oxytocin (OXT)

[23] Testosterone (T) and Cortisol (CRT) (along with arginine vasopressin) are typically associated with avoidance behavior and distrust, while serotonin (5-HT) and oxytocin (OXT) (along with estrogen and dopamine) are typically associated with approach behavior and trust (Riedl and Javor, 2012, p. 73)

[24] Under the control of the medial hypothalamus (Di Scala *et al.,* 1984)

Table 3 – The law of perceived predation in neurobiological terms

Trait judgment	Valence evaluation	Associated construct or sub-construct using the Mesly model of financial predation (see Annex B)	Associated main construct
Trustworthy	0.95	Trust	Trust
Caring	0.91	Benevolence	Trust
Responsible	0.91	Integrity	Trust
Emotionally stable	0.91	Equilibirum	Equilibrium
Sociable	0.90	Atmosphere	Atmosphere
Attractive	0.79	Affinity	Trust
Intelligent	0.70	Problem resolution	Cooperation
Confident	0.63	Ability	Trust
Dominant	-0.30	Predator	Predator
Unhappy	-0.70	Atmosphere	Atmosphere
Aggressive	-0.75	Atmosphere	Atmosphere
Mean	-0.78	Atmosphere	Atmosphere
Threatening	-0.78	Predator	Predator
Weird	-.85	Atmosphere	Atmosphere
Explained variance	62.9%	----	----

Table 4 – Factorial analysis on the grouping of 834 participants

Population (n= 834				
	Component 1		Component 2	
	Tends towards			
Trust	.946	1	.071	0
Cooperation	.936	1	.144	0
Equilibrium	906	1	- .013	0
Predator	.342	≈ 0	.744	1
Prey	-.150	0	.865	1
Predator *vs.* Prey	>		<	

Varimax rotation; 3 iterations

Table 5 – A Cluster analysis on n=834

	Class *(rounded-up numbers)*			
	1	2	3	4
Trust (in %)	90	81	64	84
Cooperation (in %)	90	79	63	83
Predator	5.5	3.3	3.3	5.2
Prey	1.3	2.3	3.5	4.7
Predator/Prey	4.7	1.5	1.0	1.2
Number of observations	57	315	239	223
Likely personality type[25]	Hostile	Stable	Avoiding	Anxious
% of population	7	38	29	27

Table 6 – A Cluster analysis on n=300

	Class	
	1	2
Predator/Prey ratio	1.55	1.30
Cooperation/Dependence ratio	5.67	1.22
Number of observations	5	295

[25] Mikulincer and Shaver, 2007, p. 279) explain: "A large literature indicates that secure people engage in positive, intimacy-promoting, and tension-reducing interpersonal behavior, and have a positive memory bias for interpersonal exchanges. In contrast, avoidant people are relatively disengaged during social interactions, easily become bored or tense, and are likely to forget their partner's feelings and remarks. They try not to become either positively or negatively emotional but when they do, they tend to be angry, hostile, or disparaging, and rarely experience unadulterated gratitude or forgiveness. Attachment-anxious people exhibit ambivalent blends of positive and negative reactions that reflect their characteristic conflict between desires for closeness and love on the one hand, and fears of rejection, disapproval, and abandonment on the other. They are capable of gratitude and forgiveness, but these emotions are often mixed with negative self-referential feelings rarely experienced by more secure people."

Table 7: Critical *k* value of the ratio predator/prey (the reverse of perceived predation) for 19 groups

Value of *k*	4.7	3-2	2-1	< 1
Observed behaviour	Some tense erratic behaviours	Some erratic behaviours	Fairly stable groups	G7 and G11: these two groups showed a high turnover level