UNIVERSITÀ DEGLI STUDI DI TRENTO
Dipartimento di Psicologia
e Scienze Cognitive

XXXII Cycle
Doctoral School in Psychological Sciences and Education

Shame on you! Cognitive mechanisms and neural correlates of shame

Candidate:
Edoardo Pappaianni

Supervisors:
Prof. Remo Job
Prof. Alessandro Grecucci

Index

Acknowledgements 1

Preface 2

Chapter 1 Theoretical introduction 4

A brief historical excursus on moral emotions 4

Shame as moral emotion 5

Shame: social features and psychological function 8

Cultural differences in the perception of shame 10

Shame and guilt: similarities and differences 11

Psychological models of shame 14

A theoretical proposal 15

Conclusions 17

References 17

Chapter 2 Shame Task 26

Study I - Shame Task 26

Introduction 26

Previous empirical studies 26

Research questions and hypothesis 27

Method 28

Stimuli validation 28

Participants 29

Experimental design 30

Results 32

Analysis of shame 32

Linear regression - Shame model 33

Analysis of guilt 34

Linear regression - Guilt model 35

Correlations between shame/guilt perception and behavioral tests 36

Discussion 37

Limitations 41

Conclusions 41

Study II - Empathetic Shame Task 42

Introduction ... 42
Previous studies on vicarious emotions ... 44
Aims and research questions ... 45
Method ... 46
Participants ... 46
Experimental procedure ... 46
Results ... 48
Analysis of shame in other ... 48
Analysis of Guilt in other ... 49
Correlations between shame/guilt in others and behavioral tests ... 50
Discussion ... 51
Limitations ... 54
Conclusions ... 54
References ... 55
Chapter 3 Single-case Study ... 66
Introduction ... 66
Method ... 68
Case description ... 68
Neuropsychological assessment ... 69
Social cognition battery ... 69
Emotion recognition tasks ... 70
Subjective self-conscious emotion experience test - Shame Task ... 71
Statistical analyses ... 71
Results ... 72
Neuropsychological assessment and questionnaires ... 72
Social cognition battery ... 74
Emotion recognition tasks ... 74
Subjective self-conscious emotion experience test - Shame Task ... 76
Discussion ... 77
Limitations ... 79
Conclusions ... 79
References ... 80
Chapter 4 Functional meta-analysis on shame and guilt ... 86
Introduction ... 86

Method ... 89
Statistical analyses ... 90
Results ... 91
Shame/Embarrassment ... 91
Guilt ... 92
Contrast analyses ... 93
Discussion ... 95
Common areas ... 95
A neural map for shame ... 96
A neural map for guilt ... 97
Limitations ... 97
Conclusions ... 98
References ... 98
Chapter 5 The neural trace of shame ... 106
Introduction ... 106
Uncovering the neural bases of shame ... 106
Shame and Resting-State fMRI ... 108
Method ... 109
Participants ... 109
Shame Task - Experimental design ... 110
MRI Acquisition parameters ... 112
Shame Task fMRI analysis ... 112
Resting-state fMRI analysis ... 113
Results ... 115
Behavioral analysis ... 115
Neural results – Shame Task ... 117
Resting state networks associated to shame- and guilt-proneness ... 120
Discussion ... 125
Brain regions involved in the Shame Task ... 125
"Self-conscious" resting-state networks ... 128
Limitations ... 130
Conclusions ... 130
References ... 131
General conclusions ... 137

List of figures 140
List of tables 141

Acknowledgements

I would like to thank my two supervisors Prof. Alessandro Grecucci and Prof. Remo Job for their incredible support during my PhD and in the early stages of my career. Since we started working together (several years ago now), they have always been fundamental reference points for my human and professional growth. Thank you for all the opportunities granted to me.

I would like to thank all the members of the Clinical and Affective Neuroscience (Cli.A.N.) Lab for sharing such intense moments, characterized by passion, mutual respect, collaboration but above all friendship. My best wishes for working together again in the future.

A heartfelt thanks to all the co-authors and collaborators of the different studies, without whose help this probably would not have happened. Your competence has been the key to a sincere, loyal and fruitful collaboration from a scientific point of view. Thanks also to the two external reviewers for their time and for helping to improve the final manuscript.

Finally, thanks to Prof. Patrik Vuilleumier for welcoming me to his laboratory in Geneva during my last year of PhD, for making me feel part of his research team and for making his resources available to conduct two studies together. His professionalism, friendliness and knowledge of the subject will always impress me. Thanks and greetings to all the members of his research group, brilliant colleagues but above all fantastic people.

Preface

Typical working day, typical meeting with bosses and colleagues. At the sight of the budgets of the last year, the boss turns to you in a threatening way, by screaming: "*You are really incompetent*". All your colleagues were there and everyone saw this scene. How would you feel?

Again, we are trying to network at a conference with "big names" in our research field, so with a little bit of anxiety we introduce ourselves to different people. One of them, after shaking hands, publicly "thanks" you in front of an unknown group of people for your sweaty hand. Probably, disappearing and fleeing would be your biggest will at the time.

We have all experienced that increase in heartbeat, blushing in the face, that desire to look away and to close ourselves off or disappear. This could be due to our way of being, to a feature of our person that is considered "unusual", to an aspect of us that does not fall within the so-called social and moral "standards" of the environment in which we live. But what is the function of this negative feeling that we call shame? Is it possible to study shame in the laboratory, evoking it "artificially"? Finally, what happens in the brain when one feels ashamed?

This manuscript tries to answer these three questions. Through a theoretical introduction, the proposal of a theoretical model on the functioning of shame and the presentation of behavioral and neural studies in which shame will be elicited and measured, it will be discussed what are the cognitive mechanisms underlying shame and what are its neural bases.

In chapter one, a historical-philosophical excursus on shame will be made, together with its theoretical framework between moral emotions and the psychological constructs underlying it. It will also discuss how it differs according to culture and what its basic characteristics are. Starting from this theoretical basis, a model of functioning of shame will be proposed, which aims to be applicable in the clinical field.

In chapter two, through a series of behavioral studies, an innovative experimental paradigm (the Shame Task) will be presented with the aim of eliciting and measuring shame. Two variants of the task will be presented: in the first study, shame experienced in the first person will be studied, while the second study will try to catch the vicarious effect of shame on the individual.

In chapter three, the clinical case of a neuropsychological patient with a rare disease selectively affecting the amygdala will be described. Since the amygdala is considered a fundamental emotional hub, particularly for negative-valenced emotions, the possibility that such damage could also have an impact on the perception of shame will be tested.

Chapter four will describe a functional meta-analysis study aimed at summarizing the few evidence carried out so far in neuroscience about shame. Specifically, shame-related brain activations that emerged in previous studies will be presented and investigated.

In the last chapter, the Shame Task will be proposed during a functional magnetic resonance session, with the aim of capturing the neural signal of shame using this new experimental paradigm. In addition, it will be investigated whether being prone to shame in daily life can leave a neural trace in the brain even at rest.

All of these experimental studies, together with the theoretical proposal outlined, will be able to make a new contribution to research about one of the less studied emotions in affective neuroscience as shame is. Approaching it from different perspectives (as theoretical, psychological, neuroscientific ones) will provide a wider overview of how it works and how it impacts the individual.

Chapter 1
Theoretical introduction

In collaboration with A. Neresini

A brief historical excursus on moral emotions

The story of Ajax, Greek hero in one of Sophocles' Tragedies (445), is a clear example of how morality is important for humans. When Achilles died, Ajax expected to receive his weapons as a sign of merit and respect to symbolically remain close to his beloved friend. However, these weapons were given as a dowry to Ulysses, generating fury in Ajax because of this "moral affront". For this reason Athena, who considered him as dangerous man, decided to blind him. Guided by anger and seeking revenge, randomly he began to kill animals confusing them with enemies. Only when he realized that he had made such a mistake he felt a sense of shame, and that so strong feeling led him to kill himself.
The principle of morality is initially addressed in the Bible, book of Genesis, when the violation made by Adam and Eve can be considered as a critical step for understanding what is right and wrong: "*Behold, the man has become like one of Us, to know good and evil*" (Genesis, III; Haidt, 2003). Indeed, from the origin of religion, morality is used as a construct that allows one to approach God, while behaviors that do not respect it, anchor humans to the Earth and to animal impulses (Haidt, 2003).
The first "intermediaries" between humans and their willingness to act according to the principles of morality are moral emotions. Several philosophers during the 1700s discussed the relevance of moral emotions. Kant (1786) argued that these feelings allowed individuals to make decisions about morally right or wrong actions. This criterion would act as a driving force that motivates the human being to one action rather than another (Zahn, de Oliveira-Souza & Moll, 2013). However, Kant claimed the need for humans to use only reason that is a high representation of the soul, which should allow approaching virtue and nobility. This ostracism towards emotion was not entirely new: in ancient philosophy, Plato spoke about emotions as something separate from reason and in a certain sense at war with it. For Plato, reason is firmly located in the head and dominates over passions that are conversely located around the chest and stomach (Plato, Timeo). Aristotle kept reason (Logos) separate from emotion (Pathos). He claimed that human - or more precisely, reason- could guide emotions, but he was aware that it was hard (Aristotle, Ethics; Haidt, 2003). In some ways, reason corresponded to something virtuous, just, noble, while emotions to a human baseness waiting to be dominated. According to Kant, reason had to act as a guide for the human being, not obfuscating the mind with feelings that would lead on the wrong path. In his "Critique of Practical Reason" (1788), he speaks of human's duties as moral rules of behavior that humans carry out in certain situations in life. There should be an immediate response to all given circumstance, guided by a moral value that suggests the best way to deal with it, without rationalization or operationalization with feelings. Another important philosopher who dealt with this topic was Hume (1777) (Zahn et al., 2013), according to whom humans are composed of four instances: reason, feeling, morality, politics. Differently from other philosophers, he believed that human nature was characterized more by emotion and feelings than

rationality. Rather, reason was the result of emotion. In his view, morality had the ultimate goal of achieving well-being. Human beings choose to behave well or badly based on the emotion evoked in them but also in others in a sort of feeling of "sympathy" (whose etymological root mean "experiencing emotion together"). In this sense, moral behavior can be seen as an act toward the society that aims to share a pleasant feeling (Hume, 1740). In some ways, Kant and Hume held an opposite position: for the former, morality was a rational issue, for the latter, an emotional one. Later Nietzsche (1878-1879) also deals with this topic, stating that humans need moral, religious and aesthetic feelings, along with individual and social emotions. According to him, this particular need should be considered within a community always in transformation. Humans are not "eternal facts", but rather entities who have to create authentic values continuously updated on these changes (Nietzsche, Human All too human).

In addition to philosophy, we can also find references to moral emotions in literature. For instance, in The Metamorphosis (1915), Kafka shows the negative impact of guilt and shame (nowadays labelled as moral emotions). Gregor, the protagonist, is described as a man subordinated to the duties and moral standards imposed by society and by his family: among these, taking home money, supporting his parents and sister, increasing his role within the working environment, leaving home, being autonomous and creating his own family. However, since these conditions are not met, Gregor considers himself as a failure. He feels guilty for not being able to support his family as a self-respected man, and he also feels shame for the monstrous creature he is becoming (an insect). Why Kafka chooses an insect? The ancient philosophy associates the lack of morality to animal features. In this sense, it may be possible to link this "a-moral" dimension of Gregor's life to feelings of shame and guilt. Shame is detectable in several behaviors, such as not leaving his room for not being seen by people and as consequence of some bad statements by his family in which it was clear the disgust they felt towards him. The animal chosen by the author, an insect, can also represent the "useless" nature of the character. Kafka chooses a disgusting animal that cannot give affection or services of any kind. Shame and guilt will be so strong as to guide the protagonist towards death (Kafka, 1915).

Shame as moral emotion

Philosophers and ancient authors have long discussed the possible marriage between morality and emotions, arriving at the definition of moral emotions as emotions closely related to the welfare of society (Haidt, 2003). According to Haidt (2003), there are two types of moral emotions, although situated at two opposite poles: self-conscious emotions (such as shame, embarrassment, guilt, pride) and concerning-others emotions (such as contempt, anger and displeasure). The same author argues that emotions work as an internal engine that drives people to act differently depending on the situation and contexts. As others, moral emotions consist of trigger events and behavioral responses. The first ones, i.e. the emotional stimuli, are all those "triggers" that generate the emotion, while the second concern the behavioral manifestation caused by the same emotion. In particular, Haidt (2003) emphasizes the tendency to "prosocial action" (which originates from Frijda's theories, 1986), that motivates the individual towards important actions in society (such as revenge or affiliation). These actions may be socially destructive or beneficial. Zahn and colleagues (2013) argue that there are important relationships between moral evaluation and causal agency with respect

to a given event. Indeed, behaviors that are intentionally violated, such as getting on a bus without a ticket, will be morally evaluated by third observers who in turn will experience moral feelings. This is not beyond a sharing of common values within individuals. For instance, in order to evoke shame as social-moral emotion, people must to share common moral values that, if violated, trigger the emotion. Let us imagine the following scenario. We are the passenger of a bus and that the inspector ask us for the ticket. Unfortunately, we cannot find it: "It was here, I put it right here!" In the meantime, the other passengers (and the ticket inspector) might think we were lying and that we never bought it. Faced with this situation, almost certainly our reaction would be to blush and run in order to disappear in front of the eyes of others, even if we have not really committed any crime (Castelfranchi, 2005). According to Haidt (2003), the moral intuition that we have is an active mechanism, i.e. a type of cognition, a process in some ways similar to perception. Therefore, emotions and morality create a point of encounter between moral standards shared in a society, the moral decisions individuals make, and the moral behaviors people carry out. Tangney and colleagues (2007) define moral standards as individual knowledge of social norms and conventions; however, if on one hand they depend on moral laws that are universally accepted, on the other hand they also strictly refer to the culture of belonging. For instance, any criminal behavior is a violation of a universal moral law because it undermines the well-being of other individuals. Therefore, there are behaviors well known to be wrong from a social-moral point of view; however, this does not completely bind them from be fulfilled. Following the example described above, it is possible to be ashamed of crimes not really committed only because others might think about it and that some elements of what is happening might let it be deduced (Castelfranchi, 2005). For this to happen, however, it is necessary to share a negative moral evaluation of what is carrying on, such as to lead witnesses to believe that "we should be ashamed of ourselves" (Castelfranchi, 2005).

Moral emotions are "tools" for understanding how people behave in relation to widely accepted moral standards (Tangney et al., 2007). These emotions have flexible features, which vary according to different elements as reported by Zahn et al. (2013): 1) Valence of the event, which can be positive or negative; 2) Role of agency associated with the situation. Those who make a judgment and those who are judged play different roles; 3) Causal attributions, if the event of interest can be avoided/controlled. According to Castelfranchi (2005), it is possible to be ashamed of self-features even if they are neutral. For instance, although "being Italian" is a clear neutral attribute, it may elicit shame if it is associated with negative meanings (e.g., if we believe that Italy is all about "mafia"). In this case, the causal attribution is null and the person involved can perceive a sense of helplessness in the face of this feature. In other cases, it is possible to be ashamed of behaviors that are neutral but that make us feel under an "evaluative gaze" (e.g. making a public presentation or jumping the queue at the cinema, Castelfranchi, 2005). Such situations can be evaluated as a negative or positive event depending on our interpretation. Lack of control over events (even positive ones) can elicit shame when it affects one of our purposes (good image/self-esteem). For example, it may happen by winning the lottery when this positive event is perceived as not deserved or due to luck, switching the sense of agency that the person feels with respect to the prize received (Castelfranchi, 2005). Always according to Calstelfranchi (2005), shame can also be evoked indirectly due to features of those close to us that may lead others to judge us badly. For example, if a friend of us is atheist but we are part of a Catholic community, this could lead other members to misjudge our

friend. We may feel ashamed because of another person's characteristic that affects judgments that others have about us. It may happen to feel shame towards oneself when one believes not to respond to a fundamental requirement to preserve own self-esteem (Castelfranchi, 2005). If, for example, one of our important ethical values is not to eat animals, being at a grill of meat could provoke mockery and derision by others. On this occasion, therefore, the individual could face a conflict: be consistent with his/her values or belong to the group and be accepted by others. This situation may lead being ashamed in two ways: on the one hand with himself/herself for questioning own diet, on the other hand with others by not sharing the choice of eating meat regularly with them. The choice depends on the priorities that the person gives to his/her own goals (Castelfranchi, 2005): in this case, if the ethical value of not eating animals wins then, most likely, pressure given to others' judgment will be less (and vice versa).

It is important to consider how some features impact individuals belonging to a group: when the negative event refers on a stable characteristic of individuals, it will have different consequences than depending on a mere misbehavior (Janoff-Bulman, 1979; Zahn et al., 2013). Specifically, a non-accepted characteristic of a person will push group components to exclude that individual for a long term, while anger arising from a unique behavior generates an easily re-evaluable exclusion.

As said, moral emotions create a balance between moral standards, moral decisions and moral behavior (Tangney et al., 2007). This interaction is closely dependent on standards and emotions, whose combination is fundamental to understanding the link between behavior and moral standards. Moral emotions can be positive-valenced (pride and gratitude) and negative-valenced (for instance, moral anger, shame, guilt).

Another well-known way for labelling moral emotions, as previously mentioned by Haidt (2003) and clearly reported by Tangney and colleagues (2007), consists of two main groups: self-conscious emotions and other-focused emotions. We know that moral emotions allow people to self-reinforce their behavior or to self-punish. Self-conscious emotions (as shame and guilt) are triggered by the individual ability to reflect on him/herself and/or own actions through a self-evaluation (Tangney et al., 2007). On the other hand, other-focused emotions (including moral anger, contempt, disgust, elevation and gratitude) have an external focus.

In another words, self-conscious emotions occurs when we personally evaluate ourselves, whereas other-focused emotions when we evaluate others (Higgins, 1987; Zahn et al., 2013). For instance, let us say that a person, it does not matter if intentionally or not, carries on a negative action that prevents us from achieving a goal or that is unjust for our shared moral standards. Our emotional feeling will most likely be the so-called "moral anger" (a particular type of anger linked to moral issues). This emotion in turn creates a response in the other, who will perhaps feel guilt (self-assessing his/her own behavior) and this will induce him/her to correct the situation and repair the damage (as guilt usually suggests). For the sake of completeness, contempt and disgust are moral emotions that arise from the negative evaluation of others' behavior; however, they would seem not to motivate corrective action compared to what happens instead for anger. There are also positive-valenced moral emotions toward others such as elevation and gratitude. Elevation is elicited when virtuous behaviors are carried our by raising the social dimension of individuals, while gratitude arises in response to an unexpected action that involves a cost for the benefactor. In the latter case, feeling

gratitude has an important reward function in pursuing morally positive behaviors (Bennett et al. 1996; Clark et al., 1988; Goldman et al., 1982; Tangney et al., 2007). It follows that the feedback received as result of moral behavior is important for orienting oneself in the future (Tangney and colleagues (2007).

All the emotions we are describing have a key feature in common: they are "social" emotions. Indeed, they feed on the emotional feedback given by society, and these help individuals to understand which behaviors are consistent with the norms of their social context. Moral emotions are fundamental to arise cohesion and consistency in one's own group: guilt, gratitude and compassion are clearly emotions that promote adherence to the group, as opposed to contempt and indignation that act as disintegration and reorganization of the social group (Vélez García & Ostrosky-Solís, 2006). The presence of these emotions guarantees a push towards right behaviors and it has a preservative function against socially wrong behaviors (Kroll & Egan, 2004; Tangney et al., 2007). Guilt and pride, for example, function as an indicator of the changes that have taken place in response to the person's behavior and its social relevance. However, this does not only happen in response to such behavior, but also pondering the most socially appropriate alternatives to that behavior. For this reason, self-conscious emotions guide future choices and actions, taking advantage of previous experiences and individual history (Tangney et al., 2007). In other words, they flow into the social knowledge, i.e. the set of things learnt about shared needs and socio-cultural norms. This knowledge plays a critical role in suggesting how to behave in an appropriate way by facing different situations.

Shame: social features and psychological function

If we consider emotions as a signal that alert us about our position with respect to a goal, it is legitimate to assert that shame warns us that our public image in the sight of others and our self-esteem are threatened (Castelfranchi, 2005). Shame aims to "moral well-being" based on the standards that society imposes. It feeds on both self-referred and other-referred judgment, so it is not possible to feel shame without a real or imagined social comparison (Murphy and Kiffin-Petersen, 2016).

Shame refers to wrong or bizarre ways of being of each member within a society. Specifically, the concept behind shame is to consider a person as "defective" or inadequate with respect to what would be the expectations and standards of his/her society (Shweder, 2003; Murphy & Kiffin-Petersen, 2016). Nevertheless, the violation of social expectations is not the only event triggering shame, since even the conviction of being at fault can elicit it (Shweder, 2003; Murphy & Kiffin-Petersen, 2016). Based on this assumption, shame feeds on the relationship we maintain with other members of our community. From the other perspective, society mediates between people's behavior and the standards should be achieved; the intensity of shame perceived depends on how much the individual has internalized the expectations of the culture of belonging (Scheff, 2003; Murphy & Kiffin-Petersen, 2016).

Tomkins (1963) introduces a distinction between the actual and anticipated shame. Regarding the first one, we have discussed it extensively. The second one is innovative. Surely, we have all experienced shame at least once in our lives: later, on the basis of that emotional experience, we have acted to prevent this unpleasant feeling from reoccurring (as

described earlier). Therefore, a loop is generated through which a shameful triggering event is recorded in our emotional memory (with all its psychophysical features), by giving feedback that alerts us whenever up to face similar circumstances. This form of "anticipated emotion" aims to safeguard us against situations in which we may appear as defective and socially unacceptable; in other words, this can be seen as a form of defense from the possibility of being devalued by others. Anticipated shame develops in early adolescence, in association with the capacity for abstraction, as an "insurance" for social knowledge and appropriate behaviors to be used in adulthood (Abe and Izard 1999; Izard 1997; Murphy & Kiffin-Petersen, 2016). Therefore, the adaptive function of shame is clear. (Weisfeld, 1997; Murphy & Kiffin-Petersen, 2016).

More recently, Sznycer and colleagues (2016) suggested an "information threat theory", according to which shame arises by the possibility that negative information about the person may reach others. From a cognitive point of view, shame has the function of: 1) preventing the individual from carrying out actions that may lead to social devaluation of his/her person; 2) limiting exposure to harmful information about him/herself; 3) limiting the consequences of the eventual social devaluation; 4) forcing the individual to respond as adaptive as possible, if devaluation is occurring.

Therefore, as a form of prevention, shame may act as a force that distracts the individual in order to avoid devaluing situations. When a person is already devalued, then he/she will put in place retreating behaviors with inhibitory attitude, accepting a certain social submission but opening to social collaboration. Although its function is adaptive, it is important to understand that shame arises from a negative event (i.e., the negative assessment of one's own person): for this reason, it may be very painful and accompanied by important changes in physiology, such as irregular breathing, blushing and rapid heartbeat (Scherer & Wallbott 1994; Wallbott & Scherer 1989; Pivetti et al., 2016). "*The ashamed person focuses more on devaluing or condemning the entire self, experiences the self as fundamentally flawed, feels self-conscious about the visibility of one's actions, fears scorn, and thus avoids or hides from others*" (Ferguson & Stegge, 1998:20; Eisenberg, 2000).

However, shame may entail maladaptive features as well, including aggressive responses and comorbidity with psychopathological states such as anxiety, depression and paranoid ideation (Sznycer et al., 2016). This maladaptive side of shame is mostly linked to reactions that do not bring the individual closer to others, but rather promote his/her estrangement as a self-esteem defense. These reactions may include verbal and/or physical aggression, lowering of the tone of the voice, distraction of the gaze, facial blushing, lowering of the head, face coverage or freezing (Bafunno and Camodeca 2013; Barrett 2005; Pivetti et al., 2016). In these cases, an emotion immediately linked to shame is anger, which could be triggered by the loss of personal pride due to the negative assessment and judgment toward the self. Anger following shame is often projected outwards, since the individual attributes responsibility for his/her defect to others in order to regain control of own identity.

In light of what said, moral emotions are a construct composed of two parts: a subjective component, i.e. the proper emotional experience; and a social component, which reflects our life with others according to shared social-moral norms. Because of their function, moral emotions are necessarily framed within an interpersonal domain. Cooley (1922), Mead (1934) and Goffman (1967) discuss the social aspects of the self, focusing on the social-relational aspect

of emotions and specifying how much the latter should be associated with the individual's introspection (Scheff & Retzinger, 2000). In particular, Mead underlines how the self is both a social and biological construct. Therefore, it is necessary to observe situations from one's own and others' perspectives (Scheff & Retzinger, 2000). Cooley consideres the concept of self in relation to its proper "role", which is decisive in eliciting different emotions. In other words, for him shame and pride are triggered when the individual sees him/herself in the other's shoes. In association with this, he proposes the concept of "the looking glass self" (Cooley, 1922) which considers the social nature of the self that is associated only with shame and pride (Scheff & Retzinger, 2000). The same author proposes the existence of a process of "self-monitoring" composed of three aspects, including how we imagine our person in the sight of others, how we represent the judgment of others towards us and a subjective component of self-feeling (Cooley, 1922; Scheff & Retzinger, 2000). Goffman also argues on taking different roles to generate different emotions, and in many of his works (1959, 1959a, 1963, 1963a, 1967) he focuses on the concept of seeing his own image reflected through others (Scheff & Retzinger, 2000). As conclusion, the author considers shame as a dominant factor in interindividual interaction (Scheff & Retzinger, 2000).

This "external eye" is linked to Sartre's philosophy, who in "Being and Nothing" (1943) states that no one can have an objective image of him/herself in own life, but that he/she continues to judge him/herself critically trying to observe him/herself as an "object". It is precisely when the other person focuses on how his/her "object" is evaluated that shame is generated. In other words, for Sartre we can see ourselves as objects by the presence of others, as we manifest ourselves to them in this way. This emotion becomes a "source of recognition" about our own identity (Sartre, 1943). "*I am ashamed of myself as I appear to the Other*" (Sartre, 2003:246).

We also have similar proposals in literature. For example, Kundera in "The Unbearable Lightness of Being" (1985) reflects on how much we may be influenced from the outside observer. According to the Czech writer, whenever we are in front of an audience our actions and our way of being are no longer true, since we inevitably adapt to our observer (Kundera, 1985). The conceptual link with shame emerges: when an imposed or self-imposed standard is violated, one feels inadequate only facing others' judgment.

Cultural differences in the perception of shame

A key point of discussion concerns the cross-cultural nature of moral emotions. Are they universal? Do they differ between cultures? According to cognitive development researchers, there are rules and norms that can change based on the culture, but moral problems concerning justice, individual rights and harm are universal (Kohlberg, 1969; Piaget, 1932; Turiel, Killen, & Helwig, 1987; Shweder & Sullivan, 1993). On the other hand, cultural psychologists argue that morality goes beyond these concepts because it also includes customs, eating habits and religion of different cultures (Miller, Bersoff, & Harwood, 1990; Shweder, Mahapatra, & Miller, 1987; Shweder & Sullivan, 1993).

While basic emotions (happiness, sadness, anger, fear, disgust, surprise) share universal features (such as specific facial expression or meaning attributed to the emotional event), complex emotions (including shame) depend closely on the cultural context. We know that Eastern collectivist societies consider the individual as integral part of a group, contrary

to Western individualist cultures where the individual is much more oriented towards his personal goals and in some ways more isolated. As a result, individuals experience shame differently. Indeed, it seems that shame is generally valued more positively in collectivist societies than in individualist ones (Menon & Shweder, 1994). In a study that asks to associate different emotions according to their degree of similarity, people from East consider more similar to each other shame and happiness than anger, while for Americans this pattern of similarity between shame and happiness does not emerge (Wong & Tsai, 2007). Moreover, Japanese people attribute a positive value to shame that is in contrast, for example, with English speakers (Romney et al., 1997; Wong & Tsai, 2007).

In addition, it seems that shame's role is crucial in the East (Frijda & Mesquita, 1994; Wong & Tsai, 2007) and this emotion is used by parents even in education. In China, shame is deliberately triggered in children with strategic function, much more than in America (Fung, 1999; Fung & Chen, 2001; Fung, Lieber, & Leung, 2003; Wong & Tsai, 2007). Even from a linguistic-lexical point of view, the importance of shame is clear: in the Chinese language, there are 113 headwords to indicate different dimensions of shame (Russell & Yik, 1996; Li et al., 2004; Wong & Tsai, 2007). Differences emerged across societies may also refer to religious beliefs. If we compare a Christian and Buddhist society, considerable differences in definition and perception of shame may emerge. Collectivists consider their own person closely linked to others, while individualists see themselves as separated from others. For example, Tsai (2006) reports that Americans perceive shame as a result of first-person behavior, while Asians as a result of behavior committed by neighbors (Wong & Tsai, 2007); as a further evidence, Asian-Americans associate shame with events experienced by others more frequently than Europeans-Americans (Liem, 1997). Cultural differences in shame can also be seen in behavioral responses. Bagozzi and colleagues (2003) report that Dutch citizens feel ashamed during painful experiences, just like Filipinos; however, the former engage in isolation and self-protective behavior, the latter establish relationships and are more friendly with others (Wong & Tsai, 2007). So, for collective culture, feeling ashamed increases the possibility of sustaining relationships (diminishing the possibility of conflict and breakage) more than in individualistic culture (Wallbott & Scherer, 1995; Wong & Tsai, 2007). However, Sznycer and colleagues (2016) report some intracultural and inter-cultural similarities by studying shame in India, the United States and Israel. This may be due to the importance that society gives to the concept of inclusion and the intrinsic interest of individuals in remaining members of a group.

In summary, it is quite evident that shame as a social-moral emotion has different connotations depending on society. These differences are validated by linguistic and religious factors, but above all by the contrast between the individual as isolated entity and individuality at the base of the community. This confirms once again how the social component of shame is the cornerstone of this emotion.

Nevertheless, shame is not the only moral emotion with a social nature.

Shame and guilt: similarities and differences

Among moral/social emotions, shame has often been associated (and in some ways confused) with guilt. In the last years, the most common approach is to distinguish them based on three factors: their triggering events, their nature

(i.e. private or public) and their evaluative focus (i.e. on the self or on specific behavior) (Tangney et al., 2007). However, not all scholars agree with this schema. According to some, while guilt is always associated with moral violations, shame may arise by a wide range of situations not strictly moral domain-related (Ferguson et al. 1991; Sabini & Silver 1997, Smith et al. 2002; Tangney et al., 2007). On the other side, both emotions are intrinsically linked with morality (Tangney et al., 2006b; Tangney et al., 2007).

Actually, no particular evidence emerged in differentiating shame and guilt based on the classification of specific events (Keltner & Buswell 1996; Tangney, 1992; Tangney et al. 1994; Tracy & Robins, 2006), except for events that classically elicit them. Actions as "lying" and "stealing" have been associated indifferently with both shame and guilt. Therefore, the use of this factor alone is not sufficient to discriminate against them, since they are elicited by several and sometimes common morally relevant situations.

The audience may play an important role in discriminating shame and guilt. For many years, shame has been considered as a "public" emotion, evoked by the presence of an audience that observes, judges and eventually disapproves the person (who feels "naked" and exposed to that judgement); on the contrary, guilt has been seen as a more "private" emotion, arised by an internal and conscious evaluation about him/herself as a result of a conflict between Ego and Superego in psychoanalytical terms (Freud, 1896, 1916-17a; Weiss, 2015). However, over time, this opinion has been revised and not supported by empirical research. According to Tangney and colleagues (1994), the public is not a key factor in discriminating against them (Tangney et al., 2007). In the same vein, more recent thoughts by Deonna and Teroni (2011) emphasize that the public, imagined or real, is not an indispensable aspect to feel ashamed.

Last factor regards their focus. Tangney's research group reports that, in describing shameful situations, people are concerned about other people's judgment about them, whereas this was not the case with guilt experiences where the main concern was about the possible harm done to others. Starting from evidence, shame may be considered an "egocentric" emotion, whereas guilt as more oriented towards others may be “allocentric” (Tangney et al., 2007). In other words, an individual who feels ashamed focuses his attention on him/herself, negatively evaluating his own person and worrying about the judgment of others: for this reason, he/she feels particularly exposed and sensitive to the criticism of others. On the contrary, experiencing guilt leads us to pay attention to our wrong behavior, but this does not merge with our personal identity. The main concern in this latter case are the effects and consequences of such a wrong behavior, not the evaluation of the self. This concept is already present in Lewis (1971), who links shame to a negative evaluation of one's own identity (“I am bad”), while guilt to a negative action (“I made a mistake”).

Since it concerns a critical evaluation of one's identity, shame brings more pain than guilt (Tangney et al, 1992). Shame is associated with a feeling of impotence: ashamed people feel deprived of a protective barrier and they perceive a sort of "unmasking" of their wrong intimate self. Instead, guilt is usually less painful than shame because it does not question the individual identity, but it refers to behaviors that may be intentionally fixed. A guilty subject is worried about the consequences of his/her action, feels remorse and regret about the action carried out, but in the first instance is not concerned with the opinion or judgment towards him/her. Although both emotions are elicited in a social context, they imply different outcomes. According to Tracy and Robins (2006), stable and uncontrollable failing attributions are more linked to shame, while those unstable and controllable with guilt. Starting from these claims, the

adaptive function of guilt appears deeper than shame's one, since the latter implies costs for the individual. Shame lets the person get defensive, pushing to hide and to carry out avoidance behaviors in order to escape the negative judgment. Guilt provides the individual with a more active role, by motivating to seek behaviors that can repair the damage caused (i.e., confessions, apologies or actions with a constructive attitude). Another difference concerns the social impact of both. If on the one hand shame implies a distance by interrupting the social relationship and thus preventing empathetic sharing, guilt feeds on empathetic other-oriented feelings. Shame-prone people tend to respond with intense anger, expressed in a both verbal and physical aggression. However, these individuals are aware that this kind of response has strongly negative consequences in long-term period, both for themselves and for their social relationships. Guilt-prone people are less likely to experience external anger, while they concentrate their resources more on constructive behavior, reporting positive long-term consequences (Tangney et al., 2007). To sum up, negative feelings associated with shame imply an aggressive response; guilt, on the contrary, uses an empathetic approach and a strong sense of responsibility that diminishes destructive attitudes.

However, one might argue that shame and guilt can arise together. According to some authors (Tangney et al., 1996a; Tangney et al., 2007), guilt becomes particularly maladaptive if it occurs in conjunction with shame. When a behavior is no longer separated from one's own self, guilt's restorative attitude feeling is lost. When shame and guilt occur together, the person not only consider his/her actions as wrong, but he/she also consider his/her own person as negative. This may trigger very painful feelings such as self-contempt.

To briefly summarize, shame and guilt are characterized by different triggering events, different behavioral outcomes and different impact on sociality, whereas the audience might not play a critical role in order to distinguish them. However, by taking into account all these factors, we claim that these two emotions are clearly distinct. Nevertheless, perhaps self-evident, they share common characteristics, such as their role of moral mediator in social relations between the individual and the group of belonging and the urge to reflection. For a schematic view of shame and guilt features, please see Table 1.1.

	SHAME	GUILT
OBJECT OF EVALUATION	Global self. "I am a bad person"	Specific behavior. "I made something bad"
EMOTIONAL ACTIVATION	Very painful	Less painful
SUBJECTIVE EXPERIENCE	Reduction of the body, sense of helplessness, feeling small	Tension, remorse, sorrow
ACTION ON SELF	The self is "broken" between observed self and observer self	The self remains intact

	SHAME	GUILT
IMPACT ON SELF	Affected	Not affected
INTERPERSONAL ASPECT	It depends on others' evaluation	It depends on effects on others
OBJECT OF REGULATION	Inhibiting/punishing aspects of the self	Inhibiting/preventing specific behaviors
MOTIVATIONAL ASPECT	Desire to escape and hide	Desire to apologize and repair

Table 1. 1 Modified by Tangney & Dearing, 2002

Psychological models of shame

Freud was one of the first to take an interest in shame, linking it with the fear of feeling exposed, "naked" and unprotected (Freud, 1896, 1916-17a; Weiss, 2015). According to the founder of psychoanalysis, it may derive from the man's genital exposure, while in women it may be due to its lack (Tangney & Dearing, 2002). According to him, shame could also arise from the awareness of the Oedipus complex resolution and from the expression of interest in sexuality (Freud, 1905; Weiss, 2015). Helen Lewis (1971), another psychoanalyst, believes that shame is a destructive emotion resulting from a process of observing capacities of the human being who has the ability to become both the observer and the object of observation (Tangney & Dearing, 2002).

According to the Swiss psychoanalyst Léon Wurmser (1981, 1991), shame cannot be considered as a standing-alone emotion, but must necessarily be connected to traumas at the level of the Super-Ego (inevitably linked to one's moral values), that trigger narcissistic and masochistic defenses (Weiss, 2015).

In a more general perspective, Tomkins (1987) states that shame arises whenever a pleasant experience is interrupted (Tomkins, 1963; Elison et al., 2006). Nathanson (1992) claims that one can approach shame in different ways: understanding its cause and evaluate whether to face or avoid it or even managing it in a dysfunctional way (Elison et al., 2006). The same author defines shame as a "critical regulator of human social behavior" (IIRP, 2016). In this regard, he proposes a "Compass of Shame" (Nathanson, 1992; IIRP, 2016) that summarizes its most common behavioral outcomes in case of a maladaptive approach: withdrawal, in association with isolation and escape; self-attack, up to masochistic behaviors; avoidance, which is accompanied by denial, drugs use and the rejection of emotions; hetero-attack, i.e. aggressive behavior aimed at people and/or objects (IIRP, 2016)

This theory is the basis of the work of Elison and colleagues (2006), who propose a scale for measuring the styles used by people in perceiving shame: the "Compass of Shame Scale" (CoSS). This scale has been developed to measure the poles of Nathanson's "Compass of Shame" as both trait and status responses.

The already mentioned Tomkins (2008) proposes a "theory of affection" with a particular emphasis on shame. He defines "affections" taking advantage by the non-cognitive and biological components that characterize emotions (Tangney & Dearing, 2002). Specifically, Tomkins describes an "affect-system" composed of neuromuscular coordination that allows individuals to respond through physiological and behavioral components that are innate, such as blushing in the face, lowering the head or averting one's gazeduring shame (Tangney & Dearing, 2002). Thus, shame has a double function: on the one hand, it increases protective behavior, and on the other, it arises humiliation (Nathanson, 1987; Sas, 1992; Weiss, 2015).

Michael Lewis (2008) proposes a "cognitive and attributional model" of shame composed of three features: standards, rules and goals (with the acronym of SRG); individual evaluation; attributes to the self (Tangney & Dearing, 2002). These three components act as regulators of behavior: they are beliefs that orient people regarding what is acceptable or not in their social context (Lewis, 2008; Tangney & Dearing, 2002). It follows that such a system is deeply based on one's culture of belonging, social groups and society (Tangney & Dearing, 2002). The "Evaluation" component corresponds to the cognitive ability to judge one's thoughts, actions, feelings related to SRG, and it includes both internal and external key aspects of "self-conscious emotions" (Tangney & Dearing, 2002). The "attributes to the self" can be either global (considering the person as a whole) or specific (i.e. referring to singular aspects of the person as his/her actions) (Tangney & Dearing, 2002). It is evident that shame refers more to global attributes of the self, while guilt to specific dimensions of the person. Independently of this, "prototypical situations" characterized by contextual details influence the rise of emotion. Thus, shame is the result of how the individual interprets him/herself in light of events and circumstances. In a similar way, guilt is generated after a careful assessment of one's own behaviour in certain circumstances. The "evaluative" component (referring to one's own person or to what has been done) is essential, since no event triggers alone both emotions (Tangney & Dearing, 2002).

A theoretical proposal

Taking Nathanson's model as basis, we propose shame as "an algorithm for correcting the self" while facing a moral violation (Piretti, Pappaianni, Rumiati, Job and Grecucci, under review). This algorithm controls all those aspects of the self that do not conform to social standards, and it acts in protective and learning function. Being a "moral algorithm", our brain uses shameful signal to regulate aspects of the self that are socially and morally reprehensible. Specifically, once a moral violation occurs, then the brain generates a painful signal (i.e. shame) in order to inhibit undesirable aspects of the self that arise in those circumstances (Piretti et al., under review). Using a computer science language, the algorithm can be represented as a simple logical implication: "IF (moral/social violation), THEN (signal of shame to inhibit the unwanted aspect of the self)" (See Figure 1.1).

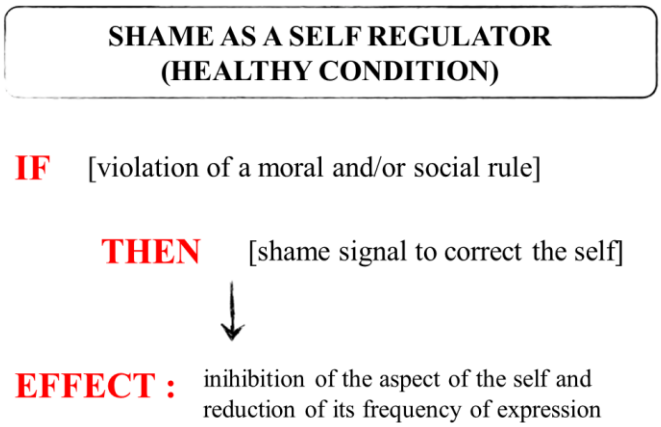


Figure 1. 1 Algorithm of shame functioning as self-regulator

This model aims to describe the functioning of shame under both healthy and pathological conditions. Indeed, we know that individuals with psychopathological disorders often suffer from abnormal regulation of shame (meaning as excess or lack of it) (Fig. 1.1). Let us imagine the regulation of shame as if it were a continuum, in which at the centre we represent a condition of correct functioning (healthy population), while the closer you get to the extremes, the more the same regulation is abnormal (in both directions). In case of excessive shame, the algorithm would excessively inhibit and punish the self, leading to mental suffering and behavioral inhibition that are typical of the Social Anxiety Disorder (SAD), the Obsessive Compulsive Disorder (OCD) and the "covert" forms of Narcissistic Personality Disorder (NPD). Extreme feeling of shame compromises the relational and social domain through forms of isolation and exclusion, preceded by thoughts about the self as wrong and defective (Nathanson, 1994). Conversely, in case of lackness of shame, the algorithm would fail to inhibit morally and socially reprehensible aspects of the self, creating instead a state of "moral blindness" and behavioral dysregulation. We often find this condition in the Antisocial Personality Disorder (ASPD), the "overt" forms of Narcissistic Personality Disorder (NPD), and all forms of behavior characterized by aggression, violence and crime (Piretti et al., in prep.). Pathological pornography addiction seems related to lack of shame and particularly hostile reactions (Janin, 2007). This is consistent with the observation of a patient's improvements, after having made contact with their inner experiences (Weiss, 2015).

To conclude, despite being framed purely from a theoretical point of view, our model aims to explain the functioning of shame from a psychophysiological point of view. It follows that, although based on previous theories and built in a simple but rigorous way, it requires to be tested in the future in order to be validated in its entirety.

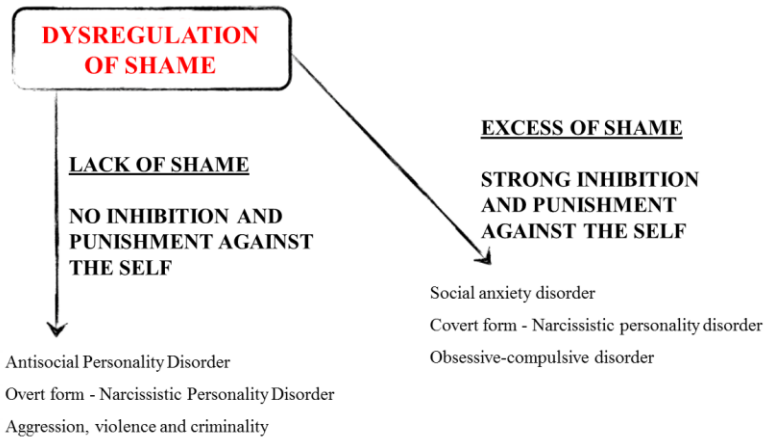


Figure 1. 2 Excessive or scarce shame dysregulation are connected to different psychopathological disorders

Conclusions

The emotion of shame has been the subject of discussion for many years. It has been dealt with in different aspects by philosophers, psychologists, researchers and ultimately neuroscientists. Although it is defined as a social and moral emotion, it is intrinsically connected to the intimate world of the individual and it is triggered facing different events and circumstances. Its interpersonal nature makes it an emotion that springs both from the judgment of others and from the thought of how others might evaluate us. In addition, it may be evoked both in response to an actual event or in an anticipatory way. Being linked to specific moral values, shame is influenced by the culture of belonging in determined contexts. However, at a more general look, it seems to be the prerogative of all societies. It arises always when one questions one's own identity by critically evaluating one's own person. Shame is very painful and linked to mental suffering if not regulated in the right way (as happens for many psychopathological diseases). In healthy conditions, it has a primary adaptive function, since it protects the individual from negative evaluations; in clinical populations, its adaptive role fails, undermining the individual's psychophysical well-being. However, in spite of what has been said, there are still a number of grey areas that need to be investigated in the future, such as its causes, how it is processed and its actual impact on the individual (particularly in clinical conditions).

References

Abe, J. A. A., & Izard, C. E. (1999). The developmental functions of emotions: An analysis in terms of differential emotions theory. *Cognition & Emotion*, *13*(5), 523-549.

American Psychiatric Association. (2014). Manuale diagnostico e statistico dei disturbi mentali (DSM-V). *Raffaello Cortina Editore.*

Andrews, B., Brewin, C. R., Rose, S., & Kirk, M. (2000). Predicting PTSD symptoms in victims of violent crime:

The role of shame, anger, and childhood abuse. *Journal of abnormal psychology*, *109*(1), 69.

Bafunno, D., & Camodeca, M. (2013). Shame and guilt development in preschoolers: the role of context, audience and individual characteristics. European Journal of Developmental Psychology, 10(2), 128–143.

Bagozzi, R. P., Verbeke, W., & Gavino Jr, J. C. (2003). Culture moderates the self-regulation of shame and its effects on performance: the case of salespersons in The Netherlands and the Philippines. *Journal of Applied Psychology*, *88*(2), 219.

Barrett, K. C. (2005). The origins of social emotions and self-regulation in toddlerhood: new evidence. Cognition and Emotion, 19, 953–979.

Bennett, L., Ross, M. W., & Sunderland, R. (1996). The relationship between recognition, rewards and burnout in AIDS caring. *Aids care*, *8*(2), 145-154.

Bennett, D. S., Sullivan, M. W., & Lewis, M. (2005). Young children's adjustment as a function of maltreatment, shame, and anger. Child maltreatment, 10(4), 311-323.

Castelfranchi, C. (2005). Che figura: emozioni e immagine sociale. Il mulino.

Clark, H. B., Northrop, J. T., & Barkshire, C. T. (1988). The effects of contingent thank-you notes on case managers' visiting residential clients. *Education and Treatment of Children*, 45-51.

Cooley, Charles H. (1922). Human Nature and the Social Order. New York: Scribner's.
Deonna, J., & Teroni, F. (2011). Is shame a social emotion? In *Self-Evaluation* (pp. 193-212). Springer, Dordrecht.

Eisenberg, N. (2000). Emotion, regulation, and moral development. *Annual review of psychology*, *51*(1), 665-697.

Elison, J., Lennon, R., & Pulos, S. (2006). Investigating the compass of shame: The development of the Compass of Shame Scale. *Social Behavior and Personality: an international journal*, *34*(3), 221-238.

Elison, J., Pulos, S., & Lennon, R. (2006). Shame-focused coping: An empirical study of the compass of shame. *Social Behavior and Personality: an international journal*, *34*(2), 161-168.

Ferguson, T. J., Stegge, H., & Damhuis, I. (1991). Children's Understanding of Guild and Shame. *Child development*, *62*(4), 827-839.

Ferguson, T. J., & Stegge, H. (1998). Measuring guilt in children: A rose by any other name still has thorns.

Freud S. (1896). Further remarks on the neuro-psychoses of defence. SE III:159–84.

Freud S. (1905). Three essays on the theory of sexuality. SE VII:135–243.

Freud S. (1916–17a). Introductory letters on psycho-analysis. SE XV-XVI.

Frijda, N. H. (1986). The emotions: Studies in emotion and social interaction.*Paris: Maison de Sciences de l'Homme*.

Frijda, N. H., & Mesquita, B. (1994). The social roles and functions of emotions.

Fung, H. (1999). Becoming a moral child: The socialization of shame among young Chinese children. *Ethos*, *27*(2), 180-209.

Fung, H., & CHEN, E. C. H. (2001). Across time and beyond skin: Self and transgression in the everyday socialization of shame among Taiwanese preschool children. *Social Development*, *10*(3), 419-437.

Fung, H., Lieber, E., & Leung, P. W. (2003). Parental beliefs about shame and moral socialization in Taiwan, Hong Kong, and the United States. *Contributions in psychology*, *42*, 83-110.

Goffman, E. (1959) Presentation of Self in Everyday Life. New York: Anchor.

Goffman, E. (1959a). Asylums. New York: Anchor.

Goffman, E. (1963). Behavior in Public Places. New York: Free Press

Goffman, E. (1963a). Stigma. Englewood Cliffs, NJ. Prentice-Hall.

Goffman, E. (1967). Interaction Ritual. New York: Anchor.

Goldman, M., Seever, M., & Seever, M. (1982). Social labeling and the foot-in-the-door effect. *The Journal of Social Psychology*, *117*(1), 19-23.

Haidt, J. (2003). The moral emotions. *Handbook of affective sciences*, *11*, 852-870.

Harper, F. W., & Arias, I. (2004). The role of shame in predicting adult anger and depressive symptoms among victims of child psychological maltreatment. *Journal of family Violence*, *19*(6), 359-367.

Higgins, E. T. (1987). Self-discrepancy – a theory relating self and affect. *Psychological Review*, *94*(3), 319–40.

Hume, D. (1739-1740) Trattato sulla natura umana. A cura di E. *Guglielmoni (2001), Milano, Bompiani*.

Izard, C. E. (1997). Emotions and facial expressions: A perspective from Differential Emotions Theory. *The psychology of facial expression*, *2*, 57-77.

Janin C (2007). *La Honte, ses Figures et ses Destins*. Paris: Presses Universitaires de France.

Janoff-Bulman, R. (1979). Characterological ver- sus behavioral self-blame – inquiries into depression and rape. *Journal of Personality and Social Psychology*, *37*(10), 1798–1809.

Kafka, F. (1915) La metamorfosi. in Ed. Acrobat a cura di Patrizio Sanasi

Kant, I. (1788) Critica della ragion pratica in Martinetti, P. (2017). *Antologia kantiana*.

Keltner, D. Buswell, B.N. (1996). Evidence for the distinctness of embarrassment, shame, and guilt: A study of recalled antecedents and facial expressions of emotion.*Cognition & Emotion*, *10*(2), 155-172.

Kohlberg, L. (1969). *Stage and sequence: The cognitive-developmental approach to socialization*. Rand McNally.

Kroll, J., & Egan, E. (2004). Psychiatry, moral worry, and the moral emotions.*Journal of Psychiatric Practice®*, *10*(6), 352 360.

Kundera, M. (1985). *L'insostenibile leggerezza dell'essere*. Milano: Adelphi.

Leith, K. P., & Baumeister, R. F. (1998). Empathy, shame, guilt, and narratives of interpersonal conflicts: guilt-prone people are better at perspective taking.*Journal of personality*, *66*(1), 1-37.

Lewis, H. B. (1971). Shame and guilt in neurosis. *Psychoanalytic review*, *58*(3), 419.

Lewis, M. (2008). Self-conscious emotions: Embarassment, Pride, Shame and Guilt. In Lewis, M., Haviland-Jones, J. M., & Barrett, L. F. (Eds.). (2010). *Handbook of emotions*. Guilford Press. *Emotions*, 742.

Li, J., Wang, L., & Fischer, K. (2004). The organisation of Chinese shame concepts? *Cognition and emotion*, *18*(6), 767 797.

Liem, R. (1997). Shame and guilt among first-and second-generation Asian Americans and European Americans. *Journal of Cross-Cultural Psychology*, *28*(4), 365-392.

Mead, G. H. (1934). Mind, Self, and Society. Chicago: U. of Chicago Press.

Menon, U., & Shweder, R. A. (1994). Kali's tongue: Cultural psychology and the power of shame in Orissa, India. *Emotion and culture: Empirical studies of mutual influence*, 241-284.

Miller, J. G., Bersoff, D. M., & Harwood, R. L. (1990). Perceptions of social responsibilities in India and in the United States: Moral imperatives or personal decisions? *Journal of personality and social psychology*, *58*(1), 33.

Murphy, S. A., & Kiffin-Petersen, S. (2016). The exposed self: A multilevel model of shame and ethical behavior. *Journal of Business Ethics*, *141*(4), 657-675.

Nathanson DL, editor. (1987). *The many faces of shame*. New York: Guilford Press.

Nathanson, D. L. (1992). *Shame and pride*. New York: Norton.

Nathanson, D. L. (1994). Shame, compassion and the "borderline" personality. *Psychiatric Clinics*

Nathanson, D. (2003). Managing Shame, Preventing Violence: A call to our clergy.

Nietzsche, F. (1878-1879) Umano, troppo umano. Un libro per spiriti liberi. A cura di F., Colli, G., Montinari, M., & Giametta, S. (1970). *Umano, troppo umano; Scelta di frammenti postumi, 1881-1882*. Mondadori.

Patrick, C. J., Bradley, M. M., & Lang, P. J. (1993). Emotion in the criminal psychopath: startle reflex modulation. Journal of abnormal psychology, 102(1), 82.

Paulhus, D. L., Robins, R. W., Trzesniewski, K. H., & Tracy, J. L. (2004). Two replicable suppressor situations in personality research. *Multivariate Behavioral Research*, *39*(2), 303-328.

Piaget, J. (1932). The moral judgment of children. *London: Routledge& Kegan-Paul.*

Pivetti, M., Camodeca, M., & Rapino, M. (2016). Shame, guilt, and anger: Their cognitive, physiological, and behavioral correlates. *Current Psychology*, *35*(4), 690-699.

Platone (155b-157c), Carmide, in M. Gigante, M. Valgimigli (1971) Opere complete, vol. IV, Ed. Laterza, Bari

Romney, A. K., Moore, C. C., & Rusch, C. D. (1997). Cultural universals: Measuring the semantic structure of emotion terms in English and Japanese.*Proceedings of the National Academy of Sciences*, *94*(10), 5489-5494.

Russell, J. A., & Yik, M. S. (1996). Emotion among the Chinese.

Sabini, J., & Silver, M. (1997). In defense of shame: Shame in the context of guilt and embarrassment. *Journal for the Theory of Social Behaviour*, *27*(1), 1-15.

Sartre, J. P. (1943). *L'essere e il nulla. La condizione umana secondo l'esistenzialismo. Ed.* Il saggiatore (Vol. 8).

Sas SA (1992). Ambiguity as the route to shame. *Int J Psychoanal* 73:329–41.

Scheff, T. J. (2003). Shame in self and society. *Symbolic interaction*, *26*(2), 239-262.

Scheff, T. J., & Retzinger, S. M. (2000). Shame as the master emotion of everyday life. *Journal of Mundane Behavior*, *1*(3), 303-324.

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. Journal of Personality and Social Psychology, 66(2), 310.

Shweder, R. A. (2003). Toward a deep cultural psychology of shame. *Social Research: An International Quarterly*, *70*(4), 1100-1129.

Shweder, R. A., & Sullivan, M. A. (1993). Cultural psychology: Who needs it? *Annual review of psychology*, *44*(1), 497-523.

Shweder, R. A., Mahapatra, M., & Miller, J. G. (1987). Culture and moral development. *The emergence of morality in young children*, 1-83.

Smith, R. H., Webster, J. M., Parrott, W. G., & Eyre, H. L. (2002). The role of public exposure in moral and nonmoral shame and guilt. *Journal of Personality and Social Psychology*, *83*(1), 138–159.

Steiner J (1993). *Psychic retreats: Pathological organisations in psychotic, neurotic and borderline patients*.London, New York: Routledge.

Steiner J (2006). *Narzisstische Einbrüche: Sehen und Gesehenwerden. Scham und Verlegenheit bei pathologischen Persönlichkeitsorganisationen* (Weiss H, Frank C, editors). Stuttgart: Klett-Cotta.

Steiner J (2011). *Seeing and being seen: Emerging from a psychic retreat*. London, New York: Routledge.

Sznycer, D., Tooby, J., Cosmides, L., Porat, R., Shalvi, S., & Halperin, E. (2016). Shame closely tracks the threat of devaluation by others, even across cultures. *Proceedings of the National Academy of Sciences*, *113*(10), 2625-2630.

Tangney, J. P., Wagner, P., Fletcher, C., & Gramzow, R. (1992). Shamed into anger? The relation of shame and guilt to anger and self-reported aggression.*Journal of personality and social psychology*, *62*(4), 669.

Tangney, J. P., Marschall, D. E., Rosenberg, K., Barlow, D. H., & Wagner, P. E. (1994). Children's and adults' autobiographical accounts of shame, guilt and pride experiences: An analysis of situational determinants and interpersonal concerns. Journal of Personality and Social Psychology*, 70*(6), 1256-1269

Tangney, J. P., Miller, R. S., Flicker, L., & Barlow, D. H. (1996a). Are shame, guilt, and embarrassment distinct emotions?. *Journal of personality and social psychology*, *70*(6), 1256.

Tangney, J. P., Stuewig, J., & Mashek, D. (2006b). An emotional-cognitive framework for understanding moral behavior. *Unpubl. manuscr. George Mason Univ., Fairfax, VA*.

Tangney, J. P. (1992). Situational detenninants of shame and guilt in young adulthood. *Personality and Social Psychology Bulletin*, *18*(2), 199-206.

Tangney, J. P., & Dearing, R. L. (2002). Emotions and social behavior. *Shame and guilt*, *10*(9781412950664), 388.

Tangney, J. P., Stuewig, J., & Mashek, D. J. (2007). Moral emotions and moral behavior. *Annual Review of Psychology*, *58*, 345:372.

Tangney, J. P., Wagner, P., Fletcher, C., & Gramzow, R. (1992). Shamed into anger? The relation of shame and guilt

to anger and self-reported aggression.*Journal of personality and social psychology*, *62*(4), 669.

Tomkins, S. S. (1963). Affect imagery consciousness, 2: The negative affects. Springer

Tomkins, S. S. (1987). Shame. In D. L. Nathanson (Ed.), *The many faces of shame* (pp. 133-161). New York, NY, US: The Guilford Press.

Tomkins, S. S. (1991). Affect, imagery, consciousness: Anger and fear (Vol. 3). Springer

Tomkins, S. S. (2008). Affect imagery consciousness: The complete edition: Two Volumes. Springer Publishing Company.

Tracy, J. L., & Robins, R. W. (2006). Appraisal antecedents of shame and guilt: Support for a theoretical model. *Personality and social psychology bulletin*, *32*(10), 1339-1351.

Tsai, J. L. (2006). Cultural differences in the valuation of shame and other complex emotions. *Manuscript in preparation*.

Turiel, E., Killen, M., & Helwig, C. C. (1987). Morality: Its structure, functions, and vagaries. *The emergence of morality in young children*, 155-243.

Vélez García, A. E., & Ostrosky-Solís, F. (2006). From morality to moral emotions. *International Journal of Psychology*, *41*(5), 348-354.

Wallbott, H. G., & Scherer, K. R. (1989). Assessing emotion by questionnaire. Emotion: Theory, Research, and Experience, 4, 55–82.

Wallbott, H. G., & Scherer, K. R. (1995). *Cultural determinants in experiencing shame and guilt*. Guilford Press.

Weisfeld, G. E. (1997). Discrete emotions theory with specific reference to pride and shame. In N. L. Segal, G. E. Weisfeld, & C. C. Weisfeld (Eds.), *Uniting psychology and biology: Integrative perspectives on human development* (pp. 419-443). Washington, DC, US: American Psychological Association.

Weiss, H. (2015). Introduction: The role of shame in psychoanalytic theory and practice. *The International Journal of Psychoanalysis*, *96*(6), 1585-1588.

Wong, Y., & Tsai, J. (2007). Cultural models of shame and guilt. *The self-conscious emotions: Theory and research*, 209-223.

Wurmser L (1981). *The mask of shame*. Baltimore, MD: The Johns Hopkins UP.

Wurmser L (1991). *Scham und der böse Blick: Verstehen der negativen therapeutischen Reaktion*. Stuttgart: Kohlhammer.

Zahn, R., de Oliveira-Souza, R., & Moll, J. (2013), Moral emotions. In Armony, J., & Vuilleumier, P. (Eds.). (2013). *The Cambridge handbook of human affective neuroscience*. Cambridge university press.

Chapter 2
Shame Task

Study I - Shame Task

Introduction

One answered question in affective neuroscience is how the brain regulates the self to foster a moral life and benefit society. Shame is believed to pursue this goal as it serves, together with guilt, to help individuals to adjust themselves in order to stick to social and moral standards (Tangney et al., 2007). Research has clarified that shame and guilt are two distinct emotions that differ on the focus of judgment. Shame is typically elicited by situations in which one has being negatively evaluated by others for "what I am", whereas guilt stems from a negative evaluation for "what I do" (see Chapter 1 for more details) (Levis, 1971; Tracy & Robins, 2004; Tangney et al., 2007). In other words, "guilt is the experience that you made a mistake, while shame is the experience that you are a mistake" (Bradshaw, 2005). Although some advancements on guilt have been recently made and we know some of the psychological variables involved (Baumeister et al., 1994), its neural substrates (Bastin et al., 2016 for a review), and its effect on behavior (De Hooge et al., 2007; Nelissen et al., 2007), research on shame has made few progresses. A clear understanding of how the brain uses shame to adjust the self (in parallel to how guilt adjusts behaviors toward others, see for example De Hooge et al., 2007), is still lacking. Of all emotions, shame has always been recognized as an important emotion for normal and abnormal development. Indeed, reduced shame is linked to aggression, violence and antisocial behaviors, and exaggerated shame is linked to social anxiety, exclusion and withdrawal (Raine and Yung, 2006). Although the role of the shame is increasingly acknowledged to be important, rarely scholars expressly addressed the specific issues arising when shame becomes dysregulated. Clinical observations suggest that shame and moral reasoning are impaired in criminals (Raine and Yung, 2006), and it has been hypothesized that the avoidance of the experience of shame is a central theme of antisocial personality (Holmqvist, 2008; Nathanson, 1994; McWilliams, 1994). Others authors have reported that shame-eliciting situations cause expressions of intense reactive anger and hostility (Andrews et al., 2000, Bennett, et al., 2005, Harper and Arias 2004; Lewis, 1971; Paulhus et al., 2004, Tangney & Dearing 2002; Tangney et al., 2007). However, an understanding of the cognitive and neural mechanisms behind shame still needs to be clarified (Tangney and Dearing, 2002).

Previous empirical studies

Historically, the first attempts to study empirically shame were conducted using laboratory manipulations designed to threaten the social self. Methodologically, these experiments typically required participants either to write about a recent incident (Dickerson et al., 2004b), or to perform public speaking in front of an audience (Gruenewald et al., 2004). As a result, increased proinflammatory cytokine, heart rate and blood pressure were found (see Dickerson et al. 2004a for a review). Importantly, these experiments did not control for other possible emotions elicited by the situations (self-blame and guilt when reporting an incident, and anxiety when speaking in public), limiting the

interpretation of their results. Takahashi et al. (2004) (but see also Moll et al., 2012) had participants to read sentences describing individuals who experienced shame and guilt and imagining the situations (script driven paradigm), while scanning their brain activity with fMRI. For embarrassment (similar in many ways to shame), they found a distinctly greater activation in the right temporal cortex and hippocampus when compared to sentences describing guilt. More recently, Michl and colleagues (Michl et al., 2012) used a script driven mental imagery paradigm with sentences describing shameful-(for example "I was asked to dance, but didn't know how to"), and guilt–related situations. Middle and frontal gyrus and hippocampal gyrus were found to be active in the shame condition. With a similar paradigm, Finger et al. (2006), instructed participants to imagine themselves in guilt, shame and embarrassing situations and found dorsomedial and ventrolateral prefontal cortex as as well as amygdala activations. Similarly, Henning-Fast studied shame in individuals with obsessive-compulsive disorder and reported increased activity in limbic, temporal and hypothalamus areas for shame situations as compared to the same situations in controls (Henning-Fast et al., 2015). However, script driven imagery of shame situations is not the same as being ashamed by someone for real. Wagner and colleagues (Wagner et al., 2011, but see also Roth et al., 2014) asked participants to mentally relieve past shame and guilt-laden experiences specifically described in a pre-scanning phase (autobiographical recall). Several brain regions (portions of the prefrontal, temporal and occipital cortices) responded to shame more than the neutral condition. Although this methodology in principle is able to elicit the experience of shame, shame is not directly manipulated and controlled. Another study asked participants to read neutral and shameful judgments toward themselves or toward a third party (Pulcu et al., 2013), however, no control over other related emotions was provided, and no effect on the self or toward others was assessed. For the above reasons, there is no consistency in terms of methodology and results in previous studies. We believe that one of the main problems in studying shame is the difficulty of eliciting the experience of shame (Blum, 2008). With such limitations, research on shame has been barely fruitless for years. Notably, if it is true that shame is linked to interpersonal problematic behaviors, the experimental paradigms used so far do not permit to evaluate how shame provides a feedback and adjust the self and how it affects interpersonal reactions.

Research questions and hypothesis

In light of the criticisms levelled at previous studies, we developed a "Shame task" (explained in details in the next section) to study shame. The Shame Task is a behavioral paradigm that aims to elicit and measure self-conscious emotions as shame and guilt as control. Specifically, it is intended to reproduce interpersonal situations in which those target emotions are evoked and assessed. Since in experimental literature the link between shame and guilt is still a matter of discussion, the strength of this task is the possibility to study them together using the same experimental framework.

1. First, we aim at testing the ability of the stimuli to induce shame and guilt in the participants. The first experiment presented here served as a starting point for the studies presented in the next chapters. We expect participants to report a higher level of perceived shame/guilt in the target situations, whereas a lower or null amount

of shame/guilt for neutral stimuli.

2. We also expect our stimuli to differentiate between shame and guilt. Although similar, and often confounded in the previous literature, we expect the level of perceived shame to be higher in stimuli categorized as shame-evoking, while the level of perceived guilt to be higher in stimuli eliciting this same emotion. Our expectation is that perceived shame may be lower than guilt in guilt-eliciting stimuli; conversely, we expect perceived guilt to be lower than shame in ashamed stimuli. If our hypotheses were confirmed, this would be a clear sign that our stimuli are suitable for eliciting the target emotion and that participants are able to distinguish between the two self-conscious emotions.

3. Finally, given the complex nature of shame and guilt, we expect individual differences in their perception. Everyone can be more or less prone to shame, as well as guilt. This may depend on several factors such as personality features, affectivity at the time of testing, empathic skills or social intelligence. To enrich the psychological profile of the participants, we measured through self-report questionnaires the participants' propensity to shame and guilt, emotional personality traits, affectivity and dispositional empathic abilities. Our hypothesis is that the propensity to shame can modulate its perception in the task, as well as the propensity to guilt for perceived guilt. Since both emotions are globally considered as negatively valenced, we also expect a relationship between them and negative affectivity, as well as specific traits of affective personality. Finally, given the particularly social nature of guilt, we would not be surprised by a link between perceived guilt and empathic abilities of individuals.

Method

Stimuli validation

Based on several questionnaires' items and previous studies on shame, ninety Italian sentences were built with the aim of eliciting shame. To avoid linguistic confounding, we tried to keep the structure of each sentence constant by inserting a subject, a verb (mostly "to be") and a nominal part or object complement. For instance: *"You are a bad worker"*.

In addition to these, ninety sentences with a similar structure were constructed with a neutral or absent emotional impact. Since it is not possible to express a neutral evaluation, it was chosen to construct sentences related to the person that did not contain negative (nor positive) elements about the individual or his/her behavior. For instance: *"You are a worker"*.

Beside neutral stimuli, we used also guilt eliciting stimuli as a control for a similar emotion. Shame and guilt are considered moral and self-conscious emotions. To be sure that the effect observed in our experiments were due to shame and not to moral and reflective emotions in general, the comparison with guilt was necessary. For this reason, a further ninety guilt-inducing phrases have been constructed. Since guilt is much more related to misbehavior than to a way of being, items mostly expressed a wrong action performed in the recent past. For instance: *"You lost my notebook"*.

In total, two hundred seventy sentences (shame-inducing, guilt-inducing and neutral) were newly designed and divided into three different questionnaires. Questionnaires were created using Google Forms development environment (https://www.google.com/forms/about/) with online administration via Desktop PC, smartphone and tablet.

Contrary to what will be done in the actual experimental task, the faces of the partners were not presented but they were replaced by fictitious name. The participants were presented with the phrasal stimulus in the following form: "*Imagine that Luca says to you in front of everyone: You are a traitor*". Combined with each stimulus, twelve possible emotions were proposed (including neutral) and a scale likert in which it was necessary to indicate the strength of the emotion experienced. As the instructions show, we tried to emphasize the social aspect of self-conscious emotions, suggesting to imagine the scene in front of a generic audience. The order of the twelve options has been randomized among participants. The choice to divide the items into three different questionnaires was made in order not to overload the participants in the rating task; in this way, the risk of an "adaptive" effect of the emotions under examination was avoided as well.

Fifty-eight people completed questionnaire one, fifty-eight people completed questionnaire two, fifty-seven people completed questionnaire three. They were all Italian mother-tongue. For the data analysis, we capitalized on the integrated tools of Google Forms that automatically return a descriptive analysis of the collected responses in the form of pie charts and response frequency percentages. In our case, we obtained pie charts constructed on the response frequency percentage related to the emotion in each item, and a histogram based on the response percentages related to the Likert scale inquiring into the strength of that emotion.

Since our main focus was shame and guilt, we isolated the stimuli that had the highest frequency of response and the highest score about strength for both emotions. However, due to the complex nature of the stimuli, an adequate number of items for a future experimental study was not achieved. To overcome this problem, we collapsed the percentages of shame and guilt with the two "most similar" emotions at a semantic and linguistic level, namely embarrassment and regret. In this way, also in the light of the literature that differentiates the two emotions based on their main "object", we obtained two clearer indices in reference to the "Self" (shame + embarrassment) and in reference to "Others" (guilt + regret). These indices made it possible to distinguish clearly between the two categories of emotions. Although taken into consideration together, it is worth noting that the percentage of responses related to our two main emotions has always been greater than that one of the two "younger sisters" in the items considered. With regard to neutral items, we considered those that were considered more neutral and not in reference to moral emotions. Finally, thirty shame-inducing, thirty guilt-inducing, and thirty neutral items will be included in the experimental studies described below.

Participants

In study 1, 30 participants were included in the study. The mean age of the participants (16 females) was 21 (SD = 2.05) years and their mean education was 13.63 (SD = 1.49) years. The entire experimental procedure was approved by the ethical review board of the University of Trento, and all participants were asked to read and sign an informed consent, as provided in the code of ethics for research. All participants were native speakers of Italian and had no previous neurological or psychiatric diseases. Participants' privacy and anonymity of their answers were guaranteed for all the entire procedure.

Experimental design

The Shame Task is a behavioral task that recreates several scenarios of social interaction between the participant and different partners. During this interaction, the participant is exposed to different evaluations or judgments concerning his/her person or behavior. The aim is to elicit the emotion of shame through the imagination of that scene. In affective neuroscience and emotional research, the use of a paradigm that exploits the imagination to study emotional constructs is not new. Specifically, there is evidence in the literature that these paradigms actually succeed in recreating a social interaction between participants and simulated characters (see for example Grecucci, Giorgetta, van't Wout, Bonini, & Sanfey, 2013; Grecucci, Giorgetta, Bonini, & Sanfey, 2013; Grecucci et al., 2015). The use of an affective stimulus such as an image, the indication of the name or anything related to the (fake) partner allows the creation of the social link with the participant.

Regarding the Shame Task, the idea is to create the interaction proposing the partner's featured photo in addition to the evaluation expressed in text form. To maximize the interpersonal aspect during such interactions, we have chosen to use the face as a salient social stimulus in addition to the assessment presented (our target stimulus). We selected ninety faces (forty-five men and forty-five women) of Caucasian adults from the Chicago Face Database (Ma, Correll, & Wittenbrink, 2015). Specifically, in order to avoid race side effects that were outside the goals of the study, we selected the ninety stimuli categorized in the normative phase as the most "Caucasian" ones (all normative data are freely available on the website https://chicagofaces.org/default/) (see Figure 2.1).

The first version of the Shame task was administered within the common laboratories of the Department of Psychology and Cognitive Sciences, University of Trento. The experimental setting included an aseptic room containing a desk with a Desktop PC and two chairs. Participants had to go personally to the laboratory to take part in the study. No reimbursement was provided for participation expenses, but university students could obtain credits for the time needed for the test. Participants were seated in the chair in front of the computer and given the consent form for the treatment of personal data. After signing the consent, the investigator illustrated on screen the instructions for the experimental task.

After clarifying any doubts, the participant undertook three test trials to become familiar with the experimental task. Specifically, a shame-eliciting item, a guilt-eliciting item and a neutral one were shown. After practice, if everything was clear, the real task would begin. It included ninety stimuli in total, thirty per type of stimulus. After a 500 ms fixation point, the item appeared on the screen for 7 seconds. During this period of time, the participant had to imagine a social context in which he spoke directly with the person whose face was shown, and imagine that the evaluation expressed concerned him/her personally. Subsequently, two questions were proposed. The first investigating the measure of shame that the participant would feel in such a situation, the second in reference to guilt.

OpenSesame 3 (Mathôt, Schreij, & Theeuwes, 2012) as open-source, graphical social sciences experiment builder based on Python, was used for designing and running the experiment. Since the parts of the speech in Italian are gender-

specific, two versions of the task have been built: one dedicated to female participants, and one dedicated to male participants. The structure of the items has not been changed.

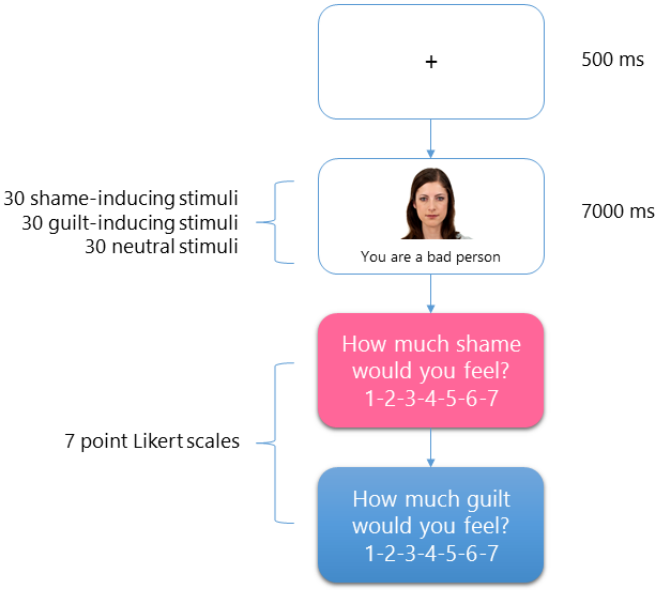


Figure 2. 1 Experimental design of the Shame Task

In addition to the experimental task, with the aim of enriching the psychological and emotional profile of the participants, several questionnaires were presented. The order of administration of all questionnaires was randomized between participants.

- The Test of Self-Conscious Affect-3 (J. P. Tangney, Dearing, Wagner, & Gramzow, 2000) is one of the most recognized tools to measure shame and guilt-proneness and disposition to blame others (externalization). For each scenario, participants rated their likelihood of responding in the manner depicted by several statements on a 5-point Likert scale (1 = very unlike me, 5 = very like me).
- With the aim of assessing the current affective state of participants, the Italian version (Terracciano, McCrae, & Costa, 2003) of the Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988) was proposed. PANAS is a twenty word-items questionnaire describing emotional state: participants need to indicate in a 5-point Likert scale how that emotional state was representative of their current internal situation, ranging from "Very slightly or not at all (1)" to "Extremely (5)".
- The Affective Neuroscience Personality Scale (ANPS, Davis, Panksepp, & Normansell, 2003) is a tool designed to investigate endophenotypes related to six basic emotional systems that have emerged through research in affective neuroscience (Pingault, Falissard, Côté, & Berthoz, 2012). The ANPS provides an innovative starting point in the study of personality from an affective perspective. It is composed of 110 items investigating the following basic emotional endophenotypes: PLAYFULNESS/joy, SEEKING/interest, CARING/nurturance, ANGER/rage,

FEAR/anxiety, and SADNESS/separation distress. In addition to these, some items also investigate aspects related to SPIRITUALITY, for a total of seven subscales. Each item consists of a statement and requires a response in a 4 point Likert scale, ranging from "Very agreeable (0)" to "Very disagreeable (3)".

- Finally, participants filled out the Italian version (Albiero, Ingoglia, & Lo Coco, 2006) of the Interpersonal Reactivity Index (IRI; (M. Davis, 1983) as a measure of dispositional empathy. IRI is a 28-items answered on a 5-point Likert scale ranging from "Does not describe me well (1)" to "Describes me very well (5)". Four subscales are derivable (each one composed of 7-items): Perspective Taking (PT), Fantasy (FA), Empathic Concern (EC) and Personal Distress (PD).

Results

Analysis of shame

With the aim of highlighting any differences in the perception of shame between the three types of stimulus, we performed a one-way analysis of variance (ANOVA) with shame means distribution as dependent variable and the type of stimulus as factor. JASP software (Version 0.8.4, https://jasp-stats.org) was used for data analysis. Results show a main significant effect related to the type of stimulus ($F(2) = 104.3$, $p < 0.001$, $\eta^2 = 0.70$). See Table 2.1 for any detail related to the omnibus ANOVA.

ANOVA – Shame

Cases	Sum of Squares	df	Mean Square	F	p	η^2	η^2_p
StimType	195.82	2	97.910	104.3	< .001	0.706	0.706
Residual	81.68	87	0.939				

Table 2. 1 ANOVA omnibus for shame perception. Note: Type III Sum of Squares

Bonferroni-corrected post-hoc analyses have shown a significant difference in the perception of shame between neutral and shame-inducing stimuli ($t = -13.595$, $p < .001$), between guilt-inducing and shame-inducing stimuli ($t = -2.576$, $p = 0.035$) and between guilt-inducing and neutral stimuli ($t = 11.019$, $p < .001$). See Table 2.2 for all details about post-hoc comparisons, while Figure 2.2 shows a graphical description of the difference between distributions.

Post Hoc Comparisons – StimType

		Mean Difference	SE	t	Cohen's d	p_{tukey}	p_{bonf}
Guilt	Neutral	2.757	0.250	11.019	1.161	< .001	< .001
	Shame	-0.644	0.250	-2.576	-0.272	0.031	0.035
Neutral	Shame	-3.401	0.250	-13.595	-1.433	< .001	< .001

Table 2. 2 Post Hoc Comparisons based on the stimuli type.

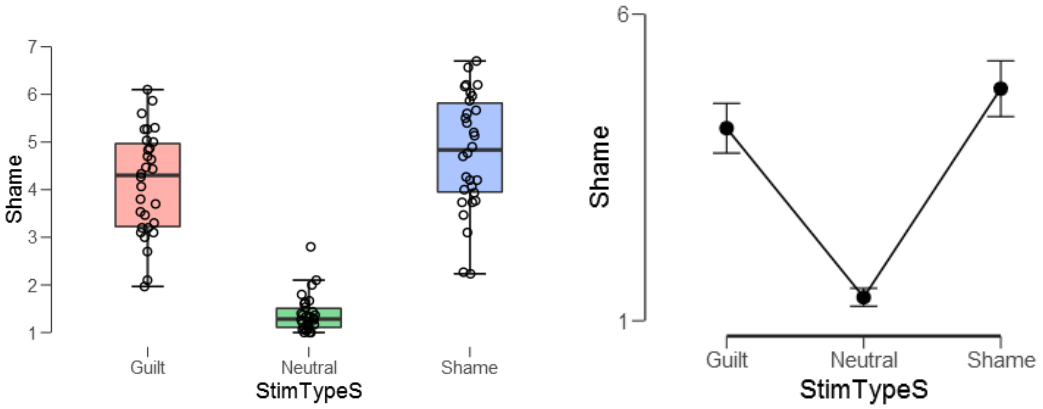


Figure 2. 2 On the left, boxplot for the means distribution of shame perception within the three types of stimuli (Guilt, Neutral and Shame). On the right, descriptive plot of shame perception with error bars and 95% confidence interval is shown.

Linear regression - Shame model

With the aim of verifying the impact of other measured variables on the perception of shame, we built a linear regression model. The distribution of the means related to the perception of shame for shame-inducing stimuli has been set as a dependent variable, while we inserted age, education, a measure of shame-proneness and one for guilt-proneness (from TOSCA questionnaire) as covariates. Durbin-Watson test was performed in order to check for autocorrelation among coefficients. Table 2.3 summarizes model parameters (R, R^2, Adjusted R^2, Root Mean Square Error - RMSE, Durbin-Watson test), ANOVA on the model and coefficients.

Model Summary - Shame

Model	R	R^2	Adjusted R^2	RMSE	Durbin-Watson
1	0.582	0.339	0.233	1.066	2.174

ANOVA

Model		Sum of Squares	df	Mean Square	F	p
1	Regression	14.58	4	3.646	3.205	0.030
	Residual	28.43	25	1.137		
	Total	43.01	29			

Coefficients

Model	Unstandardized	Standard Error	Standardized	t	p	2.5%	97.5%

1	(Intercept)	3.612	3.931		0.919	0.367	-4.483	11.707
	Age	0.120	0.185	0.201	0.648	0.523	-0.261	0.500
	Education	-0.342	0.224	-0.420	-1.527	0.139	-0.803	0.119
	Shame (TOSCA)	0.075	0.034	0.455	2.229	0.035	0.006	0.145
	Guilt (TOSCA)	0.017	0.046	0.075	0.368	0.716	-0.078	0.111

Table 2. 3 Linear regression model for shame perception. Age, Education, Shame-proneness (TOSCA) and guilt-proneness (TOSCA) added as covariates.

Durbin-Watson test result (2.173) expresses low degree of autocorrelations between all variables. Overall, the predictors and covariates explained 23% of the variance (Adjusted $R^2 = .23$, $F(4, 25) = 3.205$, $p = 0.03$). As coefficients table shows, shame perception during the task was positively predicted by shame-proneness assessed by TOSCA questionnaire (β weight = 0.455, 95% CI [0.006, 0.145], $t(29) = 2.229$, $p = 0.035$). Age, Education and guilt-proneness do not impact the dependent variable (all ps > 0.05).

Analysis of guilt

As we did for shame, we performed a one-way analysis of variance (ANOVA) with guilt means distribution as dependent variable and the type of stimulus as factor. Results show a significant main effect related to the type of stimulus ($F(2) = 160.5$, $p < 0.001$, $\eta^2 = 0.787$). See Table 2.4 for any detail related to the omnibus ANOVA.

ANOVA – Guilt

Cases	Sum of Squares	df	Mean Square	F	P	η^2	η^2_p
StimType	268.46	2	134.231	160.5	< .001	0.787	0.787
Residual	72.77	87	0.836				

Table 2. 4 ANOVA omnibus for guilt perception. Note. Type III Sum of Squares

Post-hoc Bonferroni-corrected analyses have shown a significant difference in the perception of guilt between guilt-inducing and neutral stimuli ($t = -16.6$, $p < .001$), between guilt-inducing and shame-inducing stimuli ($t = 2.466$, $p = 0.047$) and between neutral and shame-inducing stimuli ($t = -14.134$, $p < .001$). See Table 2.5 for all details about post-hoc comparisons, while Figure 2.3 shows a graphical description of the difference between distributions.

Post Hoc Comparisons - StimType

		Mean Difference	SE	t	Cohen's d	p tukey	p bonf
Guilt	Neutral	3.920	0.236	16.600	1.750	< .001	< .001
	Shame	0.582	0.236	2.466	0.260	0.041	0.047
Neutral	Shame	-3.338	0.236	-14.134	-1.490	< .001	< .001

Table 2. 5 Post Hoc Comparisons based on the stimuli type. Note. Cohen's d does not correct for multiple comparisons.

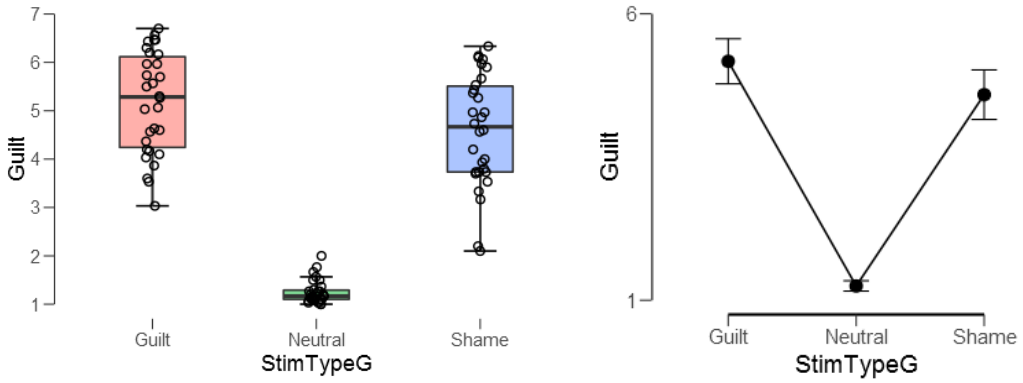


Figure 2. 3 On the left, boxplot for the means distribution of guilt perception within the three types of stimuli (Guilt, Neutral and Shame). On the right, descriptive plot of guilt perception with error bars and 95% confidence interval is shown.

Linear regression - Guilt model

As we did for shame, we built a linear regression model for guilt perception in order to investigate the possible impact of other variables of interest on it. The model was structured in the same way as the previous one. That is, the distribution of the means related to the perception of guilt for guilt-inducing stimuli in the task has been set as a dependent variable, while age, education, guilt-proneness and shame-proneness (assessed by TOSCA) as covariates. Durbin-Watson test was performed in order to check for autocorrelation among coefficients. Table 2.6 summarizes model parameters (R, R^2, Adjusted R^2, Root Mean Square Error - RMSE, Durbin-Watson test), ANOVA on the model and coefficients.

Model Summary

Model	R	R^2	Adjusted R^2	RMSE	Durbin-Watson
1	0.592	0.351	0.247	0.914	2.311

ANOVA

Model		Sum of Squares	df	Mean Square	F	p
1	Regression	11.29	4	2.823	3.378	0.024
	Residual	20.89	25	0.836		
	Total	32.19	29			

Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p	2.5%	97.5%
1	(Intercept)	4.006	3.369		1.189	0.246	-2.934	10.945
	Age	-8.432e -4	0.158	-0.002	-0.005	0.996	-0.327	0.325
	Education	-0.148	0.192	-0.210	-0.771	0.448	-0.543	0.247
	Shame (TOSCA)	0.063	0.029	0.442	2.181	0.039	0.004	0.123
	Guilt (TOSCA)	0.023	0.039	0.118	0.586	0.563	-0.058	0.104

Table 2. 6 Linear regression model for guilt perception. Age, Education, Shame-proneness (TOSCA) and Guilt-proneness (TOSCA)

As in the shame-model, Durbin-Watson test result (2.311) expresses low degree of autocorrelations between all variables. Overall, the predictors and covariates explained 24% of the variance (Adjusted $R^2 = .24$, $F(4, 25) = 3.378$, $p = 0.024$). Contrary to our expectations, guilt perception during the task was not predicted by guilt-proneness assessed by TOSCA ($p > 0.05$), whereas it was positively predicted by shame-proneness (β weight = 0.442, 95% CI [0.004, 0.123], $t(29) = 2.181$, $p = 0.039$). Age and Education do not impact the dependent variable (both ps > 0.05).

Correlations between shame/guilt perception and behavioral tests

In order to verify if the perception of shame and guilt assessed by Shame Task was linked to other measured behavioural variables, we calculated the correlation (based on Spearman's rho coefficient) between the two measures and the subscales from the questionnaires used (TOSCA, PANAS, ANPS and IRI).

Results show a significant positive correlation between shame and shame-proneness assessed by TOSCA (rho = 0.447, $p = 0.013$, C.I. [0.103, 0.695]). See figure 2.4 for a scatterplot of this correlation. No other significant correlations concerning shame emerged (all ps > 0.05).

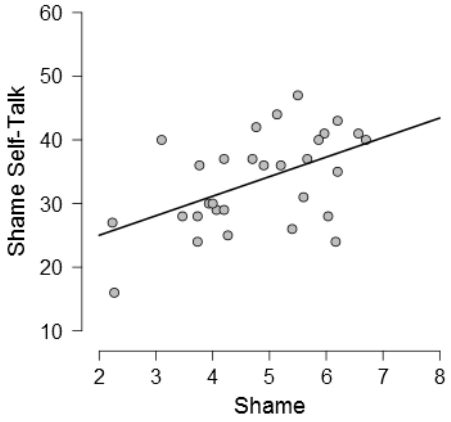


Figure 2. 4 Scatterplot of the positive correlation between shame perception (Shame Task) and shame-proneness ("Shame Self-Talk" subscale, TOSCA questionnaire).

About guilt, we found a positive correlation between guilt-perception and shame-proneness assessed by TOSCA (rho = 0.517, p = 0.003, C.I. [0.193, 0.739]) and between guilt perception and Fantasy subscale measured by IRI (rho = 0.478, p = 0.007, C.I. [0.143, 0.715]). See Figure 2.5 for visualizing both correlations in a scatterplot. No other significant correlations emerged between guilt and behavioral tests (all ps > 0.05).

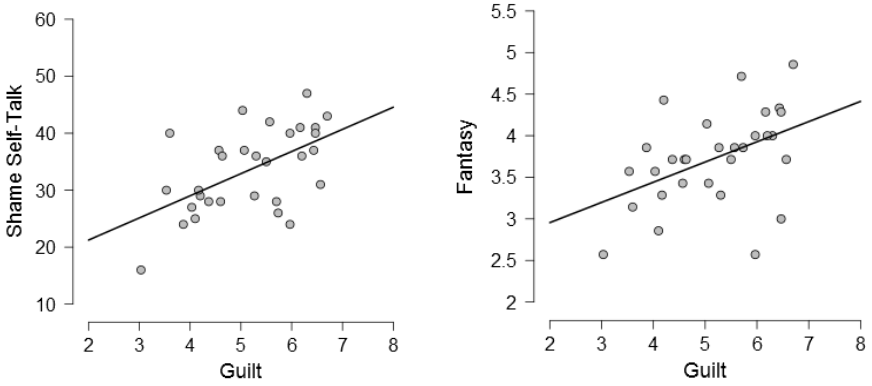


Figure 2. 5 Scatterplots of correlations among behavioral variables. On the left, positive correlation between guilt perception and shame-proneness (TOSCA); on the right, positive correlation between guilt perception and fantasy (IRI).

Discussion

Shame is one of the less studied emotions from an experimental perspective. From a theoretical point of view, shame is elicited in the presence of a moral violation strictly concerning the self. Moreover, shame is considered a "self-conscious emotions", or an emotion generated by self-aware reflection (Haidt, 2003). Moreover, shame is often confused with guilt, another self-conscious emotion with which it shares several characteristics (including, among

others, the moral violation necessary to evoke it, the negative valence, the interpersonal context, the painful impact on the individual).

In this first study, we tried to disentangle shame and guilt. Both emotions were elicited and measured by using a novel experimental paradigm that we called the "Shame Task". This task exposed participants to numerous social interactions with imagined partners, who expressed judgments and opinions towards the person and correctly eliciting the two self-conscious emotions. These interactions were made more truthful thanks to the presentation of randomized different faces, all with neutral facial expression, coupled with each individual evaluation. Thanks to the use of proper scales, participants autonomously evaluated their degree of shame and guilt in the face of every interpersonal situation, providing a subjective estimate of the emotion that would be felt in certain contexts.
From the statistical analysis, a clear distinction in emotion perception emerged between experimental and neutral items, with the former much more arousing than the latter. So, our first hypothesis is confirmed by the fact that people experienced and reported a higher level of shame and guilt by facing target stimuli, compared to the neutral ones. The use of a neutral control condition has made it possible to maximize the emotional impact of the target stimuli, creating a non-negative emotional baseline randomized within the items.

In addition, our experimental paradigm were effective in arousing the target emotion in our participants. Indeed, when faced with a shameful stimulus, they reported a greater perception of shame than guilt. Conversely, when faced with a guilt stimulus, perceived guilt was higher than reported shame. In light of what we have assumed in the second hypothesis, the stimuli we created and validated within our novel experimental paradigm seem to be strong elicitors of self-conscious emotions such as shame and guilt. This may mark a breakthrough in psychological research about shame. In our paradigm, shame and guilt are not measured on the basis of descriptive scenarios, autobiographical memories, simple questionnaires or list of words as done in the past (Carpenter, Tignor, Tsang, & Willett, 2016; Pivetti, Camodeca, & Rapino, 2016; Pulcu et al., 2014), but participants are directly exposed to an evaluation. Although they are responsible for imagining the social context of interaction, the focus of the evaluation is always on the person. The keystone of our paradigm is the request for representation of the self, that being stripped bare and under accusation generates the feeling of discomfort that we call shame or guilt. If we want to say it provocatively, the Shame task uses cognition and representation to study emotion. Although many cognitivists (and many scholars of emotions) would shudder at such a statement, we believe that this somewhat integrated approach makes possible a true measure of one's self in certain contexts (such as social interactions). The choice to match a face to each evaluation is another strength of our task. Although static, the vision of the face, with its intrinsic social component, immediately generates an implicit relationship between the participant and the person depicted. In addition, we believe that reading a sentence combined with an immediately available face also facilitates the imagination of the spoken interaction.

As far as the psychological profile of individuals is concerned, a clear picture did not emerge. Our data show that the general shame-proneness correctly predicts the shame perceived in the task. Indirectly, this confirms the validity of

our shameful stimuli in light of the fact that the TOSCA questionnaire (J. P. Tangney et al., 2000) is a consolidated and recognized tool for the study of self-conscious emotions. Beside the shame-proneness, a measure of guilt-proneness was assessed using the same questionnaire. Although we believed that this index was a possible predictor of perceived guilt during the task, we did not find any significant relationship between these two variables. On the contrary, the same shame-proneness was a predictor of guilt in the task. In literature, shame-proneness and guilt-proneness have often been compared. However, we stress that a direct comparison of the different scales within the questionnaires was beyond the scope of our study. To our knowledge, both scales have never been related to an experimental task investigating similar constructs (in our case, perceived shame and guilt). One possible explanation for our results might come from the work of Giner-Sorolla and colleagues (2011), who wondered if the TOSCA guilt and shame scales measured more affect itself or action in response to emotion. Based on some piece of literature, they discussed that TOSCA guilt-proneness scale seems to be more a measure of the motivation to repair to a made mistake (concept that is intrinsic to the definition of guilt), while the TOSCA shame-proneness seems to be more a measure of the tendency to experience general negative self-conscious affect. Specifically, in one of their studies, TOSCA shame was a predictor of shame, guilt and other self-focused emotions (Giner-Sorolla, Piazza, & Espinosa, 2011). In another study aiming at validating self-report measure of shame and guilt in Borderline Personality Disorder (BPD) patients and controls, the authors show that in general shame-proneness and guilt-proneness appeared moderately related, although the guilt scale measured by TOSCA showed a not very strong internal consistency (Rüsch et al., 2007). Cohen and colleagues (2011) suggest that another possible limitation of TOSCA is that emotional and behavioural responses to transgressions are confounded in the proposed scenarios. We know that guilt-proneness derives from negative evaluations of one's own behaviour and from a willingness to repair the situation. Shame-proneness, on the other hand, is derived from negative evaluations of oneself and inhibitory behavioural tendencies. The TOSCA does not discern between evaluation and behavior, considering the construct of self-conscious emotions as a whole, and so leading to possible confounds on both emotions. According to the authors, evaluation and behavior should be split to obtain a more selective measure of emotion (Cohen, Wolf, Panter, & Insko, 2011; Wolf, Cohen, Panter, & Insko, 2010). However, despite these possible weaknesses, we decided to use such questionnaire since it remains the main tool for the investigation of self-conscious emotions (Cohen et al., 2011) and because it shows consistency with other similar tests (Schaumberg & Flynn, 2012).

We have not found any significant relationship between our task and the general affectivity measured by PANAS as well as the six emotional endophenotypes measured by ANPS. The little literature on this subject has focused more on the link between the tendency to feel shame (or guilt) in everyday life and its impact on affectivity and general wellbeing. In a previous study (Schoenleber & Berenbaum, 2010), shame-proneness was inversely related to positive affect, whereas it was directly related to negative one. This is in line with the definition of shame as a negative valenced moral emotion, and show that its dark side has a visible expression in affect. Nevertheless, a considerable impact of affectivity on the shame (and guilt) perceived in the task did not emerge from our data.

To our knowledge, this is the first study that relates models of affective personality to shame and guilt. Taking a look at the literature, we know that guilt-proneness appeared positively correlated with different dimensions of personality, such as honesty, conscientiousness and agreeableness (Cohen, Panter, & Turan, 2012), whereas shame-proneness with all Cluster C (i.e., avoidant, dependent, and obsessive-compulsive) personality disorders symptoms (Schoenleber & Berenbaum, 2010). Personally, we were not interested in connotation of shame- or guilt-proneness with "stable" traits of individual personality. We believed that the perception of shame and guilt could somehow be modulated by a negative affective personality trait (such as ANPS "fear" or "anger" endophenotypes). However, this assumption has not been confirmed by our data.

Our interpretation and possible justification is that a test that investigates personality traits (ANPS) or trait affectivity (PANAS) may fail to capture specific emotional elements of the person for a single moment, such as shame and guilt perceived during a single task. Future studies will have to better clarify this type of relationships. In addition to this, it is also worth considering that personality is a complex construct that evolves and develops over time based on different biological and environmental factors such as social relationships (Specht, 2017). Considering that our sample was made up of young adults, it is plausible to assume that a precise pattern of affective personality has not yet developed. In the future, it would be interesting to study how the affective personality evolves and changes over the entire lifespan in relation to the social (and therefore moral) environment of the individual.

Finally, perceived guilt was found positively related to Fantasy subscale from IRI. In general, guilt research is much broader than shame research, thanks also to its wider range of application in the laboratory (e.g., game theory or decision making field, see for example Coricelli, Dolan, & Sirigu, 2007; Krajbich, Adolphs, Tranel, Denburg, & Camerer, 2009; Wagner, Handke, Dörfel, & Walter, 2012). The IRI is composed by four subscales that together provide a truthful and validated measure of people's empathic abilities (Davis, 1996). The link between guilt and empathy is not new. Already several years ago, Tangney (1991) claimed that guilt-proneness, contrary to shame-proneness, was positively related to empathic general skills, perspective taking and propensity to experience emotional closeness to others (Treeby, Prado, Rice, & Crowe, 2016). Over time, other studies have also confirmed this link between guilt and empathy. (Leith & Baumeister, 1998; Stuewig, Tangney, Heigel, Harty, & McCloskey, 2010). Our result seems in line with this evidence, confirming that those who felt more guilt during the task show more empathetic connotations in daily life. Fantasy subscale returns an estimate of how much a person can identify with fictional characters. Slightly outside the context of empathy, we can also suggest that this index may provide an estimate of the individual's capacity for imagination. The Shame Task brings all these elements together. As it is structured, it is based on the imagination of a social interaction, facilitated by the face and the sentence. Our data, which shows a positive relationship between perceived guilt and fantasy skills, may be symptomatic of the fact that people with higher imaginative capacity have actually experienced greater arousal. Although our data was not statistically significant ($p = 0.07$), the relationship between perceived shame and fantasy skills follows the same trend. Also in this case, we could speculate that the increase of the imaginative capacity also increases the shame perceived during the task.

Limitations

There are several limitations in the study to be reported. The sample consisted mainly of university students of psychology with a relatively low average age. Although most psychological research studies include a sample of young adults (mostly students of psychology), possible biases related to age and education must always be taken into account. As already mentioned, it would be interesting to enlarge the sample to different age cohorts with the aim of comparing the perception of self-conscious emotions even in older adults. The sample size seemed adequate for a study with within-subject design. Nevertheless, a replication of the study with a larger sample would further support the results obtained.

One of the criteria for inclusion in the study was the presence of no diagnosis of psychological/psychiatric disorder. With the aim of not making the experimental session too lengthy, we did not measure and test possible effects of anxiety or depression in the participants. Nevertheless, we cannot exclude the possibility that some participants might be affected by such effects even if they are not diagnosed.

In the experimental task the participants were asked to imagine different scenarios with them as protagonists. We cannot be sure that all participants have correctly imagined such situations, not getting a specific measure of imagination.

Shame and guilt in the task were indicated using a self-report scale, as well as questionnaires on shame- and guilt-proneness, emotional personality traits and empathy. In the psychological literature, it is well known that self-report measures may suffer from several biases (Althubaiti, 2016), although they continue to be one of the most used tools for individual investigation.

We cannot be sure that the participants have experienced the emotions described in the task. The addition of physiological measurements in the future could directly confirm the arousal of participants.

Conclusions

In this first study, we succeeded in evoking shame and guilt in healthy participants using a new experimental paradigm called the Shame Task. This opens up new scenarios and possibilities for the study of these moral emotions, since it provides an instant measure of the strength of the emotion experienced. The application of the task in a clinical setting would allow to shed light on the abnormal mechanisms of perception and regulation of shame that characterize different psychiatric populations (including different mood, attachment and personality disorders).

Study II - Empathetic Shame Task

Introduction

Shame is a self-conscious moral emotion characterized by the awareness of a damaged self, which for some reason does not meet the standards imposed by society and therefore evokes suffering and pain in the individual. From this definition, it emerges clearly that the central focus of this emotion is precisely the self when exposed to social situations. However, let's try to imagine this scenario.

Like every workday, we get on the tram in the morning to get to work. On that day, halfway along the way, we get on the inspector to check for tickets. A little bored by the presence of the inspector, we open our wallets and show our annual public transport pass. After a few moments, the inspector asks for the ticket to a girl of our age sitting next to us. The girl, red on her face and agitated, begins to look for the ticket in the bag, repeating that she bought and validated it but that she was no longer able to find it. After a few minutes, the inspector begins to rage against the girl, shouting that it is ignoble not to buy a ticket for a public service. He wasn't worried that many more people were watching the scene and that the girl was at the centre of everyone's attention. The more time passes, the more the girl shows several signs of postural and vocal inhibition, feeling misjudged by people she doesn't know.

What about us? How would we feel in front of this scene? How would we react to the sight of that girl who shows clear signs of feeling shame in front of everyone?

We would probably feel ashamed for her too, at that moment. A sort of emotional contagion, in this case a negative feeling that pervades us at the sight of the suffering of another person. We feel emotions because something specific happens to us, but we also feel emotions when something happens to someone else (Wondra & Ellsworth, 2015). In the latter case, we are talking about so-called vicarious emotions. An emotion is called vicarious when, almost by osmosis, it is experienced both by the target individual and by an external observer who automatically becomes a participant in that emotional event. Vicarious emotions work in a somewhat bizarre way. When an emotional event strikes someone, it provokes a reaction in us too, even though we have no connection whatsoever with that person (Krach et al., 2011; Marcus, Wilson, & Miller, 1996; Shearn, Spellman, Straley, Meirick, & Stryker, 1999).
Several emotions are considered vicarious, such as joy (K. D. Smith, Keating, & Stotland, 1989) and anger (Hoffman, 2000; Montada & Schneider, 1989; Vitaglione & Barnett, 2003). However, even self-conscious emotions as shame, guilt, embarrassment and pride can be included in the set of vicarious emotions. But, how can we experience a self-conscious emotion about someone else's wrong behavior? This seems strongly in contrast to the definition of these emotions as self-oriented and globally focused on the self. However, this attentional focus on oneself can be somehow modulated by what happens in someone else in the proximal environment. This may depend on simple spatial proximity factors (Hatfield, Cacioppo, & Rapson, 1993; Lickel, Schmader, Curtis, Scarnier, & Ames, 2005; Miller, 1987) , or on social identity factors related to successes or misfortunes of members of a specific social group (Cialdini & de Nicholas, 1989; Lickel et al., 2005; Tajfel & Turner, 2004; Tesser, 1988). The relationship between oneself and his/her

social group is fundamental in this regard. As far as shame and guilt are concerned, these emotions have a greater vicarious effect in Eastern collectivist societies (where the identity aspect is very much addressed to the group) than in Western individualistic societies where the main protagonist is the single individual (Lickel et al., 2005; Stipek, 1998; Yamawaki, Spackman, & Parrott, 2015). Indeed, it is known that emotions can be experienced on behalf of one's social group, if someone identifies with the group itself (Mackie, Silver, & Smith, 2004; Welten, Zeelenberg, & Breugelmans, 2012). In one of the few studies on this subject, Lickel and colleagues (2005) discussed two possible determining factors for the appraisal of vicarious shame and guilt, that are *shared identity* and *interpersonal interdependency* respectively. The first refers to durable and immutable characteristics of identity that is common to several individuals and that has a strong impact on the actions and ways of being of the members. According to the authors, the function of vicarious shame and guilt in this case could be to protect the individual self-identification and self-esteem that are reflected in the social group (Lickel et al., 2005). As for the interpersonal interdependency, it refers to individuals with shared characteristics such as objectives and social norms that through frequent communication have the ability to influence behavior of social partners (such as colleagues, friends, teammates). Although they seem to be similar in some ways, the key difference is that these individuals continue to have varied relationships with others who do not really belong to this inner circle (Lickel et al., 2005), while in the shared identity the aspect of sharing permeates much more individual life. In the latter case, the function of vicarious shame and guilt may be that of preserving social interaction, providing direct and empathetic support to one of our interpersonal partners.

From this last statement, the natural connection between vicarious emotions and empathy appears logical and obvious. With regard to the example at the beginning of the chapter, it is clear that if we are particularly empathic people, we can fully grasp different emotional nuances in others (in that case, feeling of shame in that girl) that necessarily have an impact on ourselves. And this also has an influence on our social relations with others. It is well known that the human capacity to understand the emotions, thoughts or reactions of other individuals is a fundamental step in establishing meaningful social relationships (Frieder M. Paulus, Müller-Pinzler, Westermann, & Krach, 2013). Regarding this, empathy has been defined as the ability to experience an emotional response equal to that observed, being therefore aware that one's own emotional response derives from others (de Vignemont & Singer, 2006; Frieder M. Paulus et al., 2013). Wondra & Ellsworth (2015) have put this relationship on paper in their appraisal theory of empathy. The authors stated that "[...] *A central element of an appraisal theory of empathy is that an observer's appraisal of a target's situation crucially determines the observer's vicarious emotional experiences, including empathy*" (Wondra & Ellswort, 2015 - page 418). Also based on Smith's Theory of Moral Sentiments (1761), the authors argue that vicarious (empathic) emotions have more to do with interpretation than with the simple perception of the state of others. They therefore have a more complex foundation since they require the ability to apply situation interpretation in order to evoke emotion (Wondra & Ellsworth, 2015). It seems self-evident that there may be individual differences in the ability to imagine and reflect on a given situation. These differences are reflected in the differences in empathic abilities. Those who are most prone to empathy and perspective taking are those who will most easily express vicarious emotions depending on the context. But how can we measure vicarious emotions?

Previous studies on vicarious emotions

Several investigated vicarious anger and vicarious embarrassment strictly in relation with empathy. Based on the definition by Hoffman (1990), vicarious (empathetic) embarrassment is the feeling of being embarrassed while observing another person being embarrassed or doing something embarrassing. It occurs when the other person is not in line with the expectations of the society due, for example, to a particular physical characteristic or clumsiness in the movements. Krach and colleagues (2011) carried out a series of studies aimed at investigating the impact of vicarious embarrassment, also from a neural point of view. In their first study, they created an online questionnaire composed by several vignettes covering different situations, asking people to report an estimate of the embarrassment experienced by the person in the vignette. In addition, they were asked to imagine themselves observing that situation and to rate how they would feel embarrassed for that person. Results showed that the reported estimate of the vicarious embarrassment was even higher than the estimate of the first-hand embarrassment experienced by the protagonist of the vignettes (Krach et al., 2011). Vicarious embarrassment has been found related to the activation of the anterior cingulate cortex and anterior insula (Müller-Pinzler, Rademacher, Paulus, & Krach, 2016) in addition to high-order somatosensory areas (Paulus, Müller-Pinzler, Jansen, Gazzola, & Krach, 2015). In another fMRI study, the involvement of the anterior cingulate cortex and the left anterior insula was confirmed in vicarious feelings of others' pain and in the experience of feeling others' social pain (Krach et al., 2011). In addition, the same authors found a relationship between these areas and individual empathetic skills. Their result from one side suggests the presence of vicarious systems also with regard to pain (see also Vandenbroucke et al., 2013), from the another one it confirms that vicarious experiences go hand in hand with empathy (Krach et al., 2011).

About shame, few studies inquired vicarious effects connected with it. Welten and colleagues (2012) used an autobiographical recall paradigm in which participants were asked to report an event where they were ashamed of someone else's behavior and to indicate through self-report scales some indexes of social identity threat, empathy and perceived shame. They found an association between vicarious shame and social identity threat and empathic perspective taking respectively (Welten et al., 2012). In another study of the same research group, people were presented with several scenarios in which a member of both in- and out-group was committing a moral offense; in this case, they were asked to imagine themselves observing the situation not directly but through a filter (e.g. "news")(Welten et al., 2012). In another experiment, they used again an autobiographical recall questionnaire to collect information about ashamed vicarious events (Welten et al., 2012). Based on all results, vicarious shame was elicited and correctly reported by participants. Even in another study (Lickel et al., 2005), the same autobiographical recall paradigm was used in order to disentangle between vicarious shame-inducing and guilt-inducing events. To our knowledge, this was the only attempt to distinguish vicarious shame and guilt, leaving a significant gap in scientific research on self-conscious emotions.

However, these studies suffer from methodological shortcomings. As much as the correct perception of vicarious shame was reported in the results, there was no control over the correct emotion felt by the person. The use of an

autobiographical recall paradigm may not be very reliable since it leaves room for possible mnestic bias due to the emotional impact of that particular event that may have "stained" the memory. In other words, although it is the most used for this type of investigation, it is a paradigm that does not allow direct manipulation by the experimenter. In addition, it does not allow a clean comparison of vicarious emotions, since it is only the memory of the participants that guides the experiment. For example, if the participant is not clear about the difference between shame and guilt, this does not lead to reliable results for both the first and second type of vicarious emotion.

Aims and research questions

With the aim of overcoming these limits, we propose our experimental task called "Empathetic Shame Task (EST)". EST is based on the paradigm described in study 1 that aims to recreate scenarios of social interaction between two characters in which a negative or neutral evaluation is expressed towards one of the two, while the participant imagines to observe such interaction. EST lays the foundation on the Shame task, our paradigm validated during the study 1, which allowed to evoke and measure shame and guilt in the first person. It does not differ from the original paradigm in the basic structure, but only in the framework of the social interactions. Indeed, in EST, negative evaluations are no longer addressed to the participant, but are addressed to a third person. The participant is a simple observer of this interaction who may (or may not) experience a vicarious emotion as a reflection. Even in this case, we chose to use guilt as emotional control.

In summary, although exploratory, we set ourselves three main goals in this Study 2.

- As a first step, we aim to replicate results from Study 1. Despite the fact that the target of the negative evaluation changes, we expect people to report higher levels of perceived shame by facing a shame-inducing evaluations than neutral stimuli; in parallel, we expect to find higher levels of guilt in the face of guilt-evoking stimuli compared to the neutral ones. In addition, we expect participants to be able to dissociate between shame and guilt within the negative stimuli. Such a result could, on the one hand, further confirm the Shame Task as a means of eliciting and measuring self-conscious emotions, and on the other hand show how it is a flexible tool in the study of such emotions within different social contexts.
- We aim to obtain an indirect measure of empathic shame (and guilt). By asking the participant to indicate the perceived level of shame/guilt in the evaluated third person, we aim to push the focus towards the other and to have an estimate of the shame perceived by the observer as a reflection. We expect people to be able to interpret each scenario, differentiating between shame- and guilt evoking interactions.
- Based on the literature linking vicarious emotions to empathy, we expect a modulation of empathic capacities in the perception of shame and guilt in the third person. Our hypothesis is that greater empathic abilities may correspond to a higher level of perceived emotion. In addition to the dimensions of empathy, we tested the possibility that other behavioural variables, such as affectivity, inclination to shame and guilt or dimensions of affective personality, could somehow relate to the perception of vicarious emotions. To do this, we used self-report measures, in addition to EST results.

Method

Participants

35 participants were tested in the study. However, three participants were excluded from the analysis due to corrupted output data. The final sample consisted of 32 participants (9 males) with an average age of 23.88 (SD = 4.014) and education of 16.19 (SD = 2.934). They were mostly recruited among the students of the Department of Psychology and Cognitive Science of the University of Trento. The Ethical Committee of the same university approved the experimental protocol. Inclusion criteria for this study required to be native Italian speakers and to have no diagnosis of any neurological or psychiatric disease. Before the experimental session, participants read and signed an informed consent as set forth in the code of ethics.

Experimental procedure

The study was run within the laboratories of the Department of Psychology and Cognitive Sciences, University of Trento. The experimental setting included an isolated room containing a chair and desk with a Desktop PC. No reimbursement was provided for participation expenses, but university students could obtain credits for the time needed for the test. After signing the informed consent, participants faced the Empathetic Shame Task (EST), a modified version of the Shame Task (see Study 1 for a detailed description of the original task). The Shame task consists of an experimental procedure that creates social interaction between participants and non-real partners with the aim of eliciting shame and guilt through different personal evaluations. In each trial, matched with a random face, a judgment towards a person is provided. We used the same face stimuli as we did in Study 1, specifically ninety faces (forty-five men and forty-five women) of Caucasian adults from the Chicago Face Database (Ma, Correll, & Wittenbrink, 2015). Even in this case, we included only faces of Caucasian people to prevent possible race effects that were outside the goals of the study. Normative face data are all available online (https://chicagofaces.org/default/). After signing the consent, the investigator illustrated on screen the instructions for the experimental task.

The experimental session was preceded by three training trials with the aim of familiarizing participants with the task (shame-inducing, guilt-inducing and neutral item respectively). As in study 1, we included ninety stimuli in total, thirty per type of stimulus. After a 500 ms fixation point, the item appeared on the screen for 7 seconds matched with a random face. During this period of time, the participant had to imagine a social interaction between a third person and the person represented in the picture, who was expressing the written judgement/evaluation toward the other one. In other words, the participant had to imagine that he/she was the spectator of that interpersonal relationship. After that, two questions were proposed. The first one asking the amount of shame that the evaluated person would feel in that social situation, whereas the second investigating the third one's level of perceived guilt in the same interpersonal context. See Figure 2.6 for a graphic description of the experimental design. The experiment was built and run using OpenSesame 3 (Mathôt, Schreij, & Theeuwes, 2012), an open-source social sciences experiment builder based on Python.

As for study 1, two versions of the modified Shame Task were built because of the gender-specificity in Italian language: one dedicated to female participants, the other one for male ones. However, the structure of the items has not been changed between versions.

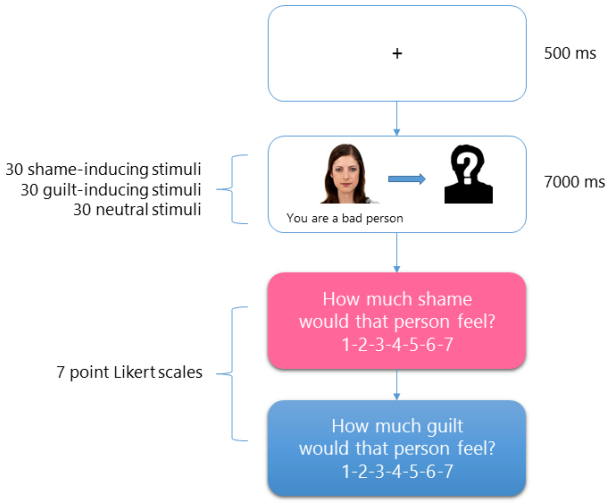


Figure 2. 6 Experimental design of the Empathetic Shame Task (EST).

As we did for study 1, after the computerized session several questionnaires in a randomized order between participants were proposed for better characterizing their psychological and emotional profile.

- The Italian version (Albiero et al., 2006) of the Interpersonal Reactivity Index (IRI; (M. Davis, 1983) as a measure of dispositional empathy was used. IRI is one of the main tools for assessing empathic dimensions. It is composed by 28-items answered on a 5-point Likert scale ranging from "Does not describe me well (1)" to "Describes me very well (5)". Four subscales are derivable (each one composed of 7-items): Perspective Taking (PT), Fantasy (FA), Empathic Concern (EC) and Personal Distress (PD).
- The Test of Self-Conscious Affect-3 (J. P. Tangney et al., 2000) was proposed for measuring shame and guilt-proneness and disposition to blame others (externalization). For each reaction-inducing scenario, participants rated their likelihood of responding in the manner depicted by several statements on a 5-point Likert scale (1 = very unlike me, 5 = very like me).
- The Italian version (Terracciano et al., 2003) of the Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988) was proposed to assess the affective state of our participants. PANAS is a twenty word-items questionnaire describing emotional state: participants need to indicate in a 5-point Likert scale how that emotional state was representative of their current internal situation, ranging from "Very slightly or not at all (1)" to "Extremely (5)".
- Finally, with the aim of enriching the affective profile of individuals, the Affective Neuroscience Personality Scale (ANPS, Davis, Panksepp, & Normansell, 2003) was used. ANPS is a tool designed to investigate endophenotypes

related to six basic emotional systems that have emerged through research in affective neuroscience (Pingault et al., 2012). It is composed of 110 items investigating the following basic emotional endophenotypes: PLAYFULNESS/joy, SEEKING/interest, CARING/nurturance, ANGER/rage, FEAR/anxiety, and SADNESS/separation distress, plus an index related to SPIRITUALITY. Each item consists of a statement and requires a response in a 4 point Likert scale, ranging from "Very agreeable (0)" to "Very disagreeable (3)".

Results

Analysis of shame in other

We used JASP software (Version 0.8.4, https://jasp-stats.org) for all data analysis. With the aim of measuring whether participants showed differences in the shame of others based on the three types of stimulus, we performed a one-way analysis of variance (ANOVA) with reported shame means distributions as dependent variable and the type of stimulus as factor. Results show a main significant effect related to the type of stimulus ($F(2) = 270.8$, $p < 0.001$, $\eta^2 = 0.85$). See Table 2.7 for any detail related to the omnibus ANOVA.

ANOVA - Shame

Cases	Sum of Squares	df	Mean Square	F	p	η^2
StimulusTypeS	313.35	2	156.676	270.8	< .001	0.853
Residual	53.80	93	0.579			

Table 2. 7 Omnibus ANOVA. Note. Type III Sum of Squares

Bonferroni-corrected post-hoc analyses have shown a significant difference in reported shame between neutral and shame-inducing stimuli ($t = -21.939$, $p < .001$), between guilt-inducing and shame-inducing stimuli ($t = -4.245$, $p > .001$) and between guilt-inducing and neutral stimuli ($t = 17.694$, $p < .001$). See Table 2.8 for all details about post-hoc comparisons, while Figure 2.7 shows a graphical description of the difference between distributions.

Post Hoc Comparisons - StimulusTypeS

		Mean Difference	SE	t	p_{tukey}	p_{bonf}
Guilt	Neutral	3.365	0.190	17.694	< .001	< .001
	Shame	-0.807	0.190	-4.245	< .001	< .001
Neutral	Shame	-4.172	0.190	-21.939	< .001	< .001

Table 2. 8 Post-hoc comparisons

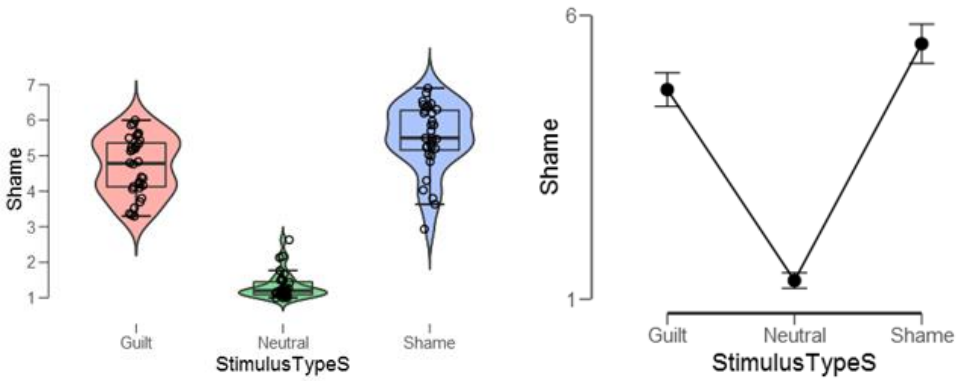


Figure 2. 7 On the left, boxplot for the means distribution of shame perception in other people within the three types of stimuli (Guilt, Neutral and Shame). On the right, descriptive plot of shame perception with error bars and 95% confidence interval is shown.

Analysis of Guilt in other

In order to detect possible differences in guilt of others perception based on the three types of stimulus, we performed a one-way analysis of variance (ANOVA) with reported guilt means distributions as dependent variable and the type of stimulus as factor. Results show a main significant effect related to the type of stimulus ($F(2) = 291$, $p < 0.001$, $\eta^2 = 0.862$). See Table 2.9 for any detail related to the omnibus ANOVA.

ANOVA - Guilt

Cases	Sum of Squares	df	Mean Square	F	p	η^2
StimulusTypeG	303.62	2	151.808	291.0	< .001	0.862
Residual	48.52	93	0.522			

Table 2. 9 Omnibus ANOVA. Note. Type III Sum of Squares

Post-hoc analyses with Bonferroni correction have shown a significant difference in reported guilt between guilt-inducing and neutral stimuli ($t = 23.005$, $p < .001$), between guilt-inducing and shame-inducing stimuli ($t = 5.215$, $p > .001$) and between neutral and shame-inducing stimuli ($t = -17.790$, $p < .001$). See Table 2.10 for all details about post-hoc comparisons, while Figure 2.8 shows a graphical description of the difference between distributions.

Post Hoc Comparisons - StimulusTypeG

		Mean Difference	SE	t	p_{tukey}	p_{bonf}
Guilt	Neutral	4.154	0.181	23.005	< .001	< .001
	Shame	0.942	0.181	5.215	< .001	< .001
Neutral	Shame	-3.213	0.181	-17.790	< .001	< .001

Table 2. 10 Post-hoc comparisons

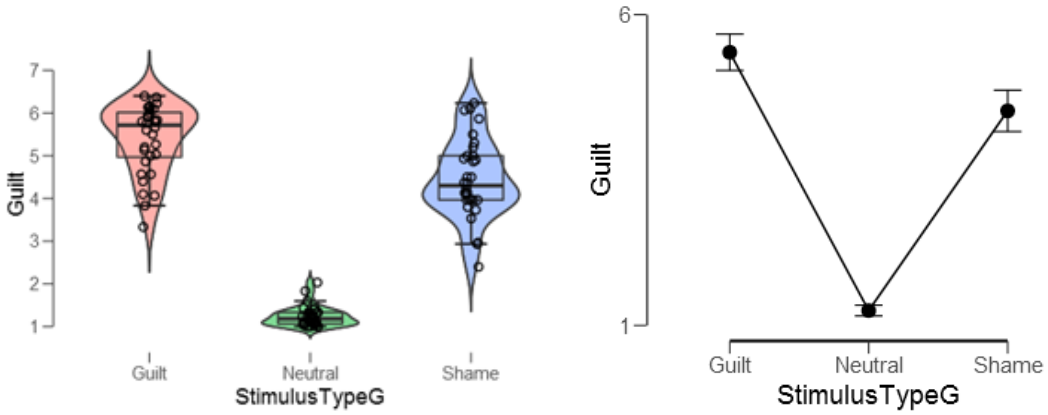


Figure 2. 8 On the left, boxplot for the means distribution of perceived guilt in other people within the three types of stimuli (Guilt, Neutral and Shame). On the right, descriptive plot of guilt perception with error bars and 95% confidence interval is shown.

Correlations between shame/guilt in others and behavioral tests

In order to detect possible relationships between self-conscious emotions assessed by our task and other behavioural variables, we calculated the correlation (based on Spearman's rho coefficient) between the two measures and the subscales from the questionnaires used (TOSCA, PANAS, ANPS and IRI).

Results show a marginally significant positive correlation between reported shame and Fantasy subscale by IRI (rho = 0.354, p = 0.047, C.I. [0.006, 0.625]). In addition, we found another marginally significant positive correlation between shame and Empathic Concern index from IRI (rho = 0.351, p = 0.049, C.I. [0.003, 0.624]. No other significant correlations concerning shame emerged (all ps > 0.05). About guilt, we found a positive significant correlation between reported guilt and Fantasy subscale of IRI (rho = 0.389, p = 0.028, C.I. [0.047, 0.650]), whereas no other correlations emerged (all ps > 0.05). See figure 2.9 for a scatterplot of these three significant correlations.

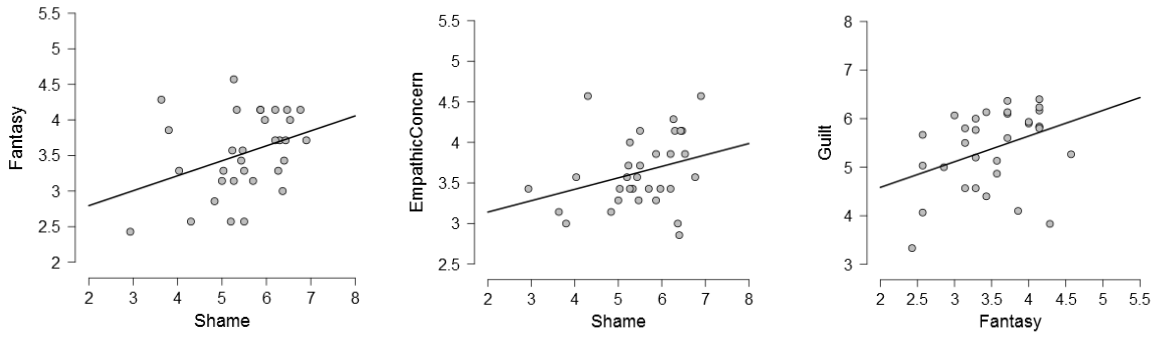


Figure 2. 9 Scatterplots of correlations among behavioral variables.

Discussion

When someone is a spectator of an emotional event that involves another person and is pervaded by that emotional force, we talk about vicarious emotions. Although there are several emotions that can play a vicarious role (e.g. joy, anger, sadness), research aiming to study them from an experimental point of view is scarce. In the case of the study of self-conscious vicarious emotions, one of the most widely used paradigms has been the autobiographical recall (e.g. Lickel et al., 2005; Welten et al., 2012; Yamawaki et al., 2015), which may suffer from intrinsic mnestic bias and is not under control of experimental manipulations. To overcome these methodological limitations, we proposed an innovative paradigm called the Empathetic Shame Task (EST), which aims to measure vicarious shame and guilt in interpersonal contexts. EST has its roots in the Shame Task, an experimental task we used previously that correctly and specifically elicited shame and guilt in participants (for details, see Study 1). The key difference between these two tasks is the focus of the negative evaluation: if in the previous study it was the participant him/herself, in this study, the evaluated individual is a third person at the discretion of the participant. In other words, the participant is an external observer of a social interaction between an individual (whose face he/she sees) and a third person who receives such an evaluation.

Even if the social context was different, our primary goal was to confirm the results of Study 1. Specifically, we wanted to confirm that the stimuli we created really elicit shame and guilt and that people were able to distinguish between these two emotions.

In this second study, our data point in the same direction. Participants actually interpreted the emotional scenarios as the most shameful and guiltful respect to neutral ones. In addition, people reported a different level of shame and guilt depending on whether the stimulus was of one type or another. Specifically, participants correctly attributed a greater shame felt by the third person in the face of evaluations evoking shame; conversely, they indicated a greater guilt in social situations built to evoke guilt. Even in a previous study (Lickel et al., 2005), vicarious shame and guilt were effectively distinguished. However, it must be taken into account that: 1) the stimuli consisted of participants' autobiographical reports; 2) participants' reactions were tagged in 23 different categories, leading the authors to cluster

"embarrassment, shame, humiliation and disgrace" under the label "shame", while "guilt, regret and remorse" under the label "guilt". Despite the clear semantic proximity between these categories and the two target labels, we cannot exclude that these results are contaminated by the inclusion of other emotional variables. Although we do not question the goodness and foresight of the study in question (Lickel et al., 2005), we believe that our evidence are even more reliable in the light of the fact that each stimulus has been carefully validated at a preliminary stage. In other words, our results, together with ones from Study 1, can be considered a clear proof that our stimuli are well calibrated and that they elicit what they were created for.

Closely connected with the previous point, our second goal was to study vicarious self-conscious emotions (as shame and guilt) using an innovative experimental approach. To our knowledge, this was the first attempt to study these emotions not by means of an autobiographical recall paradigm. Starting from these few results present in the literature (for example, see: Lickel et al., 2005; Welten et al., 2012; Krach et al., 2011), and combining them with the theories on vicarious emotions (see for example Paulus et al., 2013, Wondra & Ellsworth, 2015), we aimed to indirectly measure the vicarious emotion felt by the participant inferring them by a third-person measurement. Krach and colleagues (2011) showed that participants exposed to vignettes indicated in average higher vicarious embarrassment than first-hand embarrassment, suggesting an intrinsic relationship between these two measures. Starting from this, contrary to what has been done so far, we preferred not to insert a first-person question in the task since it could divert participant's attention from the social context to him/herself, losing effectiveness in the interpretation of the scenario. We therefore believe that, although it was not explicitly stated, the detection of shame and guilt in the third person can act in two ways. On the one hand, as a proxy for the measures of vicarious shame and guilt; on the other hand, as an indicator of the ability to interpret the social situation. Nevertheless, further studies (perhaps by adding an explicit control measurement) to confirm such speculation would be intriguing in the future.

Last but not least, the relationship between vicarious emotions and empathy. As described before, we hypothesized a modulation by empathic abilities measured by self-report questionnaire (IRI) in the appraisal of the interpersonal context (therefore in recognizing and reporting third-person shame and guilt). A positive correlation between shame and guilt perceived by others and the IRI's Fantasy sub-scale emerged. IRI is known to be composed of four subscales that together provide a general measure of people's empathic abilities (Davis, 1996). Specifically, Fantasy subscale refers to the ability of individuals to identify with imaginative characters. An example of an item in this subscale is as follows: *"I really get involved with the feelings of the characters in a novel"*. In addition to Fantasy, the shame perceived in the third person was positively related to IRI's Empathic Concern subscale. This subscale is a measure of concerns for others and is a good index for emotional empathy (e.g., *"I am often quite touched by things that I see happen"*).
As said in the introduction, the link between vicarious experiences and cognitive empathy is not new. Krach and colleagues (2011) assessed that empathic process was an essential condition for vicarious embarrassment experiences, creating a bridge between cognition, emotion and social processes. Our findings seem to confirm this relationship. In addition, as we did for study 1, we can interpret the correlation we found between Fantasy and third-person

shame/guilt perception as an index of the individual's capacity for imagination. Since the EST is a task based on imagination, our data suggest that as the empathic abilities of imagination grews, so does the emotion reported in the third person. The fact that this applies both out of our experimental conditions (shame and guilt), it corroborates our proposal. It is quite surprising that the relationship between vicarious emotions and Empathic Concern has emerged out of shame and not to a statistically significant level through guilt. Given the more social nature of guilt, we would have expected guilt involvement in relation to empathic concern. If a positive relationship between empathy and shame in the first person would have been difficult to argue, in this case we believe that this type of relationship may make sense because of attentive factors towards the outside world that may lead to a more focused interpretation of the social situation. Claiming that if increasing attention to others, the greater shame reported in the third person is, we refer to general aspects of dedication to the outside world (falling within the empathic domain) that can probably modulate the emotional reactions that do not involve us personally (such as those evoking vicarious shame). Nevertheless, future studies should clarify this discrepancy between vicarious shame and guilt in relation to empathic concern.

We did not find any relationship between third person shame/guilt and shame/guilt proneness measured by TOSCA. Although we could have expected a modulation of the inclination to shame and guilt in the interpretation of the social scenario, the data at our disposal suggest independence between the individual inclination to experience such emotions and the recognition of them in the interpersonal context. Our possible explanation is that TOSCA items were built with exclusive focus on the self, and this may lead to fail in the detection of vicarious experiences. It would be interesting in the future to create a self-report tool that can measure together individual shame/guilt proneness within third-person contexts.

No significant relationship between shame-guilt perception and affectivity, as well as affective personality traits emerged. As our study is of an exploratory nature, we had no well-delineated hypotheses about the possible impact of affectivity and personality traits on behavioural responses. What we can infer from our data is that affectivity does not play a primary role in modulating the perception of shame and guilt in the third person. About that, we could infer that: 1) given the very cognitive nature of our task, the current affective state of the individual is not important enough to change the interpretation of the social situations; 2) speculating, that the cognitive domain (which includes empathy) takes precedence over the affective one in the evaluation of external events.

No patterns of affective personality endophenotypes emerged as correlated with task responses. We stress that it was not in the interests of this study to investigate the relationship between different variables within the self-report questionnaires. To our knowledge, there are no studies in literature that have tested the hypothesis that the tendency to experience vicarious emotions is proper to some affective pattern of personality. Given the exploratory nature of our study, we do not feel able to say much more about this result. Future studies will serve to clarify whether or not there is any relationship between patterns of affective personality and vicarious feeling.

Limitations

Several limitations in this study have to be reported.

The distribution of males and females within the sample was not balanced (only 9 males). Although most studies in the emotional field include only women, this imbalance may have introduced a bias into the sample. In addition, the sample consisted mainly of university students of psychology. Although most psychological research studies include a sample of young adults most of the time students of psychology, possible biases related to education must always be taken into account. It would be intriguing to enlarge the sample to different age cohorts with the aim of measuring developmental trajectories of vicarious self-conscious experiences through lifespan. The sample size seemed adequate for a study with within-subject design. Nevertheless, a replication of the study with a larger sample would further support the results obtained.

One of the criteria for inclusion in the study was the presence of no diagnosis of psychological/psychiatric disorder. With the aim of not making the experimental session too heavy and lengthy, we did not measure and test possible effects of anxiety or depression in the participants. Nevertheless, we cannot exclude the possibility that some participants might be affected by such effects even if they are not diagnosed.

In the experimental task, the participants were asked to imagine different scenarios with them as observers of a social interaction between fake partners. We cannot be sure that all participants have correctly imagined such situations, without getting a specific measure of imagination. In addition, we do not have information about the third person they imagined each time. While the possibility to leave freedom to the participants was desired, on the other hand we did not have control over this variable that could be important. In future studies, in order to understand it, it would be interesting to "force the hand" and push the participants to imagine people from social in-group or out-group to reveal any possible differences in the interpretation of social emotion.

We cannot be sure that the participants have experienced the vicarious emotions we were supposed to elicit indirectly by leading them into negative social scenarios. As already said, in the future an additional control question may be implemented in order to measure explicitly vicarious experience. The use of psychophysiological measures may return more information about the actual arousal of participants.

Shame and guilt in the task were indicated using a self-report scale, as well as questionnaires on empathy, shame- and guilt- proneness, affectivity and emotional personality traits. Criticalities already raised in the past with regard to these tools must be reported, since it is well known they can suffer from several biases (Althubaiti, 2016).

Conclusions

In this second study, we ventured into the study of self-conscious emotions as shame and guilt, prompting participants to be observers of social interactions and interpreters of such emotional situations. To do that we capitalized on a modified version of the Shame Task, called the Empathetic Shame Task, aiming to elicit and measure shame and guilt in third-person. This paradigm is innovative as it exposes participants directly to social interactions. People have correctly recognized shame and guilt felt by a third party, and the provided estimation of shame and guilt depended

on their empathic skills. Even though this was the first attempt, this study opens up new possible scenarios and possibilities for the study of vicarious emotions.

References

Aboulafia-Brakha, T., Manuel, A.L., Ptak, R. (2016). Prefrontal transcranial direct current stimulation facilitates affective flexibility. Neuropsychologia, 86, 13-8.

Acarturk, C., Cuijpers, P., van Straten, A., de Graaf, R. (2009). Psychological treatment of social anxiety disorder: a meta-analysis. Psychological Medicine, 39, 241-254.

Albiero, P., Ingoglia, S., & Lo Coco, A. (2006). Contributo all'adattamento italiano dell'Interpersonal Reactivity Index. TPM. TESTING PSICOMETRIA METODOLOGIA, 13, 2, 107–125.

Althubaiti, A. (2016). Information bias in health research: Definition, pitfalls, and adjustment methods. Journal of Multidisciplinary Healthcare, 9, 211–217. https://doi.org/10.2147/JMDH.S104807

Andrews, B., Brewin, C.R., Rose, S., Kirk, M. (2000). Predicting PTSD symptomsin victims of violent crime: the role of shame, anger, and childhood abuse. Journal of Abnormal Psychology, 109, 69–73.

Andrews, B., Qian, M., Valentine, J.D. (2002). Predicting depressive symptoms with a new measure of shame: the experience of shame scale. British journal of Clinical Psychology, 41, 29-42.

Balzarotti, S., John, O.P., Gross, J.J. (2010). An Italian adaptation of the Emotion Regulation Questionnaire (ERQ). European Journal of Psychological Assessment, 26(1), 61-67.

Barlow, D.H., Ellard, K.K., Fairholme, C.P., Farchione, T.J., Boisseau, C.L., Ehrenreich May J.T., Allen, L.B. (2010). Unified Protocol for Transdiagnostic Treatment of Emotional Disorders Workbook. Oxford University Press.

Bastin, C., Harrison, B.J., Davey, C., Moll, J., Whitte, S. (2016). Feelings of shame, embarrassment and guilt and their neural correlates: A Systematic Review. Neurosci Biobehav Rev. 2016 Dec;71:455-471

Baumeister, R.F., Stillwell, A.M., Heatherton, T.F. (1994). Guilt: An interpersonal approach. Psychological Bulletin, 115, 243–267.

Bendixen, M., Olweus, D. (1999). Measurement of Antisocial Behavior in Early Adolescence and Adolescence: Psychometric Properties and Substantive Findings. Criminal Behaviour and Mental Health, 9(4), 323-354.

Bennett, D.S., Sullivan, M.W., Lewis, M. (2005). Young children's adjustment as a function of maltreatment, shame, and anger. Children Maltreatment, 10(4), 311–323.

Blum, A., (2008). Shame and Guilt, Misconceptions and Controversies: A Critical Review of the Literature. Traumatology, 14(3), 91-102.

Boggio, P.S., Rego, G.G., Marques, L.M., Costa, T.L. (2016). Transcranial current stimulation in Social and Emotion Research. In. A. Brunori et al., (eds)., Transcranial Direct Current Stimulation in Neuropsychiatric Disorders, Springer Publishing.

Boggio, P.S., Rigonatti, S.P., Ribeiro, R.B., Myczkowski, M.L., Nitsche, M.A., Pascual-Leone, A., Fregni, F. (2008). A randomized, double-blind clinical trial on the efficacy of cortical direct current stimulation for the treatment of major depression. International Journal of Neuropsychopharmacology, 11, 249-254.

Boggio, P.S., Zaghi, S., Fregni, F. (2009). Modulation of emotions associated with images of human pain using anodal transcranial direct current stimulation (tDCS). Neuropsychologia, 47(1), 212-217.

Bradshaw, J. (2005). Healing the shame that binds you. HCI press.

Britton, J.C., Suway, J.G., Clementi, M.A., Fox, N.A., Pine, D.S., Bar-Haim, Y. (2015). Neural changes with attention bias modification for anxiety: a randomized trial. Social Cognitive and Affective Neuroscience, 10, 913-920.

Brown, M.Z., Comtois, K.A., Linehan, M.M. (2002). Reasons for suicide attempts and non-suicidal injury in women with borderline personality disorders. Journal of Abnormal Psychology, 111, 198-202.

Brunori, A., Loo, C., Nitsche, M. (2016). Safety and tolerability. In. A. Brunori et al., (eds)., Transcranial Direct Current Stimulation in Neuropsychiatric Disorders, Springer Publishing.

Buhle, J.T., Silvers, J.A., Wager, T.D., Lopez, R., Onyemekwu, C., Kober, H., Weber, J. Ochsner, K.N. (2013). Cognitive reappraisal of emotion: A meta-analysis of human neuroimaging studies. Cerebral Cortex, 24, 2981-2990.

Burdens of Mental Illness. Clinical Psychological Science, 1(2), 170-191.

Burns, J. M., Davenport, T. A., Durkin, L. A., Luscombe, G. M., Hickie, I. B. (2010). The internet as a setting for mental health service utilization by young people. Medical Journal of Austrialia, 192 (11 Suppl), S22-S26.

Caballo, V.E., Salazar, I.C., Irurtia, M.J., Arias, B., Hofmann, S.G., CISO-A Research Team (2012).

The multidimensional nature and multicultural validity of a new measure of social anxiety: the Social Anxiety Questionnaire for Adults. Behavior Therapy, 43, 313-328.

Carpenter, T. P., Tignor, S. M., Tsang, J.-A., & Willett, A. (2016). Dispositional self-forgiveness, guilt- and shame-proneness, and the roles of motivational tendencies. Personality and Individual Differences, 98, 53–61. https://doi.org/10.1016/j.paid.2016.04.017

Christou-Champi, S., Farrow, T.F.D., Webb, T.L. (2014). Automatic control of negative emotions:

Evidence that structured practice increases the efficiency of emotion regulation. Cognition and Emotion, 29(2), 319-31.

Cialdini, R. B., & de Nicholas, M. E. (1989). Self-presentation by association. Journal of Personality and Social Psychology, 57(4), 626–631. https://doi.org/10.1037/0022-3514.57.4.626

Cleckley, H. (1982) The mask of sanity (5th Ed). St. Louis, MO: Mosby.

Coan, J.A., Allen, J.J.B. (2007). Handbook of Emotion Elicitation and Assessment.Oxford University Press.

Cohen, T. R., Panter, A. T., & Turan, N. (2012). Guilt Proneness and Moral Character (No. 21, 355–359). Current Directions in Psychological Science.

Cohen, T. R., Wolf, S. T., Panter, A. T., & Insko, C. A. (2011). Introducing the GASP scale: A new measure of guilt and shame proneness. Journal of Personality and Social Psychology, 100(5), 947–966. https://doi.org/10.1037/a0022641

Cook, D.R. (1987). Measuring shame: The internalized shame scale. Alcoholism Treatment Quarterly, 4, 197-215.

Coricelli, G., Dolan, R. J., & Sirigu, A. (2007). Brain, emotion and decision making: The paradigmatic example of regret. Trends in Cognitive Sciences, 11(6), 258–265. https://doi.org/10.1016/j.tics.2007.04.003

Corradi-Dell'Acqua, C., Hofstetter, C., & Vuilleumier, P. (2011). Felt and seen pain evoke the same local patterns of cortical activity in insular and cingulate cortex. The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 31(49), 17996–18006. https://doi.org/10.1523/JNEUROSCI.2686-11.2011

Corradi-Dell'Acqua, C., Tusche, A., Vuilleumier, P., & Singer, T. (2016). Cross-modal representations of first-hand and vicarious pain, disgust and fairness in insular and cingulate cortex. Nature Communications, 7(1), 1–12. https://doi.org/10.1038/ncomms10904

D'Silva, K., Duggan, C., McCarthy, L. (2004). Does Treatment Really Make Psychopaths Worse? A Review of the Evidence. Journal of Personality Disorders, 18(2), 163-77.

Davis, K. L., Panksepp, J., & Normansell, L. (2003). The Affective Neuroscience Personality Scales: Normative Data and Implications. Neuro-Psychoanalysis, 5(1), 57–69. https://doi.org/10.1080/15294145.2003.10773410

Davis, M. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. Journal of Personality and Social Psychology, 44(1), 113–126.

Davis, M. H. (1996). Empathy: A Social Psychological Approach. https://doi.org/10.4324/9780429493898

De Hooge, I.E., Zeelenberg, M., Breugelmans, S.M. (2007). Moral sentiments and cooperation: Differential influences of shame and guilt. Cognition and Emotion, 21, 1025–1042.

de Vignemont, F., & Singer, T. (2006). The empathic brain: How, when and why? Trends in Cognitive Sciences, 10(10), 435–441. https://doi.org/10.1016/j.tics.2006.08.008

Dickerson, S.S., Gruenewald, T. L., Kemeny, M.E. (2004b). When the social self is threatened: Shame, physiology, and health. Journal of Personality, 72, 1192-1216.

Dickerson, S.S., Kemeny, M.E., Aziz, N., Kim, K.H., Fahey, J.L. (2004a). Immunological effects of induced shame and guilt. Psychosomatic Medicine, 66, 124-131.

Dressler, J. (2009). Understanding Criminal Law, Fifth Edition. Matthew Bender & Company, Inc. Newark, NJ.

Ehring, T. (2013). Emotion regulation and psychopathology. Journal of Experimental Psychopathology, 4, 448-450.

Eichhammer, P. (2011). Potential for transcutaneous vagus nerve stimulation in pain management. Focused transcranial direct current stimulation (tDCS) over the dorsolateral prefrontal cortex modulates specific domains of self-regulation. Pain Management, 1(4), 287-289.

Elison, J., Pulos, S., Lennon, R. (2006). Shame-focused coping: An empirical study of the Compass of Shame. Social Behavior & Personality, 34, 161-168.

Finger, E.C., Marsh, A.A., Kamel, N., Mitchell, D.G., Blair, J.R., 2006. Caught in the act: the impact of audience on the neural response to morally and socially inappropriate behavior, Neuroimage, 33(1), 414-21.

Fontaine, J.R.J., Luyten, P., Estas, C., Corveleyn, J. (2004). Scenario-Based and Frequency-Based Approaches towards the Measurement of Guilt and Shame: Empirical Evidence for Unique Contributions. In Shohov, S.P. (ed.) Advances in Psychology Research, 30, 141-154.

Frederickson, J. (2013). Co-Creating Change. Effective Dynamic Therapy Techniques. Seven Leaves Press.

Free, C., Phillips, G., Watson, L., Galli, L., Felix, L., Edwards, P., Patel, V., Haines, A. (2013). The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. PLoS Medicine, 10(1), e1001363.

Garnefski, N., Kraaij, V., Spinhoven, P. (2002). Manual for the use of the Cognitive Emotion Regulation Questionnaire. Leiderdorp, The Netherlands: DATEC.

Geraghty A.W.A., Torres, L.D., Leykin, Y., Pérez-Stable, E.J., Muñoz, R.F. (2013). Understanding attrition from international Internet health interventions: a step towards global eHealth. Health Promotion International, 28(3), 442-452.

Giner-Sorolla, R., Piazza, J., & Espinosa, P. (2011). What do the TOSCA guilt and shame scales really measure: Affect or action? Personality and Individual Differences, 51(4), 445–450. https://doi.org/10.1016/j.paid.2011.04.010

Giorgetta, C., Carpenteri, S., Di Marzio, F., Grecucci, A. (in prep). Abnormal experience of shame and anger in Parkison disease.

Grecucci, A., De Pisapia, N., Venuti, P., Palladino, M.P. Job, R. (2015a). Baseline and strategic mindful regulation: behavioral and physiological investigation. Plos One, 10(1): e0116541.

Grecucci, A., Di Marzio, F., Frederickson, J., Job, R. (2016a). Anxiety and its regulation: Neural mechanisms and regulation techniques according to the experiential-dynamic approach. F. (Ed). Anxiety Disorders. InTech publishing.

Grecucci, A., Di Marzio, F., Frederickson, J., Job, R. (in prep). Shame on you! An experimental study on shame and how it affects the perception of others.

Grecucci, A., Frederickson, J., Job, R. (2016b). How dare you don't recognize the role of my contempt? Insights from Experimental Psychopathology. Behavioral and Brain Sciences, 40

Grecucci, A., Giorgetta, C., Bonini, N., Sanfey, A. G. (2013b). Living emotions, avoiding emotions: behavioral investigation of the regulation of socially driven emotions. Frontiers in Psychology, 3:616

Grecucci, A., Giorgetta, C., Brambilla, P., Zanon, S., Perini, L. Balestrieri, M. Bonini, N., Sanfey, A. G. (2013d). Anxious Ultimatums. How Anxiety Affects Socio-economic Decisions. Cognition & Emotion. 27(2), 230-44

Grecucci, A., Giorgetta, C., M. Bonini, N., Sanfey, A. G. (2013c). Reappraising social emotions: the role of inferior frontal gyrus, temporo-parietal junction and insula in interpersonal regulation. Frontiers in Human Neuroscience, 7, 523.

Grecucci, A., Giorgetta, C., van Wout, M., Bonini, N., Sanfey, A. G. (2013a). Reappraising the Ultimatum: an fMRI study of emotion regulation and decision-making. Cerebral Cortex, 23(2), 399-410.

Grecucci, A., Giorgetta, C., van't Wout, M., Bonini, N., & Sanfey, A. G. (2013). Reappraising the Ultimatum: An fMRI Study of Emotion Regulation and Decision Making. Cerebral Cortex, 23(2), 399–410. https://doi.org/10.1093/cercor/bhs028

Grecucci, A., Job, R. (2015). Rethinking reappraisal: insights from Affective Neuroscience. Behavioral and Brain Sciences, 38, e102.

Grecucci, A., Rubicondo D., Siugzdaite, R., Surian, L., Job, R. (2016c). Uncovering social deficits in autistic individuals: A source based morphometry study. Frontiers in Neuroscience, 10:388.

Grecucci, A., Siugzdaite, R., Bertoldi, A., Luchesa, S., Job, R. (2016d). La regolazione emozionale sociale e non sociale. Uno studio di morfometria cerebrale. Giornale Italiano di Psicologia, 1.

Grecucci, A., Thneuick, A., Frederickson, J., Job, R. (2015b). Mechanisms of social emotion regulation: from neuroscience to psychotherapy. In Bryant, M.L. (editor), "Handbook on Emotion Regulation: Processes, Cognitive Effects and Social Consequences". Nova Publishing.

Grecucci, Alessandro, Giorgetta, C., Bonini, N., & Sanfey, A. G. (2013). Living Emotions, Avoiding Emotions: Behavioral Investigation of the Regulation of Socially Driven Emotions. Frontiers in Psychology, 3. https://doi.org/10.3389/fpsyg.2012.00616

Grecucci, Alessandro, Pisapia, N. D., Thero, D. K., Paladino, M. P., Venuti, P., & Job, R. (2015). Baseline and Strategic Effects behind Mindful Emotion Regulation: Behavioral and Physiological Investigation. PLOS ONE, 10(1), e0116541. https://doi.org/10.1371/journal.pone.0116541

Grefkes, C., Fink, G.R. (2014). Connectivity-based approaches in stroke and recovery of function. Lancet Neurology, 13(2), 206-216.

Gross, J.J. (2002). Emotion regulation: affective, cognitive, and social consequences, Psychophysiology, (39)3, 281-291.

Gross, J.J. (2014). Handbook of Emotion Regulation (Eds). New York: Guilford Press.

Gross, J.J., John, O.P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. Journal of Personality and Social Psychology, 85, 348-62.

Gruenewald, T. L., Kemeny, M. E., Aziz, N., Fahey, J. L. (2004). Acute threat to the social self: shame, social self-esteem, and cortisol activity. Psychosomatic Medicine, 66(6), 915-24

Haidt, J. (2003). The moral emotions. Oxford: Oxford University Press.

Harper, F.W.K., Arias, I. (2004). The role of shame in predicting adult anger and depressive symptoms among victims of child psychological maltreatment. Journal of Family Violence, 19(6):367–
375.

Harris, G.T., Rice, M.E. (2006). Treatment of Psychopathy: A Review of Empirical Findings, in Patrick, C.J. (Ed). (2006). Handbook of psychopathy , (pp. 555-572). New York, NY, US: Guilford
Press.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional Contagion. Current Directions in Psychological Science, 2(3), 96–99. Retrieved from JSTOR.

Heeren, A., Mogoaşe, C., Philippot, P., McNally, R.J. (2015). Attention bias modification for social anxiety: A systematic review and meta-analysis. Clinical Psychological Review, 40, 76-90.

Herbert, W. (2003). The Two Faces of Shame, Association for Psychological Science website, posted on 1st October 2013, http://www.psychologicalscience.org/index.php/news/were-only-human/the- two-faces- of-shame.html.

Hoffman, M. L. (1990). Empathy and justice motivation. Motivation and Emotion, 14(2), 151–172. https://doi.org/10.1007/BF00991641

Hoffman, M. L. (2000). Empathy and moral development: Implications for caring and justice. https://doi.org/10.1017/CBO9780511805851

Hoglund, C.L., Nicholas, K.B. (1995). Shame, guilt, and anger in college students exposed to abusive family environments. Journal of Family Violence, 10, 141-157.

Holmqvist, R. (2008). Psychopathy and affect consciousness in young criminal offenders. Journal of Interpersonal Violence, 23, 209-224.

In Patrick, C. J. (Ed), Handbook of psychopathy, (pp. 555-572). New York, NY, US: Guilford Press.

Kazdin, A., Rabbitt, S. (2013). Novel Models for Delivering Mental Health Services and Reducing the

Keil, J., Weisz, N., Paul-Jordanov, I., Wienbruch, C. (2010). Localization of the magnetic equivalent of the ERN and induced oscillatory brain activity. Neuroimage, 51(1), 404-11.

Koenigsberg, H.W., Fan, J., Ochsner, K. N., Liu, X., Guise, K., Pizzarello, S.,et al. (2011). Neural correlates of using distancing to regulate emotional responses to social situations. Neuropsychologia 48, 1813-1822.

Kohn, N., Eickhoff, S. B., Scheller, M., Laird, A. R., Fox, P. T., Habel, U. (2014). Neural network of cognitive emotion regulation. An ALE meta-analysis and MACM analysis. NeuroImage 87, 345-355.

Krach, S., Cohrs, J. C., Loebell, N. C. de E., Kircher, T., Sommer, J., Jansen, A., & Paulus, F. M. (2011). Your Flaws Are My Pain: Linking Empathy To Vicarious Embarrassment. PLOS ONE, 6(4), e18675. https://doi.org/10.1371/journal.pone.0018675

Krajbich, I., Adolphs, R., Tranel, D., Denburg, N. L., & Camerer, C. F. (2009). Economic Games Quantify Diminished Sense of Guilt in Patients with Damage to the Prefrontal Cortex. Journal of Neuroscience, 29(7), 2188–2192. https://doi.org/10.1523/JNEUROSCI.5086-08.2009

Leahy, R.L., Tirch, D., Napolitano, L.A. (2011). Emotion Regulation in Psychotherapy. A Practitioner's Guide. New York: Guilford Press.

Leith, K. P., & Baumeister, R. F. (1998). Empathy, shame, guilt, and narratives of interpersonal conflicts: Guilt-prone people are better at perspective taking. Journal of Personality, 66(1), 1–37. https://doi.org/10.1111/1467-6494.00001

Lewis, H.B. (1971). Shame And Guilt In Neurosis. New York: International Universities Press. Lineahn, M. M. (2014). DBT Skills Training Manual, Second Edition. New York: The Guilford Press.

Lickel, B., Schmader, T., Curtis, M., Scarnier, M., & Ames, D. R. (2005). Vicarious Shame and Guilt. Group Processes & Intergroup Relations, 8(2), 145–157. https://doi.org/10.1177/1368430205051064

Mackie, D. M., Silver, L. A., & Smith, E. R. (2004). Intergroup Emotions: Emotion as an Intergroup Phenomenon. In Studies in Emotion and Social Interaction. The social life of emotions (pp. 227–245). https://doi.org/10.1017/CBO9780511819568.013

Mani, M., Kavanagh, D.J., Hides, L., Stoyanov, S.R. (2015). Review and Evaluation of Mindfulness- Based iPhone Apps. Journal of Medical Internet Research Mhealth Uhealth, 19, 3(3), e82.

Marcus, D. K., Wilson, J. R., & Miller, R. S. (1996). Are perceptions of emotion in the eye of the beholder? A social relations analysis of judgments of embarrassment. Personality and Social Psychology Bulletin, 22(12), 1220–1228. https://doi.org/10.1177/01461672962212003

Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. Behavior Research Methods, 44(2), 314–324. https://doi.org/10.3758/s13428-011-0168-7

McWilliams, N. (1994). Psychoanalytic diagnosis. Understanding personality structure in the clinical process. New York: The Guilford Press.

Michl, P., Meindl, T., Meister, F., Born, C., Engel, R.R., Reiser, M., Hennig-Fast, K. (2014). Neurobiological underpinnings of shame and guilt: a pilot fMRI study. Social Cognitive and Affective Neuroscience, 9(2), 150-157.

Miller, R. S. (1987). Empathic embarrassment: Situational and personal determinants of reactions to the embarrassment of another. Journal of Personality and Social Psychology, 53(6), 1061–1069. https://doi.org/10.1037/0022-3514.53.6.1061

Miranda, P.C., Faria, P., Hallett, M. (2009). What does the ratio of injected current to electrode area tell us about current density in the brain during tDCS? Clinical Neurophysiology, 120(6), 1183- 1187.

Moll, J., Zahn, R., de Oliveira-Souza, R., Krueger, F., Grafman, J., 2005. The neural basis of human moral cognition. Nature Reviews Neuroscience 6, 799-809.

Montada, L., & Schneider, A. (1989). Justice and emotional reactions to the disadvantaged. Social Justice Research, 3(4), 313–344. https://doi.org/10.1007/BF01048081

Morrison, D., Gilbert, P. (2001). Social rank, shame and anger in primary and secondary psychopaths. Journal of Forensic Psychiatry, 12, 330-356.

Müller-Pinzler, L., Rademacher, L., Paulus, F. M., & Krach, S. (2016). When your friends make you cringe: Social closeness modulates vicarious embarrassment-related neural activity. Social Cognitive and Affective Neuroscience, 11(3), 466–475. https://doi.org/10.1093/scan/nsv130

Nathanson, D.L. (1994). Shame and Pride: Affect, Sex, and the Birth of the Self. New York: W. W. Norton & Company.

Nelissen, R.M.A., Dijker, A.J., De Vries, N.K. (2007). How to turn a hawk into a dove and vice versa: Interactions between emotions and goals in a give-some dilemma game. Journal of

Experimental Social Psychology, 43, 280–286.

Nelissen, R.M.A., Zeelenberg, M. (2009). When guilt evokes self-punishment: evidence for the existence of a Dobby Effect, Emotion, 9(1), 118-22.

Norman, K.A., Polyn, S.M., Detre, G.J., Haxby, J.V. (2006). Beyond mind-reading: multi-voxel pattern analysis of fMRI data. Trends in Cognitive Science,10(9), 424-30.

Nyströ̈m, M., Mikkelsen, F. (2013). Psychopathy-Related Personality Traits and Shame Management Strategies in Adolescents. Journal of Interpersonal Violence, 28(3), 519- 537.

Ochsner, K.N., Gross, J.J. (2005). The cognitive control of emotion. Trends in Cognitive Sciences, 9 (5), 242-249.

Paulhus, D.L., Robins, R.W., Trzesniewski, K.H., Tracy, J.L. (2004). Two replicable suppressor situations in personality research. Multivariate Behavior Research, 39, 303–328.

Paulus, Frieder M., Müller-Pinzler, L., Westermann, S., & Krach, S. (2013). On the distinction of empathic and vicarious emotions. Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00196

Paulus, Frieder Michel, Müller-Pinzler, L., Jansen, A., Gazzola, V., & Krach, S. (2015). Mentalizing and the Role of the Posterior Superior Temporal Sulcus in Sharing Others' Embarrassment. Cerebral Cortex (New York, N.Y.: 1991), 25(8), 2065–2075. https://doi.org/10.1093/cercor/bhu011

Pingault, J. B., Falissard, B., Côté, S., & Berthoz, S. (2012). A New Approach of Personality and Psychiatric Disorders: A Short Version of the Affective Neuroscience Personality Scales. PLoS One, 7.

Pivetti, M., Camodeca, M., & Rapino, M. (2016). Shame, Guilt, and Anger: Their Cognitive, Physiological, and Behavioral Correlates. Current Psychology, 35(4), 690–699. https://doi.org/10.1007/s12144-015-9339-5

Pripfl, J., Lamm, C. (2015). Focused transcranial direct current stimulation (tDCS) over the dorsolateral prefrontal cortex modulates specific domains of self-regulation. Neuroscience Research, 91,
41-47.

Pulcu, E., Lythe, K., Elliott, R., Green, S., Moll, J., Deakin, J. F. W., & Zahn, R. (2014). Increased amygdala response to shame in remitted major depressive disorder. PloS One, 9(1), e86900. https://doi.org/10.1371/journal.pone.0086900

Pulcu, E., Zahn, R., Elliott, R., 2013. The role of self-blaming moral emotions in major depression and their impact on social-economical decision making. Frontiers in Psychology, 4, 310.

Raine, A., Yang, Y. (2006). Neural foundations to moral reasoning and antisocial behavior. Social Cognitive Affective Neuroscience, 1, 203-213.

Robins, R.W., Noftle, E.E., Tracy, J.L. (2007). Assessing Self-Conscious Emotions. A Review of Self- Report and Non Verbal Measures. In J.L. Tracy, R.W. Robins, J.P. Tangney (Eds), The Self- Conscious Emotions: Theory and Research. The Guilford Press.

Roth, L., Kaffenberger, T., Herwig, U., Brühl, A.B., 2014. Brain Activation Associated with Pride and Shame. Neuropsychobiology 69, 95-106.

Rüsch, N., Corrigan, P. W., Bohus, M., Jacob, G. A., Brueck, R., & Lieb, K. (2007). Measuring shame and guilt by self-report questionnaires: A validation study. Psychiatry Research, 150(3), 313–325. https://doi.org/10.1016/j.psychres.2006.04.018

Saarimäki, H., Gotsopoulos, A., Jääskeläinen, I.P., Lampinen, J., Vuilleumier, P., Hari, R., Sams, M., Nummenmaa, L. (2016). Discrete Neural Signatures of Basic Emotions. Cerebral Cortex, 26(6), 2563-73.

Salekin, R.T., Worley, C.B., Grimes, R.D. (2010). Treatment of psychopathy: A review and brief introduction to the mental models approach. Behavioral Sciences and the Law, 28, 235-266.

Sanfey, A.G., Rilling, J.K., Aronson, J.A., Nystrom, L.E., Cohen, J.D. (2003). The neural basis of economic decision-making in the Ultimatum Game. Science, 300(5626), 1755-8.

Schaumberg, R. L., & Flynn, F. J. (2012). Uneasy lies the head that wears the crown: The link between guilt proneness and leadership. Journal of Personality and Social Psychology, 103(2), 327–342. https://doi.org/10.1037/a0028127

Schoenleber, M., & Berenbaum, H. (2010). Shame aversion and shame-proneness in Cluster C personality disorders. Journal of Abnormal Psychology, 119(1), 197–205. https://doi.org/10.1037/a0017982

Shearn, D., Spellman, L., Straley, B., Meirick, J., & Stryker, K. (1999). Empathic Blushing in Friends and Strangers. Motivation and Emotion, 23(4), 307–316. https://doi.org/10.1023/A:1021342910378

Smith, A. (1761). The Theory of Moral Sentiments. A. Millar.

Smith, K. D., Keating, J. P., & Stotland, E. (1989). Altruism reconsidered: The effect of denying feedback on a victim's status to empathic witnesses. Journal of Personality and Social Psychology, 57(4), 641–650. https://doi.org/10.1037/0022-3514.57.4.641

Specht, J. (2017). Personality Development Across the Lifespan. Retrieved from https://www.elsevier.com/books/personality-development-across-the-lifespan/specht/978-0-12-804674-6

Stein, M. B., Stein, D. J. (2008). Social anxiety disorder. Lancet, 371(9618), 1115-1125. Stoyanov, S., Hides, L., Kavanagh, D., Tjondronegoro, D., Zelenko, O., Mani, M. (2015). Mobile App

Rating Scale: A new tool for assessing the quality of health-related mobile apps. Journal of

Medical Internet Research Mhealth Uhealth, 3(1), e27.

Stipek, D. (1998). Differences between Americans and Chinese in the Circumstances Evoking Pride, Shame, and Guilt. Journal of Cross-Cultural Psychology, 29(5), 616–629. https://doi.org/10.1177/0022022198295002

Stuewig, J., Tangney, J. P., Heigel, C., Harty, L., & McCloskey, L. (2010). Shaming, Blaming, and Maiming: Functional Links Among the Moral Emotions, Externalization of Blame, and Aggression. Journal of Research in Personality, 44(1), 91–102. https://doi.org/10.1016/j.jrp.2009.12.005

Tajfel, H., & Turner, J. C. (2004). The Social Identity Theory of Intergroup Behavior. https://doi.org/10.4324/9780203505984-16

Takahashi, H., Yahata, N., Koeda, M., Matsuda, T., Asai, K., Okubo, Y. (2004). Brain activation

associated with evaluative processes of guilt and embarrassment: an fMRI study. NeuroImage, 23, 967-974.

Tangney, J. P., Dearing, R., Wagner, P. E., & Gramzow, R. (2000). The Test of Self-Conscious Affect-3 (TOSCA-3): George Mason University.

Tangney, J.P. (1994). The mixed legacy of the super-ego: Adaptive and maladaptive aspects of shame and guilt. In J.M. Mashng & R. E Bornstein (Eds.), Empirical perspectives on object relations theory (pp. 1-28). Washington, DC: American Psychological Association.

Tangney, J.P., Dearing, R.L. (2002). Shame and guilt. New York: Guilford Press.

Tangney, J.P., Mashek, D., Stuewig, J. (2007). Working at the social-clinical community-criminology interface: The George Mason University inmate study, Journal of Social and Clinical

Psychology, 26, 1-21.

Tangney, J.P., Wagner, P.E., Fletcher, C., Gramzow, R. (1992). Shamed into anger? The relation of shame and guilt to anger and self-reported aggression. Journal of Personality and Social Psychology, 62, 669-675.

Tangney, J.P., Wagner, P.E., Gramzow, R. (1989). The Test of Self-Conscious Affect (TOSCA). Fairfax, VA: George Mason University.

Tangney, June P. (1991). Moral affect: The good, the bad, and the ugly. Journal of Personality and Social Psychology, 61(4), 598–607. https://doi.org/10.1037/0022-3514.61.4.598

TangneyJ. R, Wagner, R E., Marschafl, D., & Gramzow, R. (1991). The Anger Response Inventory (ARI). George Mason University, Fairfax, VA.

Terracciano, A., McCrae, R. R., & Costa, P. T. (2003). Factorial and construct validity of the Italian Positive and Negative Affect Schedule (PANAS). European Journal of Psychological Assessment : Official Organ of the European Association of Psychological Assessment, 19(2), 131–141. https://doi.org/10.1027//1015-5759.19.2.131

Tesser, A. (1988). Toward a Self-Evaluation Maintenance Model of Social Behavior. In L. Berkowitz (Ed.), Advances in Experimental Social Psychology (Vol. 21, pp. 181–227). https://doi.org/10.1016/S0065-2601(08)60227-0

Tiedens, L.Z., Leach, C.W. (Eds.). (2004). The social life of emotions. New York: Cambridge University Press.

Treeby, M. S., Prado, C., Rice, S. M., & Crowe, S. F. (2016). Shame, guilt, and facial emotion processing: Initial evidence for a positive relationship between guilt-proneness and facial emotion recognition ability. Cognition and Emotion, 30(8), 1504–1511. https://doi.org/10.1080/02699931.2015.1072497

Vandenbroucke, S., Crombez, G., Van Ryckeghem, D., Brass, M., Van Damme, S., & Goubert, L. (2013). Vicarious pain while observing another in pain: An experimental approach. Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00265

Vitaglione, G. D., & Barnett, M. A. (2003). Assessing a New Dimension of Empathy: Empathic Anger as a Predictor of Helping and Punishing Desires. Motivation and Emotion, 27(4), 301–325. https://doi.org/10.1023/A:1026231622102

Wagner, U., Handke, L., Dörfel, D., & Walter, H. (2012). An Experimental Decision-Making Paradigm to Distinguish Guilt and Regret and Their Self-Regulating Function via Loss Averse Choice Behavior. Frontiers in Psychology, 3. https://doi.org/10.3389/fpsyg.2012.00431

Wagner, U., N'Diaye, K., Ethofer, T., Vuilleumier, P. (2011). Guilt-specific processing in the prefrontal cortex. Cerebral Cortex, 21(11), 2461-2470.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54(6), 1063–1070. https://doi.org/10.1037//0022-3514.54.6.1063

Welten, S. C. M., Zeelenberg, M., & Breugelmans, S. M. (2012). Vicarious shame. Cognition and Emotion, 26(5), 836–846. https://doi.org/10.1080/02699931.2011.625400

Werner, K., Gross, J. J. (2010). Emotion regulation and psychopathology. A conceptual framework, in Emotion Regulation and Psychopathology: A Transdiagnostic Approach to Etiology and

Treatment, eds A. M. Kring and D. M. Sloan, NewYork: The Guilford Press,13-37.

Wolf, S. T., Cohen, T. R., Panter, A. T., & Insko, C. A. (2010). Shame Proneness and Guilt Proneness: Toward the Further Understanding of Reactions to Public and Private Transgressions. Self and Identity, 9(4), 337–362. https://doi.org/10.1080/15298860903106843

Wondra, J. D., & Ellsworth, P. C. (2015). An appraisal theory of empathy and other vicarious emotional experiences. Psychological Review, 122(3), 411–428. https://doi.org/10.1037/a0039252

Woods, A.J., Antal, A., Bikson, M., Boggio, P.S., Brunoni, A.R., Celnik, P., Cohen, L.G., Fregni, F., Herrmann, C.S., Kappenman, E.S., Knotkova, H., Liebetanz, D., Miniussi, C., Miranda, P.C., Paulus, W., Priori, A., Reato, D., Stagg, C., Wenderoth, N., Nitsche, M.A. (2016). A technical guide to tDCS, and related non-invasive brain stimulation tools. Clinical Neurophysiology, 127 (2), 1031-48.

Woods, A.J., Martin, D.M. (2016). Clinical research and Methodological Aspects for tDCS Research. In. A. Brunori et al., (eds)., Transcranial Direct Current Stimulation in Neuropsychiatric Disorders, Springer Publishing.

Xu, L., Groth, K. M., Pearlson, G., Schretlen, D. J., Calhoun, V. D. (2009). Source-based morphometry: the use of independent component analysis to identify gray matter differences with application to schizophrenia. Human Brain Mapping, 30(3), 711-724.

Yamawaki, N., Spackman, M. P., & Parrott, W. G. (2015). A Cross-Cultural Comparison of American and Japanese Experiences of Personal and Vicarious Shame. Journal of Cognition and Culture, 15(1–2), 64–86. https://doi.org/10.1163/15685373-12342141

Yoder, K.J., Harenski, C., Kiehl, K.A., Decety, J. (2005). Neural networks underlying implicit and explicit moral evaluations in psychopathy. Translational Psychiatry, 5, e625.

Chapter 3

Single-case Study

In collaboration with L. Piretti, A. Lunardelli, I. Zorzenon, M. Kumar, V. Pesavento, R.I. Rumiati

Introduction

As previously mentioned, self-conscious emotions (i.e., shame, guilt, embarrassment and pride) are moral emotions related to self-evaluation (Haidt, 2003) that are thought to regulate social behaviour by providing immediate punishment or reinforcement when a social and moral violation occurs (Tangney et al., 2007).

One of the cornerstones in affective neuroscience, and in particular in the study of emotions, is the involvement of a limbic structure called "the amygdala" (LeDoux, 2003). Its name comes from the Greek, and it explicitly refers to the almond shape of this structure, located in the medial temporal lobe. It is one of the pivots of what is called the emotional brain, and is directly linked to several "low-level" emotional processes (LeDoux, 2007). Neuroimaging studies suggested that even self-conscious emotions processing might be associated with amygdala activation. For instance, in a study based on a shame induction paradigm, amygdala was constantly activated (Finger et al., 2006). Nevertheless, it is not wrong to assume that there may be important differences between self-conscious emotions regarding their involvement with this structure. Indeed, in patients with major depressive disorder, who typically suffer from exaggerated feeling of both shame and guilt, a higher amygdala activation for shame than guilt was reported (Pulcu et al., 2014). Another possible distinction between shame and guilt in relation to the amygdala comes from a structural investigation in adolescents, where grey matter thickness of posterior cingulate cortex and amygdala inversely correlated with shame- but not guilt- proneness (Whittle et al., 2016). However, guilt still was found related to amygdala activation (Kédia et al., 2008; Wagner et al., 2011; Michl et al., 2014), although a recent meta-analysis on guilt functional activations did not confirm this result (Gifuni et al., 2017).

Although previous evidence suggested that both guilt and shame processing might rely on the amygdala functioning, this brain structure might differentially contribute towards the processing of the two emotions, as they differ in various respects (Tangney, 1996). As already said in previous chapters, crucial divergences between shame and guilt regard their focus, their behavioural consequences and action tendencies. We know that guilt is an "other-oriented" emotion while shame is a "self-oriented" one. Guilt induces pro-social behavioural responses, including empathic tendencies, aiming at repairing the moral transgression, while shame leads to behavioural inhibition and the disruption of empathic tendencies (Tangney, 2007). These differences might be determinant in explaining why the selective activation of amygdala for shame and/or guilt was inconsistent in the literature.

In addition, amygdala has also been associated with other processes. Damage to the amygdala in both monkeys (Mason et al., 2006; Machado et al., 2009) and humans (Buchanan et al., 2009; Kennedy et al., 2009) gave rise to important behavioural modifications, mainly including the tendency to approach other individuals and led to impaired reinforcement learning (Johansen et al., 2011). In other studies, using functional neuroimaging, amygdala was activated by self-relevant (Ewbank et al., 2009) and highly arousing stimuli (Anderson et al., 2003; Ball et al., 2009). Moreover,

it is known that amygdala damage in humans is associated with the inability to perceive facial expressions of fear (Adolphs et al., 1994; Calder et al., 1996), but spared abilities in recognizing emotions from other modalities such as body gestures (Atkinson et al., 2007) and prosody (Adolphs and Tranel, 1999; Bach et al., 2013). The inability of recognizing fearful facial expression may be caused by patients' reduced tendency to fixate the eye region (Adolphs et al., 2005; Spezio et al., 2007), that is notoriously diagnostic for fear facial processing (Smith et al., 2005). Hence, the amygdala is involved in orienting attention to salient cues (e.g. eyes in this case), in order to deal with ambiguous stimuli (Whalen, 1999). Since self-conscious emotions might rely on the ability to appraise complex social situations, often ambiguous, the activation of amygdala might also reflect its role in uncertainty resolution.

The association between self-conscious emotions and amygdala functioning comes into play also by studies on psychopathy (Frick, 1995; Hare, 2003). Individuals with a diagnosis of psychopathy and antisocial personality disorder, that are two conditions associated with relevant emotional deficits and high rates of delinquency (Frick, 1995; Hare, 2003), they tend to suffer from important impairments in moral processing (Blair, 2017), deficits in detecting moral/conventional transgressions (Blair, 1995; 1997), utilitarian moral judgments (Gao and Tang, 2013; Glenn et al., 2009; Koenigs et al., 2011) and an anomalous subjective feeling of guilt and shame (Cripps, 1997; Tangney et al., 2011; Prado et al., 2017, Keen, 2008). Specifically, two brain areas have been found to be consistently associated with psychopathic individuals: the amygdala and the mPFC (Anderson and Kiehl, 2012). Structural neuroimaging studies revealed that individual with psychopathy show lower grey matter volume in medial temporal areas (including amygdala and hippocampus) and mPFC in comparison with healthy controls (Boccardi et al., 2011; Gregory et al., 2012, Yang et al., 2009). At the functional level, during resting state functional magnetic resonance imaging (fMRI), a reduced functional connectivity (see Chapter 5 for a description of this method) between these two regions in psychopathic individuals compared with controls was detected (Motzkin et al., 2011; Espinoza et al., 2018). It has been suggested also that the link between the abnormal feeling of negative self-conscious emotions and the dysfunction between the amygdala and medial prefrontal cortex (mPFC) may play a relevant role in psychopathic traits genesis (Blair, 2007; 2017). According to Blair (2007; 2017) the deficit in stimulus-reinforcement learning caused by amygdala damage (Johansen et al., 2011) might disrupt the association between moral transgressions and aversive stimuli; this may lead to reduced experiences of negative self-conscious emotions, and consequently to antisocial behaviours.

While mPFC damage acquired during adulthood induces a condition very similar to psychopathy, characterized by higher rates of aggression (Blair and Cipolotti, 2000) and self-conscious emotion deficit (Beer et al. 2003), the role of an acquired damage to the amygdala in processing self-conscious emotions has not been investigated to date.

In light of this, the aim of the present single-case study is to clarify the role of the amygdala in processing negative self-conscious emotions. In order to achieve this aim, we tested a patient with acquired bilateral amygdala damage with different tasks tapping social cognitive skills, emotion facial recognition, and self-conscious emotion subjective perception. If the amygdala is involved in processing shame and guilt, its lesion should reduce the subjective experiences of both shame and guilt, while if it is involved in the regulation of self-conscious emotion, its lesion should augment the subjective experience of the either emotions. Another possible outcome, given the role of amygdala in

coding saliency, is that its lesion could impair the ability to understand social situations, giving rise to secondary deficit in self-conscious emotion feeling (i.e., it does not impact a specific self-conscious emotion).

Method

Case description

FF is a right handed middle-aged man with 13 years of education who was admitted to the rehabilitation ward with a diagnosis of Erdheim-Chester disease (non-Langerhans cells histiocytosis, see Diamond et al., 2014), with neurological and dermatological symptoms. About two years earlier, FF showed hyperprolactinemia and diabetes insipidus and, subsequently, he reported hypostenia and hypoaesthesia of the lower limbs, balance issues, emotional lability and hypogeusia and received a diagnosis of gait ataxia and mild right hemiparesis. The MRI scan, acquired at the time of the diagnosis, revealed bilateral cortical thickening mainly at the level of amygdala. The lesion extended to the pituitary stalk, optic chiasm, hypothalamus and involved also lenticular nucleus, internal and external capsule in the left hemisphere, and the external capsule in the right hemisphere. Moreover, diffuse signal intensity alterations involved cervical and thoracic spinal cord (mainly in the posterior columns). At the time of the testing, the neurological symptoms had regressed, with a marked reduction of the emotional lability, mild improvement of the motor abilities and minimal impairments in the cerebellar tests. Likewise, the MRI pattern at five months after the diagnosis (see Figure 3.1) revealed a marked reduction in intensity alteration at the level of amygdala, hippocampus and pituitary stalk. Signal alterations located within bilateral internal and external capsule, as well as at the level of right lenticular nucleus were not anymore detectable.

Before taking part in the experiment, patient FF, as well as a sample of healthy controls, signed an informed consent, which was approved by the local ethical committee. Healthy control sample included 13 age- and education-matched healthy male individuals (age: 48.6 ± 9.3, education: 13.8 ± 3.2, MMSE: 29.5 ± 0.5) who were tested on all the experimental tasks, as well as on PANAS and TOSCA. For technical issues, we did no test three healthy controls for their ability in emotion recognition (prosody task and the emotional gestures recognition task), and another participant for his affectivity level with PANAS questionnaire.

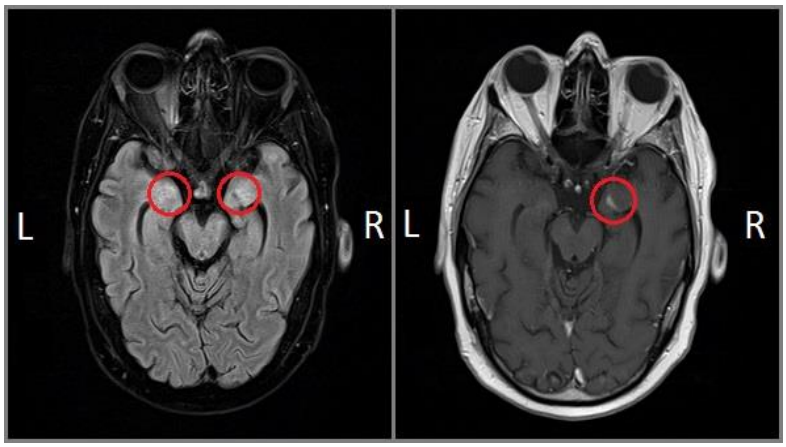


Figure 3. 1 FF's MRI scans: FLAIR (left) and T1-weighted gadolinium enhanced (right) sequences.

Neuropsychological assessment

First, FF underwent a neuropsychological battery to assess his cognitive abilities (See Table 1). This battery included evaluation of short and long term memory (prose memory), working memory (digit span backward and Corsi's span backwards, attention (trail making test – part A), executive functions (trail making test – Part B, phonemic/semantic alternate fluency, WAIS Similarities subtest, Tower of London test, Raven's progressive matrices, Wisconsin card Sorting test, verbal judgment test, cognitive estimation test), fluency (phonological fluency, semantic fluency), praxis (freehand copying of drawings task, clock drawing test) and perception (facial recognition test). Finally, the Positive and Negative Affect Schedule (PANAS, Crawford & Henry, 2004) was administered in order to assess the current affectivity of the patient and healthy controls. PANAS, consisting of 10-items measuring both negative and positive affect, is a self-report questionnaire in which participants are asked to indicate their level of experienced affect in that moment in a 5-points Likert-scale.

Social cognition battery

The "Social cognition battery" (Prior et al., 2003) is a self-administered task with four different tests assessing different aspects of social cognition including the emotion attribution, the theory of mind, the social situation and the moral/conventional distinction. Each test proposes brief stories and asks to answer some related questions. In the emotion attribution test, these stories describe one character in a specific emotional context (e.g., *"Silvia wakes up and sees a poisonous spider in her bed"*). The participant is asked to provide a free answer to specific questions related to the feeling of the character (e.g., "*How does Silvia feel in this situation?"*). Items relate to different emotions: Sadness (N = 10), Fear (N = 10), Shame (N = 12), Disgust (N = 3), Happiness (N = 10), Anger (N = 10), Envy (N = 3). In the theory of mind task, stories (N = 13) involve two or more characters interacting (e.g., "*Katia and Emma are two children and are playing at home. Emma gets a banana and puts it close to her ear and says to Katia: -"Look, it's a phone"*). The participant is asked to answer specific questions related to the character's perspective (e.g., *"Is true what Emma said?*). The social situation task includes stories about two distinct social behaviours: one is a normative social behaviour, the other a social norm violation. Participant is asked to rate how the behaviour of the character can be considered normal, by using a scale

from "normal behaviour" to "extremely strange behaviour". Three scores can be obtained: Normal behaviour identified, Social violations identified and the severity of the social violations. The moral/conventional distinction test consisted of twelve children's stories within the school context. In the moral condition (half of the stories, N = 6) one character is a victim of harm or of an injustice by other characters, while in the other condition (N = 6) one character is involved in a social rule violation, without provoking any injury to other individuals. Participants are asked to answer four questions: (1) whether the character is behaving in a proper way, (2) how this behaviour is serious from 0 to 10, (3) whether this behaviour can be considered right in another cultural context with different rulesor (4) in case the teacher allow any children to behave like they want. Hence, for each condition of the moral/conventional distinction task, three scores are available: (1) accuracy in detecting forbidden behaviour, (2) the severity of the violation, and (3) the accuracy in detecting forbidden behaviour without given rules.

Emotion recognition tasks

Emotional facial expressions recognition task

In this task, participants were asked to label the emotion presented into different labels (anger, disgust, fear, happiness, sadness, shame and neutral). We selected 120 greyscale facial pictures taken from the "Montreal Set of Facial Displays of Emotion" (MSFDE, Beaupré et al., 2000). This database is composed of neutral and emotional pictures morphed at various degrees (20%, 40%, 60% and 80%). We selected for each emotion (anger, disgust, fear, happiness, sadness and shame), morphed pictures from 20% to 80% and fully emotional pictures. We included four items per condition. (See Figure 3.2).

Figure 3. 2 Two standardized items from the Montreal Set of Facial Displays of Emotion (MSFDE, Beaupré et al., 2000). On the left, facial expression of shame is presented at 20% degree of intensity. On the right, facial expression of shame presented at 100%.

Emotional prosody recognition task

Through headphones, we auditorily presented 48 sentences with neutral content (e.g., "the book is on the table") and emotional prosody. We included four items for each emotion (anger, fear, disgust, happiness, sadness and surprise). Participants were asked to identify the emotion conveyed by the prosody choosing among different options (anger,

fear, disgust, happiness, sadness, surprise and neutral), and then to rate the intensity of the emotion on an 8-point Likert scale (from 0 to 7).

Emotional gestures recognition task

We used 32 greyscale body photographs expressing emotional body gestures derived from BEAST (www.beatricedegelder.com/) (de Gelder and Van den Stock, 2011; see also Cecchetto et al., 2014). In order to hide any possible facial cue, actor's faceswere covered by a grey circle. . Emotions included anger, fear, happiness, sadness. Participants were asked to identify the emotion expressed by body gestures selecting one among five options (these four emotions plus neutral) and to rate the arousal of the expressed emotion on a 7-point Likert scale.

Subjective self-conscious emotion experience test - Shame Task

To measure participants' subjective experience of shame and guilt, we capitalized on a modified version of the Shame Task (for more details, see Chapter 2).

As we know, in this task social judgments towards the participants are presented. Each social judgment is associated with the pictures of one individual. Participants were asked to imagine that the person in the picture expresses the judgment directed towards them, as in a real social interaction. To save the patient from fatigue, we used a reduced version of the task, composed by 18 trials in total (18 judgements associated with 18 pictures). Judgments included two conditions: the "shame" or "social standards" condition involves violations of social norms or social standards strictly related to the participant (e.g., "*You have put on a lot of weight*"), while the 'harming-other' (or "guilt") condition involves injuries or harm towards the participant about something that he made wrongly (e.g., *"You destroyed my life"*). In this version, pictures were selected from the NimStim database (Tottenham et al., 2009) and Caucasian individuals of both genders (50% females) were included. As in the classical version of the Shame Task, participants were asked to imagine that the person in the picture expresses the judgment directed towards them; participants had to rate their subjective experience of shame and guilt on a Likert scale ranging from 0 to 6.

Statistical analyses

We compared FF's scores on the neuropsychological and social cognition batteries with the available normative data, while those on the other tests, including PANAS, emotion recognition tasks and Shame Task were compared with healthy controls' scores. Specifically, we used the software "SingleBayes_ES.exe" (https://homepages.abdn.ac.uk/j.crawford/pages/dept/psychom.htm), implementing the method described by Crawford and Garthwaite (2007) and Crawford and collaborators (2010), to transform patient's scores into z-scores (or effect size or Zcc) based on controls' means and standard deviations and then using the computed Zcc to test the probability that patient's Zcc fell out of the lower and upper endpoints of a 95% credible interval. Then, in case of deficit, a second analysis was performed (e.g., Bayesian Standardized difference test) (Crawford and Garthwaite, 2007; Crawford et al., 2010), using another software called DissocsBayes_ES.exe (https://homepages.abdn.ac.uk/j.crawford/pages/dept/psychom.htm), to test whether patient's performance

reduction is significantly lower that other scores of the same task, configuring a strong or classical dissociation (Crawford and Garthwaite, 2005). This method of analysis was applied to PANAS, Emotion recognition from prosody task, emotional gestures recognition task and Shame Task, while the facial emotion recognition task, given the complexity of the design, was analysed with mixed-effect models (MMs), capitalizing on the package lme4 (https://cran.r-project.org/web/packages/lme4/) within the R environment (https://www.r-project.org/). MMs represent powerful tool in the analysis of single case data, allowing a comparison between patient and controls' performances even in complex study designs, as repeated measure designs (Huber et al., 2015, Wiley and Rapp, 2018). Specifically, we built a generalized mixed-effect model (function glmer) on the responses accuracy in the facial emotion recognition task (binomial) using the subject and the identity of the actor in the stimuli as random factors, and the group (patient, controls), the emotion type (anger, disgust, fear, joy, sadness and shame), the emotion intensity, and their interactions as fixed-factors. Then, we removed stepwise any fixed-factor not inducing any significant loss of fit to the model (tested with likelihood ratio test). The interaction between group * emotion and the interaction between emotion * intensity were included as fixed factors in the final model. We used the package lsmeans (https://cran.r-project.org/web/packages/lsmeans/index.html) to explore these interactions, performing planned Bonferroni-corrected contrast between patient and controls' scores for each emotion type.

Results

Neuropsychological assessment and questionnaires

FF's results are summarized in Table 3.1. He showed deficits at the Wisconsin's card sorting test and similarities subtest of the W.A.I.S. battery, suggesting an impairment in affecting abstraction abilities. His performances on phonological and semantic fluency were also poor, while he was at the average level concerning alternate semantic/phonological fluency. FF's score on the Benton's facial recognition test was in the borderline range. Analysis of PANAS revealed that FF's affective (both positive and negative) state did non differ from healthy controls (FF: positive affect score = 37, negative affect score = 18; controls: mean positive affect score = 29.92 ± 7.43, mean negative affect score = 18.33 ± 7.28; all ps > .05).

Test	Range	Cut-offs	Raw score (Corrected score)	Z-scores
Memory				
Digit Span Forward	0-9	<4.26	6 (5.75)	
Corsi's Span Forward	0-9	<3.46	5 (4.74)	
Digit Span Backward	0-9	<2.65	4 (3.71)	
Corsi's Span Backwards	0-9	<3.08	5 (4.77)	
Prose memory	0-28	<7.5	14.5 (15)	
Executive functions and attention				

Trail Making Test				
- A	-	>94	59 (56)	
- B	-	>283	158 (152)	
Phonemic/semantic alternate fluency	-	<12.7	26 (25.31)	
- Composite Shifting Index		<0.38	1.15 (1.12)	
Similarities	0-28		6*	
Raven's progressive matrices	0-36	≤18.96	34 (31.80)	
Tower of London test	0-36		32	-0.57¥
Wisconsin Card Sorting Test				
- number of categories	0-6	≤2	2*	
- number of perseverations	0-36	≥6.41	-	
Verbal Judgement test	0-50	-	46 (40.25)	
Cognitive estimation test	0-27	≤12	9 (9.62)	
Language				
Phonological fluency	-	<17.35	18 (13.3)*	
Semantic fluency	-	<28.34	27 (27.34)*	
Praxis				
Freehand copying of drawings task	0-12	≤ 7.18	9 (8.4)	
Clock drawing test	0-10	≤8	8.5	
Perception				
Facial recognition test	0-54	<39	39	
Affective state				
PANAS				
-positive	0-50		37	0.95§
-negative	0-50		18	-0.05§

Table 3. 1 Patient's performances on the neuropsychological battery: short (digit span forward and Corsi's span forward, Monaco et al., 2013) and long term memory (prose memory, Novelli et al., 1987), working memory (digit span backward and Corsi's span backwards, Monaco et al., 2013), attention (trail making test – part A, Giovagnoli et al., 1996) executive functions (trail making test – part B, Giovagnoli et al., 1996; phonemic/semantic alternate fluency, Costa et al., 2013; Similarities subtest of W.A.I.S., Wechsler, 2014; Tower of London test, Krikorian et al., 1994; Raven's progressive matrices, Carlesimo et al., 1995; Wisconsin card Sorting test, Caffarra et al., 2004; verbal judgment test, Spinnler and Tognoni, 1987; cognitive estimation test, Scarpina et al., 2015) fluency (phonological fluency, Carlesimo et al 1995; semantic fluency, Costa et al., 2013), praxis (freehand copying of drawings task, Carlesimo et al. 1995; clock drawing test, Mondini et al., 2003) and perception (facial recognition test, Benton et al., 1994; Albonico et al., 2017).*: impaired performance, §: obtained with healthy controls mean and standard

deviation scores, ¥: obtained with normative data.

Social cognition battery

Emotion attribution task (see Table 3.2) revealed that FF was impaired in attributing sadness and disgust to characters of brief stories, while his performance on fear, shame, happiness anger and envy was above the cut-off. It is worth noting that errors in sadness and disgust attributions included mainly anger (errors on sadness: 80% anger, 20% shame; errors on disgust: 100% anger). On the social situation task, FF showed impaired abilities in identifying normal social behaviour and social violations, while his evaluation of the severity of the social violation was just above the cut-off. Patient's performances on both the theory of mind task and the moral/conventional distinction task were in normal ranges.

Test	Score	Range	Cut-offs
Theory of mind	12	0-13	≥ 12
Emotion attribution			
-Sadness	5*	0-10	≥ 6
-Fear	10	0-10	≥ 8
-Shame	10	0-12	≥ 8
-Disgust	1*	0-3	≥ 2
-Joy	9	0-10	≥ 10
-Anger	9	0-10	≥ 6
-Envy	3	0-3	≥ 1
Social situations			
-Identification of correct social behaviours	12*	0-15	≥ 13
-Identification of social violations	20*	0-25	≥ 22
-Rating of the entity of violations	45	0-75	≥ 45
Moral/Conventional distinction			
-Moral behaviours	6	0-6	≥ 6
-Conventional behaviours	6	0-6	≥ 5

Table 3. 2 Patient's scores on the social cognition battery * Impaired performance

Emotion recognition tasks

Emotional facial expressions recognition task

The final model (logLik = -854.2, marginal $r^2 = 0.39$, conditional $r^2 = 0.44$) revealed a significant main effects of emotion ($\chi2(5) = 48.18$, $p < .001$) and intensity ($\chi2\ (1) = 232.85$, $p < .001$) and significant interactions of group *

emotion ($\chi 2$ (5) = 27.34, p < .001) and emotion * intensity ($\chi 2$ (5) = 49.21, p < .001). Participants were overall more accurate in recognizing facial expression of joy than all other emotions (joy vs. sadness: z = 2.71, p = .07, all other ps < .05), except for those displaying anger (p > .1). Participants recognized shame and fear less accurately than all other emotions (all ps < .05). Patient FF recognized shameful and fearful faces worse than controls (fear: z = -2.43, p = .088; shame: z = 2.55, p = 0.63), although this difference is only marginally significant. No difference between FF and controls emerged respect to all other facial expressions (z: anger = -0.87, disgust = 0.24, joy = -0.06; all ps > .1) but sadness (z: = 2.02). However, iIt is worth noting that the differences between FF's and controls' performances in recognizing shame and fear was significantly higher than those associated with sadness (sadness vs. shame: z = -4.20, p < .001; sadness vs. fear: z = -4.19, p < .001). Finally, no difference was found contrasting the difference between FF's and controls' performance in emotion recognition of shameful and fearful faces (fear vs. shame: z = 0.26, p > .1) (See Figure 3.3 for a graphical representation of the results).

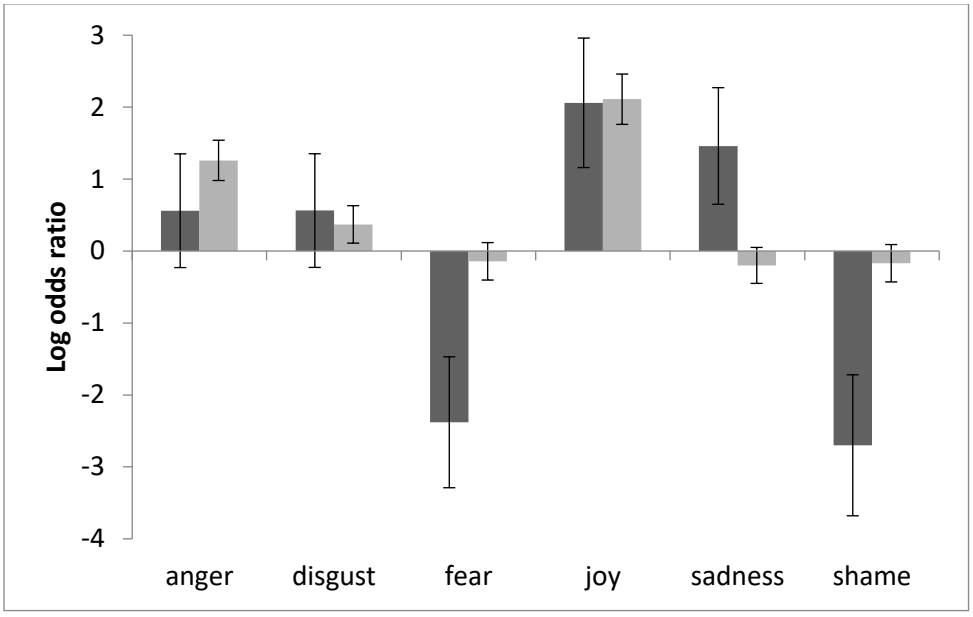


Figure 3. 3 Patient's and healthy controls performance on emotional facial recognition task. Patient's (dark grey) and healthy controls' (light grey) log odds ratio. Bars indicate standard error of the mean.

Emotional gestures recognition task

No difference in any emotion was detected between FF and healthy controls' performance during the emotional gesture recognition task (See Table 3.3) (all ps > .01). This result suggested that the patient was not impaired in recognizing emotions from body gestures.

Emotion Recognition from prosody

The analyses of emotion recognition of auditory stimuli did not show any significant difference betweenFF and controls' performances (all ps > .1) (see Table 3.3).

	FF	Controls			
		Mean	SD	Zcc	%P
Body emotion recognition accuracy					
Anger	6	6.90	1.60	-0.56	30.25
Fear	8	7.40	0.70	0.86	78.26
Joy	3	5.10	2.13	-0.99	20.34
Sadness	8	8.00	0.00	-	-
Prosody emotion recognition accuracy					
Anger	4	3.50	0.71	0.70	74.06
Disgust	3	1.90	1.20	0.92	79.76
Fear	4	3.40	0.97	0.62	71.51
Joy	3	3.10	0.99	-0.10	46.28
Sadness	3	3.50	0.53	-0.94	19.60
Surprise	3	3.00	0.94	0.00	50.01

Table 3. 3 Accuracy and mean intensity ratings for the different emotion recognition tasks. Zcc = effect size, %P = Bayesian point estimate of percentage of control population falling below FF's score

Subjective self-conscious emotion experience test - Shame Task

FF's shame ratings (see Figure 3.4) in the 'social standards' condition (i.e. facing shameful stimuli) were lower than healthy controls (Zcc = -1.810, superior C.I. = -1.030, p = .053), and his ratings on the 'other-harming' (i.e. guilty stimuli) condition were within the control level (Zcc = -0.852, superior C.I. = -0.300, p > .1). Moreover, patient's ratings of guilt were not different from those of controls in any condition (social standards: Zcc = -0.690, superior C.I. = -0.166, p > .1; other harming: -0.327, superior C.I. = 0.149, p > .1). The reduction in shame ratings for the 'social standard' condition was also significantly different than guilt ratings on the same condition (Z-dcc = -1.904 C.I. upper limit = -0.999, p < .05), while it was not significantly different than shame ratings on the 'other harming' condition (Z-dcc = -1.018 C.I. upper limit = -0.261, p > .1)

Figure 3. 4 Patient's and healthy controls performance on Shame Task. Patient's (dark grey) and healthy controls' (light grey) scores. The error bars indicate standard deviations

Discussion

In this single-case study, we investigated the amygdala contribution to self-conscious emotions. FF, a middle-age man with acquired bilateral amygdala damage, performed several tests including emotion recognition, social cognition and subjective emotional experience of shame and guilt. During the facial emotion recognition task, FF showed a deficit in recognizing both fearful and shameful facial expressions. Instead, no difference emerged between the patient and the healthy controls concerning all other facial emotions. Looking more in detail, the entity of shame and fear recognition reduction was significantly higher than that of sadness and disgust, but not of joy and anger. This pattern of findings falls within the criteria for a dissociation (Crawford and Garthwaite, 2005) between the emotion facial recognition of fear and shame with respect to disgust and sadness, but not joy and anger. Our findings are consistent with previous studies reporting selective deficits at recognizing fear from facial expressions in patients with amygdala damage (Adolphs et al., 1994; Calder et al., 1996). Social emotion recognition impairment (including moral emotions) has also been reported in these patients (Adolphs et al., 2002); however, to our knowledge this is the first time that a specific deficit in recognition of shameful facial expression is reported in this type of patients. The lack of dissociation among fear and shame, with respect to anger might be attributable to a mild, non-significant deficit in recognizing angry faces which is consistent with previous studies on the same type of patients (Sato et al., 2002) and on healthy individuals undergoing fMRI (Adams et al., 2003).

A selective deficit in fearful facial expression recognition has been interpreted as a consequence of the role for amygdala in detecting threat (Öhman et al., 2007). However, recently a new hypothesis has been proposed: amygdala may play a

critical role in orienting attention to the eye region when presented with a facial stimulus (Jacobs et al., 2012). Indeed, we know that the eye region is fundamental for the identification of fearful and angry facial expressions (Smith et al., 2005), and is poorly fixated by patients with amygdala damage during face presentation (Adolphs et al., 2005; Spezio et al., 2007). In support of this claim, patients' performance in recognizing fearful facial expression improves when their attention is directed to the eye region in the picture (Adolphs, 2005). A similar account might be hypothesized to interpret the deficit at recognizing shameful facial expressions. Indeed, although the idea that the eye region might be diagnostic of shameful expression recognition has never been tested, the action tendencies associated with the shame experience seem to involve gaze movement downward, in addition to blushing and inhibition of speech and movement (Asendorpf 1990; Keltner and Buswell, 1997). Hence, this attentional deficit related to the eye region might prevent patients with amygdala damage from perceiving a shift of gaze direction downward, typically associated with shameful facial expression.

Although his deficits in facial emotion recognition, FF preserved his ability to recognize specific emotions from bodily gestures and from prosody. However, he was impaired at recognising sadness and disgust from brief written stories, mainly confusing them with anger. FF rated as more intense than controls body gestures of fear and anger. Although functional neuroimaging studies found the association between amygdala activation and the processing of fearful gestures (De Gelder et al., 2006; Pichon et al., 2009) and angry prosody (Frühholz et al., 2011; Sanders et al., 2005), previous neuropsychological studies on patients with amygdala damage reported intact abilities in recognizing emotions from bodily gestures (Atkinson et al., 2007) and emotional auditory stimuli (Adolphs and Tranel 1999; Bach et al., 2013). The latter is consistent with our results.

The assessment of subjective experience of negative self-conscious emotion revealed two different patterns for shame and guilt. First, patient's guilt ratings were at the control level in both social standards (i.e. shame) and harming-other (i.e. guilt) conditions, likewise his ability to discriminate between moral and conventional rules. These results are not in line the claim that the amygdala may be engaged in processing guilt and, in general, play a critical role in moral cognition (see Boccia et al., 2016; Blair, 2017 for reviews). It is worthy of consideration that while FF's lesion was acquired in adulthood, the same dysfunction in people with psychopathy is developmental. Hence, amygdala might be crucial in the development and building of moral emotions, while its role in guilt processing during adulthood, when these emotions are already developed, seem to be less relevant.

Second, but not less important, FF showed a reduction in the subjective experience of shame with respect of controls, that was limited to situations regarding violations of social standards (i.e. facing shameful stimuli) not involving harming other people. In addition, he was impaired in recognizing whether a social situation was normal or not. Taken together, these findings are not consistent with the view of a primary role for the amygdala in self-conscious emotion processing including shame. Indeed, if amygdala was involved in the generation of shame, after its lesion we would expect an overall lower feeling of shame not strictly dependent of the condition. Starting from our results, the reduction in the subjective experience of shame might be secondary to the impaired ability to detect whether a social situation is to be considered normal: after all, if an individual is not able to detect the occurrence of a social violation, he/she will not be able to react properly to such violation. One possibility is that a patient might fail to understand social situations

because of a lack of social knowledge: for instance, the patient is not able to detect relevant cues from social situations and to match them with prior social knowledge. This view is supported by studies with monkeys with lesions of the anterior temporal lobes (sparing the amygdala) who showed pervasive impairments in emotional and social behaviours (i.e., psychic blindness) due to lackness of social knowledge (Franzen and Myers, 1973). Rather than directly binding the amygdala with the processing of moral emotions, we are more inclined to believe that FF's deficit might relate to the inability to recognize social situations. This view is consistent with previous studies in which the amygdala was found to be involved in processing highly arousing or salient information (Anderson et al., 2003; Ball et al., 2009), reflecting the subjective impact of the stimuli presented (Ewbank et al., 2009).

To sum up, our suggestion is that an acquired damage in the amygdala may lead to an impairment at orienting attention towards relevant cues that are necessary to understand social context. This is consistent with the hypothesis that the amygdala is able to modulate other brain areas to obtain more efficient processing of the stimuli (Whalen, 1999; 2007), becoming particularly relevant in the processing of ambiguous or unpredictable situations, when many details need to be collected in order to disentangle the situation. This explanation is also consistent with the patient's poor performance on both the Wisconsin card sorting test and Analogies. In fact, these tasks require the ability to focus towards specific details that are relevant to achieve tasks goals.

Limitations

The present study involves the testing of a patient with the bilateral lesion of amygdala, which also associated with the lesion of the surrounding part of the hippocampus. Hence, the reported deficits might also be attributable to the lesion of the hippocampus of to the combination of the lesion of hippocampus and amygdala. In addition, since this study involved the testing of a single patient, the generalizability of our findings is low, and needs to be confirmed by further studies.

Conclusions

The investigation of self-conscious emotion processing in a patient with acquired bilateral amygdala damage revealed impaired perceptual abilities in detecting shameful (and fearful) facial stimuli that is more easily explained by a reduction in allocation of attention towards the eye region. In addition, FF showed reduced feelings of shame in self-relevant social situations in association with a deficit in discriminating normal social situations and social violations, impaired performance on Wisconsin card sorting test and WAIS Analogies. These latter findings are congruent with a deficit in detecting salient cues in order to understand social situations and, consequently, to generate shame feelings in case of violations. Hence, the amygdala integrity appears to be relevant in the detecting of shameful stimuli at a perceptual level (i.e., shameful faces), as well at a more abstract one (i.e., social violations). These findings are more easily explained assuming a role of amygdala in ambiguity and uncertainty resolution, as suggested by Whalen (1999). However, further research is necessary in order to understand better the role in amygdala in self-conscious emotion processing.

References

Adolphs, R., & Tranel, D. (1999). Intact recognition of emotional prosody following amygdala damage. *Neuropsychologia*, *37*(11), 1285-1292.

Adolphs, R., Gosselin, F., Buchanan, T. W., Tranel, D., Schyns, P., & Damasio, A. R. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature*, *433*(7021), 68.

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. *Nature*, *372*(6507), 669.

Albonico, A., Malaspina, M., & Daini, R. (2017). Italian normative data and validation of two neuropsychological tests of face recognition: Benton Facial Recognition Test and Cambridge Face Memory Test. *Neurological Sciences*, *38*(9), 1637-1643.

Anderson, A. K., Christoff, K., Stappen, I., Panitz, D., Ghahremani, D. G., Glover, G., ... & Sobel, N. (2003). Dissociated neural representations of intensity and valence in human olfaction. *Nature neuroscience*, *6*(2), 196.

Anderson, N. E., & Kiehl, K. A. (2012). The psychopath magnetized: insights from brain imaging. *Trends in cognitive sciences*, *16*(1), 52-60.

Asendorpf, J. B. (1990). Development of inhibition during childhood: Evidence for situational specificity and a two-factor model. *Developmental Psychology*, *26*(5), 721.

Atkinson, A. P., Heberlein, A. S., & Adolphs, R. (2007). Spared ability to recognise fear from static and moving whole-body cues following bilateral amygdala damage. *Neuropsychologia*, *45*(12), 2772-2782.

Bach, D. R., Hurlemann, R., & Dolan, R. J. (2013). Unimpaired discrimination of fearful prosody after amygdala lesion. *Neuropsychologia*, *51*(11), 2070-2074.

Ball, T., Derix, J., Wentlandt, J., Wieckhorst, B., Speck, O., Schulze-Bonhage, A., & Mutschler, I. (2009). Anatomical specificity of functional amygdala imaging of responses to stimuli with positive and negative emotional valence. *Journal of neuroscience methods*, *180*(1), 57-70.

Beaupré, M. G., Cheung, N., & Hess, U. (2000). The Montreal set of facial displays of emotion. Available from Ursula Hess, Department of Psychology, University Quebec at Montreal, PO Box, 8888.

Blair, R. J. R. (1995). A cognitive developmental approach to morality: Investigating the psychopath. *Cognition*, *57*(1), 1-29.

Blair, R. J. R. (1997). Moral reasoning and the child with psychopathic tendencies. *Personality and individual differences*, *22*(5), 731-739.

Blair, R. J. R. (2007). The amygdala and ventromedial prefrontal cortex in morality and psychopathy. *Trends in cognitive sciences*, *11*(9), 387-392.

Blair, R. J. R. (2017). Emotion-based learning systems and the development of morality. *Cognition*, *167*, 38-45.

Boccardi, M., Frisoni, G. B., Hare, R. D., Cavedo, E., Najt, P., Pievani, M., ... & Vaurio, O. (2011). Cortex and amygdala morphology in psychopathy. *Psychiatry Research: Neuroimaging*, *193*(2), 85-92.

Boccia, M., Dacquino, C., Piccardi, L., Cordellieri, P., Guariglia, C., Ferlazzo, F., ... & Giannini, A. M. (2017). Neural foundation of human moral reasoning: an ALE meta-analysis about the role of personal perspective. *Brain imaging and behavior*, *11*(1), 278-292.

Buchanan, T.W., D. Tranel & R. Adolphs. 2009. In *The Human Amygdala*. P.W. Whalen & L. Phelps Eds.: 289– 320 Oxford University Press. New York, NY.

Caffarra, P., Vezzadini, G., Dieci, F., Zonato, F., and Venneri, A. (2004). Modified Card Sorting Test: Normative data. *J. Clin. Exp. Neuropsychol.* 26, 246–250.

Calder, A. J. (1996). Facial emotion recognition after bilateral amygdala damage: Differentially severe impairment of fear. *Cognitive Neuropsychology*, *13*(5), 699-745.

Carlesimo, G. A., Caltagirone, C., and Gainotti, G. (1996). The Mental Deterioration Battery: Normative data, diagnostic reliability and qualitative analyses of cognitive impairment. *Eur. Neurol.* 36, 378–384.

Cecchetto, C., Aiello, M., D'Amico, D., Cutuli, D., Cargnelutti, D., Eleopra, R., & Rumiati, R. I. (2014). Facial and bodily emotion recognition in multiple sclerosis: the role of alexithymia and other characteristics of the disease. *Journal of the International Neuropsychological Society*, *20*(10), 1004-1014.

Costa, A., Bagoj, E., Monaco, M., Zabberoni, S., De Rosa, S., Papantonio, A. M., ... & Carlesimo, G. A. (2014). Standardization and normative data obtained in the Italian population for a new verbal fluency instrument, the phonemic/semantic alternate fluency test. *Neurological Sciences*, *35*(3), 365-372.

Crawford, J. R., & Garthwaite, P. H. (2002). Investigation of the single case in neuropsychology: Confidence limits on the abnormality of test scores and test score differences. *Neuropsychologia*, *40*(8), 1196-1208.

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. *Brain Journal of Clinical Psychology* 2004 Sep;43(Pt 3):245-65.

Cripps, J. E. (1997). *The association between the neutralization of self-punishment, guilt, and psychopathy among extrafamilial child molesters* (Doctoral dissertation, Carleton University).

Davis, M., & Whalen, P. J. (2001). The amygdala: vigilance and emotion. *Molecular psychiatry*, *6*(1), 13.

De Gelder, B. (2006). Towards the neurobiology of emotional body language. *Nature Reviews Neuroscience*, *7*(3), 242.

De Gelder, B., & Van den Stock, J. (2011). The bodily expressive action stimulus test (BEAST). Construction and validation of a stimulus basis for measuring perception of whole body expression of emotions. *Frontiers in psychology*, *2*, 181.

Diamond, E. L., Dagna, L., Hyman, D. M., Cavalli, G., Janku, F., Estrada-Veras, J., ... & Feeley, N. K. (2014). Consensus guidelines for the diagnosis and clinical management of Erdheim-Chester disease. *Blood*, *124*(4), 483-492.

Espinoza, F. A., Vergara, V. M., Reyes, D., Anderson, N. E., Harenski, C. L., Decety, J., ... & Koenigs, M. (2018). Aberrant functional network connectivity in psychopathy from a large (N= 985) forensic sample. *Human brain mapping*, *39*(6), 2624-2634.

Ewbank, M. P., Barnard, P. J., Croucher, C. J., Ramponi, C., & Calder, A. J. (2009). The amygdala response to images with impact. *Social cognitive and affective neuroscience*, *4*(2), 127-133.

Finger, E. C., Marsh, A. A., Kamel, N., Mitchell, D. G., & Blair, J. R. (2006). Caught in the act: The impact of audience on the neural response to morally and socially inappropriate behavior. *NeuroImage*, *33*(1), 414-421.

Fontaine, J. R., Luyten, P., De Boeck, P., & Corveleyn, J. (2001). The test of self-conscious affect: Internal structure, differential scales and relationships with long-term affects. *European Journal of Personality*, *15*(6), 449-463.

Franzen, E. A., & Myers, R. E. (1973). Neural control of social behavior: prefrontal and anterior temporal cortex. *Neuropsychologia*, *11*(2), 141-157.

Frick, P. J. (1995). Callous-unemotional traits and conduct problems: A two-factor model of psychopathy in children. *Issues in Criminological & Legal Psychology*.

Frühholz, S., Ceravolo, L., & Grandjean, D. (2011). Specific brain networks during explicit and implicit decoding of emotional prosody. *Cerebral Cortex*, *22*(5), 1107-1117.

Gao, Y., & Tang, S. (2013). Psychopathic personality and utilitarian moral judgment in college students. *Journal of Criminal Justice*, *41*(5), 342-349.

Gifuni, A. J., Kendal, A., & Jollant, F. (2017). Neural mapping of guilt: a quantitative meta-analysis of functional imaging studies. *Brain imaging and behavior*, *11*(4), 1164-1178.

Giovagnoli, A. R., Pesce, M., Del Mascheroni, S., Simoncelli, M., Laiacona, M., and Capitani, E. (1996). Trail making test: Normative values from 287 normal adult controls. *Ital. J. Neurol. Sci.* 17, 305–309.

Glenn, A. L., Raine, A., & Schug, R. A. (2009). The neural correlates of moral decision-making in psychopathy. *Molecular psychiatry*, *14*(1), 5.

Gregory, S., Simmons, A., Kumari, V., Howard, M., Hodgins, S., & Blackwood, N. (2012). The antisocial brain: psychopathy matters: a structural MRI investigation of antisocial male violent offenders. *Archives of general psychiatry*, *69*(9), 962-972.

Haidt, J. (2003). The moral emotions. *Handbook of affective sciences*, *11*(2003), 852-870.

Hare, R. D. (2003). *The psychopathy checklist–Revised* (*PCL-R*, 2nd ed.). Toronto, ON. Multi Health Systems

Harenski, C. L., Harenski, K. A., Shane, M. S., & Kiehl, K. A. (2010). Aberrant neural processing of moral violations in criminal psychopaths. *Journal of abnormal psychology*, *119*(4), 863.

Herry, C., Bach, D. R., Esposito, F., Di Salle, F., Perrig, W. J., Scheffler, K., ... & Seifritz, E. (2007). Processing of temporal unpredictability in human and animal amygdala. *Journal of Neuroscience*, *27*(22), 5958-5966.

Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., & Camerer, C. F. (2005). Neural systems responding to degrees of uncertainty in human decision-making. *Science*, *310*(5754), 1680-1683.

Jacobs, R. H., Renken, R., Aleman, A., & Cornelissen, F. W. (2012). The amygdala, top-down effects, and selective attention to features. *Neuroscience & Biobehavioral Reviews*, *36*(9), 2069-2084.

Johansen, J. P., Cain, C. K., Ostroff, L. E., & LeDoux, J. E. (2011). Molecular mechanisms of fear learning and memory. *Cell*, *147*(3), 509-524.

Johansen, J. P., Cain, C. K., Ostroff, L. E., & LeDoux, J. E. (2011). Molecular mechanisms of fear learning and memory. *Cell*, *147*(3), 509-524.

Kédia, G., Berthoz, S., Wessa, M., Hilton, D., & Martinot, J. L. (2008). An agent harms a victim: a functional magnetic resonance imaging study on specific moral emotions. *Journal of cognitive neuroscience*, *20*(10), 1788-1798.

Keen, S. (2008). *Perceived social rank, social expectation, shame and general emotionality within psychopathy* (Doctoral dissertation, University of London).

Keltner, D., & Buswell, B. N. (1997). Embarrassment: its distinct form and appeasement functions. *Psychological bulletin*, *122*(3), 250.

Kennedy, D. P., Gläscher, J., Tyszka, J. M., & Adolphs, R. (2009). Personal space regulation by the human amygdala. *Nature neuroscience*, *12*(10), 1226.

Klüver, H., & Bucy, P. C. (1937). "Psychic blindness" and other symptoms following bilateral temporal lobectomy in Rhesus monkeys. *American Journal of Physiology*.

Klüver, H., & Bucy, P. C. (1939). Preliminary analysis of functions of the temporal lobes in monkeys. *Archives of Neurology & Psychiatry*, *42*(6), 979-1000.

Koenigs, M., Kruepke, M., Zeier, J., & Newman, J. P. (2011). Utilitarian moral judgment in psychopathy. *Social cognitive and affective neuroscience*, *7*(6), 708-714.

Krikorian, R., Bartok, J., & Gay, N. (1994). Tower of London procedure: a standard method and developmental data. *Journal of clinical and Experimental Neuropsychology*, *16*(6), 840-850.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. University of Florida, Gainesville, FL

LeDoux, J. (2003). The Emotional Brain, Fear and the Amygdala. *Cellular and Molecular Neurobiology* vol. 23, pp. 727–738

LeDoux, J. (2007). The Amygdala. *Current Biology,* vol. 17(20), pp. 868-874

Machado, C. J., Kazama, A. M., & Bachevalier, J. (2009). Impact of amygdala, orbital frontal, or hippocampal lesions on threat avoidance and emotional reactivity in nonhuman primates. *Emotion*, *9*(2), 147.

Mason, W. A., Capitanio, J. P., Machado, C. J., Mendoza, S. P., & Amaral, D. G. (2006). Amygdalectomy and responsiveness to novelty in rhesus monkeys (Macaca mulatta): generality and individual consistency of effects. *Emotion*, *6*(1), 73.

Michl, P., Meindl, T., Meister, F., Born, C., Engel, R. R., Reiser, M., & Hennig-Fast, K. (2012). Neurobiological underpinnings of shame and guilt: a pilot fMRI study. *Social cognitive and affective neuroscience*, *9*(2), 150-157.

Monaco, M., Costa, A., Caltagirone, C., Carlesimo, G.A. (2013). Forward and backward span for verbal and visuo-spatial data: standardization and normative data from an Italian adult population. *Neurol Sci.* 34, 749–754.

Mondini, S., Mapelli, D., Vestri, A., & Bisiacchi, P. S. (2003). Esame neuropsicologico breve. *Milano: Raffaello Cortina Editore*, *160*.

Motzkin, J. C., Newman, J. P., Kiehl, K. A., & Koenigs, M. (2011). Reduced prefrontal connectivity in psychopathy. *Journal of Neuroscience*, *31*(48), 17348-17357.

Novelli, G., Papagno, C., Capitani, E., Laiacona, M., Vallar, G., and Cappa, S. F. (1986). Tre test clinici di memoria verbale a lungo termine. *Archivio di Psicologia Neurologia e Psichiatria.* 47, 278–296.

Öhman, A., Carlsson, K., Lundqvist, D., & Ingvar, M. (2007). On the unconscious subcortical origin of human fear. *Physiology & Behavior*, *92*(1-2), 180-185.

Pichon, S., de Gelder, B., & Grèzes, J. (2009). Two different faces of threat. Comparing the neural systems for recognizing fear and anger in dynamic body expressions. *Neuroimage*, *47*(4), 1873-1883.

Prado, C. E., Treeby, M. S., Rice, S. M., & Crowe, S. F. (2017). Facial emotion recognition, guilt and sub-clinical psychopathic traits: an exploration of mediation effects. *Motivation and Emotion*, *41*(5), 636-645.

Pulcu, E., Lythe, K., Elliott, R., Green, S., Moll, J., Deakin, J. F., & Zahn, R. (2014). Increased amygdala response to shame in remitted major depressive disorder. *PloS one*, *9*(1), e86900.

Sander, D., Grandjean, D., Pourtois, G., Schwartz, S., Seghier, M. L., Scherer, K. R., & Vuilleumier, P. (2005). Emotion and attention interactions in social cognition: brain regions involved in processing anger prosody. *Neuroimage*, *28*(4), 848-858.

Scarpina, F., D'Aniello, G. E., Mauro, A., Castelnuovo, G., & MacPherson, S. E. (2015). How many segments are there in an orange: normative data for the new Cognitive Estimation Task in an Italian population. *Neurological Sciences*, *36*(10), 1889-1895.

Smith, M. L., Cottrell, G. W., Gosselin, F., & Schyns, P. G. (2005). Transmitting and decoding facial expressions. *Psychological science*, *16*(3), 184-189.

Spezio, M. L., Huang, P. Y. S., Castelli, F., & Adolphs, R. (2007). Amygdala damage impairs eye contact during conversations with real people. *Journal of Neuroscience*, *27*(15), 3994-3997.

Spinnler, H., and Tognoni, G. (1987). Standardizzazione e taratura italiana di test neuropsicologici. *Ital. J. Neurol. Sci.* 8, 8-20.

Tangney, J. P., Miller, R. S., Flicker, L., & Barlow, D. H. (1996). Are shame, guilt, and embarrassment distinct emotions?. *Journal of personality and social psychology*, *70*(6), 1256.

Tangney, J. P., Stuewig, J., & Martinez, A. G. (2014). Two faces of shame: The roles of shame and guilt in predicting recidivism. *Psychological science*, *25*(3), 799-805.

Tangney, J. P., Stuewig, J., & Mashek, D. J. (2007). Moral emotions and moral behavior. *Annu. Rev. Psychol.*, *58*, 345-372.

Tangney, J. P., Stuewig, J., Mashek, D., & Hastings, M. (2011). Assessing jail inmates' proneness to shame and guilt: Feeling bad about the behavior or the self?. *Criminal justice and behavior*, *38*(7), 710-734.

Tangney, J. P., Wagner, P., & Gramzow, R. (1992). Proneness to shame, proneness to guilt, and psychopathology. *Journal of abnormal psychology*, *101*(3), 469.

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., ... & Nelson, C. (2009). The NimStim set of facial expressions: judgments from untrained research participants. *Psychiatry research*, *168*(3), 242-249.

Wagner, U., N'diaye, K., Ethofer, T., & Vuilleumier, P. (2011). Guilt-specific processing in the prefrontal cortex. *Cerebral cortex*, *21*(11), 2461-2470.

Weber, S., Habel, U., Amunts, K., & Schneider, F. (2008). Structural brain abnormalities in psychopaths—A review. *Behavioral sciences & the law*, *26*(1), 7-28.

Wechsler, D. (2014). Wechsler adult intelligence scale–Fourth Edition (WAIS–IV). *San Antonio, Texas: Psychological Corporation*.

Whalen, P. J. (1999). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current directions in psychological science*, *7*(6), 177-188.

Whalen, P. J. (2007). The uncertainty of it all. *Trends in cognitive sciences*, *11*(12), 499-500.

Whittle, S., Liu, K., Bastin, C., Harrison, B. J., & Davey, C. G. (2016). Neurodevelopmental correlates of proneness to guilt and shame in adolescence and early adulthood. *Developmental cognitive neuroscience*, *19*, 51-57.

Yang, Y., Raine, A., Narr, K. L., Colletti, P., & Toga, A. W. (2009). Localization of deformations within the amygdala in individuals with psychopathy. *Archives of general psychiatry*, *66*(9), 986-994.

Olthof, T., Schouten, A., Kuiper, H., Stegge, H., & Jennekens-Schinkel, A. (2000). Shame and guilt in children: Differential situational antecedents and experiential correlates. *British Journal of Developmental Psychology*, *18*(1), 51-64.

Chapter 4

Functional meta-analysis on shame and guilt

In collaboration with L. Piretti and R.I. Rumiati

Introduction

As said previously, shame is typically elicited by the belief that the individual's violation of moral standards defines who the individual is (Wong and Tsai, 2007). Hence, it is strictly dependent on how the individual believes other people see him/her and how they judge his/her inadequacy to fulfil social standards (Tangney et al., 1992). Even though people often use the terms guilt, shame and embarrassment interchangeably, there are important differences within the negative self-conscious emotions family (Gibson, 2015). The distinction between shame and embarrassment is still a matter of debate (for review see Crozier, 2014). For some, embarrassment may be intended as a specific expression of shame (Kaufman, 1989; Lewis, 1971; Probyn, 2005), while for others it might represent a distinct emotional entity (Keltner and Buswell, 1997; Tangney et al., 1996). However, embarrassment seems related to the violation of social conventions, while shame emerges when one perceives first-hand the violation of a moral norm (Keltner & Buswell, 1996; Tangney et al., 1996; Buss, 2001; Haidt, 2003; Tangney, 2003). Furthermore, shame and embarrassment are different in the duration (i.e., feeling of shame is usually longer than embarrassment) (Scheff, 1994) and in the intensity (i.e., shame is more intense than embarrassment) (Rochat, 2009). Nonetheless, both emotions share common features as well, as same specific physiological reactions (e.g., blushing) (Sabini and Silver, 2005) and action tendencies (e.g., inhibitory behaviour in order to reduce social presence) (Asendorpf, 1990, Keltner and Buswell, 1997).

As said in Chapter 1, shame and guilt are considered two different emotions. Guilt occurs when the violation of social norms induces harm or suffering to other individuals within the same social group (Hoffman, 1982; Fiske, 1991). While shame is a self-focused emotion in which the self is perceived as defective, guilt is other-oriented and it occurs when a specific action is typically perceived as wrong (Hoffman, 1982; Lewis, 1971; Lewis et al., 1993). The occurrence of guilt induces remorse and willlingness to repair the wrong action (Tangney et al., 2007). Empathy is another discriminating factor between shame and guilt: while guilt tends to increase the empathic concern towards other people, shame seems to disrupt empathic responses because of self-oriented distress (Tangney et al., 2007).

Moral behaviour is strictly implicated with the different action tendencies triggered by shame and guilt (see Table 4.1). On one hand, guilt proneness has been negatively associated with criminal recidivism in prison populations, which might be associated with the tendency to repair the moral transgression and highlighted the adaptive role of guilt. On the other hand, shame proneness has a paradoxical effect (Tangney et al., 2014), since it appears to modulate recidivism by means of two different mechanisms: it prompts individuals to blame others and to avoid taking their responsibilities for the transgressions (that is a risk factor for recidivism), but it also induces social withdrawal, which reduce the propensity to recidivism (Tangney et al., 2014).

	SHAME	GUILT
Target	What we are: related to the entire self. "I'm bad"	What we do: related to specific behaviours "What I did has been bad"
Level	Interpersonal – it occurs only with others	Intrapsychic – it occurs alone
Emotional activation	Painful	Less painful
Emotional perception	Difficult to recognize	Easy to recognize
Action tendency	Motivates hiding and inhibition	Motivates reparation to the situation
Relation with aggression, hostility, violence, externalization	Increased for shame-proneness individuals	Decreased for guilt- proneness individuals
Scapegoat	Blame mainly others	Blame myself
Responsibility	Deflected outward	Accepted

Table 4. 1 Differences between shame and guilt

Although the neural underpinnings of basic emotions (Ekman, 1992) have been extensively studied in the past years (Vytal and Hamann, 2010), self-conscious emotions only recently have received attention in the field of cognitive neuroscience. Studies on brain-impaired patients reported the disruption of moral behaviour (e.g., stealing, violence) as a consequence of damages within the medial prefrontal cortex (mPFC). This disturbance seems associated with the lack of remorse, especially when the damage occurs early in life (Anderson, 1999). Grey matter volume of the mPFC appears to be reduced (Gregory et al., 2012) in psychiatric individuals with antisocial personality disorder (APD) (American Psychiatric Association, 2013). Individuals with such a diagnosis show emotional lability, impulsivity, mood and anxiety disorders and reactive aggression (Hodgins et al., 2010). However, same individuals with psychopathic traits are characterized also by reduced affective experience of embarrassment and guilt, empathy and remorse lackness, and proneness to instrumental aggression (Blair et al., 2005). Together with the association of mPFC with self-referential processing (Schmitz et al., 2006), that is a crucial aspect of processing all of the self-conscious emotions, these findings suggest that both shame and guilt might rely on mPFC functioning.

However, mPFC is not the only region that deals with emotional processing. The anterior insula was proposed as a crucial area in self-referential processing as well (Johnson et al., 2005; Modinos et al., 2009). In addition, insula was also associated with emotional unpleasantness (Carretié et al., 2009), arousal (Lewis et al., 2006; Grecucci et al., 2013) and emotional awareness (Craig, 2009). These findings may be easily explained by a model proposed by Moll and colleagues (2008). In this model, moral emotions are sustained by a network: the interplay between prefrontal and temporal lobes would be responsible for the detection of the violation (by getting access to previous knowledge) and limbic and paralimbic cortices would be involved in representing affective responses (Moll et al., 2008). However, this model appears incomplete, since it does not take into account two important dimensions of emotional processing: specifically, a regulatory component and a specific output. Indeed, many different psychopathological populations are

associated with exaggerated subjective experience of self-conscious emotions that impairs severely patients' quality of life (Tangney et al., 1992). Specifically, dysregulated shame and guilt have been associated with obsessive-compulsive disorder (Weingarden and Renshaw, 2015), schizophrenia (Miller and Mason, 2005), depression (Orth et al., 2006), eating disorders (Goss and Allan, 2009; Troop et al., 2008), and post-traumatic stress disorder (Street and Arias, 2001; Harman and Lee, 2010) (see Table 4.2). Moreover, increased subjective experience of shame, but not guilt, has been found in patients with other personality disorders as borderline and narcissistic ones (Ritter et al., 2014) and individuals with social anxiety disorder (Hedman et al., 2013). Even the dorso-lateral prefrontal cortex (dlPFC) may play a role in regulating self-conscious emotions. Structural neuroimaging studies on clinical populations constantly highlighted a reduction of grey matter volume within this area. Specifically, lower dlPFC grey matter volume has been observed in obsessive-compulsive disorder (Rotge et al., 2010), depression (Grieve et al., 2013), schizophrenia (Glahn et al., 2008), bulimia nervosa (Schäfer et al., 2010) and PTSD (Li et al., 2014).

While similarities between shame and guilt are expected to be associated with common neural substrates, at the same time we predict how the already discussed behavioural differences between the two emotions may give rise to distinct neural underpinnings. For instance, since the ability of understanding others is specific for the generation of guilt feelings, regions as the temporo-parietal junction (TPJ) that is usually associated with theory of mind and empathy, they may be part of the guilt network, but not of the shame network. Conversely, inhibitory brain areas (e.g. premotor areas) that are involved in behavioural inhibition and withdrawal, they may be associated with shame feelings and not with guilt.

Disorder	**Shame**	**Guilt**	**Reference**
Social anxiety	Enhanced	Normal	Hedman et al., 2013
Depression	Enhanced	Enhanced	Orth et al., 2006
Narcissistic personality disorder	Enhanced	Reduced/Normal	Ritter et al., 2014; Tracy and Robins, 2004; Ronningstam, 2010
Schizophrenia	Enhanced	Enhanced	Miller & Mason, 2005
Antisocial personality disorder	Reduced	Reduced	Tangney et al., 2014
Obsessive-Compulsive	Enhanced	Enhanced	Weingarden & Renshaw, 2015
Eating Disorders	Enhanced	Enhanced	Goss and Allan, 2009; Troop et al., 2008
Post-Traumatic Stress Disorder	Enhanced		Street and Arias, 2001; Harman and Lee, 2010
Borderline Personality Disorder	Enhanced	Enhanced	Rüsch et al., 2007

Table 4. 2 Moral emotions and psychopathological conditions

In light of what said, in order to investigate if shame/embarrassment and guilt share common or distinct neural substrates, in this study we run a functional meta-analysis on previous research about these self-conscious emotions.

Method

We conducted a meticulous research on PubMed (https://www.ncbi.nlm.nih.gov/pubmed/) using the terms ((“fMRI” OR “functional magnetic resonance imaging” OR “PET”) AND (“shame” OR “embarrassment” OR “guilt” OR “moral emotions” OR “self-conscious emotions” OR "moral violations" OR "social standard violation")), and setting a range of dates between January 1st 1995 and December 14th 2018. We identified 123 studies matching those keywords. Subsequently, we sharpened our research by applying the following criteria:

1) papers originally published in English;

2) fMRI or PET studies including only task-related whole brain analyses. Studies reporting regions of interest (ROIs) analyses, resting-state fMRI analyses and structural analysis as diffusion tensor imaging (DTI) or voxel-based morphometry (VBM) were excluded;

3) we included only healthy adults: in case of studies involving neurological or psychiatric patients, children or adolescents, we considered only contrasts involving healthy controls, if reported;

4) we run two different meta-analyses: one including previous research about shame/embarrassment, the other one by considering functional studies investigating guilt. Specifically, we included studies contrasting shame/embarrassment vs. neutral or other emotional conditions and guilt vs. neutral or other emotional conditions. Studies failing to distinguish embarrassment/shame and guilt were excluded. We collapsed shame and embarrassment in the same set since these emotions share shame physiological reactions, same action tendencies and, as we said in the introduction, their distinction is still a matter of debate.

This method allowed us to identify 17 studies for the shame/embarrassment set (194 foci, 439 total subjects) and 17 studies for the guilt set (122 foci, 367 total subjects) (see Table 4.3). The most used paradigm in the included studies was the emotion induction through verbal scripts (shame/embarrassment = 5; guilt = 8), pictures (shame/embarrassment = 5), both scripts and pictures (guilt = 2), vignettes (shame/embarrassment = 5) or movies (guilt = 1), while a few studies used the recollection of autobiographical memories through verbal scripts (shame/embarrassment = 1; guilt = 3), interpersonal games (shame/embarrassment = 1, guilt = 3), or implicit association task (guilt = 1).

Subset	Authors	Paradigm	Stimulus type	Contrasts	Foci	Subjects (Female)
Shame/	Bas-Hoogendam et al. 2017	Induction	Verbal scripts	Unintentional violations > neutral	5	21(15)
embarrassment	Berthoz et al. 2002	Induction	Verbal scripts	Unintentional violations > normal	15	12(0)
	Finger et al. 2006	Induction	Verbal scripts	Moral and social with audience > social and neutral without audience	2	16(-)
	Krach et al. 2011	Induction	Vignettes	Vicarious embarrassment > neutral	9	32(17)
	Krach et al. 2015	Induction	Vignettes	Social pain > social neutral	17	16(0)
	Laneri et al., 2017	Induction	Vignettes	Empathic embarrassment > neutral	14	51(21)
	Melchers et al. 2015	Induction	Pictures	Vicarious embarrassment > neutral	6	60(39)
	Michl et al. 2012	Induction	Verbal scripts	Shame > neutral	10	14(7)

	Morita et al. 2008	Induction	self- and other-faces	Self-face > other-face	9	19(10)
	Morita et al. 2012	Induction	self- and other-faces	Self-face > other-face	29	15(2)
	Morita et al. 2014	Induction	self- and other-faces	Self-face > other-face	17	32(16)
	Morita et al. 2016	Induction	self- and other-faces	Self-face > other-face	13	18(0)
	Paulus et al. 2015	Induction	Vignettes	Positive correlation of vicarious embarrassment	11	32(17)
	Paulus et al. 2018	Induction	Vignettes	Fremdscham > neutral	15	34(0)
	Takahashi et al. 2004	Induction	Verbal scripts	Embarrassment > neutral	10	19(9)
	Wagner et al. 2011	Recollection	Verbal scripts	Shame > neutral	10	15(15)
	Zhu et al., 2018	Interpersonal game	Pictorial stimuli (dots)	Shame > happiness	2	30(17)
Guilt	Basile B et al. 2011	Induction	Verbal and facial stimuli	Guilt > anger and sadness	3	22(13)
	Finger et al. 2006	Induction	Verbal scripts	Moral > social and neutral	5	16(-)
	Fourie et al. 2014	implicit association task	verbal and facial stimuli	Prejudice feedback > neutral feedback	5	22(22)
	Gilead et al. 2016	Induction	Verbal scripts	Guilt > anger, joy, pride	10	19(14)
	Gradin et al. 2016	Interpersonal game	Verbal	Defection > cooperation	6	25(17)
	Green et al. 2012	Induction	Verbal scripts	Guilt > indignation (Within HC)	7	22(18)
	Kédia et al. 2008	Induction	Verbal scripts	Guilt > self-anger	4	29(14)
	Michl et al. 2012	Induction	Verbal scripts	Guilt > neutral	19	14(7)
	Molenberghs et al., 2015	Induction	Video	Civilians > Soldiers	3	48(24)
	Morey et al. 2012	Induction	Verbal scripts	Positive correlation of guilt	6	16(0)
	Peth et al., 2015	Recollection	Verbal	Guilty action > neutral	10	20(6)
	Shin et al. 2000	Recollection	Verbal scripts	Guilt > neutral	8	8(0)
	Takahashi et al. 2004	Induction	Verbal scripts	Guilt > neutral	5	19(9)
	Ty et al. 2017	Induction	Verbal and pictorial stimuli	Restitution > harm	1	18(9)
	Wagner et al. 2011	Recollection	Verbal scripts	Guilt > neutral	24	15(15)
	Yu et al. 2014	Interpersonal game	Pictorial stimuli (dots)	Self-incorrect > both incorrect	1	24(11)
	Zhu et al., 2018	Interpersonal game	Pictorial stimuli (dots)	Guilt > happiness	5	30(17)

Table 4. 3 Studies investigating shame/embarrassment and guilt brain processing

Statistical analyses

Analyses were conducted using the software GingerALE v2.4.6 (http://brainmap.org/). The activation likelihood estimation method, implemented in the software (Eickhoff et al., 2009; 2012; Turkeltaub et al., 2012), uses probability theory to define the spatial convergence of foci reported in the selected studies. Specifically, a Gaussian blur with an empirically-derived full-width half maximum (dependent on the number of participants included in the study) is applied to each focus from a single study. Then, all the foci from a single study are represented in a modelled activation map and voxel-wise ALE scores are computed combining all the individual maps. To distinguish between true convergence of foci from random noise a permutation test is applied. We followed the method described by Turkeltaub et al. (2012) that minimizes within-study effects, preventing the summation of foci of the same experiment that are placed close to each other. For both meta-analyses, we applied a cluster-level family-wise error correction using an uncorrected *p*-

value < .001 for individual voxels, 1000 permutations and a cluster-level threshold of $p < .05$, as suggested by Eickhoff and collaborators (2016). In addition, since paradigms and stimuli of the studies included in both meta-analyses were quite heterogeneous, we performed sensitivity analyses. We run again the analyses discarding 1) studies using autobiographical memory recall paradigms from the guilt dataset (N = 3) and 2) studies using facial stimuli from the shame/embarrassment dataset (N = 4). This has been done to prevent the risk that neural activations would depend solely on the specific paradigm and stimuli and not on the emotional component itself.

Finally, in order to highlight similarities and differences between shame/embarrassment and guilt activation maps we performed contrast (conjunction and subtraction) analyses by comparing the two different sets of studies. Contrast analyses were performed subtracting one of the outputs of the previous analyses (ALE images) to the other (i.e., Shame/Embarrassment vs. Guilt, Guilt vs. Shame/Embarrassment). Since the two sets of studies differ in the sample size, GingerALE software computes a simulation of data randomly pooling the original data and then creating two new sets of the same size of the original datasets. For each new dataset, an ALE image is created and then subtracted to the other. These simulated images are compared with the real observed data. After 10^4 permutations, a voxelwise P-value image reveals for each voxel, where the real data is located in the distribution of all the possible values (for that specific voxel). Values are converted into z-scores. Contrast analyses results are presented with a threshold of $p < .05$ uncorrected and a cluster size > 200 mm^3, since input data for these contast analyses were already corrected for multiple comparsions, as in previous studies (Eickoff et al., 2012, Laird et al., 2005; Zmigrod et al., 2016). We used MRIcroGL (https://www.mccauslandcenter.sc.edu/mricrogl) to visualize results.

Results

Shame/Embarrassment

The meta-analysis on shame/embarrassment revealed 8 significant clusters (see Figure 4 and Table 4.3). One cluster included the left anterior insula and the *pars orbitalis* of the left inferior frontal gyrus (cluster 1), while 6 clusters were located within the frontal lobes and included left medial prefrontal cortex (cluster 2), left pre-supplementary motor area (pre-SMA) (cluster 4), right dorsal ACC (cluster 5), the left pars triangularis (cluster 6) and the right pars opercularis (cluster 8) of the inferior frontal gyrus and the right dorsolateral prefrontal cortex (DLPFC) (cluster 7). Another cluster was located at the level of basal ganglia (cluster 3), involving the medial portion of thalami bilaterally and the caudate body.

The sensitivity analysis performed discarding studies using facial stimuli (number of studies discarded = 4) revealed only five clusters. Indeed, clusters 5, 6, 7 and 8 (see Table 4.4), involving mainly dACC, DLPFC and premotor areas, did not reach the significance threshold in this analysis. In addition, the cluster involving anterior insula and IFGorb, found in the previous analysis, gave rise to two different clusters, one involving the anterior insula, and the other involving IFGorb.

Cluster #	Volume (mm^3)	Extrema Value	Coordinate			Side	Anatomical Label	BA
			x	y	z			
1	3896	27.37	-28	22	8	Left	Anterior Insula	
		17.81	-36	20	-8		IFGorb	47
2	2064	21.19	-10	44	26	Left	Medial frontal gyrus	9
		19.53	-20	36	36		Superior frontal gyrus	9
		17.05	-6	38	42		Medial frontal gyrus	8
3	1976	29.51	-6	-10	10	Left	Thalamus	
		18.24	-14	4	14	Left	Caudate	
		15.41	6	-20	6	Right	Thalamus	
4	1688	22.70	-6	14	44	Left	Pre-SMA	6
		22.57	-6	14	48		Pre-SMA	8
		20.21	-8	18	32		dACC	32
5*	1016	16.64	4	-2	34	Right	dACC	24
		16.45	4	16	36		dACC	32
6*	976	17.42	-42	28	16	Left	Middle frontal gyrus	46
		13.98	-52	20	12		IFGtri	45
7*	960	25.41	42	30	14	Right	Middle frontal gyrus	46
8*	832	21.25	44	2	30	Right	Precentral gyrus/IFGop	9

Table 4. 4 Results of the meta-analysis on shame/embarrassment processing

Note. The table shows results on the meta-analysis on shame/embarrassment neural correlates. BA = Brodmann's area, IFGorb = Inferior frontal gyrus pars orbitalis, IFGtri = Inferior Frontal gyrus pars triangularis, IFGop = Inferior frontal gyrus pars opercularis, * = not reach the significance level when studies using facial stimuli are excluded from the analysis. Results are corrected with cluster-wise correction, using $p < .001$ at the voxel level and $p < .05$ at the cluster level. Coordinates are in Talaraich space.

Guilt

The meta-analysis on guilt revealed three significant clusters (See Figure 4.1 and Table 4.4). Two clusters were located at the level of insula, with a bigger cluster on the left hemisphere (cluster 1), and a smaller one on the right hemisphere (cluster 3). The other cluster was located on the posterior part of the left superior temporal gyrus, at the border with the parietal lobe (cluster 2). The same analysis obtained excluding studies using autobiographical memory recollection paradigms from the dataset (N = 3) led the right anterior insula cluster (cluster 3) to not reach the significance threshold (see Table 4.5).

Cluster #	Volume	ALE value	Coordinates	Side	Anatomical label	BA

	(mm³)	(*10³)						
			x	y	z			
1	1528	23.42	-32	18	-2	Left	Anterior insula/IFGorb	47
2	1080	20.34	-44	-58	16	Left	Superior temporal gyrus	22
3*	848	14.65	30	20	4	Right	Anterior insula	
		11.04	32	16	-10			
		10.81	28	16	-6			

Table 4. 5 Results of the meta-analysis on guilt processing

Note. The table shows results on the meta-analysis on guilt neural correlates. BA = Brodmann's area, IFGorb = Inferior frontal Gyrus pars orbitalis, * = not reach the significance level when studies using autobiographical memory recall tasks are excluded from the analysis. Results are corrected with cluster-wise correction, using $p < .001$ at the voxel level and $p < .05$ at the cluster level. Coordinates are in Talaraich space.

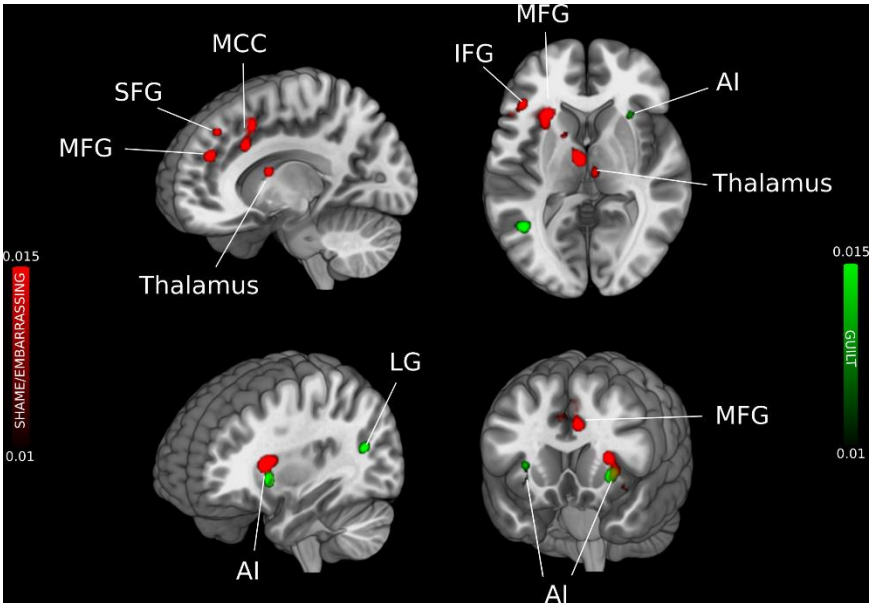


Figure 4. 1 Shame/Embarrassment and Guilt functional activations

Contrast analyses

Conjunction analyses (see Figure 4.2 and Table 4.6) showed that both shame/embarrassment and guilt shared the activation of one cluster located within left ventral anterior insula and the *pars orbitalis* of the left inferior frontal gyrus. Subtraction analyses revealed no significant cluster for the subtraction 'guilt vs. shame/embarrassment' and eight clusters for the contrast 'shame/embarrassment vs. guilt'. It is worth noting that, while seven of these clusters corresponded to clusters from 2 to 8 of the shame/embarrassment meta-analysis, the other cluster included only the dorsal portion of the left anterior insula, being located superiorly to the one emerging from conjunction analysis.

Shame/embarrassment and Guilt

Cluster #	Volume (mm^3)	ALE value ($*10^3$)	Coordinates			Side	Anatomical label	BA
			x	y	z			
1	1160	18.76	-34	18	0	Left	Anterior insula/IFGorb	47
Shame/embarrassment vs. Guilt								
Cluster #	Volume (mm^3)	Z-scores	Coordinates			Side	Anatomical label	BA
			x	y	z			
1	1280	2.56	0	-10	12	Left	Thalamus	
		2.14	-10	2	14		Caudate	
2	1280	3.06	-30	20	14	Left	Anterior insula	
3	1200	2.56	-8	17	43	Left	dACC	32
		1.98	-10	14	48		Pre-SMA	6
4	1000	3.06	0	4	36	Right	dACC	24
5	960	2.36	40	28	18	Right	Middle frontal gyrus	46
		2.07	44	32	8		IFGorb	46
6	688	3.24	-39	28	17	Left	Middle frontal gyrus	46
7	672	2.44	-18	32	36	Left	Middle frontal gyrus	8
		2.18	-14	38	34		Superior frontal gyrus	9
		2.13	-20	40	36		Superior frontal gyrus	9
8	536	2.12	48	1	29	Right	Precentral gyrus	6
		1.89	46	3	36		Precentral gyrus	6

Table 4. 6 Contrast analysis results.

Note. The table shows results on the meta-analysis on guilt neural correlates. BA = Brodmann's area, dACC = dorsal anterior cingulate cortex, pre-SMA = pre-supplementary motor area, IFGorb = Inferior frontal gyrus pars orbitalis. Results are uncorrected with $p < .05$. Coordinates

are in Talaraich space.

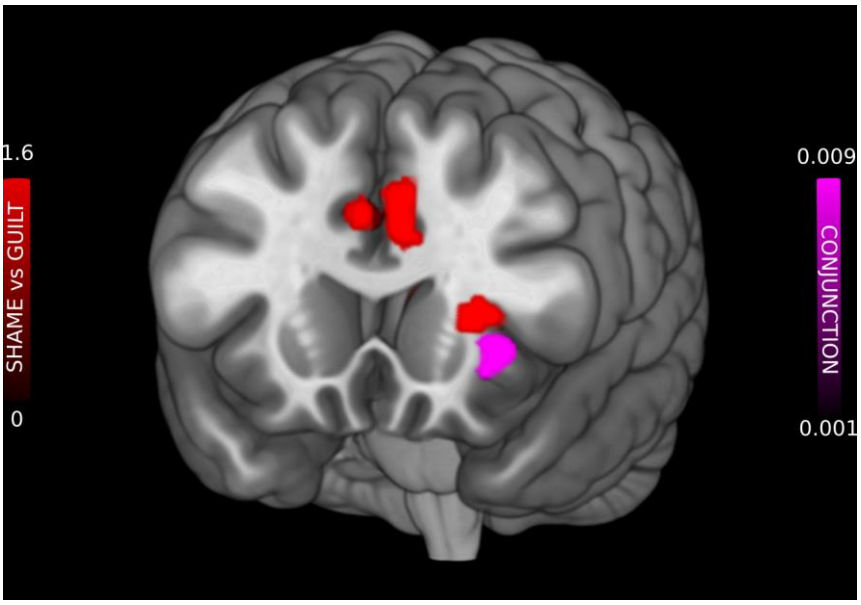


Figure 4. 2 Conjunction analysis between Shame/Embarrassment and Guilt showing the left anterior insula.

Discussion

In this study, we capitalized on the functional neuroimaging literature on shame/embarrassment and guilt aiming to identify the brain areas consistently associated with the processing of these emotions. Our results reveal that shame/embarrassment and guilt processing is linked to activations within the left anterior insula, but that these emotions are associated with specific sets of areas as well.

Common areas

We know that the anterior insula is associated with a wide variety of tasks (see Craig 2009). Among the cognitive functions associated with anterior insula that include also interoception, pain perception and body awareness, it is worth mentioning its role in emotional awareness (Craig, 2009), arousal and self-reflection (e.g., Johnson et al., 2005; Modinos et al., 2009). In addition, patients with lesion within insular cortices reported pain asymbolia (Berthier et al., 1988), a condition in which they are still able to localize a painful stimulation and to identify it as pain but its unpleasant aspects are lost (e.g. bodily, emotional and behavioural signs)(Aydede, 2005). The same type of patients showed reduced arousal ratings, and attenuated valence rating to emotional stimuli than both pathological and healthy controls (Berntson et al., 2011). The interpretation of these findings is not univocal. If on the one hand, they might reflect the impairment in arousal processing, on the other they might be caused also by a deficit in emotional awareness. In addition, anterior insula activation was reported in functional neuroimaging studies on healthy individuals investigating self-referential processing (e.g., Johnson et al., 2005; Modinos et al., 2009). Hence, the association between negative self-conscious emotion processing and the activation of left anterior insula might reflect the awareness of the subjective

experience of shame/embarrassment and guilt, its intensity, or self-directed evaluation processes that are necessary in order to generate both guilt and shame experiences.

Contrary to our predictions, the conjunction analysis did not show the involvement of mPFC in representing both shame and guilt. Although our shame/embarrassment meta-analysis revealed the activation of the left mPFC (cluster 2), guilt did not follow the same pattern. However, using a more liberal threshold ($p < .001$ uncorrected, minimum cluster size = 250), the activation of the very same area in association with guilt processing emerged, possibly reflecting the heterogeneity of the paradigm and stimuli included in the guilt dataset. It is worth noting that these clusters of activations overlap with the results of a previous meta-analysis on guilt processing (Gifuni et al., 2017). The mPFC represents a high-level integration area and supports different aspects of social and affective processing (Amodio and Frith, 2006; Roy et al., 2012). These processes range from self-reflection (van der Meer et al., 2010) to person perception (Mitchell et al., 2002), affective appraisal (Scherer, 2001), theory of mind (Frith and Frith 2006) and finally learning and predicting actions outcome (Alexander and Brown, 2011). Moreover, functional studies about moral judgement reported an involvement of the same area, specifically by comparing moral evaluations with non-moral or neutral baselines (Garrigan et al., 2016). Through a direct connection with anterior temporal lobes, mPFC may associate external stimuli (context-based information) with their socio-emotional value (Moll et al., 2008). At the same time, mPFC might be involved in self-referential processing (e.g., representation of traits, abilities, attitudes and behaviours regarding the self), which is necessary in order to generate self-conscious emotions. This latter hypothesis seem to be confirmed by neuropsychological studies showing that patients with mPFC lesions were impaired in self-referential memory (Philippi et al., 2011), self-evaluation (Schmitz et al., 2006) and self-referential verbal production (Kurczek et al., 2015).

A neural map for shame

Since we know that feelings of shame/embarrassment lead to self-emotional distress (Tangney et al., 2007), it is not surprising to find the involvement of the dorsal ACC (cluster 4 and 5), left anterior insula (cluster 1) and the medial nuclei of the thalami (cluster 3) in the processing of these emotions. Neuropsychological patients with dorsal ACC lesions, typically induced in order to treat drug-resistant pain (Yen et al., 2005), are still able to perceive and correctly localize painful sensations, but such sensations do not cause distress anymore (Foltz and White, 1962). Moreover, the surgical lesion of the dorsal ACC also leads to a reduced concern about social judgment of other people (Tow and Whitty, 1953); in addition, it can be used in the treatment of drug-resistant obsessive-compulsive disorder, a psychiatric syndrome which is often associated with extremely intense shame experiences (Weingarden et al., 2015). Medial thalamic nuclei are involved in affective aspects of physical pain perception and attachment-related processes (Price, 2000). It is worth noting that all these areas highly overlap with those involved in both physical and social pain processing (Eisenberger, 2012). Social pain is defined as the unpleasant experience associated with damage to social bonds or to social values (e.g., rejection, negative social evaluations, bereavement), and is processed by part of the neural circuit involved in physical pain (MacDonald and Leary, 2005). The linkage is intuitive. Shame and

embarrassment are components of social pain, since they intervene when social standards are not achieved. (MacDonald and Leary, 2005).

Our results about shame/embarrassment also revealed the right premotor area (cluster 8) and the left pre-SMA (cluster 4), that have been associated with motor and speech inhibition (Simmonds et al., 2008; Xue et al., 2008). Both shame and embarrassment lead to a reduction of social presence, speech and movements (Asendorpf, 1990, Keltner and Buswell, 1997), which could explain the activation of areas involved in motor and speech inhibition in shame/embarrassment processing. In addition, such activations could be a reflection of the urge to move and escape in order to protect the individual.

Bilateral dlPFC activations (cluster 7) might represent top-down regulatory mechanisms that prevent exaggerated shameful responses. Indeed, in addition to cognitive control (MacDonald et al., 2000), dlPFC might be also involved in regulating emotions (Etkin et al, 2015). Several psychiatric disorder are typified by lower grey matter volume within the dlPFC, as the obsessive-compulsive disorder (Rotge et al., 2010), depression (Grieve et al., 2013), schizophrenia (Glahn et al., 2008), bulimia nervosa (Schäfer et al., 2010) and PTSD (Li et al., 2014); interestingly, abnormal shameful perception and regulation is a key feature among all of them. This leads us to speculate that dlPFC may have a modulatory function in shameful situations.

A neural map for guilt

We already said that guilt is modulated by social abilities, as empathy and theory of mind (Leith and Baumeister, 1998; Bastin et al., 2016). Based on our data, guilt processing related to TPJ, which is consistently considered an important hub for social processes as distinguishing self- and other-actions and representing other individuals' mental and affective states (See Decety and Lamm, 2007 for a meta-analysis). Although in our contrast analysis (i.e. guilt vs shame/embarrassment) TPJ did not reach significance level), in light of results from a previous meta-analisis (Gifuni et al., 2017), the well-defined relation between guilt and the theory of mind and between the theory of mind and the TPJ, we speculate that this area may play an important role in the processing of guilt. Feeling of guilt increases the comprehension of others' affective and mental states (Tangney et al., 2007), but at the same time taking others' perspective and empathising with others seem to be crucial for experiencing guilt (Giammarco et al., 2015). Hence, our results might refer to functions that are cause or consequence of the emotional experience.

Additional explorative analyses by excluding autobiographical memory recall paradigms from our dataset corroborated the link between guilt and the left anterior insula and the TPJ. In fairness, however, this analysis showed also that the cluster located over the right insular cortex did not reach the significance level, suggesting that guilt induction tends to activate less consistently right than left insula.

Limitations

There are two critical issues in this study. A limitation of our study is the small amount of studies investigating shame, embarrassment and guilt, and the relative small number of participants included. In addition, the huge variety of

paradigm investigating self-conscious emotions, including reading scripts, viewing vignettes and recalling autobiographical memories, might affect the reliability of the results.

Conclusions

Our meta-analysis revealed common and distinct neural substrates for the processing of shame/embarrassment and guilt. While the activation of left anterior insula was associated with both shame/embarrassment and guilt processing, the pain network, including medial thalami, dorsal ACC and inferior anterior insula, and premotor areas were specifically associated with shame/embarrassment processing and left TPJ and right anterior insula were associated with specific guilt processing. However, due to the lack of studies investigating self-conscious emotions and the variety of experimental paradigms used, further research is necessary in order to establish overlapping and distinct brain networks among them.

References

Alexander, W. H., & Brown, J. W. (2011). Medial prefrontal cortex as an action-outcome predictor. *Nature neuroscience*, *14*(10), 1338.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nature Reviews Neuroscience*, *7*(4), 268.

Anderson, S. W., Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1999). Impairment of social and moral behavior related to early damage in human prefrontal cortex. *Nature neuroscience*, *2*(11), 1032.

Asendorpf, J. B. (1990). Development of inhibition during childhood: Evidence for situational specificity and a two-factor model. *Developmental Psychology*, *26*(5), 721.

Aydede, M. (Ed.). (2005). *Pain: new essays on its nature and the methodology of its study*. *MIT Press*.

Bas-Hoogendam, J. M., van Steenbergen, H., Kreuk, T., van der Wee, N. J., & Westenberg, P. M. (2017). How embarrassing! The behavioral and neural correlates of processing social norm violations. *PloS one*, 12(4), e0176326.

Basile, B., Mancini, F., Macaluso, E., Caltagirone, C., Frackowiak, R. S., & Bozzali, M. (2011). Deontological and altruistic guilt: evidence for distinct neurobiological substrates. *Human Brain Mapping*, *32*(2), 229-239.

Bastin, C., Harrison, B. J., Davey, C. G., Moll, J., & Whittle, S. (2016). Feelings of shame, embarrassment and guilt and their neural correlates: A systematic review. *Neuroscience & Biobehavioral Reviews*, *71*, 455-471.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological bulletin*, *117*(3), 497.

Berntson, G. G., Norman, G. J., Bechara, A., Bruss, J., Tranel, D., & Cacioppo, J. T. (2011). The insula and evaluative processes. *Psychological science*, *22*(1), 80-86.

Berthier, M., Starkstein, S., & Leiguarda, R. (1988). Asymbolia for pain: A sensory-limbic disconnection syndrome. *Annals of neurology*, *24*(1), 41-49.

Berthoz, S., Armony, J. L., Blair, R. J. R., & Dolan, R. J. (2002). An fMRI study of intentional and unintentional (embarrassing) violations of social norms. *Brain*, *125*(8), 1696-1708.

Blair, R. J. R. (1995). A cognitive developmental approach to morality: Investigating the psychopath. *Cognition*, *57*(1), 1-29.

Buss, A. (2001). Psychological dimensions of the self. Thousand Oaks, CA, US: Sage Publications, Inc

Carretié, L., Albert, J., López-Martín, S., & Tapia, M. (2009). Negative brain: an integrative review on the neural processes activated by unpleasant stimuli. *International Journal of Psychophysiology*, *71*(1), 57-63.

Craig, A. D., & Craig, A. D. (2009). How do you feel--now? The anterior insula and human awareness. *Nature reviews neuroscience*, *10*(1).

Crozier, W. R. (2014). Differentiating shame from embarrassment. *Emotion Review*, *6*(3), 269-276.

Decety, J., & Lamm, C. (2007). The role of the right temporoparietal junction in social interaction: how low-level computational processes contribute to meta-cognition. *The Neuroscientist*, *13*(6), 580-593.

Eickhoff, S. B., Bzdok, D., Laird, A. R., Kurth, F., & Fox, P. T. (2012). Activation likelihood estimation meta-analysis revisited. *Neuroimage*, *59*(3), 2349-2361.

Eickhoff, S. B., Laird, A. R., Grefkes, C., Wang, L. E., Zilles, K., & Fox, P. T. (2009). Coordinate-based activation likelihood estimation meta-analysis of neuroimaging data: A random-effects approach based on empirical estimates of spatial uncertainty. *Human brain mapping*, *30*(9), 2907-2926.

Eickhoff, S. B., Nichols, T. E., Laird, A. R., Hoffstaedter, F., Amunts, K., Fox, P. T., ... & Eickhoff, C. R. (2016). Behavior, sensitivity, and power of activation likelihood estimation characterized by massive empirical simulation. *Neuroimage*, *137*, 70-85.

Eisenberger, N. I. (2012). The pain of social disconnection: examining the shared neural underpinnings of physical and social pain. *Nature Reviews Neuroscience*, *13*(6), 421.

Ekman, P. (1992). An argument for basic emotions. *Cognition & emotion*, *6*(3-4), 169-200.

Etkin, A., Büchel, C., & Gross, J. J. (2015). The neural bases of emotion regulation. *Nature reviews neuroscience*, *16*(11), 693.

Finger, E. C., Marsh, A. A., Kamel, N., Mitchell, D. G., & Blair, J. R. (2006). Caught in the act: The impact of audience on the neural response to morally and socially inappropriate behavior. *NeuroImage*, *33*(1), 414-421.

Fiske, A. P. (1991). Structures of social life: The four elementary forms of human relations: Communal sharing, authority ranking, equality matching, market pricing. New York, NY, US: Free Press.

Foltz, E. L., & White Jr, L. E. (1962). Pain "relief" by frontal cingulumotomy. *Journal of neurosurgery*, 19(2), 89-100.

Fourie, M. M., Thomas, K. G., Amodio, D. M., Warton, C. M., & Meintjes, E. M. (2014). Neural correlates of experienced moral emotion: an fMRI investigation of emotion in response to prejudice feedback. *Social neuroscience*, *9*(2), 203-218.

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron*, *50*(4), 531-534.

Garrigan, B., Adlam, A. L., & Langdon, P. E. (2016). The neural correlates of moral decision-making: A systematic review and meta-analysis of moral evaluations and response decision judgements. *Brain and cognition*, *108*, 88-97.

Giammarco, E. A., & Vernon, P. A. (2015). Interpersonal guilt and the dark triad. *Personality and Individual Differences*, *81*, 96-101.

Gibson, M. (2015). Shame and guilt in child protection social work: new interpretations and opportunities for practice. *Child & Family Social Work*, *20*(3), 333-343.

Gifuni, A. J., Kendal, A., & Jollant, F. (2017). Neural mapping of guilt: a quantitative meta-analysis of functional imaging studies. *Brain imaging and behavior*, *11*(4), 1164-1178.

Gilead, M., Katzir, M., Eyal, T., & Liberman, N. (2016). Neural correlates of processing "self-conscious" vs."basic" emotions. *Neuropsychologia*, *81*, 207-218.

Glahn, D. C., Laird, A. R., Ellison-Wright, I., Thelen, S. M., Robinson, J. L., Lancaster, J. L., ... & Fox, P. T. (2008). Meta-analysis of gray matter anomalies in schizophrenia: application of anatomic likelihood estimation and network analysis. *Biological psychiatry*, *64*(9), 774-781.

Goss, K., & Allan, S. (2009). Shame, pride and eating disorders. *Clinical psychology & psychotherapy*, *16*(4), 303-316.

Gradin, V. B., Pérez, A., Macfarlane, J. A., Cavin, I., Waiter, G., Tone, E. B., ... & Steele, J. D. (2016). Neural correlates of social exchanges during the Prisoner's Dilemma game in depression. *Psychological medicine*, *46*(6), 1289-1300.f

Grecucci, A., Giorgetta, C., Van't Wout, M., Bonini, N., & Sanfey, A. G. (2013). Reappraising the ultimatum: an fMRI study of emotion regulation and decision making. *Cerebral Cortex*, *23*(2), 399-410.

Green, S., Ralph, M. A. L., Moll, J., Deakin, J. F., & Zahn, R. (2012). Guilt-selective functional disconnection of anterior temporal and subgenual cortices in major depressive disorder. *Archives of General Psychiatry*, *69*(10), 1014-1021.

Gregory, S., Simmons, A., Kumari, V., Howard, M., Hodgins, S., & Blackwood, N. (2012). The antisocial brain: psychopathy matters: a structural MRI investigation of antisocial male violent offenders. *Archives of general psychiatry*, *69*(9), 962-972.

Grieve, S. M., Korgaonkar, M. S., Koslow, S. H., Gordon, E., & Williams, L. M. (2013). Widespread reductions in gray matter volume in depression. *NeuroImage: Clinical*, *3*, 332-339.

Haidt, J. (2003). The moral emotions. *Handbook of affective sciences*, *11*(2003), 852-870.

Harman, R., & Lee, D. (2010). The role of shame and self-critical thinking in the development and maintenance of current threat in post-traumatic stress disorder. *Clinical psychology & psychotherapy*, *17*(1), 13-24.

Hedman, E., Ström, P., Stünkel, A., & Mörtberg, E. (2013). Shame and guilt in social anxiety disorder: effects of cognitive behavior therapy and association with social anxiety and depressive symptoms. *PloS One*, *8*(4), e61713.

Hodgins, S., De Brito, S. A., Chhabra, P., & Côté, G. (2010). Anxiety disorders among offenders with antisocial personality disorders: a distinct subtype?. *The Canadian Journal of Psychiatry*, *55*(12), 784-791.

Hoffman, M. L. (1982). Development of prosocial motivation: Empathy and guilt. In *The development of prosocial behavior* (pp. 281-313).

Johnson, S. C., Schmitz, T. W., Kawahara-Baccus, T. N., Rowley, H. A., Alexander, A. L., Lee, J., & Davidson, R. J. (2005). The cerebral response during subjective choice with and without self-reference. *Journal of cognitive neuroscience*, *17*(12), 1897-1906.

Kaufman, G. (1989). The psychology of shame: Theory and treatment of shame-based syndromes. New York, NY, US: Springer Publishing Co.

Kédia, G., Berthoz, S., Wessa, M., Hilton, D., & Martinot, J. L. (2008). An agent harms a victim: a functional magnetic resonance imaging study on specific moral emotions. *Journal of cognitive neuroscience*, *20*(10), 1788-1798.

Keltner, D., & Buswell, B. N. (1996). Evidence for the distinctness of embarrassment, shame, and guilt: A study of recalled antecedents and facial expressions of emotion. *Cognition and Emotion*, 10, 155-171.

Keltner, D., & Buswell, B. N. (1997). Embarrassment: its distinct form and appeasement functions. *Psychological bulletin*, *122*(3), 250.

Krach, S., Cohrs, J. C., de Echeverría Loebell, N. C., Kircher, T., Sommer, J., Jansen, A., & Paulus, F. M. (2011). Your flaws are my pain: Linking empathy to vicarious embarrassment. *PLoS One*, *6*(4), e18675.

Krach, S., Kamp-Becker, I., Einhäuser, W., Sommer, J., Frässle, S., Jansen, A., ... & Paulus, F. M. (2015). Evidence from pupillometry and fMRI indicates reduced neural response during vicarious social pain but not physical pain in autism. *Human Brain Mapping*, *36*(11), 4730-4744.

Kroll, J., & Egan, E. (2004). Psychiatry, moral worry, and the moral emotions. *Journal of Psychiatric Practice®*, *10*(6), 352-360.

Kurczek, J., Wechsler, E., Ahuja, S., Jensen, U., Cohen, N. J., Tranel, D., & Duff, M. (2015). Differential contributions of hippocampus and medial prefrontal cortex to self-projection and self-referential processing. *Neuropsychologia*, *73*, 116-126.

Laird, A. R., Fox, P. M., Price, C. J., Glahn, D. C., Uecker, A. M., Lancaster, J. L., ... & Fox, P. T. (2005). ALE meta-analysis: Controlling the false discovery rate and performing statistical contrasts. *Human brain mapping*, *25*(1), 155-164.

Laneri, D., Krach, S., Paulus, F. M., Kanske, P., Schuster, V., Sommer, J., & Müller-Pinzler, L. (2017). Mindfulness meditation regulates anterior insula activity during empathy for social pain. *Human brain mapping*, *38*(8), 4034-4046.

Leith, K. P., & Baumeister, R. F. (1998). Empathy, shame, guilt, and narratives of interpersonal conflicts: Guilt-prone people are better at perspective taking. *Journal of personality*, *66*(1), 1-37.

Lewis, H. B. (1971). Shame and guilt in neurosis. *Psychoanalytic review*, *58*(3), 419.

Lewis, M., Haviland-Jones, J. M., & Feldman Barrett, L. (1993). Handbook of Emotions. New York.

Lewis, P. A., Critchley, H. D., Rotshtein, P., & Dolan, R. J. (2006). Neural correlates of processing valence and arousal in affective words. *Cerebral cortex*, *17*(3), 742-748.

Li, L., Wu, M., Liao, Y., Ouyang, L., Du, M., Lei, D., ... & Gong, Q. (2014). Grey matter reduction associated with posttraumatic stress disorder and traumatic stress. *Neuroscience & Biobehavioral Reviews*, *43*, 163-172.

MacDonald, A. W., Cohen, J. D., Stenger, V. A., & Carter, C. S. (2000). Dissociating the role of the dorsolateral prefrontal and anterior cingulate cortex in cognitive control. *Science*, *288*(5472), 1835-1838.

MacDonald, G., & Leary, M. R. (2005). Why does social exclusion hurt? The relationship between social and physical pain. *Psychological bulletin*, *131*(2), 202.

Melchers, M., Markett, S., Montag, C., Trautner, P., Weber, B., Lachmann, B., ... & Reuter, M. (2015). Reality TV and vicarious embarrassment: An fMRI study. *NeuroImage*, *109*, 109-117.

Michl, P., Meindl, T., Meister, F., Born, C., Engel, R. R., Reiser, M., & Hennig-Fast, K. (2012). Neurobiological underpinnings of shame and guilt: a pilot fMRI study. *Social cognitive and affective neuroscience*, *9*(2), 150-157.

Miller, R., & Mason, S. E. (2005). Shame and guilt in first-episode schizophrenia and schizoaffective disorders. *Journal of Contemporary Psychotherapy*, *35*(2), 211-221.

Mitchell, J. P., Heatherton, T. F., & Macrae, C. N. (2002). Distinct neural systems subserve person and object knowledge. *Proceedings of the National Academy of Sciences*, *99*(23), 15238-15243.

Modinos, G., Ormel, J., & Aleman, A. (2009). Activation of anterior insula during self-reflection. *PloS one*, *4*(2), e4618.

Molenberghs, P., Ogilvie, C., Louis, W. R., Decety, J., Bagnall, J., & Bain, P. G. (2015). The neural correlates of justified and unjustified killing: an fMRI study. *Social cognitive and affective neuroscience*, *10*(10), 1397-1404.

Moll, J., De Oliveira-Souza, R., & Zahn, R. (2008). The neural basis of moral cognition. *Annals of the New York Academy of Sciences*, *1124*(1), 161-180.

Moll, J., Oliveira-Souza, R. D., Garrido, G. J., Bramati, I. E., Caparelli-Daquer, E. M., Paiva, M. L., ... & Grafman, J. (2007). The self as a moral agent: linking the neural bases of social agency and moral sensitivity. *Social Neuroscience*, *2*(3-4), 336-352.

Morey, R. A., McCarthy, G., Selgrade, E. S., Seth, S., Nasser, J. D., & LaBar, K. S. (2012). Neural systems for guilt from actions affecting self versus others. *Neuroimage*, *60*(1), 683-692.

Morita, T., Itakura, S., Saito, D. N., Nakashita, S., Harada, T., Kochiyama, T., & Sadato, N. (2008). The role of the right prefrontal cortex in self-evaluation of the face: a functional magnetic resonance imaging study. *Journal of Cognitive Neuroscience*, *20*(2), 342-355.

Morita, T., Kosaka, H., Saito, D. N., Fujii, T., Ishitobi, M., Munesue, T., ... & Sadato, N. (2016). Neural correlates of emotion processing during observed self-face recognition in individuals with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *26*, 16-32.

Morita, T., Kosaka, H., Saito, D. N., Ishitobi, M., Munesue, T., Itakura, S., ... & Sadato, N. (2012). Emotional responses associated with self-face processing in individuals with autism spectrum disorders: An fMRI study. *Social Neuroscience*, *7*(3), 223-239.

Morita, T., Tanabe, H. C., Sasaki, A. T., Shimada, K., Kakigi, R., & Sadato, N. (2013). The anterior insular and anterior cingulate cortices in emotional processing for self-face recognition. *Social cognitive and affective neuroscience*, *9*(5), 570-579.

Orth, U., Berking, M., & Burkhardt, S. (2006). Self-conscious emotions and depression: Rumination explains why shame but not guilt is maladaptive. *Personality and social psychology bulletin*, *32*(12), 1608-1619.

Paulus, F. M., Müller-Pinzler, L., Jansen, A., Gazzola, V., & Krach, S. (2014). Mentalizing and the role of the posterior superior temporal sulcus in sharing others' embarrassment. *Cerebral cortex*, *25*(8), 2065-2075.

Paulus, F. M., Müller-Pinzler, L., Stolz, D. S., Mayer, A. V., Rademacher, L., & Krach, S. (2018). Laugh or cringe? Common and distinct processes of reward-based schadenfreude and empathy-based fremdscham. *Neuropsychologia*, *116*, 52-60.

Peth, J., Sommer, T., Hebart, M. N., Vossel, G., Büchel, C., & Gamer, M. (2015). Memory detection using fMRI—Does the encoding context matter?. *NeuroImage*, *113*, 164-174.

Philippi, C. L., Duff, M. C., Denburg, N. L., Tranel, D., & Rudrauf, D. (2012). Medial PFC damage abolishes the self-reference effect. *Journal of Cognitive Neuroscience*, *24*(2), 475-481.

Price, D. D. (2000). Psychological and neural mechanisms of the affective dimension of pain. *Science*, *288*(5472), 1769-1772.

Probyn, E. (2005). *Blush: Faces of shame*. U of Minnesota Press.

Ridley, M., & Waal, F. B. D. (1996). The origins of virtue. *Nature*, *383*(6603), 785-785.

Ritter, K., Vater, A., Rüsch, N., Schröder-Abé, M., Schütz, A., Fydrich, T., ... & Roepke, S. (2014). Shame in patients with narcissistic personality disorder. *Psychiatry research*, *215*(2), 429-437.

Rochat, P. (2009). *Others in mind: Social origins of self-consciousness*. Cambridge University Press.

Rotge, J. Y., Langbour, N., Guehl, D., Bioulac, B., Jaafari, N., Allard, M., ... & Burbaud, P. (2010). Gray matter alterations in obsessive–compulsive disorder: an anatomic likelihood estimation meta-analysis. *Neuropsychopharmacology*, *35*(3), 686.

Roy, M., Shohamy, D., & Wager, T. D. (2012). Ventromedial prefrontal-subcortical systems and the generation of affective meaning. *Trends in cognitive sciences*, *16*(3), 147-156.

Sabini, J., & Silver, M. (2005). Why emotion names and experiences don't neatly pair. *Psychological inquiry*, *16*(1), 1-10.

Schäfer, A., Vaitl, D., & Schienle, A. (2010). Regional grey matter volume abnormalities in bulimia nervosa and binge-eating disorder. *Neuroimage*, *50*(2), 639-643.

Scheff, T. J. (1994). *Microsociology: Discourse, emotion, and social structure*. University of Chicago Press.

Scherer, K. R., Schorr, A., & Johnstone, T. (Eds.). (2001). *Appraisal processes in emotion: Theory, methods, research*. Oxford University Press.

Schmitz, T. W., Rowley, H. A., Kawahara, T. N., & Johnson, S. C. (2006). Neural correlates of self-evaluative accuracy after traumatic brain injury. *Neuropsychologia*, *44*(5), 762-773.

Shin, L. M., Dougherty, D. D., Orr, S. P., Pitman, R. K., Lasko, M., Macklin, M. L., ... & Rauch, S. L. (2000). Activation of anterior paralimbic structures during guilt-related script-driven imagery. *Biological psychiatry*, *48*(1), 43-50.

Simmonds, D. J., Pekar, J. J., & Mostofsky, S. H. (2008). Meta-analysis of Go/No-go tasks demonstrating that fMRI activation associated with response inhibition is task-dependent. *Neuropsychologia*, *46*(1), 224-232.

Sober, E., & Wilson, D. S. (1998). Unto others: The evolution and psychology of unselfish behavior. *Cambridge/Mass*.

Street, A. E., & Arias, I. (2001). Psychological abuse and posttraumatic stress disorder in battered women: Examining the roles of shame and guilt. *Violence and victims*, *16*(1), 65.

Sznycer, D. (2018). Forms and Functions of the Self-Conscious Emotions. *Trends in cognitive sciences*, 23(2), 143-157.

Takahashi, H., Yahata, N., Koeda, M., Matsuda, T., Asai, K., & Okubo, Y. (2004). Brain activation associated with evaluative processes of guilt and embarrassment: an fMRI study. *Neuroimage*, *23*(3), 967-974.

Tangney, J. P. (2003). Self-relevant emotions. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of self and identity* (pp. 384-400). New York, NY, US: Guilford Press.

Tangney, J. P., Miller, R. S., Flicker, L., & Barlow, D. H. (1996). Are shame, guilt and embarrassment distinct emotions? *Journal of Personality and Social Psychology*, 70, 1256-1267

Tangney, J. P., Stuewig, J., & Martinez, A. G. (2014). Two faces of shame: the roles of shame and guilt in predicting recidivism. *Psych. Sci. 2014 Mar;25(3):799-805.*

Tangney, J. P., Stuewig, J., & Mashek, D. J. (2007). Moral emotions and moral behavior. *Annu. Rev. Psychol.*, *58*, 345-372.

Tangney, J. P., Wagner, P., & Gramzow, R. (1992). Proneness to shame, proneness to guilt, and psychopathology. *Journal of abnormal psychology*, *101*(3), 469.

Tow, P. M., & Whitty, C. W. M. (1953). Personality changes after operations on the cingulate gyrus in man. *Journal of neurology, neurosurgery, and psychiatry*, *16*(3), 186.

Troop, N. A., Allan, S., Serpell, L., & Treasure, J. L. (2008). Shame in women with a history of eating disorders. *European Eating Disorders Review*, *16*(6), 480-488.

Turkeltaub, P. E., Eickhoff, S. B., Laird, A. R., Fox, M., Wiener, M., & Fox, P. (2012). Minimizing within-experiment and within-group effects in activation likelihood estimation meta-analyses. *Human brain mapping*, *33*(1), 1-13.

Ty, A., Mitchell, D. G., & Finger, E. (2017). Making amends: Neural systems supporting donation decisions prompting guilt and restitution. *Personality and Individual Differences*, *107*, 28-36.

van der Meer, L., Costafreda, S., Aleman, A., & David, A. S. (2010). Self-reflection and the brain: a theoretical review and meta-analysis of neuroimaging studies with implications for schizophrenia. *Neuroscience & Biobehavioral Reviews*, *34*(6), 935-946.

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: a voxel-based meta-analysis. *Journal of cognitive neuroscience*, *22*(12), 2864-2885.

Wagner, U., N'diaye, K., Ethofer, T., & Vuilleumier, P. (2011). Guilt-specific processing in the prefrontal cortex. *Cerebral cortex*, *21*(11), 2461-2470.

Weingarden, H., & Renshaw, K. D. (2015). Shame in the obsessive compulsive related disorders: a conceptual review. *Journal of affective disorders*, *171*, 74-84.

Wong, Y., & Tsai, J. (2007). Cultural models of shame and guilt. *The self-conscious emotions: Theory and research*, 209-223.

Xue, G., Aron, A. R., & Poldrack, R. A. (2008). Common neural substrates for inhibition of spoken and manual responses. *Cerebral Cortex*, *18*(8), 1923-1932.

Yen, C. P., Kung, S. S., Su, Y. F., Lin, W. C., Howng, S. L., & Kwan, A. L. (2005). Stereotactic bilateral anterior cingulotomy for intractable pain. *Journal of clinical neuroscience*, *12*(8), 886-890.

Yu, H., Hu, J., Hu, L., & Zhou, X. (2013). The voice of conscience: neural bases of interpersonal guilt and compensation. *Social cognitive and affective neuroscience*, *9*(8), 1150-1158.

Zhu, R., Feng, C., Zhang, S., Mai, X., & Liu, C. (2019). Differentiating guilt and shame in an interpersonal context with univariate activation and multivariate pattern analyses. *NeuroImage*, *186*, 476-486.

Zmigrod, L., Garrison, J. R., Carr, J., & Simons, J. S. (2016). The neural mechanisms of hallucinations: a quantitative meta-analysis of neuroimaging studies. *Neuroscience & Biobehavioral Reviews*, *69*, 113-123

Chapter 5

The neural trace of shame

In collaboration with P. Vuilleumier

Introduction

Uncovering the neural bases of shame

So far, research in cognitive neuroscience has focused mainly on the investigation of the neural basis of basic emotions (Ekman, 1992; Vytal & Hamann, 2010). Despite their importance in everyday life, the study of self-conscious moral emotions has been largely neglected by the scientific community. Being self-conscious, these secondary emotions (Stanculescu, 2012) strictly refer to individual self-reflection and self-evaluation (Tangney, Stuewig, & Mashek, 2007) and they are specifically raised when social and moral norms are broken (Bastin, Harrison, Davey, Moll, & Whittle, 2016). Their main function is to provide feedback to the individual to promote defensive or adaptive behavior (e.g. facing shame and guilt) or reward (e.g. pride) (Tangney et al., 2007). We have already discussed (see chapters 1 and 5) features that unite and differentiate shame and guilt. Briefly, shame is an emotion entirely focused on oneself (Tangney, Stuewig, Mashek, & Hastings, 2011), and is evoked when an individual, being evaluated by others because of his/her way of being, does not feel within the moral standards imposed by society (Tangney et al., 2007). It is known that, as a response, it causes withdrawal behavior, inhibition and feeling of pain. On the other hand, guilt also comes as a result of moral transgression, but it is much more focused on a wrong specific action than on the person himself and leads to adaptive behavior, as repairing the situation (Tangney et al., 2011).

In addition to the theoretical definition, there is a growing evidence that shame and guilt can also be separated at the neural level (Bastin et al., 2016).

A recent review paper by Bastin and colleagues (2016) summarized all neuroimaging research about shame and guilt. Although there were few studies investigating shame, pure shame was associated with functional activations within the dorsolateral prefrontal cortex (dlPFC) (Michl et al., 2014; Roth, Kaffenberger, Herwig, & Brühl, 2014), ventrolateral prefrontal cortex (vlPFC) (Roth et al., 2014), dorsomedial prefrontal cortex (dmPFC) (Michl et al., 2014; Wagner, N'Diaye, Ethofer, & Vuilleumier, 2011). Shame-related activations were also reported in the anterior insula (Michl et al., 2014; Roth et al., 2014; Wagner et al., 2011), anterior temporal cortices (Michl et al., 2014; Wagner et al., 2011), angular gyrus and precuneus (Wagner et al., 2011), posterior cingulate cortex (PCC) (Michl et al., 2014; Roth et al., 2014), basal ganglia (Roth et al., 2014), sensorimotor areas (Michl et al., 2014; Roth et al., 2014), visual areas (Michl et al., 2014; Wagner et al., 2011) and cerebellum (Michl et al., 2014; Roth et al., 2014; Wagner et al., 2011) (Bastin et al., 2016).

On the other hand, Bastin and colleagues (2016) reported that pure guilt-related hemodynamic activations were found within prefrontal regions as dlPFC, vlPFC and dmPFC (Fourie, Thomas, Amodio, Warton, & Meintjes, 2014; Michl et al., 2014; Moll et al., 2007; Takahashi et al., 2004; Wagner et al., 2011), temporal regions (Michl et al., 2014; Moll et al., 2007; Shin et al., 2000; Wagner et al., 2011), insular cortex (Fourie et al., 2014; Shin et al.,

2000; Wagner et al., 2011), cingulate cortex (Fourie et al., 2014; Shin et al., 2000), precuneus (Fourie et al., 2014), supramarginal and angular gyrus (Wagner et al., 2011), sensorimotor cortex (Michl et al., 2014; Moll et al., 2007; Shin et al., 2000; Wagner et al., 2011), visual cortex (Michl et al., 2014; Takahashi et al., 2004; Wagner et al., 2011), cerebellum (Michl et al., 2014; Shin et al., 2000; Wagner et al., 2011) and subcortical regions as thalamus, parahippocampal gyrus, midbrain and basal ganglia (Fourie et al., 2014; Moll et al., 2007; Wagner et al., 2011) (Bastin et al., 2016).

Despite the fact that the number of studies is quite limited, many brain areas seem to be involved in both moral emotions. From a descriptive point of view, it is noticeable that there are regions active at hemodynamic level both in shame and guilt (e.g. frontal and insular regions), and others more specific for emotion. To draw more precise inferences about the neural bases of both emotions, in the previous chapter we run an updated meta-analysis on the functional studies investigating shame and guilt. Results showed that the emotion of shame/embarrassment was associated with a huge network that included, among others, several frontal regions (inferior-medial-superior frontal gyrus), the left anterior insula, the presupplementary motor area (preSMA), the thalamus and the dorsal part of the anterior cingulate cortex (dACC). On the other hand, guilt showed fewer functional activations, i.e. in the bilateral anterior insula and temporal regions. Since our conjunction analysis showed an overlap between shame and guilt only within the left anterior insula, we proposed this area as a key hub for moral processing. However, one of the legitimate criticisms of meta-analysis is that shame and embarrassment were enclosed under the same label for statistical power purposes. This is due to the fact that there are very few studies investigating shame in psychological research. In addition, as already mentioned in the meta-analysis study and in the previous chapters, the few studies carried out so far on shame (and partially guilt) suffer from a lack of consistency at the methodological level. For example, some of them (Shin et al., 2000; Wagner et al., 2011) used an autobiographical recall through verbal scripts. In these cases, participants were asked to remember and report a particular moment when they felt ashamed. Other studies used an emotion induction paradigm based on statements (Michl et al., 2014; Moll et al., 2007; Takahashi et al., 2004), in which the attempt was made to evoke shame through the presentation of sentences or scenarios. Even further, an implicit association task (Fourie et al., 2014) was used, in which negative moral emotions were elicited through a manipulated feedback that returned to participants their implicit prejudice against Black and disabled people. Although in many of these studies direct contrasts between moral emotion and neutral control have been performed, their differences at the methodological level may limit a large-scale interpretation of their results. In addition to such as methodological variability, to our knowledge very few studies (Michl et al., 2014; Pulcu et al., 2014; Wagner et al., 2011; Zhu, Feng, Zhang, Mai, & Liu, 2019) aimed for a direct comparison between shame and guilt at the neural level.

In light of this, starting from this scarce literature and from our behavioural studies presented in the previous chapters, we propose to measure shame and guilt hemodynamic responses capitalizing on our Shame Task paradigm in an fMRI session. Since from a behavioural point of view our data seem to indicate that the paradigm is suitable for eliciting such moral emotions, we expect it to be beneficial also for measuring the neural correlates related to shame and guilt. First of all, we expect 1) to replicate our behavioral results. Within the fMRI scanner, participants will be able to assess their level of perceived shame and guilt in a similar way to what has been done in our previous studies. That is, we expect them to distinguish between shame/guilt-inducing stimuli in the

evaluation of their perceived emotional state. We hypothesize they will report higher shame by facing shame-evoking stimuli, higher guilt by facing guilt-evoking stimuli and very low shame and guilt with neutral stimuli. This will serve as a manipulation check for the three conditions (shame, guilt and neutral). In parallel, we expect 2) a different hemodynamic response between shame and guilt stimuli, in line with the results of our meta-analysis. Specifically, we assume that the presentation of a shameful stimulus may recruit different brain areas, as the prefrontal cortex, insular cortex, temporal and subcortical regions. On the other hand, a guilt-evoking stimulus should be related to activations in both the insular cortices and temporal regions. We do not expect any activation in "moral" areas for neutral stimuli. If our hypotheses were correct, we could confirm the Shame Task as a suitable paradigm for the evocation and measurement of shame and guilt. In addition, if our neural hypotheses were satisfied, this would confirm that shame and guilt, as distinct emotions, also have different neural correlates.

Shame and Resting-State fMRI

It is well known that the brain occupies 2% of the human body, although it consumes as much as 20% of its energy needs even at rest (Bijsterbosch, Smith, & Beckmann, 2017). Therefore it is an organ always active at the metabolic level, even when we rest on the couch, look into the void or we are simply not doing anything. In recent years, researchers have been increasingly fascinated by this "dark" aspect of the brain, by its intrinsic activity independent of particular environmental triggers. If we see a snake walking down the street, we can expect cerebral responses in the limbic regions involved, for example, in the processing of fear. But why is the brain so active even when we're sitting on the couch?

With functional magnetic resonance imaging (fMRI), it is now possible to study this phenomenon in detail. In fact, fMRI provides information on two fundamental dimensions, namely localization and connectivity. The first refers to the spatial resolution of magnetic resonance imaging that allows to detect specific brain areas where metabolic activity is present (which we measure indirectly through the BOLD signal) at all times, so even at rest. The second refers to the potential of fMRI to trace as distinct brain areas "communicate" together over time, therefore collaborating in the processing of a given stimulus or even at rest (Bijsterbosch et al., 2017). Combining these two factors, the definition of resting state network comes up. A resting state network is a set of brain areas, not necessarily close at a spatial level, which show similarities in metabolic consumption (reflected by the BOLD signal) over time at rest (Bijsterbosch et al., 2017). More technically, a resting-state functional network consists of brain regions whose spontaneous fluctuations at low frequency (0.01-0.1 Hz), visible via the BOLD signal, correlate with each other (Buchbinder, 2016).

The study of resting-state networks is in line with the perspective of the large-scale functional brain organization that has become increasingly popular in recent years (Menon, 2015). In fact, the brain is a complex organ, formed by many interconnections between different areas. Referring to a specific area in the study of complex systems (such as cognitive ones) is no longer enough, as it is not possible to grasp the intrinsic complexity of these systems. Indeed, different functional activation patterns (i.e. networks) composed by different regions were found to be consistent between subjects over time: a) auditory, b) basal ganglia, c) posterior cingulate cortex and ventromedial prefrontal cortex (default-mode network), d) secondary visual cortex, e) language, f) left dorsolateral prefrontal cortex and left parietal cortex (executive network), g) sensorimotor, h) posterior insula, i) precuneus, j) primary

visual cortex, k) right dorsolateral prefrontal cortex and right parietal cortex (executive network), l) anterior insula and dorsal anterior cingulate cortex (salience network), m) retrosplenial cortex and medial temporal lobe, and n) intraparietal sulcus and frontal eye fields (Damoiseaux et al., 2006; Menon, 2015; Shirer, Ryali, Rykhlevskaia, Menon, & Greicius, 2012). Among these 14 patterns, some seem to recruit areas related to the execution of tasks (e.g. motor, visual, auditory, language, executive and salience network), while others emerge essentially at rest (e.g. default-mode network). The key characteristic of these two categories of networks is their interchangeability (Menon, 2015): when one type is activated, the other is deactivated (and vice versa). In particular, the default-mode network (DMN) is one of the networks that has aroused much interest in the scientific community. It is composed not only of the posterior cingulate gyrus and medial prefrontal cortex, but also of parts of the medial temporal lobe and angular gyrus (Greicius, Krasnow, Reiss, & Menon, 2003; Menon, 2015; Raichle et al., 2001). DMN is detectable in each individual, and it is notoriously involved in self-monitoring, thoughts, reflections and ruminations about the person (Buchner, Andrews-Hanna, & Schacter, 2008; Menon, 2015).

Considering the most frequently captures networks at the resting-state, it is evident that they are of a purely cognitive domain (Jiang et al., 2018). While not discussing the cognitive specificity of such networks, we wondered if other domains could also be "represented" at the neural level in a resting state network. Can dimensions such as affective or moral, which permeate the life of each individual at every moment and characterize the social life of everyone, leave a neural trace visible at the resting-state? For example, it is known that the DMN refers to the aspect of rumination and thoughts about oneself (Buchner et al., 2008; Menon, 2015). This rumination and the representation of one's own person is not far from the foundations on which moral emotions are based, that is, on an evaluation of one's own person in the light of the values of society. Or again, well-defined affective traits could have an oscillatory reflex in the resting-state. With the aim of combining affective and moral aspects, we have considered two measures of tract already discussed previously in this thesis: shame-proneness and guilt-proneness, that is the dispositional tendency to be in these emotional state (Tangney, Dearing, Wagner, & Gramzow, 2000). Capitalizing on the Test of Self-Conscious Affect (TOSCA) questionnaire (Tangney et al., 2000) as a tool for measuring shame/guilt-proneness, if our expectations are met, inclination to shame and guilt may be related to a resting-state functional network different from those of a cognitive nature. Even regarding the meta-analysis presented previously, our hypothesis is that such circuits may consist of regions linked to emotional and moral processing. In other words, an involvement of regions such as the prefrontal and frontal areas, insular cortices, subcortical regions as amygdala/thalamus and temporo-parietal regions is expected.

Method

Participants

25 participants (10 males) were included in this study. They had a mean age of 23.74 years (SD = 4.50) and mean education of 16.84 years (SD = 2.51). Participants were recruited using flyers distributed around the University of Geneva buildings and were invited to the Brain and Behaviour Lab (BBL) at the Centre Medical Universitaire (CMU) in Geneva. Upon their arrival, they were asked to fill out questionnaires relating to safety in the MR scanner, they were informed of the study purpose and given a consent form to sign. Participants who have consented to

participate in the experiment, they subsequently underwent a phase of preparation and familiarization with the experimental situation.

Inclusion criteria

A subject was eligible for the experiment if aged between 18 and 40 years old, right handed and with no diagnosis of any psychiatric disease.

Exclusion criteria

A subject was not eligible if any of the following criteria applied:

- fMRI safety inclusion conditions not met (eg: metal parts in the body, unremovable piercings, big tattoos close to the head, claustrophobia);
- Psychiatric/neurological disorder (e.g. depression). Past or current history of a clinically significant central nervous system disorder, including structural brain abnormalities, cerebrovascular disease, history of another neurological disease, including epilepsy, stroke or head trauma (defined as loss of consciousness > 5 min or requiring hospitalization).
- Taking psychoactive medication (e.g. antipsychotics, benzodiazepines) or use of an antipsychotic or benzodiazepines within the last 4 weeks.

Once consent has been given and has been established that participants are eligible to participate in an MRI study, participants were put at ease and accompanied by the laboratory technician into the scanner room. Participants have been compensated 50 CHF for their time. All data have been anonymized and no sensitive information (such as name, surname, address) were collected. Neural, behavioural and demographic data were used only in aggregate format and for statistical purposes. The entire procedure was previously submitted and approved by the Ethics of Research on humans Commission of the Canton of Geneva (*CCER, Commission Cantonale d'Ethique de la Recherche sur l'être humain*). In general, this research was conducted in accordance with such as approved protocol, the Declaration of Helsinki, the principles of Good Clinical Practice, the Human Research Act (HRA) and the Human Research Ordinance (HRO) as well as all locally relevant regulations.

Shame Task - Experimental design

E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA) was used to build the task. As said previously, the Shame Task is a behavioral task aiming to elicit shame and guilt by recreating scenarios of social interaction between the participant and different partners. During this interaction, the participant is exposed to different evaluations or judgments concerning his/her person or behavior that may elicit self-conscious emotions.

The basic structure of the task has not been changed since its original version (see studies presented in the previous chapters). The social aspect of the interaction is facilitated by proposing a face for each trial, accompanied by the stimulus in written form. We selected the stimuli from the same set of sentences as in previous studies. Since the study was carried out at the University of Geneva (Switzerland), the stimuli were translated into French by two bilingual collaborators and carefully checked by a French native speaker.

20 shame-inducing, 20 guilt-inducing and 20 neutral stimuli were included in the task. 60 Caucasian faces (30 men, 30 women) were selected from the Chicago Face Database (Ma, Correll, & Wittenbrink, 2015) to be included in each trial.

Participants were instructed in the task before entering MRI. They were presented with instructions in French and a training trial to familiarize themselves with the task. After clearing up any eventual doubts, participants were accompanied by the MRI technician inside the scanner. Over there, participants were able to look at the monitor placed in the back of the machine through a system of mirrors above their head. As a response device, he/she was given a four-button keyboard. After the instructions were resubmitted, the actual task began. With the aim of aligning the hemodynamic response to the HRF function, a jittered fixation point was presented at the center of the screen lasting randomly between 1 and 4 seconds. After that, the stimulus was presented in combination with a random face for 5 seconds, followed by an intertrial interval of one second. In series, two questions were asked about the perception of shame (*"A quel point ressens-tu de la honte?" / How much shame would you feel?*) and the perception of guilt (*"A quel point ressens-tu de la culpabilité?" / How much guilt would you feel?*). Each button on the keyboard corresponded to a scale score, where 1 was equal to "not at all" ("*Pas du tout*") and 4 was equal to "a lot" ("*Beaucoup*"). Finally, at the end of the trial, an intertrial interval lasting one second was set before to go forward to the next trial (see Figure 5.1 for the experimental design).

Since the parts of the speech in French are gender-specific, two versions of the task have been built: one dedicated to female participants, and one dedicated to male participants. The structure of the items has not been changed.

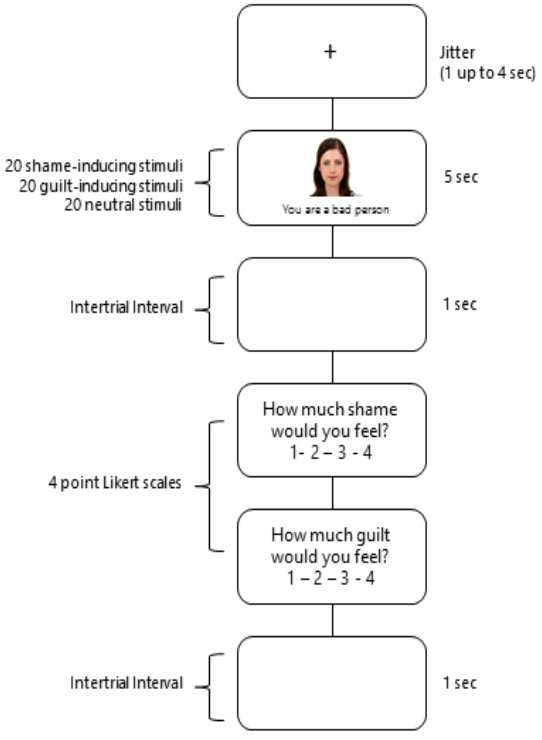


Figure 5. 1 Experimental design of the Shame Task during fMRI

Outside the scanner, participants completed several questionnaires aimed at enriching their psychological profile.

- The French version (Nugier, Gil, & Chekroun, 2012) of the Test of Self-Conscious Affect-3 (J. P. Tangney et al., 2000) was provided. TOSCA is a tool aiming to measure shame and guilt-proneness and disposition to blame others (externalization). For each scenario, participants rated their likelihood of responding in the manner depicted by several statements on a 5-point Likert scale (1 = very unlike me, 5 = very like me).
- In order to assess the current affective state of participants, the French version (Nicolas, Martinent, & Campo, 2014) of the Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988) was proposed. PANAS is composed of twenty word-items describing emotional state: participants need to indicate in a 5-point Likert scale how that emotional state was representative of their current internal situation, ranging from "Very slightly or not at all (1)" to "Extremely (5)".
- The French version (Gilet, Mella, Studer, Grühn, & Labouvie-Vief, 2013) of the Interpersonal Reactivity Index (Davis, 1983) was presented. IRI is a recognized tool for measuring empathy. It is composed of 28-items answered on a 5-point Likert scale ranging from "Does not describe me well (1)" to "Describes me very well (5)". Four subscales are derivable (each one composed of 7-items): Perspective Taking (PT), Fantasy (FA), Empathic Concern (EC) and Personal Distress (PD).

MRI Acquisition parameters

Images were acquired with a 3T Magnetom TrioTim (Siemens, Germany) scanner. For task-based fMRI, we acquired gradient echo T2*weighted echo-planar images (EPIs). Each functional volume contained 35 slices (thickness = 3 mm) with TR = 2000 ms, TE = 30 ms, descending acquisition mode, flip angle = 85°, resolution = 64 x 64, voxel size = 3 x 3 x 3 mm. During the resting-state, which lasted 7 min., the Blood Oxygenation Level Dependent (BOLD) contrast was evaluated using a T2*-weighted multi-band echo-planar sequence (EPI). 584 resting-state EPI volumes of 54 axial slices (thickness = 2.50 mm) with TR = 720 ms, TE = 30.2 ms, flip angle = 52°, FoV = 120 mm, resolution = 84 x 84, voxel size = 2.5 x 2.5 x 2.5 mm were acquired. During this part of the experiment, participants were instructed to look at the fixation cross at the center of the screen and let their mind wander without falling asleep. In addition, for each participant we acquired one high-resolution T1-weighted anatomical image composed of 192 sagittal slices with TR = 1900 ms, TI = 900 ms, TE = 2.27 ms, flip angle = 9°, FoV = 256 mm, resolution = 256 x 256, voxel size = 1.0 x 1.0 x 1.0 mm, slice thickness = 1.0 mm.

Shame Task fMRI analysis

SPM12 (Wellcome Department of Cognitive Neurology, London, UK), a toolbox for fMRI data analysis working on Matlab (The Mathworks) environment, was used for the functional data analysis. We preprocessed functional images using a standard pipeline, involving conversion from DICOM to NiFTI images, functional realignment to the first volume and unwarping (subject motion estimation and correction), slice-timing correction (with first slice as reference), outlier detection (ART-based identification of outlier scans for scrubbing), functional and structural direct segmentation and normalization to the standard Montreal Neurological Institute (MNI) atlas (simultaneous grey/white/CSF segmentation and MNI normalization), spatial smoothing with an isotropic full-width at half-maximum Gaussian kernel of 6 mm. Preprocessed data were included in the first-level analysis within the GLM framework for each participant. 3 conditions (shame, guilt and neutral) were set up. Onset of events (extracted by E-Prime software) was specified in seconds. In addition to the volumes and onsets, we included all six motion

parameters as multiple regressors in the design matrix. The canonical HRF were combined with time and dispersion derivatives. Masking threshold was set at 0.8 by default. A second-level analysis with one-sample t-test design was performed in order to detect group-level effects for each contrast between conditions. Implicit mask was set up by default.

Resting-state fMRI analysis

First-level preprocessing and denoising

CONN (Whitfield-Gabrieli & Nieto-Castanon, 2012) release 18b, an open-source Matlab/SPM-based cross-platform software, was used for the computation, display, and analysis of rs-fMRI functional connectivity. CONN combines the traditional functions of the Statistical Parametric Mapping version 12 (SPM12, https://www.fil.ion.ucl.ac.uk/spm) with a pleasant and user-friendly graphic interface. This makes it a powerful and versatile tool for fMRI data analysis. Structural and functional data were imported through CONN's Setup interface. Images have been preprocessed using the default CONN's preprocessing pipeline for volume-based analyses. It included: functional realignment and unwarping (subject motion estimation and correction), slice-timing correction, outlier detection (ART-based identification of outlier scans for scrubbing), functional and structural direct segmentation and normalization (simultaneous grey/white/CSF segmentation and MNI normalization), spatial smoothing (spatial convolution with Gaussian kernel at 6 mm). After preprocessing, all scans were denoised at first-level. This step is useful for removing unwanted motion, physiological, and other artifactual effects from the BOLD signal before computing connectivity measures. Specifically, a linear regression of confounding effects (white matter, CSF, realignment parameters, scrubbing, effect of resting-state condition), a band-pass filter [0.008 0.09] Hz and linear detrending was used. Since we were interested in fluctuations throughout the acquisition, only one condition (resting-state) was set up.

Group-level analysis - Independent Component Analysis

Independent Component Analysis (ICA) was used at first- and second-level analysis. ICA is a widely used fully data-driven (or "model free") analysis approach, aiming to detect several features (or "sources") which follow a common pattern from a multivariate signal. (Bijsterbosch et al., 2017). Here is an example of how ICA's algorithm works. Let's imagine we're in a crowded room. People talk to each other in small groups, having different conversations. If we put microphones scattered in the room and record by each one of them, we'd have in return a very noisy audio since each single registration is affected by others' noise. By applying the ICA algorithm, the mixed signal is cleaned up and each signal source is isolated. In this way, capitalizing on all microphones, we would be able to detect each individual conversation, and so capturing the totality of the information available in the room. Paraphrasing the example to the brain, it is well known that at rest the fluctuations of neural signal ("conversations"), which depend on the functional co-activation of voxels in time but not necessarily close in space ("small groups of people"), are composed of true signal and numerous artifacts ("noisy signal"). ICA, as a mathematical algorithm, manages to clean up the signal, isolating the artifacts and bringing out the signal of interest in maximally independent components (Smitha et al., 2017). Specifically, it may bring out patterns of highly functionally-connected voxels that we call functional neural networks. By applying ICA, each component is

described in terms of spatial map, i.e. "where" the signal comes from, and time series, i.e. how signal evolves "over time" (Bijsterbosch et al., 2017, see also Figure 5.1 for a graphical representation). CONN's implementation uses Calhoun's group-level ICA approach (Calhoun, Adali, Pearlson, & Pekar, 2001), with variance normalization pre-conditioning, optional subject-level dimensionality reduction, subject/condition concatenation of BOLD signal data along temporal dimension, group-level dimensionality reduction, fastICA for estimation of independent spatial components, and GICA1 backprojection for individual subject-level spatial map estimation (information taken by CONN's manual). As part of ICA's output, CONN returns automatically independent components both at temporal (time series) and spatial (spatial maps) dimensions. Since we were interested in possible spatial patterns of activation in relationship with our behavioral data, we included in our study only spatial dimension of independent components (spatial ICA). Our choice also depended on the fact that currently spatial ICA is the most commonly adopted approach to fMRI resting-state data (Bijsterbosch et al., 2017).

In our case, we set ICA following the default CONN's settings at first-level. Specifically, the extraction of 40 independent components was requested, using G1 FastICA + GICA3 Back-projection algorithms. Dimensionality reduction was set at 64. At second-level, effect of all subjects as between-subjects contrast, rest-condition as between-conditions contrast and effect of each component as between-measures contrasts were set up. In order to correlate independent components with a measure of affective/morality trait, we used the shame-proneness and guilt-proneness scores obtained by TOSCA questionnaire (Tangney et al., 2000).

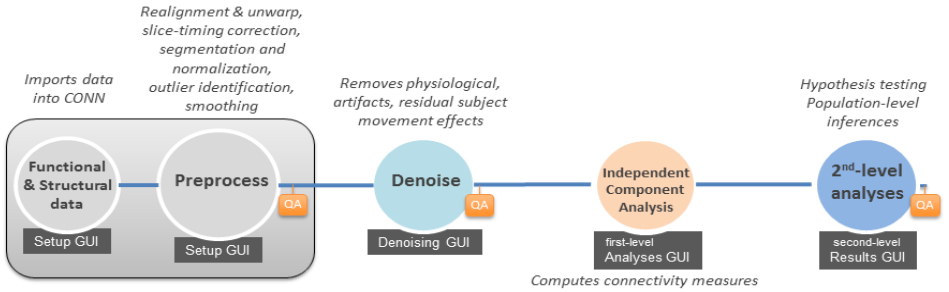


Figure 5. 2 Flow diagram describing CONN main steps: Preprocessing, Denoising, Analyses, Results.

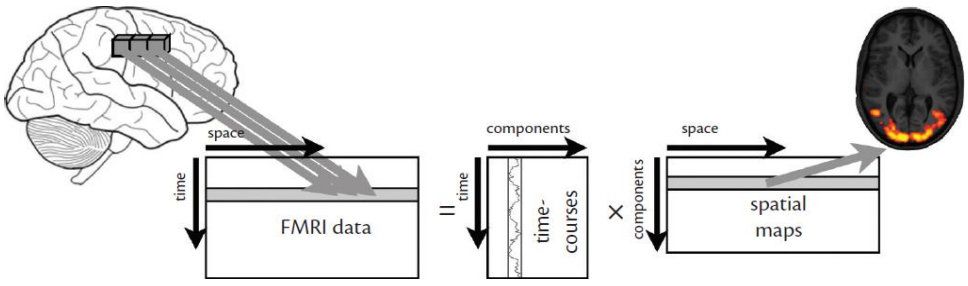


Figure 5. 3 Graphical description of ICA. ICA decomposes rs-fMRI mixed signal into temporal independent components and spatially

independent components. Figure taken by Bijsterbosch, Smith, & Beckmann (2017), pg. 56.

Results

Behavioral analysis

JASP software (Version 0.8.4, https://jasp-stats.org) was used for behavioral data analysis. In order to highlight any differences in the perception of shame between the type of stimulus, we run a one-way analysis of variance (ANOVA) with shame mean as dependent variable and the type of stimulus (three levels: shame, guilt, neutral) as factor. A main significant effect related to the type of stimulus $F(2) = 113.2$, $p < .001$, $\eta^2 = 0.759$ emerged (Table 5.1).

ANOVA - Shame

Cases	Sum of Squares	df	Mean Square	F	p	η^2
TypeStimulusS	40.35	2	20.174	113.2	< .001	0.759
Residual	12.83	72	0.178			

Table 5. 1 ANOVA omnibus for shame perception. Note. Type III Sum of Squares

We run post-hoc analysis with Bonferroni-correction (Table 5.2) in order to check for specific effects among the three types of stimulus. A significant difference in shame perception emerged between neutral and shame-inducing stimuli ($t = -14.244$, $p < .001$), guilt-inducing and shame-inducing stimuli ($t = -2.923$, $p = 0.014$) and between guilt-inducing and neutral stimuli ($t = 11.321$, $p < .001$). See Figure 5.4 for a graphical description of the difference between distributions.

Post Hoc Comparisons - TypeStimulus for shame perception

		Mean Difference	SE	t	p_{tukey}	p_{bonf}
Guilt	Neutral	1.352	0.119	11.321	< .001	< .001
	Shame	-0.349	0.119	-2.923	0.013	0.014
Neutral	Shame	-1.701	0.119	-14.244	< .001	< .001

Table 5. 2 Post-hoc comparisons based on the stimuli type.

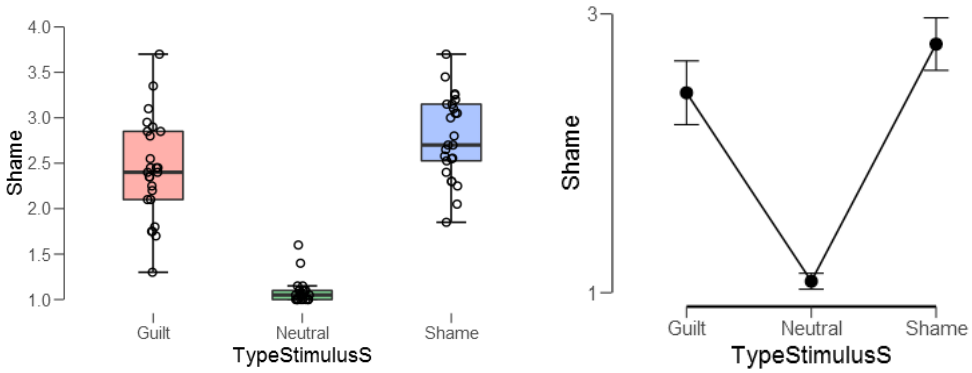


Figure 5. 4 Graphical description of the difference between distributions. On the left, boxplot for the means distribution of shame perception within the three types of stimuli (Guilt, Neutral and Shame). On the right, descriptive plot of shame perception with error bars and 95% confidence interval is shown.

As we did for shame, we run a one-way analysis of variance (ANOVA) with guilt mean as dependent variable and the type of stimulus (three levels: shame, guilt, neutral) as factor. Even in this case, we found a main significant effect related to the type of stimulus $F(2) = 127.7$, $p < .001$, $\eta^2 = 0.78$ (Table 5.3).

ANOVA - Guilt

Cases	Sum of Squares	df	Mean Square	F	p	η^2
TypeStimulusG	63.86	2	31.930	127.7	< .001	0.780
Residual	18.00	72	0.250			

Table 5. 3 ANOVA omnibus for guilt perception.

Note. Type III Sum of Squares

Bonferroni-corrected post-hoc analysis revealed a significant difference between guilt-inducing and neutral stimuli ($t = 15.329$, $p = < .001$), guilt-inducing and shame-inducing stimuli ($t = 3.748$, $p = 0.001$) and between neutral and shame-inducing stimuli ($t = -11.581$, $p < .001$) (Table 5.4). See Figure 5.5 for a graphical description of the difference between distributions.

Post Hoc Comparisons - TypeStimulus for guilt perception

		Mean Difference	SE	t	p_{tukey}	p_{bonf}
Guilt	Neutral	2.168	0.141	15.329	< .001	< .001
	Shame	0.530	0.141	3.748	0.001	0.001
Neutral	Shame	-1.638	0.141	-11.581	< .001	< .001

Table 5. 4 Post-hoc comparisons based on the stimuli type

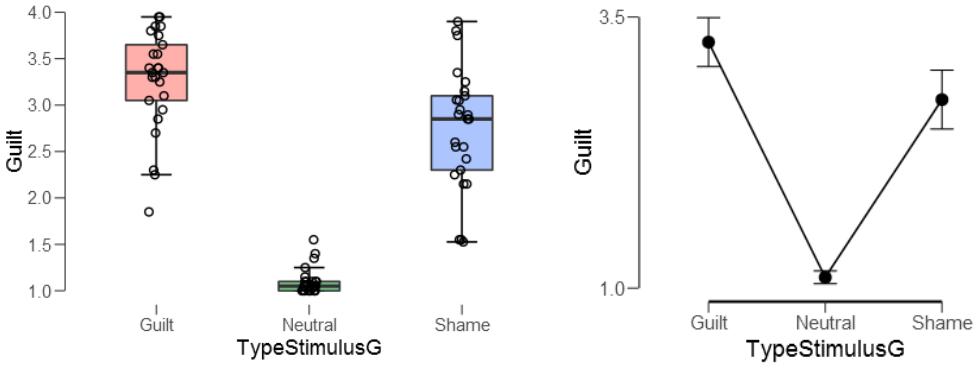


Figure 5. 5 Graphical description of the difference between distributions. On the left, boxplot for the means distribution of guilt perception within the three types of stimuli (Guilt, Neutral and Shame). On the right, descriptive plot of guilt perception with error bars and 95% confidence interval is shown.

Correlations between shame/guilt perception and behavioral tests

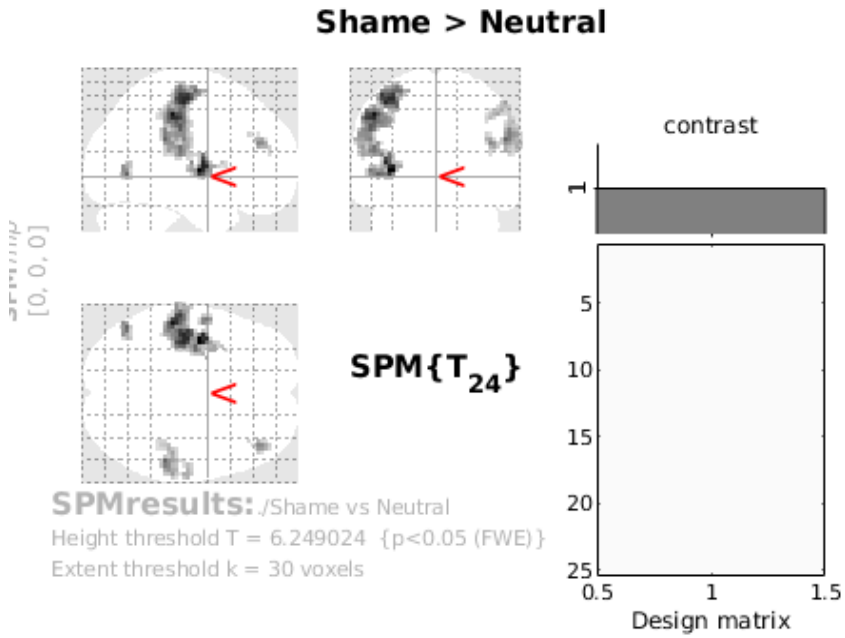
No significant correlations (all ps > .05) were found between shame and guilt means and behavioral scores (TOSCA, PANAS and IRI questionnaires).

Neural results – Shame Task

During the second-level analysis, double contrasts were carried out between the three experimental conditions. xjView toolbox (http://www.alivelearn.net/xjview) working on SPM12 was used for visual inspection of functional t-maps and to detect label areas of MNI clusters.

Shame > Neutral

First of all, we investigated the functionally active regions during shame-eliciting trials in comparison with neutral ones. Results show an increase in hemodynamic activity at cluster level in the left insula ($k = 116$, $p < .001$ FWE-corr), left ($k = 540$, $p < .001$ FWE-corr) and right ($k = 125$, $p < .001$ FWE-corr) inferior parietal lobule, left middle temporal gyrus ($k = 36$, $p < .001$ FWE-corr), right middle frontal gyrus ($k = 34$, $p < .001$ FWE-corr), right postcentral gyrus ($k = 57$, $p < .001$ FWE-corr). (See Figure 5.6, 5.7)



Statistics: ***p-values adjusted for search volume***

set-level		cluster-level				peak-level					mm	mm	mm
p	c	$p_{FWE\text{-}corr}$	$q_{FDR\text{-}corr}$	k_E	p_{uncorr}	$p_{FWE\text{-}corr}$	$q_{FDR\text{-}corr}$	T	$(Z_=)$	p_{uncorr}			
0.000	**6**	**0.000**	**0.000**	**116**	**0.000**	**0.000**	**0.003**	**12.08**	**6.80**	**0.000**	**-36**	**-9**	**3**
		0.000	0.004	10.89	6.48	0.000	-42	-6	9				
		0.000	0.044	8.81	5.83	0.000	-54	-3	3				
		0.000	**0.000**	**540**	**0.000**	**0.000**	**0.004**	**11.44**	**6.63**	**0.000**	**-51**	**-30**	**45**
		0.000	0.004	10.88	6.48	0.000	-42	-21	54				
		0.000	0.017	9.64	6.11	0.000	-54	-24	36				
		0.000	**0.000**	**125**	**0.000**	**0.000**	**0.023**	**9.37**	**6.02**	**0.000**	**54**	**-36**	**27**
		0.002	0.153	7.65	5.39	0.000	63	-21	21				
		0.002	0.159	7.60	5.37	0.000	54	-33	18				
		0.000	**0.000**	**36**	**0.000**	**0.000**	**0.023**	**9.34**	**6.01**	**0.000**	**-48**	**-66**	**0**
		0.001	0.082	8.20	5.61	0.000	-42	-69	6				
		0.000	**0.000**	**34**	**0.000**	**0.000**	**0.065**	**8.41**	**5.69**	**0.000**	**42**	**39**	**24**
		0.019	0.635	6.64	4.96	0.000	39	30	30				
		0.000	**0.000**	**57**	**0.000**	**0.001**	**0.133**	**7.82**	**5.46**	**0.000**	**54**	**-30**	**54**
		0.002	0.147	7.73	5.43	0.000	48	-30	45				
		0.010	0.419	6.93	5.09	0.000	57	-30	42				

Figure 5. 6 SPM output of Shame > Nautral contrast. Statistically significsnt results at cluster- and peak-level (p < .05 FWE-corr)

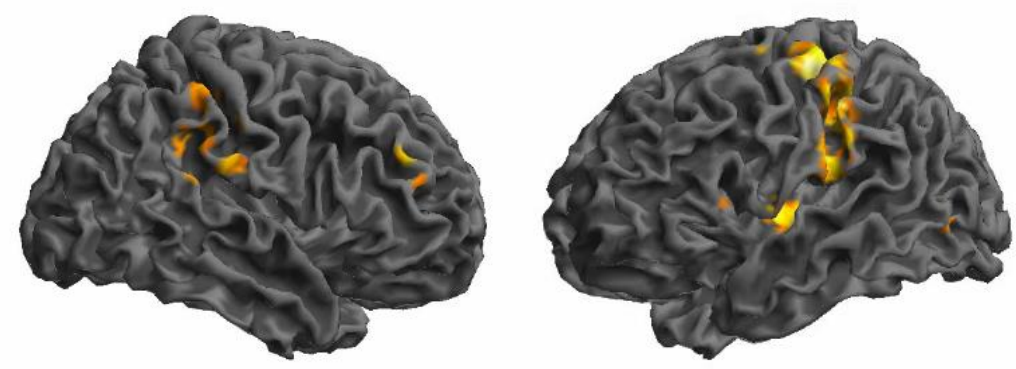
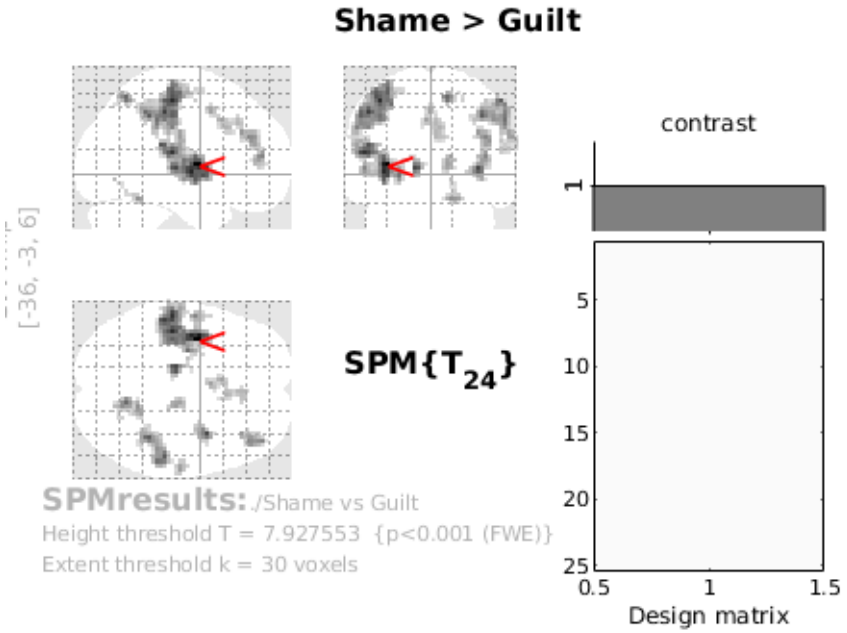


Figure 5. 7 Visual rendering of "Shame > Neutral" (p < .001 FWE corrected) contrast for both hemispheres. Shame-specific neural activations were found within the left insula, left inferior parietal lobule, right middle frontal gyrus and right inferior parietal lobule.

Shame > Guilt

Shame activations respect to guilt included the left insula (k = 866, p < .001 FWE-corr), right parietal lobule (k = 217, p < .001 FWE-corr), right precuneus (k = 40, p < .001 FWE-corr), right middle frontal gyrus (k = 97, p <

.001 FWE-corr), right culmen (cerebellum) (k = 34, p < .001 FWE-corr), right postcentral gyrus (k = 34, p < .001 FWE-corr), right thalamus (k = 36, p < .001 FWE-corr), cingulate gyrus (k = 97, p < .001 FWE-corr) (See Figure 5.8).



Statistics: ***p-values adjusted for search volume***

set-level		cluster-level				peak-level					mm	mm	mm
p	c	$p_{FWE\text{-}corr}$	$q_{FDR\text{-}corr}$	k_E	p_{uncorr}	$p_{FWE\text{-}corr}$	$q_{FDR\text{-}corr}$	T	$(Z_=)$	p_{uncorr}			
0.000	9	0.000	0.000	866	0.000	0.000	0.002	14.89	7.41	0.000	-36	-3	6
						0.000	0.005	13.45	7.11	0.000	-39	-9	0
						0.000	0.005	13.38	7.10	0.000	-42	-24	54
		0.000	0.000	62	0.000	0.000	0.008	12.46	6.89	0.000	36	3	3
						0.000	0.091	9.84	6.17	0.000	36	-3	-3
		0.000	0.000	217	0.000	0.000	0.011	11.95	6.76	0.000	39	-42	42
						0.000	0.011	11.86	6.74	0.000	54	-30	54
						0.000	0.018	11.25	6.58	0.000	57	-36	39
		0.000	0.000	40	0.000	0.000	0.015	11.48	6.64	0.000	12	-60	57
						0.000	0.470	8.48	5.71	0.000	24	-63	54
		0.000	0.000	97	0.000	0.000	0.033	10.72	6.44	0.000	42	36	27
						0.000	0.033	10.66	6.42	0.000	42	48	12
						0.000	0.074	10.07	6.24	0.000	36	30	30
		0.000	0.000	34	0.000	0.000	0.057	10.28	6.31	0.000	15	-51	-21
						0.000	0.220	9.07	5.92	0.000	15	-69	-6
						0.000	0.511	8.41	5.69	0.000	18	-60	-15
		0.000	0.000	34	0.000	0.000	0.083	9.96	6.21	0.000	63	-18	27
						0.000	0.236	8.98	5.89	0.000	60	-15	18
		0.000	0.000	36	0.000	0.000	0.091	9.88	6.18	0.000	15	-21	12
		0.000	0.000	97	0.000	0.000	0.091	9.87	6.18	0.000	-6	15	39

Figure 5. 8 SPM output of Shame > Guilt contrast. Statistically significsnt results at cluster- and peak-level (p < .001 FWE-corr)

Guilt > Neutral

No voxels survive at for this contrast at multiple comparisons corrections.

Guilt > Shame

A small cluster of voxels emerged for guilt in comparison with shame. Specifically, it was located in the right inferior occipital gyrus (k = 75, p < .001 FWE-corr) (See Figure 5.9).

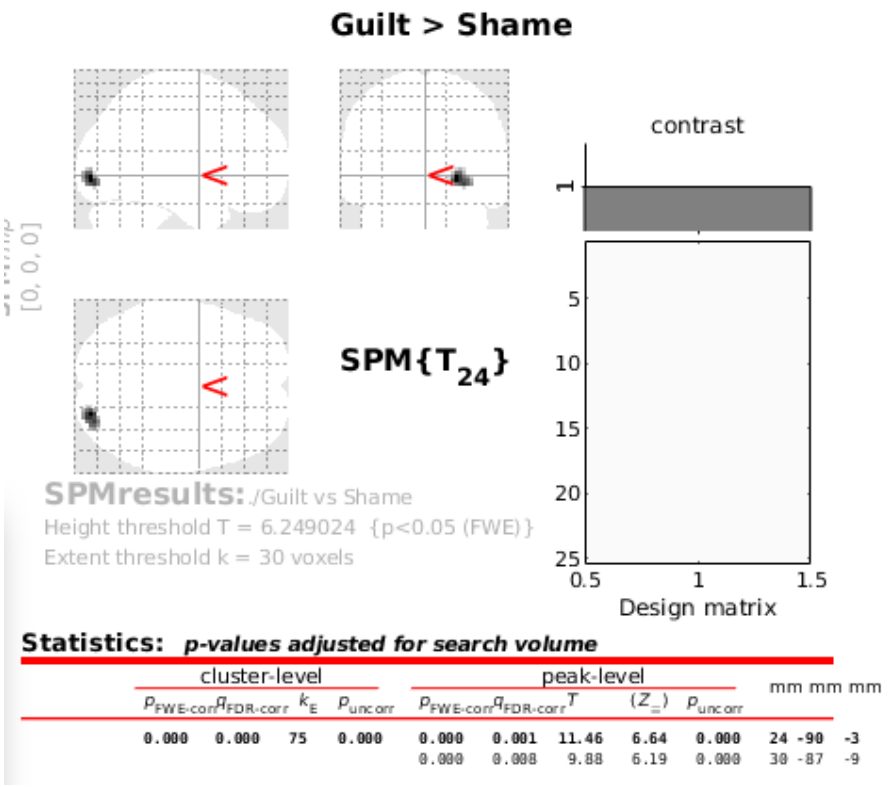


Figure 5. 9 SPM output of Guilt > Shame contrast. Statistically significsnt results at cluster- and peak-level (p < .05 FWE-corr)

Resting state networks associated to shame- and guilt-proneness

As set by CONN default, spatial ICA returned 40 functional independent components, both in variability and frequency domains. The matrix of the independent components was made up of 25 rows (one per subject) and 40 columns (the independent components). In other words, each participant had a score per component, which represented how much that component was expressed in him/her (Pappaianni et al., 2018). We correlated the normalized TOSCA's shame and guilt-proneness scores with the coefficients of the components. In the frequency domain, results showed a significant negative correlation between shame-proneness and IC5 (r = -0.495, p = 0.012) and positive correlation between guilt-proneness and IC25 (r = 0.498, p = 0.01); within the variability dimension, two significant negative correlations were found between guilt-proneness and IC14 (r = -0.476, p = 0.016) and between guilt-proneness and IC28 (r = -0.472, p = 0.017). All results are expressed at voxel threshold: p < .001 p-FDR corrected; cluster threshold: p < .05 cluster-size p-FDR corrected. Below is a brief description of each of these significant components.

IC5 was mainly composed of huge clusters in the left superior-middle frontal gyrus (-24 +20 +56) and left middle-inferior temporal gyrus (-62 -48 -06). See Table 5.5 for a detailed description of clusters involved in IC5, Figure 5.10 for a sagittal visual rendering of the component and scatterplot between IC5 and shame-proneness.

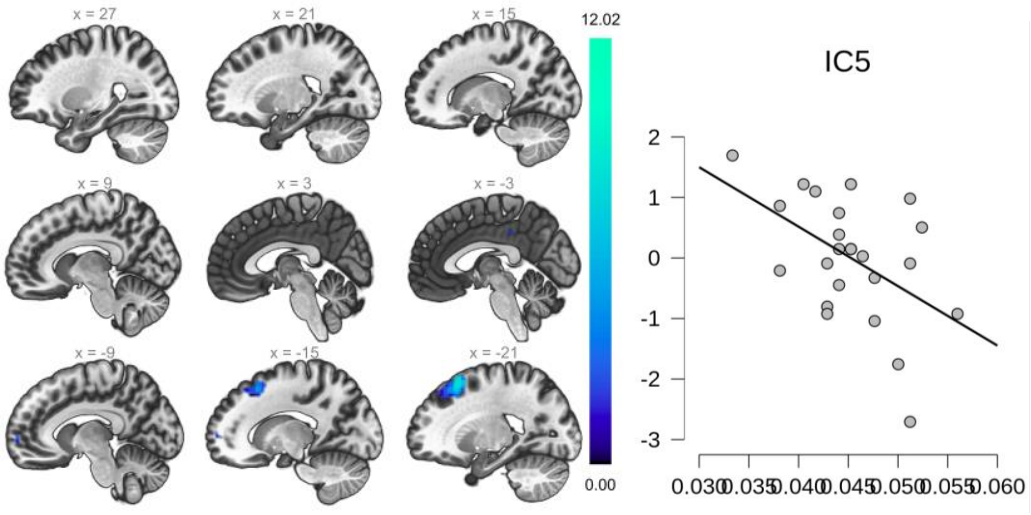


Figure 5. 10 Visual rendering and scatterplot. On the left, visual rendering ($p < .05$ at cluster-level FWE corrected) of IC5 (sagittal). On the right, scatterplot between IC5 loading coefficients (frequency) and shame-proneness ($r = -0.495$).

Clusters (x,y,z)	**size**	**size p-FWE**	**size p-FDR**	**size p-unc**	**peak p-FWE**	**peak p-unc**
-24 +20 +56	1325	0.000000	0.000000	0.000000	0.000001	0.000000
-62 -48 -06	534	0.000000	0.000000	0.000000	0.003554	0.000000
+66 -42 -22	222	0.000000	0.000000	0.000000	0.004618	0.000000
+36 -64 -36	135	0.000000	0.000001	0.000000	0.001742	0.000000
-42 -66 +30	130	0.000000	0.000001	0.000000	0.018041	0.000000
-08 +60 +00	109	0.000001	0.000005	0.000002	0.018635	0.000000
-30 -64 +50	89	0.000004	0.000022	0.000009	0.031038	0.000000
-48 -46 +44	75	0.000014	0.000066	0.000033	0.021134	0.000000
-42 +54 -14	34	0.000958	0.004013	0.002257	0.113454	0.000001
-02 -34 +38	26	0.002596	0.009796	0.006123	0.062556	0.000000

Table 5. 5 IC5 details. Clusters, size, size p-FWE, size p-FRD, size p-uncorrected, peak p-FWE, peak p-uncorrected are shown.

IC25 was localized entirely in frontal regions, as frontal medial cortex (+06 +42 -24), right middle frontal gyrus (+48 +26 +20) and left (-42 +30 -18) and right (+42 +30 -18) frontal orbital cortex. See Table 5.6 for a detailed description of clusters involved in IC25, Figure 5.11 for a sagittal visual rendering of the component and scatterplot between IC5 and shame-proneness. Please, note that for this component $p < .001$ uncorrected at voxel-threshold, $p < .05$ FWE corrected at cluster-level.

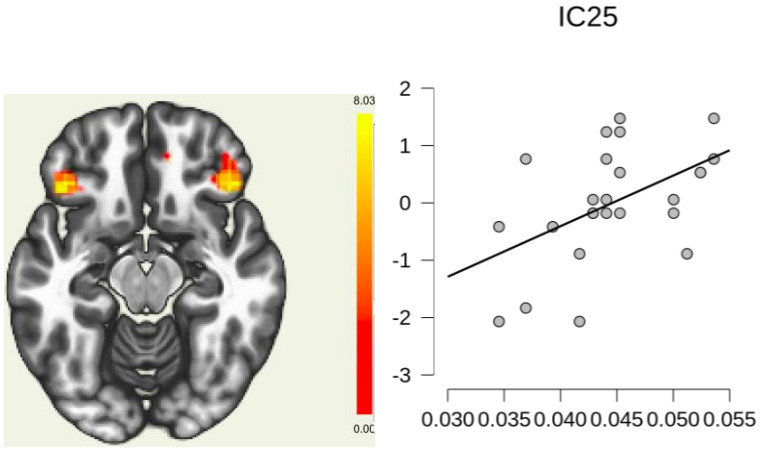


Figure 5. 11 Visual rendering and scatterplot. On the left, visual rendering ($p < .05$ at cluster-level FWE corrected) of IC25 (axial). On the right, scatterplot between IC25 loading coefficients (frequency) and guilt-proneness ($r = 0.498$).

Clusters (x,y,z)	**size**	**size p-FWE**	**size p-FDR**	**size p-unc**	**peak p-FWE**	**peak p-unc**
06 +42 -24	754	0.000001	0.000002	0.000000	0.01505	0.000000
48 +26 +20	493	0.00006	0.000068	0.000003	0.11939	0.000001
42 +30 -18	412	0.00025	0.000164	0.000013	0.011894	0.000000
-42 +30 -18	404	0.000289	0.000164	0.000016	0.003153	0.000000

Table 5. 6 . IC25 details. Clusters, size, size p-FWE, size p-FRD, size p-uncorrected, peak p-FWE, peak p-uncorrected are shown.

IC14 was an independent component consisting among others of two big clusters in the bilateral inferior frontal gyrus (+48 +30 +12 / -48 +32 +05), bilateral frontal orbital cortex (-26 +30 -18 / +30 +30 -18), left supramarginal gyrus (-56 -42 +26), right temporal fusiform cortex/inferior temporal gyrus (+46 -18 -34). See Table 5.7 for a detailed description of clusters involved in IC14 and Figure 5.12 for am axial visual rendering of the component.

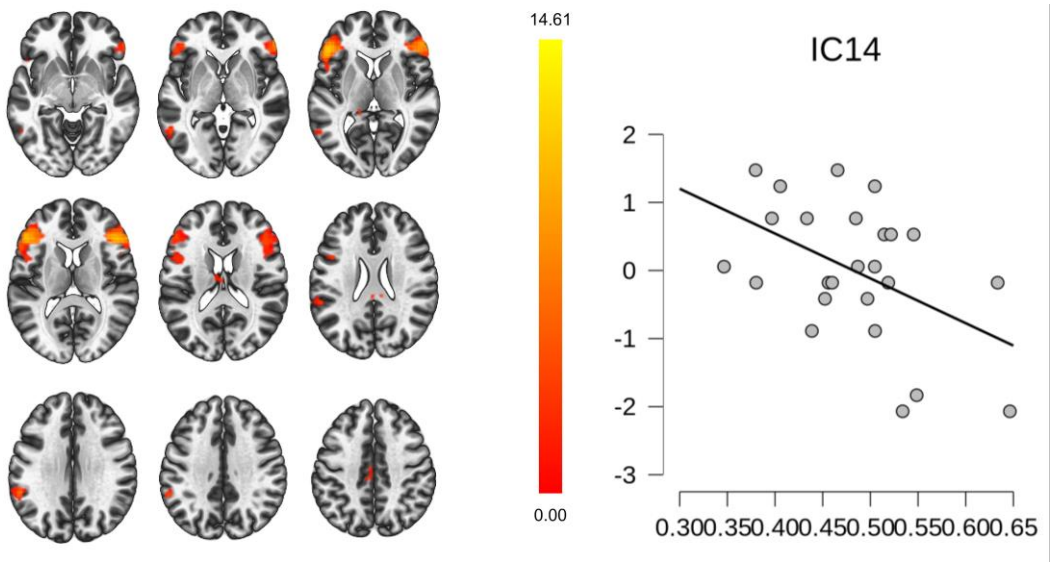


Figure 5. 12 Visual rendering and scatterplot. On the left, visual rendering ($p < .05$ at cluster-level FWE corrected) of IC14 (axial). On the right, scatterplot between IC14 loading coefficients (variability) and guilt-proneness ($r = -0.476$).

Clusters (x,y,z)	**Size (k)**	**size p-FWE**	**size p-FDR**	**size p-unc**	**peak p-FWE**	**peak p-unc**
+48 +30 +12	1604	0.000000	0.000000	0.000000	0.000000	0.000000
-48 +32 +06	1578	0.000000	0.000000	0.000000	0.000000	0.000000
-26 +30 -18	643	0.000000	0.000000	0.000000	0.000073	0.000000
-56 -42 +26	398	0.000000	0.000000	0.000000	0.000358	0.000000
+46 -18 -34	248	0.000000	0.000000	0.000000	0.00719	0.000000
+30 +30 -18	214	0.000000	0.000000	0.000000	0.000032	0.000000
-02 -30 +48	193	0.000000	0.000000	0.000000	0.019656	0.000000
-56 -58 +02	171	0.000000	0.000001	0.000000	0.012336	0.000000
-02 -18 +14	113	0.000005	0.000032	0.000006	0.014216	0.000000
+10 -34 +24	110	0.000006	0.000036	0.000008	0.021376	0.000000
+66 -30 +44	94	0.000019	0.000106	0.000026	0.092014	0.000001
+36 -58 -24	52	0.000609	0.003035	0.000809	0.009408	0.000000
-14 -36 +06	47	0.000969	0.004456	0.001287	0.017541	0.000000
-32 -48 -24	40	0.001908	0.008154	0.002537	0.123507	0.000001
-44 +02 +42	38	0.002332	0.009304	0.003101	0.023036	0.000000
+68 -48 +02	27	0.007546	0.028295	0.01006	0.212074	0.000003

-24 +38 +38	18	0.022261	0.070821	0.029902	0.281083	0.000004
+12 -04 +20	18	0.022261	0.070821	0.029902	0.234182	0.000003
-30 -70 -22	18	0.022261	0.070821	0.029902	0.31932	0.000005
+24 -28 +26	14	0.037948	0.110112	0.051386	0.170364	0.000002
-36 -06 -40	14	0.037948	0.110112	0.051386	0.336126	0.000005

Table 5. 7 . IC14 details. Clusters, size, size p-FWE, size p-FRD, size p-uncorrected, peak p-FWE, peak p-uncorrected are shown.

IC18 was a small component comprising basic ganglia areas, specifically the left (-06 +08 +02) and right (+06 +08 +02) caudate. See Table 5.8 for a detailed description of clusters involved in IC28. Figure 5.13 for a sagittal visual rendering of the component and a scatterplot between IC28 and guilt-proneness.

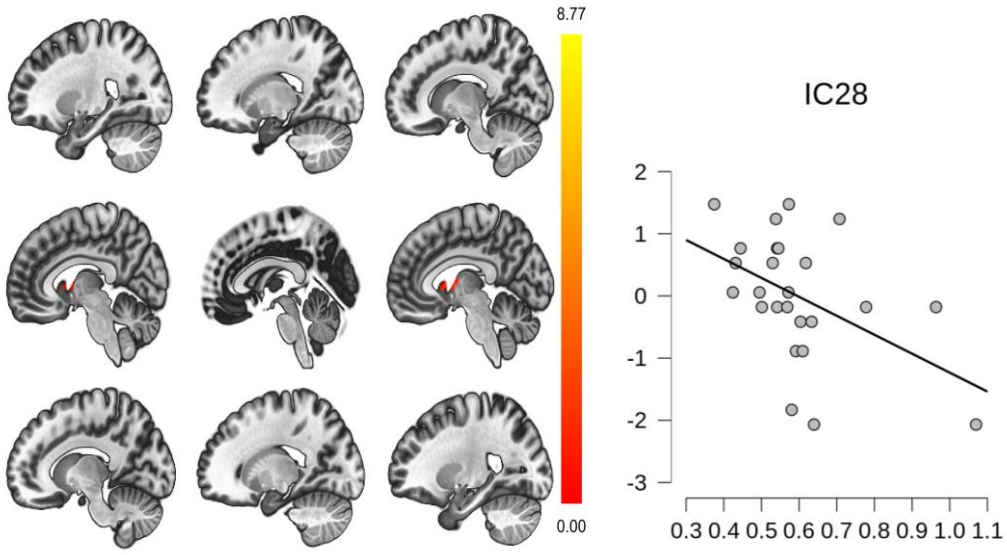


Figure 5. 13 Visual rendering and scatterplot. On the left, visual rendering ($p < .05$ at cluster-level FWE corrected) of IC28 (sagittal). On the right, scatterplot between IC28 loading coefficients (variability) and guilt-proneness ($r = -0.472$).

Clusters (x,y,z)	**size**	**size p-FWE**	**size p-FDR**	**size p-unc**	**peak p-FWE**	**peak p-unc**
+06 +08 +02	431	0.000000	0.000000	0.000000	0.000722	0.000000
-02 -36 -16	49	0.000006	0.000288	0.000052	0.001687	0.000000
-54 -46 -10	18	0.000721	0.023369	0.006373	0.02782	0.000000

Table 5. 8 IC28 details. Clusters, size, size p-FWE, size p-FRD, size p-uncorrected, peak p-FWE, peak p-uncorrected are shown.

With the aim of comparing at a qualitative level our components of interest with the other functional networks, we used a CONN function that calculates the spatial correlation between ICs and networks recognized globally as templates, as DMN, SensoriMotor, Visual, Salience, DorsalAttention, FrontoParietal, Language and Cerebellar

networks (see figure 5.14). It should be noted that the IC14, IC28, IC5 and IC25 components have a very low spatial and statistical match with all proposed cognitive networks, suggesting independence between them.

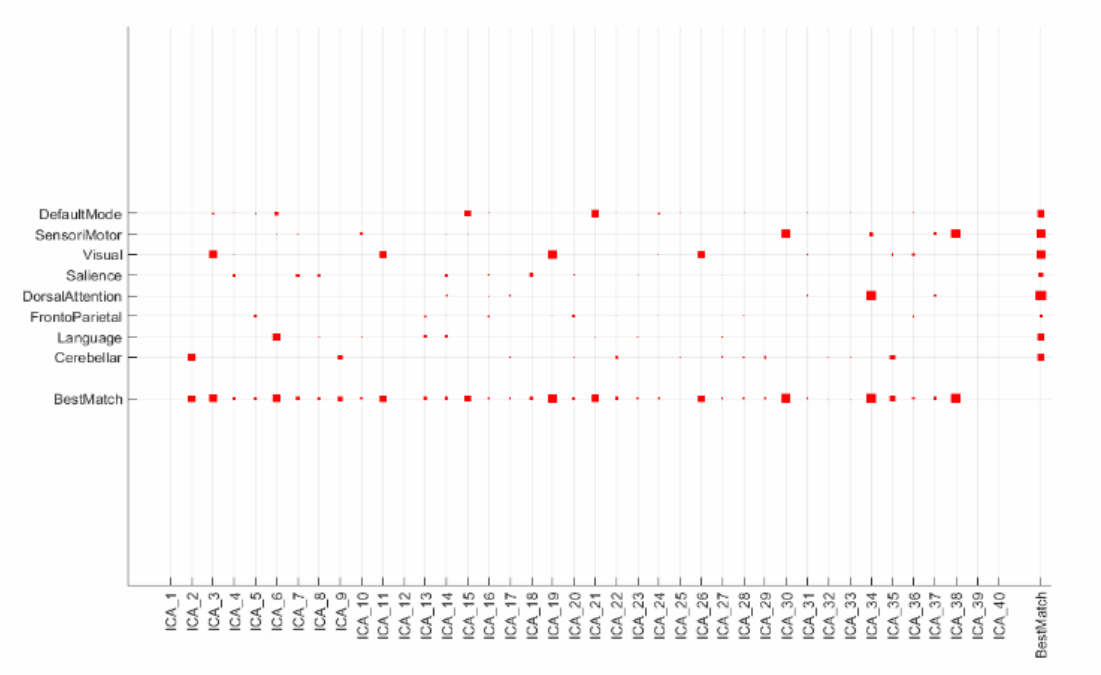


Figure 5. 14 Spatial correlation match between all ICs and the known rs-functional networks templates.

Discussion

Brain regions involved in the Shame Task

The Shame Task is an experimental paradigm aimed at eliciting shame during the simulation of social interactions. Assuming that our previous behavioral studies (see Chapter 2) have showed promising results in terms of elicitation and measure of the emotion, we decided to replicate the experiment during an fMRI session with the aim of capturing the neural basis of the perception of shame (and guilt as a self-conscious emotion of control). Thanks to a collaboration with the University of Geneva, it was possible to carry out the experiment at the Brain and Behavioral Lab within the same University.

From a behavioural point of view, the results were replicated and consistent with the behavioral study presented in chapter 2. In addition to there being a clear difference between emotional and neutral condition, the shame reported facing shameful stimuli was statistically higher than guilt, as was the guilt in the guilt-eliciting scenarios. This data supports the goodness of the Shame Task as a tool to measure shame and guilt. Instead, we did not replicate our results about significant correlations between shame/ guilt and behavioral variables (as shame/guilt-proneness or empathetic traits) from questionnaires.

At a neural level, when comparing shame stimuli with neutral ones, shame was associated primarily with extensive activation in the left insular cortex. This result is perfectly in line with our functional meta-analysis (previous chapter) which suggested the left insula as a key region for self-conscious emotions (including, therefore, shame). In addition, shame-related activations were previously reported in the anterior insula (Michl et al., 2014; Roth et

al., 2014; Wagner et al., 2011) by using paradigms in which participants were asked to imagine themselves in certain situations or to autobiographically recall shameful episodes. The ability to imagine one's own person in certain contexts (as in the case of the Shame Task) could be mediated by insular activity. The insula is known to be an important region for basic emotional processing, interoception, self-awareness and subjective emotional experience (Tayah, Savard, Desbiens, & Nguyen, 2013; Uddin, Nomi, Hebert-Seropian, Ghaziri, & Boucher, 2017). Studies on neurological patients have also shown that damage to the left insula causes deficits in the subjective processing of even basic emotions such as disgust (Borg et al., 2013; Calder, Keane, Manes, Antoun, & Young, 2000; Uddin et al., 2017). Insula is strictly related to social behavior (Cracco, Desmet, & Brass, 2016), social cognition and empathy (Lamm & Singer, 2010; Uddin et al., 2017). The fact that the Shame task is based on social interactions, could further strengthen the role of the insula as mediator of such interaction. Insula is also a key region for pain processing. Insula activations are reported not only by experiencing pain first hand, but also by seeing it in others vicariously (Corradi-Dell'Acqua, Hofstetter, & Vuilleumier, 2011; Corradi-Dell'Acqua, Tusche, Vuilleumier, & Singer, 2016). Returning to the definition of shame, we know that it is a self-conscious emotion that generates pain in those who perceive it. The fact that the insula is an important hub for pain, confirms the negative connotation of this emotion, that is associated with physical pain in the individual and brings in inhibitory behavior, withdrawal and escape very similar to those of pain. Also in consideration of the study 2 on vicarious shame, it would be interesting in the future to conduct a study in fMRI to understand the neural basis of such emotion in the third person. Our hypothesis is that areas related to vicarious pain may emerge even during vicarious shame.

In addition, we found shame-related activation at the level of the bilateral inferior parietal lobule (IPL). IPL is one of the most functionally linked regions with the anterior insula, and together with temporoparietal junction (TPJ) has been found to be involved in self-perception, undirected thinking, episodic memory and social cognition (Igelström & Graziano, 2017). In addition, it is partially included in the DMN, a neural circuit dedicated to self-reflected thoughts and self-evaluation. In a recent study investigating moral injury (Sun et al., 2019), amplitude of low-frequency fluctuations (ALFF) at resting-state within the IPL correlated with moral transgression, suggesting a possible role of IPL in morality. Moral injury is strictly related to self-referential processes and theory of mind (Sun et al., 2019), and researchers reported that people diagnosed with depression, who often report moral injury, experience a very high general level of shame (Kim, Thibodeau, & Jorgensen, 2011; Sun et al., 2019). In light of the fact that the Shame Task requires an evaluation of one's own person in a violation of moral norms scenarios, we suggest that IPL may play an important role in personal awareness during moral transgression. In a study investigating shame in OCD patients (Hennig-Fast et al., 2015), IPL activation was higher in healthy control than patients facing shameful scenarios. In addition, IPL is part of the executive and semantic process network. This network has been found to be related in the reappraisal of negative stimuli (Messina, Bianco, Sambin, & Viviani, 2015). Since our stimuli are negative to evoke shame, we cannot exclude that participants have automatically applied a type of reinterpretation in front of the negative stimuli.

Finally, our results show an activation of the middle frontal gyrus during pure shame. Previous studies investigating shame (such as Michl et al., 2014; Roth et al., 2014; Wagner et al., 2011) reported frontal regions as dlPFC, vlPFC and dmPFC to be involved in shame. This result is in line with our meta-analysis, where prefrontal regions were

within the shame network. In light of the fact that these regions are important in regulating emotions (Etkin, Büchel, & Gross, 2015), we suggest that the involvement of middle frontal regions may be symptomatic of top-down regulatory processes that prevent exaggerated shameful responses. Indeed, we know that several psychopathological conditions characterized by extreme shame perception (as for example OCD, depression, schizophrenia, bulimia nervosa, PTSD), they all are characterized by abnormalities in volume with respect to healthy controls (Glahn et al., 2008; Grieve, Korgaonkar, Koslow, Gordon, & Williams, 2013; Li et al., 2014; Rotge et al., 2010; Schäfer, Vaitl, & Schienle, 2010). In line with what we said in our meta-analysis, we propose that middle frontal gyrus may play a role of mediator of too extreme shameful experiences.

Our results show no selective amygdala activation for shame. This suggests an indirect involvement of the amygdala in the experience of shame. Hence, this is a further confirmation to our interpretation on the role of the amygdala in the perception of self-conscious emotions (see Chapter 3). Patient FF was unable to recognize facial expressions of shame, but he reported an abnormal experience of shame only in certain situations. Based on the results of the tests administered to the patient, we conferred the amygdala a primary role in the attentive detection of social cues (such as the region around the eyes that is diagnostic for facial expression of shame), while we ruled out a possible direct impact on the feeling of shame. To this is added the fact that in the functional meta-analysis carried out later on shame and guilt (Chapter 4), the amygdala did not emerge as a significant cluster for both moral emotions. As the studies included in the meta-analysis potentially captured the neural signal of the experience of shame (and guilt), we are increasingly inclined to consider the amygdala as an important attentional catalyst towards salient stimuli (such as social stimuli) rather than a "switch" for moral emotions processing. That said, it is not surprising that we did detect the activation of the amygdala during our experimental task in fMRI. Since it involves an evaluation of several possible scenarios regardless of the condition, the functional activation of this region may have been spread across all three conditions (shame, guilt and neutral). In light of all above, we preferred not to investigate further the functional dimensions of this region (e.g. through an ROI analysis), since our data in general do not suggest a real involvement of the amygdala in shame processing.

Looking at the contrast shame versus guilt, several activation clusters emerged. Specifically, this contrast returned the left insula, as well as temporo-parietal (IPL+Precuneus), cerebellum, thalamus and cingulate regions. Getting the left insula in this type of contrast was quite surprising, as was the fact that no significant clusters appeared for guilt compared to neutral. From our meta-analysis, shame and guilt shared the functional activation of the left insula, while in this case it seems limited to shame. Even in the light of the contrast between guilt and neutral, we wondered if the neural signal of guilt had actually been captured by the fMRI, as it does not seem different from a neutral control. It should be noted that, compared to the original paradigm, because of technical scanning times, we reduced the presentation time of each stimulus from 7 to 5 seconds. Even if from a behavioural point of view this does not seem to have had any effect (guilt is still correctly recognized), perhaps the mental construction of the guilty scenario is too complex for such a short time. A qualitative analysis of the written stimuli shows that the guilt sentences tend to be longer than those of shame, since they need the insertion of a variable "action" and are not simply directed at the person. Our justification is that because of the resonance times we have lost the specific signal of guilt. This is because, by speculating, the eliciting stimuli of shame were simpler on a syntactic level and

being directed to the person much more "immediate", while the stimuli of guilt foresaw a more complex imaginative force.

Compared to guilt, in addition to left insula and temporal-parietal regions, shame was related to activations in thalamus, cingulate cortex and cerebellum. These results are partially in line with our meta-analysis, in which we found an involvement of thalamus and dorsal anterior cingulate cortex (dACC) in shame activations. The thalamus, which is part of the limbic circuit, is known to be important in the arousal system of the brain that closely depends on emotional processing (Ward, 2013). Aside from being involved in many cognitive functions, the dACC plays a critical role in representing contexts and being part of the limbic system is known to be strictly related to emotional processes (Heilbronner & Hayden, 2016). Observing dACC projections with the surrounding areas, it is to be noted that it is linked to emotional areas such as insula, amygdala, hypothalamus, vmPFC, ventral striatum (Barbas & Pandya, 1989; Morecraft & Van Hoesen, 1998; Morecraft et al., 2012; Vogt & Pandya, 1987; Heilbronner & Hayden, 2016). Given its function as a "mediator" between limbic regions and purely cognitive regions such as the frontal areas (Stevens et al., 2011), it may work as a guide for the emotional experience (in this case shame) within the cognitively represented scenario.

Looking at the contrast guilt versus shame, a single cluster within occipital areas emerged. The involvement of occipital regions in guilt perception is not new. In fact, previous studies have reported visual cortex involvement in guilt (Michl et al., 2014; Takahashi et al., 2004; Wagner et al., 2011). Specifically, it emerged that during the imagination of guilt scenarios, men but not women showed higher activations in medial occipital regions, in addition to frontal and amygdala activations (Michl et al., 2014). It would be interesting in the future to study this gender effect better, including shame as well.

"Self-conscious" resting-state networks

Over time, the number of studies concerning functional resting-states and specifically functional connectivity has grown exponentially (Dosenbach, Fair, Cohen, Schlaggar, & Petersen, 2008; Fox & Raichle, 2007; Michael D. Greicius, Srivastava, Reiss, & Menon, 2004; Menon, 2015). This is due to a number of factors. First of all, studying the resting brain allows us to better understand how it works during particular tasks (Bijsterbosch et al., 2017). Understanding, for example, why some areas are activated or deactivated in conjunction with events around us is of fundamental importance to understand how the brain works at 360°. Second, the acquisition of resting state data does not involve a specific experimental design. The participant, lying in the scanner, does not have to do anything that requires a cognitive demand (Bijsterbosch et al., 2017), but just let the mind wander. This makes it easier to study even specific clinical populations, which might have difficulties in completing an fMRI task. It allows, therefore, to include in the experimental studies a greater number of populations (Bijsterbosch et al., 2017). Usually, the recording of resting states is shorter than with an fMRI task-based experiment (approximately 7-9 minutes of fMRI sequence). Given the high costs of magnetic resonance imaging, this is undoubtedly an important advantage. Not least, the possibility to study sensitive populations that do not have the possibility to lie down for a long time in the scanner. Finally but not least, it has been shown that the resting-state functional connectivity may be a reliable biomarker for the diagnosis of different mental disorders (Bijsterbosch et al., 2017), such as depression (Drysdale et al., 2017; Hopman et al., 2019), autism (Abraham et al., 2016), chronic pain (Pfannmöller

& Lotze, 2019). Although not officially recognized as a clinical method, using resting-state analysis as an indicator for diagnosis is a very promising field of application.

In recent years, the growing study of functional connectivity has brought to the fore several patterns of hemodynamic activity at rest that seem consistent between individuals. Since the context in which they were studied was that of cognitive neuroscience, logically they were interpreted on the basis of cognitive constructs. Nevertheless, it cannot be excluded from the outset that other factors, such as the emotional one, may also have an "imprint" in the state of rest. Within the topic dealt with in this manuscript, we have tested the possibility that shame-proneness, in addition to guilt-one, may show a "neural trace" in at rest. The choice of such trait characteristics is due to the fact that they should be constant over time, and not specific to a particular moment (such as variables of an experimental task). Four networks emerged correlated with the inclination to experience shame and guilt in everyday life, specifically one for shame and three for guilt. It is interesting to note that all four are composed of areas that, in one way or another, are related to both emotions according to our studies or generally to the literature about. Below is a review of the networks of interest that emerged from the analysis. However, we would like to stress that, considering that this is the first attempt to associate moral emotions to resting-states networks, we will not discuss the directionality of the correlations at stake, but we will consider them according to their absolute value. Further studies are necessary in order to correctly interpret these (preliminary) evidence.

Shame-related network (IC5) included middle-superior frontal gyrus and middle-inferior temporal gyrus. We have already discussed in the previous paragraph how the frontal medial gyrus is closely involved in shame (Michl et al., 2014; Roth et al., 2014; Wagner et al., 2011). The superior frontal gyrus, specifically the presupplementary motor area (preSMA) and the premotor area, falls in the shame network of the meta-analysis (Chapter 4).. In light of the maladaptive behaviors caused by the experience of shame, such as inhibition, desire to escape and hide from others, we suggest a possible role of these areas in initiating such behaviors as a protective function of the individual. Temporal areas have been reported to be linked to social situations processing, social cognition (Olson, McCoy, Klobusicky, & Ross, 2013) and emotion regulation as well (Grecucci, Giorgetta, Bonini, & Sanfey, 2013). In view of all this, such involvement of temporal regions, as well as frontal ones, seems to be in line with the intrinsic social impact of shame.

Guilt-related networks (IC14, IC28, IC25), taken together, referred to orbitofrontal-medial frontal cortices, inferior temporal gyrus (specifically the fusiform gyrus), supramarginal gyrus and caudate. It has been seen that the autobiographical recall of guilt-eliciting events engages the activation of the orbitofrontal cortex (Wagner et al., 2011). It is very intriguing to note that the same authors reported a correlation between the activation of these areas and guilt-proneness measured by self-report (Wagner et al., 2011), suggesting a possible mediation role of orbitofrontal activity and propensity of experience guilt. The fusiform temporal gyrus is globally considered the hub of face processing (Haxby, Hoffman, & Gobbini, 2000; Kanwisher & Yovel, 2006). Given the intrinsic social nature of the face, and given that guilt is one of the most "social" and towards-others directed emotions, we suggest this connection between guilt and fusiform gyrus as plausible. Zooming out, the involvement of temporal regions associated with guilt is generally confirmed in the literature (Michl et al., 2014; Moll et al., 2007; Shin et al., 2000; Wagner et al., 2011). This also applies to the supramarginal gyrus, considered an important area for social cognition

(Morey et al., 2012; Wagner et al., 2011). Lastly, the caudate. This subcortical region was active during an autobiographical recall task of eliciting guilt events (Mclatchie, Giner-Sorolla, & Derbyshire, 2016) and basal ganglia were found to be involved during guilt (Fourie et al., 2014; Green, Lambon Ralph, Moll, Deakin, & Zahn, 2012; Wagner et al., 2011). In addition, it is known that functional-structural abnormalities in the basal ganglia are typical of psychopathological disorders characterized by dysregulation of guilt, such as depression (Cummings, 1992; Ring & Serra-Mestres, 2002).

Limitations

Both studies have limitations. Although the sample size seems appropriate for a within-subjects design and is in line with fMRI studies on emotions in literature, for a better generalization of results would be appropriate to expand the number of participants. The sample was composed of young adults, mostly students of the Faculty of Medicine and Psychology at the University of Geneva. For a better generalization of the results, it would be appropriate to extend the age range to other cohorts. In the future, it would be interesting to study whether there is consistency in the results between young adults and older adults.

We have already discussed and hypothesized why validated guilt-inducing stimuli have not shown specific neural activations during the Shame Task. In the future, it would be more appropriate to select stimuli of shame and guilt as similar as possible in terms of length and syntax. Finally, shame-proneness and guilt-proneness have been measured by a self-report tool. As already discussed in the previous chapters, possible biases may be introduced by the use of such instruments.

Conclusions

The good spatial resolution of functional magnetic resonance imaging has been exploited to investigate the neural bases of shame. The Shame task has proved to be a good tool to catch the neural signal related to shame, less as far as guilt is concerned. Obtained results related to shame go hand in hand with shame evidence found previously, confirming the left insula, among others, as a key region in the processing of shame. We made the attempt to find a trace of shame and guilt within the resting-state networks. We stress that our intention was not to investigate functional connectivity between specific areas regarding moral emotions. In another words, in this study we did not present a targeted hypothesis concerning shame and guilt allowing us to investigate connectivity between two regions or between a region and a network of areas. This would have been subject of a seed-based or ROI-to-ROI functional connectivity analysis. Certainly, this could be an interesting next step in our investigation. Instead, with this study we aimed to show that there are resting-state networks that can go beyond a purely cognitive interpretation and be linked to other dimensions, such as affective-moral domains. The results seem encouraging and consistent with the literature. In the future, confirming that even at rest it is possible to detect emotional traits that characterize everyday life, would support the thesis that such complex emotions, such as moral ones, can leave a visible trace in the brain even in the absence of stimulation. This would open new horizons of research, no longer limited to the "cognitive" domain of functional neural networks but open to dimensions (such as emotional and affective) that are superficially considered irreconcilable with the current context of cognitive neuroscience.

References

Abraham, A., Milham, M., Martino, A. D., Craddock, R. C., Samaras, D., Thirion, B., & Varoquaux, G. (2016). Deriving reproducible biomarkers from multi-site resting-state data: An Autism-based example. Retrieved from https://hal.inria.fr/hal-01398867Chapter 5

Barbas, H., & Pandya, D. N. (1989). Architecture and intrinsic connections of the prefrontal cortex in the rhesus monkey. The Journal of Comparative Neurology, 286(3), 353–375. https://doi.org/10.1002/cne.902860306

Bastin, C., Harrison, B. J., Davey, C. G., Moll, J., & Whittle, S. (2016). Feelings of shame, embarrassment and guilt and their neural correlates: A systematic review. Neuroscience and Biobehavioral Reviews, 71, 455–471. https://doi.org/10.1016/j.neubiorev.2016.09.019

Bijsterbosch, J., Smith, S. M., & Beckmann, C. F. (2017). Introduction to Resting State FMRI Functional Connectivity. Oxford University Press.

Borg, C., Bedoin, N., Peyron, R., Bogey, S., Laurent, B., & Thomas-Antérion, C. (2013). Impaired emotional processing in a patient with a left posterior insula-SII lesion. Neurocase, 19(6), 592–603. https://doi.org/10.1080/13554794.2012.713491

Buchbinder, B. R. (2016). Chapter 4—Functional magnetic resonance imaging. In J. C. Masdeu & R. G. González (Eds.), Handbook of Clinical Neurology (pp. 61–92). https://doi.org/10.1016/B978-0-444-53485-9.00004-0

Buchner, R., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The Brain's Default Network: Anatomy, Function, and Relevance to Disease. 1124, 1–38.

Calder, A. J., Keane, J., Manes, F., Antoun, N., & Young, A. W. (2000). Impaired recognition and experience of disgust following brain injury. Nature Neuroscience, 3(11), 1077–1078. https://doi.org/10.1038/80586

Calhoun, V. D., Adali, T., Pearlson, G. D., & Pekar, J. J. (2001). A method for making group inferences from functional MRI data using independent component analysis. Human Brain Mapping, 14(3), 140–151.

Corradi-Dell'Acqua, C., Hofstetter, C., & Vuilleumier, P. (2011). Felt and seen pain evoke the same local patterns of cortical activity in insular and cingulate cortex. The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 31(49), 17996–18006. https://doi.org/10.1523/JNEUROSCI.2686-11.2011

Corradi-Dell'Acqua, C., Tusche, A., Vuilleumier, P., & Singer, T. (2016). Cross-modal representations of first-hand and vicarious pain, disgust and fairness in insular and cingulate cortex. Nature Communications, 7(1), 1–12. https://doi.org/10.1038/ncomms10904

Cracco, E., Desmet, C., & Brass, M. (2016). When your error becomes my error: Anterior insula activation in response to observed errors is modulated by agency. Social Cognitive and Affective Neuroscience, 11(3), 357–366. https://doi.org/10.1093/scan/nsv120

Cummings, J. L. (1992). Depression and Parkinson's disease: A review. The American Journal of Psychiatry, 149(4), 443–454. https://doi.org/10.1176/ajp.149.4.443

Damoiseaux, J. S., Rombouts, S. a. R. B., Barkhof, F., Scheltens, P., Stam, C. J., Smith, S. M., & Beckmann, C. F. (2006). Consistent resting-state networks across healthy subjects. Proceedings of the National Academy of Sciences of the United States of America, 103(37), 13848–13853. https://doi.org/10.1073/pnas.0601417103

Davis, M. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. Journal of Personality and Social Psychology, 44(1), 113–126.

Dosenbach, N. U. F., Fair, D. A., Cohen, A. L., Schlaggar, B. L., & Petersen, S. E. (2008). A dual-networks architecture of top-down control. Trends in Cognitive Sciences, 12(3), 99–105. https://doi.org/10.1016/j.tics.2008.01.001

Drysdale, A. T., Grosenick, L., Downar, J., Dunlop, K., Mansouri, F., Meng, Y., … Liston, C. (2017). Resting-state connectivity biomarkers define neurophysiological subtypes of depression. Nature Medicine, 23(1), 28–38. https://doi.org/10.1038/nm.4246

Ekman, P. (1992). An argument for basic emotions. Cognition and Emotion, 6(3–4), 169–200. https://doi.org/10.1080/02699939208411068

Etkin, A., Büchel, C., & Gross, J. J. (2015). The neural bases of emotion regulation. Nature Reviews. Neuroscience, 16(11), 693–700. https://doi.org/10.1038/nrn4044

Fourie, M. M., Thomas, K. G. F., Amodio, D. M., Warton, C. M. R., & Meintjes, E. M. (2014). Neural correlates of experienced moral emotion: An fMRI investigation of emotion in response to prejudice feedback. Social Neuroscience, 9(2), 203–218. https://doi.org/10.1080/17470919.2013.878750

Fox, M. D., & Raichle, M. E. (2007). Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. Nature Reviews. Neuroscience, 8(9), 700–711. https://doi.org/10.1038/nrn2201

Gilet, A.-L., Mella, N., Studer, J., Grühn, D., & Labouvie-Vief, G. (2013). Assessing dispositional empathy in adults: A French validation of the Interpersonal Reactivity Index (IRI). Canadian Journal of Behavioural Science / Revue Canadienne Des Sciences Du Comportement, 45(1), 42–48. https://doi.org/10.1037/a0030425

Glahn, D. C., Laird, A. R., Ellison-Wright, I., Thelen, S. M., Robinson, J. L., Lancaster, J. L., … Fox, P. T. (2008). Meta-analysis of gray matter anomalies in schizophrenia: Application of anatomic likelihood estimation and network analysis. Biological Psychiatry, 64(9), 774–781. https://doi.org/10.1016/j.biopsych.2008.03.031

Grecucci, A., Giorgetta, C., Bonini, N., & Sanfey, A. G. (2013). Reappraising social emotions: The role of inferior frontal gyrus, temporo-parietal junction and insula in interpersonal emotion regulation. Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00523

Green, S., Lambon Ralph, M. A., Moll, J., Deakin, J. F. W., & Zahn, R. (2012). Guilt-selective functional disconnection of anterior temporal and subgenual cortices in major depressive disorder. Archives of General Psychiatry, 69(10), 1014–1021. https://doi.org/10.1001/archgenpsychiatry.2012.135

Greicius, M.D., Krasnow, B., Reiss, A. L., & Menon, V. (2003). Functional connectivity in the resting brain: A network analysis of the default mode hypothesis. Proceedings of the National Academy of Sciences of the United States of America, 100(1), 253–258. https://doi.org/10.1073/pnas.0135058100

Greicius, Michael D., Srivastava, G., Reiss, A. L., & Menon, V. (2004). Default-mode network activity distinguishes Alzheimer's disease from healthy aging: Evidence from functional MRI. Proceedings of the National Academy of Sciences of the United States of America, 101(13), 4637–4642. https://doi.org/10.1073/pnas.0308627101

Grieve, S. M., Korgaonkar, M. S., Koslow, S. H., Gordon, E., & Williams, L. M. (2013). Widespread reductions in gray matter volume in depression. NeuroImage. Clinical, 3, 332–339. https://doi.org/10.1016/j.nicl.2013.08.016

Haxby, null, Hoffman, null, & Gobbini, null. (2000). The distributed human neural system for face perception. Trends in Cognitive Sciences, 4(6), 223–233.

Heilbronner, S. R., & Hayden, B. Y. (2016). Dorsal Anterior Cingulate Cortex: A Bottom-Up View. Annual Review of Neuroscience, 39, 149–170. https://doi.org/10.1146/annurev-neuro-070815-013952

Hennig-Fast, K., Michl, P., Müller, J., Niedermeier, N., Coates, U., Müller, N., … Meindl, T. (2015). Obsessive-compulsive disorder--A question of conscience? An fMRI study of behavioural and neurofunctional correlates of shame and guilt. Journal of Psychiatric Research, 68, 354–362. https://doi.org/10.1016/j.jpsychires.2015.05.001

Hopman, H., Chan, S., Chu, W., Lu, H., Lam, L., Mak, A., … Neggers, S. (2019). Resting-state fMRI biomarkers and effects of transcranial magnetic stimulation in treatment-refractory depression. Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation, 12(2), 574. https://doi.org/10.1016/j.brs.2018.12.903

Igelström, K. M., & Graziano, M. S. A. (2017). The inferior parietal lobule and temporoparietal junction: A network perspective. Neuropsychologia, 105, 70–83. https://doi.org/10.1016/j.neuropsychologia.2017.01.001

Jiang, P., Vuontela, V., Tokariev, M., Lin, H., Aronen, E. T., Ma, Y., & Carlson, S. (2018). Functional connectivity of intrinsic cognitive networks during resting state and task performance in preadolescent children. PLOS ONE, 13(10), e0205690. https://doi.org/10.1371/journal.pone.0205690

Kanwisher, N., & Yovel, G. (2006). The fusiform face area: A cortical region specialized for the perception of faces. Philosophical Transactions of the Royal Society B: Biological Sciences, 361(1476), 2109–2128. https://doi.org/10.1098/rstb.2006.1934

Kim, S., Thibodeau, R., & Jorgensen, R. S. (2011). Shame, guilt, and depressive symptoms: A meta-analytic review. Psychological Bulletin, 137(1), 68–96. https://doi.org/10.1037/a0021466

Lamm, C., & Singer, T. (2010). The role of anterior insular cortex in social emotions. Brain Structure & Function, 214(5–6), 579–591. https://doi.org/10.1007/s00429-010-0251-3

Li, L., Wu, M., Liao, Y., Ouyang, L., Du, M., Lei, D., … Gong, Q. (2014). Grey matter reduction associated with posttraumatic stress disorder and traumatic stress. Neuroscience and Biobehavioral Reviews, 43, 163–172. https://doi.org/10.1016/j.neubiorev.2014.04.003

Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. Behavior Research Methods, 47(4), 1122–1135. https://doi.org/10.3758/s13428-014-0532-5

Mclatchie, N., Giner-Sorolla, R., & Derbyshire, S. W. G. (2016). 'Imagined guilt' vs 'recollected guilt': Implications for fMRI. Social Cognitive and Affective Neuroscience, 11(5), 703–711. https://doi.org/10.1093/scan/nsw001

Menon, V. (2015). Large-Scale Functional Brain Organization. In A. W. Toga (Ed.), Brain Mapping (pp. 449–459). https://doi.org/10.1016/B978-0-12-397025-1.00024-5

Messina, I., Bianco, S., Sambin, M., & Viviani, R. (2015). Executive and semantic processes in reappraisal of negative stimuli: Insights from a meta-analysis of neuroimaging studies. Frontiers in Psychology, 6. https://doi.org/10.3389/fpsyg.2015.00956

Michl, P., Meindl, T., Meister, F., Born, C., Engel, R. R., Reiser, M., & Hennig-Fast, K. (2014). Neurobiological underpinnings of shame and guilt: A pilot fMRI study. Social Cognitive and Affective Neuroscience, 9(2), 150–157. https://doi.org/10.1093/scan/nss114

Moll, J., Oliveira-Souza, R. de, Garrido, G. J., Bramati, I. E., Caparelli-Daquer, E. M. A., Paiva, M. L. M. F., … Grafman, J. (2007). The self as a moral agent: Linking the neural bases of social agency and moral sensitivity. Social Neuroscience, 2(3–4), 336–352. https://doi.org/10.1080/17470910701392024

Morecraft, R. J., & Van Hoesen, G. W. (1998). Convergence of limbic input to the cingulate motor cortex in the rhesus monkey. Brain Research Bulletin, 45(2), 209–232. https://doi.org/10.1016/s0361-9230(97)00344-4

Morecraft, R., Stilwell-Morecraft, K., Cipolloni, P., Ge, J., McNeal, D., & Pandya, D. (2012). Cytoarchitecture and Cortical Connections of the Anterior Cingulate and Adjacent Somatomotor Fields in the Rhesus Monkey. Brain Research Bulletin, 87(4–5), 457–497. https://doi.org/10.1016/j.brainresbull.2011.12.005

Morey, R. A., McCarthy, G., Selgrade, E. S., Seth, S., Nasser, J. D., & LaBar, K. S. (2012). Neural systems for guilt from actions affecting self versus others. Neuroimage, 60(1), 683–692. https://doi.org/10.1016/j.neuroimage.2011.12.069

Nicolas, M., Martinent, G., & Campo, M. (2014). Evaluation of the psychometric properties of a modified Positive and Negative Affect Schedule including a direction scale (PANAS-D) among French athletes. Psychology of Sport and Exercise, 15(3), 227–237. https://doi.org/10.1016/j.psychsport.2014.01.005

Nugier, A., Gil, S., & Chekroun, P. (2012). Validation française du test des émotions réflexives (French-TOSCA-3): Une mesure des tendances émotionnelles de honte et de culpabilité. /data/revues/11629088/v62i1/S1162908811000466/. Retrieved from https://www.em-consulte.com/en/article/688227

Olson, I. R., McCoy, D., Klobusicky, E., & Ross, L. A. (2013). Social cognition and the anterior temporal lobes: A review and theoretical framework. Social Cognitive and Affective Neuroscience, 8(2), 123–133. https://doi.org/10.1093/scan/nss119

Pappaianni, E., Siugzdaite, R., Vettori, S., Venuti, P., Job, R., & Grecucci, A. (2018). Three shades of grey: Detecting brain abnormalities in children with autism using source-, voxel- and surface-based morphometry. The European Journal of Neuroscience, 47(6), 690–700. https://doi.org/10.1111/ejn.13704

Pfannmöller, J., & Lotze, M. (2019). Review on biomarkers in the resting-state networks of chronic pain patients. Brain and Cognition, 131, 4–9. https://doi.org/10.1016/j.bandc.2018.06.005

Pulcu, E., Lythe, K., Elliott, R., Green, S., Moll, J., Deakin, J. F. W., & Zahn, R. (2014). Increased amygdala response to shame in remitted major depressive disorder. PloS One, 9(1), e86900. https://doi.org/10.1371/journal.pone.0086900

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. Proceedings of the National Academy of Sciences of the United States of America, 98(2), 676–682. https://doi.org/10.1073/pnas.98.2.676

Ring, H. A., & Serra-Mestres, J. (2002). Neuropsychiatry of the basal ganglia. Journal of Neurology, Neurosurgery & Psychiatry, 72(1), 12–21. https://doi.org/10.1136/jnnp.72.1.12

Rotge, J.-Y., Langbour, N., Guehl, D., Bioulac, B., Jaafari, N., Allard, M., … Burbaud, P. (2010). Gray matter alterations in obsessive-compulsive disorder: An anatomic likelihood estimation meta-analysis. Neuropsychopharmacology: Official Publication of the American College of Neuropsychopharmacology, 35(3), 686–691. https://doi.org/10.1038/npp.2009.175

Roth, L., Kaffenberger, T., Herwig, U., & Brühl, A. B. (2014). Brain activation associated with pride and shame. Neuropsychobiology, 69(2), 95–106. https://doi.org/10.1159/000358090

Schäfer, A., Vaitl, D., & Schienle, A. (2010). Regional grey matter volume abnormalities in bulimia nervosa and binge-eating disorder. NeuroImage, 50(2), 639–643. https://doi.org/10.1016/j.neuroimage.2009.12.063

Shin, L. M., Dougherty, D. D., Orr, S. P., Pitman, R. K., Lasko, M., Macklin, M. L., … Rauch, S. L. (2000). Activation of anterior paralimbic structures during guilt-related script-driven imagery. Biological Psychiatry, 48(1), 43–50. https://doi.org/10.1016/S0006-3223(00)00251-1

Shirer, W. R., Ryali, S., Rykhlevskaia, E., Menon, V., & Greicius, M. D. (2012). Decoding subject-driven cognitive states with whole-brain connectivity patterns. Cerebral Cortex (New York, N.Y.: 1991), 22(1), 158–165. https://doi.org/10.1093/cercor/bhr099

Smitha, K., Akhil Raja, K., Arun, K., Rajesh, P., Thomas, B., Kapilamoorthy, T., & Kesavadas, C. (2017). Resting state fMRI: A review on methods in resting state connectivity analysis and resting state networks. The Neuroradiology Journal, 30(4), 305–317. https://doi.org/10.1177/1971400917697342

Stanculescu, E. (2012). The self-conscious emotion of pride as mediator between selfesteem and positive affect. Procedia - Social and Behavioral Sciences, 33, 263–267. https://doi.org/10.1016/j.sbspro.2012.01.124

Stevens, F. L., Hurley, R. A., Taber, K. H., Hurley, R. A., Hayman, L. A., & Taber, K. H. (2011). Anterior Cingulate Cortex: Unique Role in Cognition and Emotion. The Journal of Neuropsychiatry and Clinical Neurosciences, 23(2), 121–125. https://doi.org/10.1176/jnp.23.2.jnp121

Sun, D., Phillips, R. D., Mulready, H. L., Zablonski, S. T., Turner, J. A., Turner, M. D., … Morey, R. A. (2019). Resting-state brain fluctuation and functional connectivity dissociate moral injury from posttraumatic stress disorder. Depression and Anxiety, 36(5), 442–452. https://doi.org/10.1002/da.22883

Takahashi, H., Yahata, N., Koeda, M., Matsuda, T., Asai, K., & Okubo, Y. (2004). Brain activation associated with evaluative processes of guilt and embarrassment: An fMRI study. NeuroImage, 23(3), 967–974. https://doi.org/10.1016/j.neuroimage.2004.07.054

Tangney, J. P., Dearing, R., Wagner, P. E., & Gramzow, R. (2000). The Test of Self-Conscious Affect-3 (TOSCA-3): George Mason University.

Tangney, June P., Stuewig, J., Mashek, D., & Hastings, M. (2011). Assessing Jail Inmates' Proneness To Shame and Guilt: Feeling Bad About the Behavior or the Self? Criminal Justice and Behavior, 38(7), 710–734. https://doi.org/10.1177/0093854811405762

Tangney, June Price, Stuewig, J., & Mashek, D. J. (2007). Moral Emotions and Moral Behavior. Annual Review of Psychology, 58, 345–372. https://doi.org/10.1146/annurev.psych.56.091103.070145

Tayah, T., Savard, M., Desbiens, R., & Nguyen, D. K. (2013). Ictal bradycardia and asystole in an adult with a focal left insular lesion. Clinical Neurology and Neurosurgery, 115(9), 1885–1887. https://doi.org/10.1016/j.clineuro.2013.04.011

Uddin, L. Q., Nomi, J. S., Hebert-Seropian, B., Ghaziri, J., & Boucher, O. (2017). Structure and function of the human insula. Journal of Clinical Neurophysiology : Official Publication of the American Electroencephalographic Society, 34(4), 300–306. https://doi.org/10.1097/WNP.0000000000000377

Vogt, B. A., & Pandya, D. N. (1987). Cingulate cortex of the rhesus monkey: II. Cortical afferents. The Journal of Comparative Neurology, 262(2), 271–289. https://doi.org/10.1002/cne.902620208

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. Journal of Cognitive Neuroscience, 22(12), 2864–2885. https://doi.org/10.1162/jocn.2009.21366

Wagner, U., N'Diaye, K., Ethofer, T., & Vuilleumier, P. (2011). Guilt-Specific Processing in the Prefrontal Cortex. Cerebral Cortex, 21(11), 2461–2470. https://doi.org/10.1093/cercor/bhr016

Ward, L. M. (2013). The thalamus: Gateway to the mind. Wiley Interdisciplinary Reviews: Cognitive Science, 4(6), 609–622. https://doi.org/10.1002/wcs.1256

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54(6), 1063–1070. https://doi.org/10.1037//0022-3514.54.6.1063

Whitfield-Gabrieli, S., & Nieto-Castanon, A. (2012). Conn: A functional connectivity toolbox for correlated and anticorrelated brain networks. Brain Connectivity, 2(3), 125–141. https://doi.org/10.1089/brain.2012.0073

Zhu, R., Feng, C., Zhang, S., Mai, X., & Liu, C. (2019). Differentiating guilt and shame in an interpersonal context with univariate activation and multivariate pattern analyses. NeuroImage, 186, 476–486. https://doi.org/10.1016/j.neuroimage.2018.11.012

General conclusions

Despite being one of the most experienced emotions in everyday life, shame has often been neglected and little investigated in scientific research. In this thesis work, an attempt was made to deepen the emotion of shame from different perspectives.

The theoretical review described in the first part of the manuscript has brought out its intrinsic "bipolarity": on the one hand, shame has its roots exclusively in social interaction, on the other hand, its main focus is the self. This double aspect has fascinated writers and philosophers, who have described it within the context of social morality. Humans cannot ignore interacting with others, and in order to do so, they must necessarily share a common moral law. Within these common laws lie the specific customs and standards of each society. When someone goes beyond these standards, shame takes over as a wake-up call to restore the social balance. Or rather, when an outsider evaluates us negatively in the light of those shared customs and endangers our social figure, that negative feeling that we call shame serves to alert our person and prepare one to put in place restorative behaviors. These behaviors (such as inhibition and escape) may seem maladaptive at first glance, but ultimately they have a protective function towards the individual. This cycle will tend to be repeated over time, but the more this happens, the more the person manages to avoid this breach of moral rules that leads to shame. The shame functioning model proposed in this thesis is based on this concept. Under healthy conditions, shame aims to be a regulator of the self, in the sense that it can modulate the habits of the person through a painful signal. In pathological conditions, shame can fail in this intent: this can lead to total suppression of the painful signal that no longer serves as an alert, or to a painful experience to the maximum degree that leads the person to be completely inhibited. We can depict shame as part of a continuum, wherein healthy conditions it is located in the center and provides the right contribution to the regulation of the self, while in pathological conditions it is located at both extremes: too much, or too little. Unfortunately, for reasons of time, it was not possible to test this model experimentally in patients with dysregulation of shame. Nevertheless, the studies carried out in less than three years and presented in this manuscript on healthy participants are the mandatory starting point for such an investigation.

Few studies have investigated shame in psychological research. Instead, several paradigms have been used, most of the time poorly controlled. This discrepancy led to creating an innovative experimental task that would capitalize on the strengths of these paradigms. The Shame task was created from scratch based on the most common research paradigms in social and affective psychology, including those used investigating shame. In chapter two, the entire procedure for validating stimuli and the first administration of the task was described. Guilt, the "different twin" of shame, has been chosen as control emotion since often associated with shame in literature. Through this first study, the efficacy of the Shame task has been assessed, since people really felt shame and that they could clearly distinguish it from guilt.

One of the abilities that make us human is to relate to the emotional states of others. If few studies were available investigating first-hand shame, even less there were on third-person shame, otherwise known as vicarious shame. By modifying only one independent variable of our paradigm, it has been possible to study the ability to recognize

shame in others and to experience it in social contexts, even when not being the focus of social interaction. Again, people have correctly reported shame in shameful social situations, and have correctly distinguished it from guilt. This was a first attempt to study vicarious shame. In the future, it would be very interesting to go in deep with this high impact social topic, with further development of the paradigm and/or the assistance of technological tools such as virtual reality.

While in the first part of the thesis the focus was on theory and behavioral studies, in the second part (chapters 3-4-5) the neural aspects related to shame have been investigated.
It was possible to test a patient with a diagnosis of Erdheim-Chester disorder, a very rare condition that resulted in selective damage to the bilateral amygdala. Since part of the literature suggested an involvement of the amygdala in the processing of moral emotions (such as shame), this single-case study (chapter 3) investigated whether such damage caused deficits in the perception of shame. The behavioral tests showed the patient's difficulty in recognizing the facial expression of fear (a fact widely confirmed in the literature as a result of damage to the amygdala) and partially of shame. Notably, some specific difficulty has emerged in discriminating against normal social situations and conditions of a social violation. This suggested an involvement of the amygdala more as an attentive catalyst of situations with a moral and social violation, rather than its direct involvement in the process of shaming.

With the aim of reviewing the neuroscientific literature relating to shame and drawing inferences from it, a study of functional meta-analysis has been carried out and reported in Chapter 4. Results showed that the only region of functional overlap between shame and guilt (used as an emotion of control) was the left insula, which can be considered as a hub of morality. In addition, shame was linked to a large network containing several frontal and subcortical regions such as the thalamus, while guilt was localized on the right insula and temporal regions. Nevertheless, a major limitation of this research was the low number of studies included and the great diversity of experimental paradigms used within them that could have stained the results.

To overcome these limitations, a functional study was carried out using the Shame task in magnetic resonance imaging. The neural trace of shame was detected and, as discussed, was composed of brain regions reasonably connected to that emotion. The same cannot be said for guilt, whose signal has not been captured probably because of the complexity of the scenarios to be imagined in times as short as those of a resonance session. In the future, this will be addressed by further analysis or by the replication of the study with more accurate guilt-eliciting stimuli. In addition, following the recent view of the large-scale organization of the brain (i.e. functional network), a preliminary attempt was made to capture a neural trace of the propensity for shame in the absence of an experimental task (i.e. during resting-state). An exploratory analysis reported that a functional network at rest correlated with shame-proneness in everyday life. Notably, this network was composed of regions already found to be involved in shame perception. A similar pattern emerged for guilt-proneness as well. If this result were confirmed in the future, it would open interesting research scenarios, opening the doors of cognitive neuroscience also to emotional and affective aspects.

To sum up, the study of shame over the past three years has led to the design of a theoretical model about how it works, the creation of an experimental paradigm to elicit and measure it at a behavioral level, and various investigations into its neural bases. Answering the three questions asked in the preface, there is still a lot of work to do to be able to understand how shame impacts daily life. This research lays the first foundations for the study of this emotion from a theoretical, behavioral and neuroscientific perspective: this is the way to follow to fully get its intrinsic complexity.

List of figures

Figure 1. 1 Algorithm of shame functioning as self-regulator 16
Figure 1. 2 Excessive or scarce shame dysregulation are connected to different psychopathological disorders..... 17

Figure 2. 1 Experimental design of the Shame Task 31
Figure 2. 2 Boxplot and descriptive plots for the means distribution of shame perception..... 33
Figure 2. 3 Boxplot and descriptive plots for the means distribution of guilt perception 35
Figure 2. 4 Scatterplot of the positive correlation between shame perception and shame-proneness..... 37
Figure 2. 5 Scatterplots of correlations among behavioral variables..... 37
Figure 2. 6 Experimental design of the Empathetic Shame Task (EST). 47
Figure 2. 7 Boxplot and descriptive plots for the means distribution of shame perception..... 49
Figure 2. 8 Boxplot and descriptive plots for the means distribution of perceived guilt in other people. 50
Figure 2. 9 Scatterplots of correlations among behavioral variables..... 51

Figure 3. 1 FF's MRI scans. 69
Figure 3. 2 Two standardized items from the Montreal Set of Facial Displays of Emotion 70
Figure 3. 3 Patient's and healthy controls performance on emotional facial recognition task. 75
Figure 3. 4 Patient's and healthy controls performance on Shame Task. 77

Figure 4. 1 Shame/Embarrassment and Guilt functional activations 93
Figure 4. 2 Conjunction analysis between Shame/Embarrassment and Guilt..... 95

Figure 5. 1 Experimental design of the Shame Task during fMRI 111
Figure 5. 2 Flow diagram describing CONN main steps: Preprocessing, Denoising, Analyses, Results..... 114
Figure 5. 3 Graphical description of ICA..... 114
Figure 5. 4 Graphical description of the difference between distributions. On the left, boxplot for the means distribution of shame perception within the three types of stimuli (Guilt, Neutral and Shame). 116
Figure 5. 5 Graphical description of the difference between distributions. On the left, boxplot for the means distribution of guilt perception within the three types of stimuli (Guilt, Neutral and Shame). 117
Figure 5. 6 SPM output of Shame > Neutral contrast. 118
Figure 5. 7 Visual rendering of "Shame > Neutral"..... 118
Figure 5. 8 SPM output of Shame > Guilt contrast. 119
Figure 5. 9 SPM output of Guilt > Shame contrast. 120
Figure 5. 10 Visual rendering and scatterplot. 121
Figure 5. 11 Visual rendering and scatterplot. 122
Figure 5. 12 Visual rendering and scatterplot. 123
Figure 5. 13 Visual rendering and scatterplot. 124
Figure 5. 14 Spatial correlation match between all ICs and the known rs-functional networks templates. 125

List of tables

Table 1. 1 Differences shame vs guilt 14

Table 2. 1 ANOVA omnibus for shame perception. 32
Table 2. 2 Post Hoc Comparisons based on the stimuli type. 33
Table 2. 3 Linear regression model for shame perception. 34
Table 2. 4 ANOVA omnibus for guilt perception 34
Table 2. 5 Post Hoc Comparisons based on the stimuli type.. 35
Table 2. 6 Linear regression model for guilt perception. 36
Table 2. 7 Omnibus ANOVA. 48
Table 2. 8 Post-hoc comparisons 48
Table 2. 9 Omnibus ANOVA. 49
Table 2. 10 Post-hoc comparisons 50

Table 3. 1 Patient's performances on the neuropsychological battery 73
Table 3. 2 Patient's scores on the social cognition battery 74
Table 3. 3 Accuracy and mean intensity ratings for the different emotion recognition tasks 76

Table 4. 1 Differences between shame and guilt 87
Table 4. 2 Moral emotions and psychopathological conditions 88
Table 4. 3 Studies investigating shame/embarrassment and guilt brain processing 90
Table 4. 4 Results of the meta-analysis on shame/embarrassment processing 92
Table 4. 5 Results of the meta-analysis on guilt processing 93
Table 4. 6 Contrast analysis results. 94

Table 5. 1 ANOVA omnibus for shame perception. 115
Table 5. 2 Post-hoc comparisons based on the stimuli type. 115
Table 5. 3 ANOVA omnibus for guilt perception 116
Table 5. 4 Post-hoc comparisons based on the stimuli type 116
Table 5. 5 IC5 details. 121
Table 5. 6 . IC25 details 122
Table 5. 7 . IC14 details. 124
Table 5. 8 IC28 details. 124