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UNIVERSITÀ DI ROMA

The revised Reinforcement Sensitivity Theory: electrocortical correlates of threatening faces at different distances.

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Abstract

The main purpose of the present work was to evaluate individual differences in the perception of threatening stimuli at different distances.
Under the approach of the revised Reinforcement Sensitivity Theory, we analysed how the different traits of personality react to angry and neutral faces in an Augmented Reality environment using a Visual Oddball paradigm.
We found that the N2 component is the most prone to point out the differences especially for Fight and Freeze subjects, showing how they use more frontal processes in the differentiation between near and far stimuli. This results could be explained by the neuroanatomical differentiation proposed by McNaughton and Corr in the 2004.

Acknowledgements

There are many people I need to thank and acknowledge for their support and contribution throughout the duration of my PhD. First of all, I would like to express deep gratitude to my two primary supervisors, Prof. Vilfredo De Pascalis and Prof. Francesco Saverio Marucci for their deep knowledge and support during all these years we spent together.

I have to thank Jhoemar Pagao, a brilliant developer who helped me in developing the Augmented Reality integration for the experimental task.

Thanks to my colleagues of the Laboratory of Individual differences Francesca, Giuseppe, Emanuela and Enzo for their support in critical moments and for all the time we spent talking about all my doubts about the various topic related to this work.

Thanks to Pietro of the technical office for his help in solving all the electrotechnical problems I encountered in these years.

To Riccardo, Claudio, Luigi, Lorenzo, Alessandro, Andrea, Alessandra for their friendship and support during all these years of studies and work.

Finally, I would like to dedicate this thesis to my wonderful parents, Mary and Mario, for their support, which was both moral and economical, without them I would have never been able to finish this work.

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Introduction

"Fight or flight" are terms, coined by Dr. Walter B. Cannon (Cannon, 1927, 1929), to describe key behaviours that occur to all animals in the context of, or in the presence of, a threat or something terrific: a general discharge of the sympathetic nervous system, priming the animal for fighting or fleeing (Jansen, Van Nguyen, Karpitskiy, Mettenleiter, & Loewy, 1995).

This is basically the first step of the stress response in Selye's General Adaptation Syndrome (G.A.S.) (Selye, 1936).

This response is regulated by the hypothalamic–pituitary–adrenal axis (HPA or HTPA axis) that, in a cascade of reactions starting from the amygdala, triggers the pituitary gland and the secretion of the hormone ACTH (Adrenocorticotropic hormone); almost simultaneously, the adrenal gland releases another neurotransmitter: epinephrine.

With the release of these this chemicals, the production of the hormone cortisol increases and so do blood pressure and blood sugar levels: all this to ensure a boost of energy to escape from dangerous situations.

In the same years the physicians were busy discovering the basis of the fight-flight response, Carl Gustav Jung was publishing a book that had a major impact in all the future psychology of personality: Psychological Types (Carl Gustav Jung, 1921).

Among the many important theorisations of Jung in that book were the Extroversion and Introversion types: what he noticed was that some people have an "attitude-type characterised by orientation in life through subjective psychic contents" (e.g. the introverted are more focussed on one's inner psychic activity) while others have "an attitude type characterised by concentration of interest on the external object" (e.g. the extroverted ones are more focused on the outside world) (Carl G. Jung, 1963).

In general we can say that introverted people are the ones who are more solitaire and reflective, while extroverted live for external rewards.

We will have to wait until 1967 to have a "more scientific" approach and a confirmation of this intuition from a German psychologist naturalised British: Hans Eysenck.

In his book "The Biological Basis of Personality" (Hans Jürgen Eysenck, 1967), starting from a statistic approach called Factor Analysis, he showed how personality could be derived from a biological development in which genetic inheritance is progressively shaped by the surrounding environment. He found that the intuition of Jung was correct: an introversion-extraversion axis does exist, along with another dimension that he named Neuroticism.

From this point we start to see how this theory has been modified by others in the following years.

1.The revised Reinforcement Sensitivity Theory (r-RST).

The Reinforcement Sensitivity Theory (RST) has its roots in the work of the British psychologist Jeffrey Alan Gray (J. A. Gray, 1970; Jeffrey Alan Gray, 1982; J. A. Gray, 1985; Jeffrey Alan Gray, 1987) and in its more recent revision (rRST) (McNaughton & Corr, 2004; Philip J. Corr, 2008).

The birth of the theory is dated to Gray's article entitled "The psychophysiological basis of introversion-extraversion"(J. A. Gray, 1970).

Gray's purpose was to link the different emotional and motivational systems that create personality with the new knowledge, coming from brain images, about the neurophysiological networks that regulate approach or avoidance behaviours.

He proposed to turn of 30° degrees the Eysenck's axes of Extroversion and Neuroticism, introducing Anxiety and Impulsivity as traits (Fig. 1).

In the first version of his theory, Gray hypothesised the existence of 3 different systems that regulate behavioural out-comings: the 'Behavioural Approach System' (BAS), the 'Behavioural Inhibition System' (BIS) and the 'Fight-Flight' System (FFS).

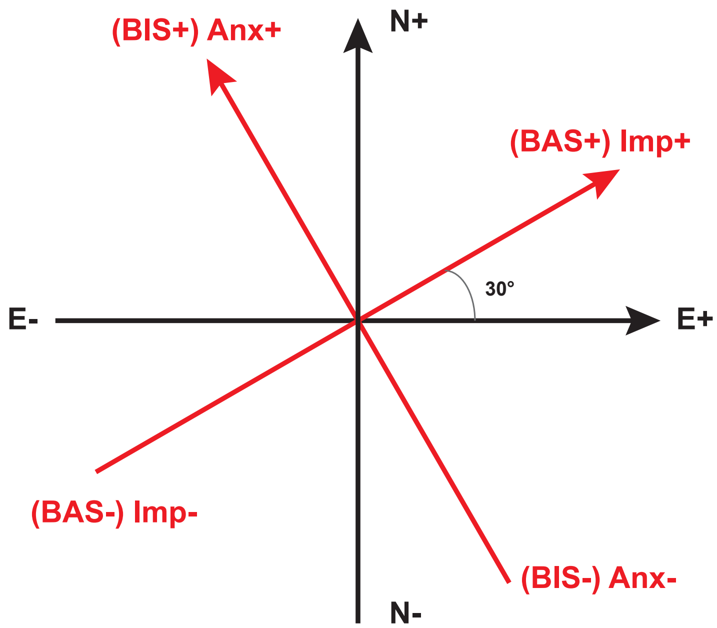


Fig. 1. Black = Eysenck's dimensions, Red = Gray's dimensions

The BAS was thought to be activated by all the appetitive conditioned stimuli and by all reward or non punishment signals. This system was associated with the dimension of Impulsivity, so that an over activation of it could lead to antisocial or risky behaviours, gambling or addictions or some attention disorder like ADHD (Attention Deficit Hyperactivity Disorder).

On the other hand, the BIS was thought to be activated by all the aversive conditioned stimuli and by all punishment or non reward signals, but also by stimuli of high intensity or of innate origin (e.g.: snakes, blood) that are more related to fear. This was the system that was supposed to regulate anxiety and, if over activated, to lead to Generalised Anxiety Disorders or Obsessive Compulsive Disorders.

The FFS, instead, was thought to be sensitive to all aversive unconditioned stimuli (all innate painful stimuli) and to be the system responsible for basic emotions like fear, rage and panic.

Recently (Jeffrey Alan Gray & McNaughton, 2000) the theory has been revised in order to include in the FFS the 'Freeze' behaviour as a reaction to aversive stimuli. In this last version the BAS and FFFS (Fight - Flight - Freeze System) result to be the behavioural reactions of approach or avoidance to all appetitive or aversive stimuli, both conditioned and unconditioned. The BIS has the new and important function of resolving the goal conflict that could arise from the simultaneous activation of BAS and FFFS.

1.1.The Behavioural Approach System (BAS) and the Behavioural Inhibition System (BIS) in the revised RTS.

In the revised Reinforcement Sensitivity Theory (Jeffrey Alan Gray & McNaughton, 2000) the function of the BAS is to activate the behavioural approach to appetitive stimuli, both conditioned and unconditioned, or rewards. As Corr pointed out later (Philip J. Corr, 2008), the BAS is involved in moving the body in the space and time gradients through the localisation of rewards. Individuals with an excessive activation of BAS are more prone to impulsive disorders (Jeffrey A. Gray, 1990; Wallace, Newman, & Bachorowski, 1991; Stanford, Greve, Boudreaux, Mathias, & Brumbelow, 1996; Revelle, 1997), secondary psychopathies (Flor-Henry, 1976; Hare, 1998; Newman, MacCoon, Vaughn, & Sadeh, 2005), bipolar disorders (Depue & Iacono, 1989) and attention deficit and hyperactivity disorders (Mitchell & Nelson-Gray, 2006).

In Gray's theory (Jeffrey Alan Gray, 1982; Jeffrey Alan Gray & McNaughton, 2000) the BAS seems to be regulated by the dopaminergic neurotransmitters of the striatal projections of the lateral and orbital prefrontal cortex (PFC).

The Behavioural Inhibition System is now considered to be a coordinator that is constantly monitoring real events and double-checking them with the awaited ones ('checking mode') and that eventually stops the motor activity already put in execution by other systems ('control mode') if there is no compatibility.

It is important to notice that the BIS is now controlling the explorative behaviour that orients the attention towards new threatening stimuli: when a mismatch happens between the expected events and real ones, the BIS is activated to search more information from the environment, increasing the level of focal attention and arousal. High levels of BIS are therefore associated with an increment of attention, higher arousal and high levels of vigilance.

An excessive activity of BIS is associated with anxiety (Jeffrey Alan Gray, 1982; Fowles, 1988; Quay, 1988), while a poor activity of BIS could lead to primary psychopathy (Jeffrey Alan Gray, 1987; Newman et al., 2005).

Now the BIS seems to be related both to the Septo-Hippocampal System, that would engage the amygdala to produce fear-related outputs, and the monoaminergic systems of the PFC and the Anterior Cingulate Cortex (ACC).

Another important feature of the revised theory is the introduction of a clear distinction between fear and anxiety: while fear has the function of moving the animal *away* from danger (fight/flight/freezing), anxiety moves the animal *toward* danger and it belongs to BIS.

Regarding the role of the BIS, two different approaches received empirical attention: the former assigns to the BIS the control of withdrawal behaviour (S. K. Sutton & Davidson, 1997; Blair, Peters, & Granger, 2004; Updegraff, Gable, & Taylor, 2004; Elliot, Gable, & Mapes, 2006; Heimpel, Elliot, & Wood, 2006; Sherman, Mann, & Updegraff, 2006); the latter suggests that the BIS is responsible for behavioural inhibition (Harmon-Jones & Allen, 1997; Arnett & Newman, 2000; Gomez & Gomez, 2002; Monteith, Ashburn-Nardo, Voils, & Czopp, 2002; Keltner, Gruenfeld, & Anderson, 2003; Cools et al., 2005; Hewig, Hagemann, Seifert, Naumann, & Bartussek, 2006). The evidence collected so far seems to validate the latter approach and its view of the BIS preeminent function in monitoring environment, confronting expectations and resolving eventual conflicts (Bartussek, Becker, Diedrich, Naumann, & Maier, 1996; Vilfredo De Pascalis, Fiore, & Sparita, 1996; V De Pascalis & Speranza, 2000; Boksem, Tops, Wester, Meijman, & Lorist, 2006; D. Amodio, Master, & Yee, 2008).

1.2.The Fight-Fligh-Freeze System (FFFS) in the revised RST.

The FFFS has been separated from the BIS (Jeffrey Alan Gray & McNaughton, 2000) and proposed as an independent system with a neuroanatomic, functional and behavioural differentiation.

To have a better understanding of these networks and the linked behaviours we should also consider the defensive system.

1.2.1.The two-dimensional defensive system.

From a detailed analysis of the defensive responses conducted by the ethologists Robert and Caroline Blanchard (D. Blanchard & Blanchard, 1988; R. Blanchard & D. Blanchard, 1990b, 1990a; R. Blanchard, Griebel, Henrie, & Blanchard, 1997), it has been hypothesised (McNaughton & Corr, 2004) that the defensive system is composed by defensive direction and defensive distance.

The 'defensive direction' is a categorical dimension: a dangerous situation can be either approached or avoided. It is related to both fear and anxiety: fear operates when someone escapes from a dangerous situation ('active avoidance'), anxiety when he steps in it (e.g. cautious 'risk assessment' approach behaviour) or withholds entrance ('passive avoidance').

The 'defensive distance' (Fig. 2) is a graded dimension: it works as a cognitive construct of internal intensity of the perceived threat. In case of defensive avoidance (Fig. 2 A), when one is avoiding a dangerous situation, smaller defensive distances will cause an explosive

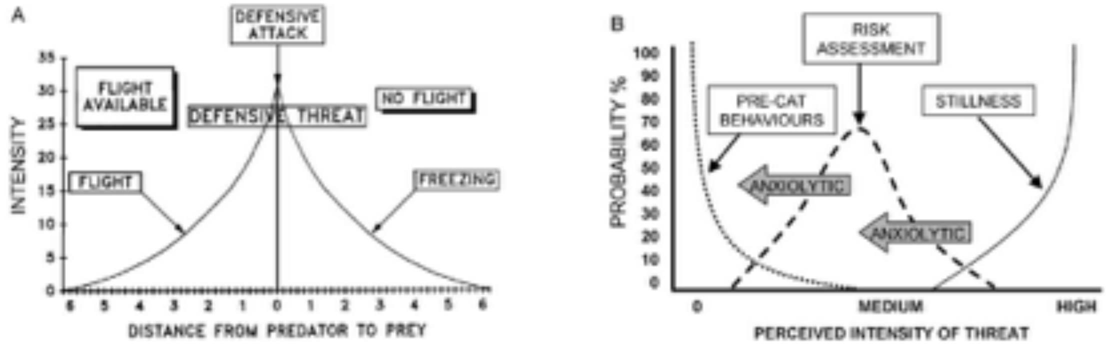


Fig. 2 . Defensive distance (A) and defensive direction (B) and from the ethology perspective. (Blanchard, R & C, 1990)

attack, while intermediate distances will cause a 'freeze' behaviour or a 'flight' (depending on the possibility or not to flee) and with longer distances the result will be a normal non-defensive response: the distance of the perceived threat is therefore an essential variable for the activation of the fight/flight/freeze behaviour. In case of defensive approach (Fig. 2 B), stillness ('freeze') occurs at the closest defensive distances, and at intermediate distances there is risk assessment from the animal, while, at greater distances, defensive behaviour disappears and normal pre-threat behaviour reappears. It is important to notice that, in the latter situation, anxiolytic drugs affect defensive distance rather than specific defensive approach behaviours: if the perceived distance from the threat is short, the anxiolytics will increase the risk assessment and, consequently, the chance that the subject will approach to the source of threat; the same thing is likely to happen also if the perceived distance is medium but, in this case, it would be because the anxiolytics decrease the risk assessment (D. C. Blanchard & R. J. Blanchard, 1990; D. Caroline Blanchard, Blanchard, Tom, & Rodgers, 1990).

1.3.The neuroanatomic pathway of FFFS in the revised RST.

McNaughton and Corr (McNaughton & Corr, 2004) noticed that the hierarchy of defensive behaviours proposed by the Blanchards was largely similar to the neural hierarchy proposed by Graeff and Deakin (F. G. Graeff & Deakin, 1991; Frederico G. Graeff, 1994) and on this base they elaborated a variant of it.

The defensive system is nowadays considered as divided into two separate parallel networks: one is for the defensive avoidance and the other for the defensive approach, with the medial hypothalamus and the periaqueductal gray matters as low-level components supposed to control the defensive approach. The concept of hierarchy has been applied to assign functions to the prefrontal and the cingulate giri.

These networks act in parallel from the periacqueductal gray (PAG) to upper structures.

The Fig. 3 (McNaughton & Corr, 2004) clarifies the dimensions of the defensive system and is divided in two parts.

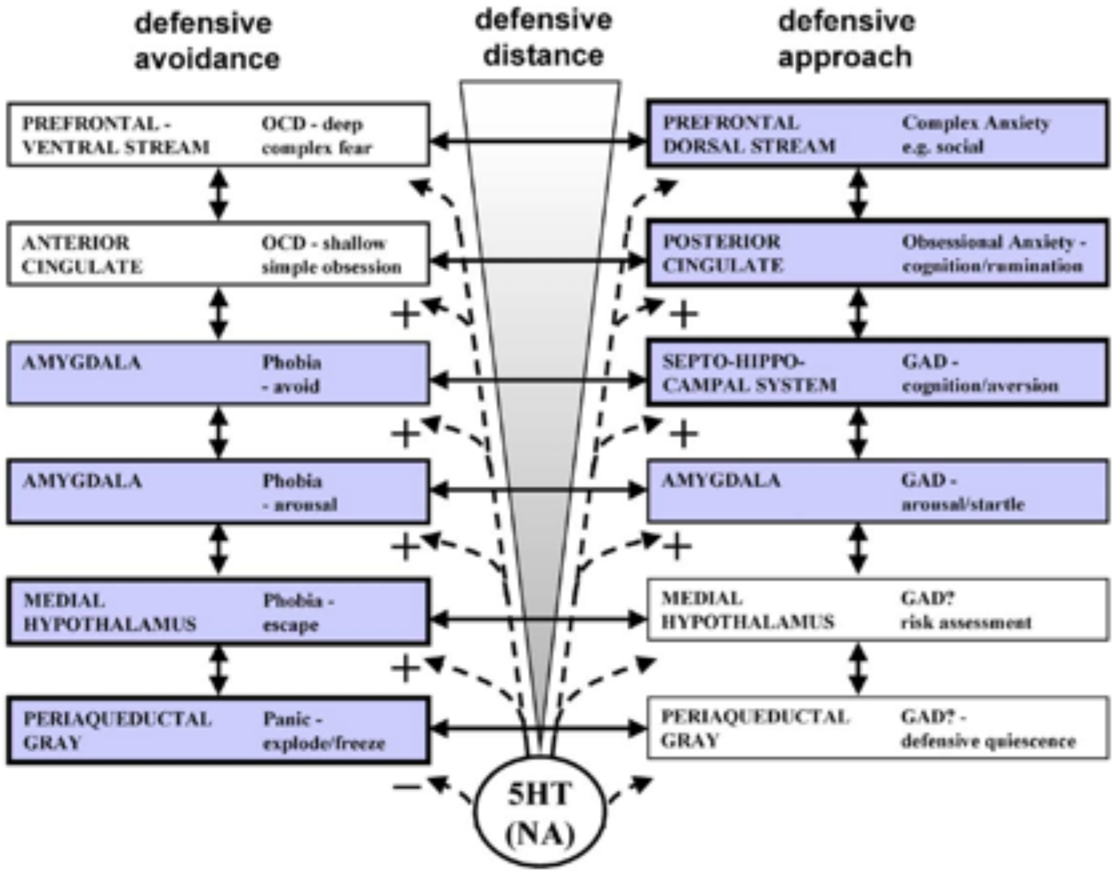


Fig. 3. The two dimensional defensive system. Here are shown the two categorial dimensions of defensive avoidance and defensive approach. Each is divided, down the page, into a number of hierarchical levels. These are ordered both with respect to neural level and to functional level (McNaughton & Corr, 2004).

On the left side one finds the defensive avoidance components that mediate fear, while on the right side one can see the aspects of defensive approach that mediate anxiety. A neuronal connectivity hierarchy corresponds to a functional behavioural hierarchy. The structures at the bottom of the figure correspond to minor distances, while moving up we encounter greater distances.

It should be noted that more complex structures such as the prefrontal cortex and the cingulate cortex can create important connections with other structures involved in emotions (amygdala).

In neuroanatomical terms, the activation of the periaqueductal gray corresponds to an undirected response of explode/freeze and, on top of this, once the medial hypothalamus is reached, it induces a direct response of escape/panic. The amygdala controls the active avoidance (phobic), with an explicit separation between the control of the autonomic arousal and the control of the behaviour of active avoidance. Above the amygdala, the anterior cingulate can be assigned to a higher active avoidance of complexity, as it requires a greater degree of anticipation and a less stringent bond level of temporal threatening stimuli.

The anterior cingulate cortex has therefore to deal directly with the output of the FFFS and is activated by inputs that can be as complex as guilt. If we keep moving up, in the upper

left corner we find the ventral prefrontal cortex, too high a hierarchical structure to be able to unambiguously define a single function.
On the right side of the graph, on the contrary, we find the description of the defensive approach. As we have already noted for defensive avoidance, if any of the higher cortical structures involved in the resolution of conflicts may lead to situations of altered behaviour (e.g.: obsessive-compulsive disorder), there must be other structures, in the neocortex, responsible for all situations where it is not possible to avoid the danger (e.g.: fear of darkness). This situation seems to be more mediated by the dorsal part of the prefrontal cortex.
If we go down along the graph, we find the posterior cingulate, mainly implicated in situations of generalised anxiety disorder (i.e.: agoraphobia). In addition to the posterior cingulate we find the hippocampal formation, with its key function already given by Gray in the first version of the theory. However is noteworthy that, in its revision, it is to the amygdala, rather than to the septal hippocampus, that is reserved the duty of arousal activation and anxiety management.
Figure 4 shows that the BIS is now deputy to the functions of conflict resolution: the most important of these functions is certainly the inhibition of behavioural output; however, we must note that in addition to the inhibition of avoidance behaviour there is also an increase in arousal and attention.
The outputs of the BIS, in any case, are not limited to immobility: an active behaviour, mediated by the septal hippocampus, is, for example, the risk assessment.

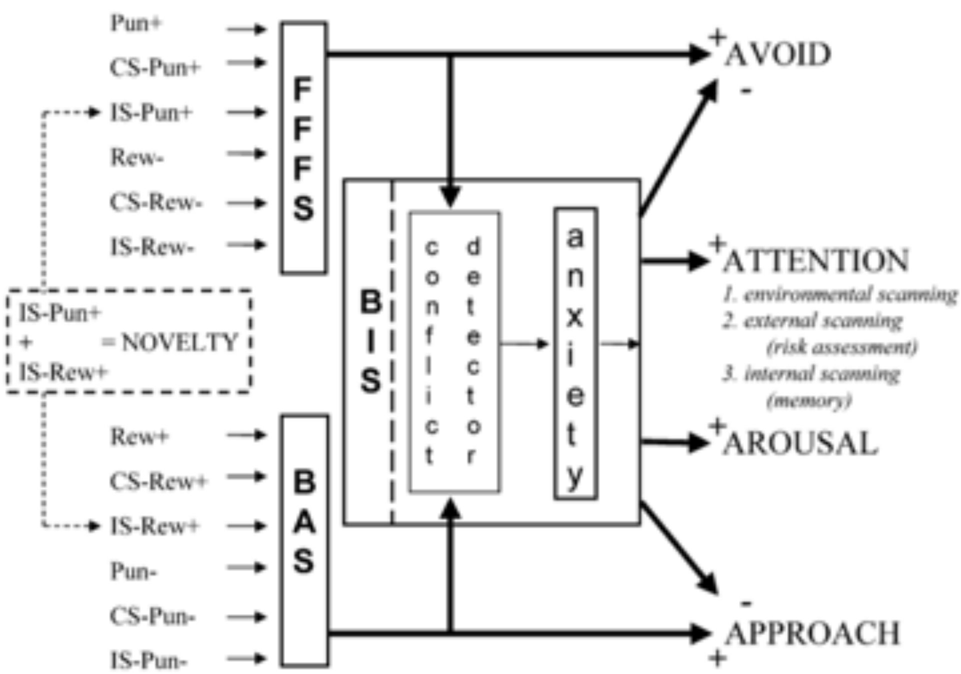


Fig. 4. Relationship between FFFS, BAS and BIS. Inputs consist of rewards (Rew) or punishments (Pun), that may be presented (+) or omitted when expected (-), and of innate stimuli (IS) or conditioned stimuli (CS) that predict these events. The simplest means to activate BIS is the concurrent activation of FFFS and BAS, i.e. approach-avoidance conflict. However, approach-approach conflict and avoidance-avoidance conflict (as in 'two-way' avoidance) will also activate BIS (McNaughton & Corr, 2004).

1.4.Electrocortical correlates of emotional processing.

The FFFS is a system activated by threats. It goes without saying that attention is implicated. Now we are going to see some results taken form the literature regarding attention and emotional processes and their correlates in Event Related Potentials (ERP), focusing on the results obtained by manipulating emotional inputs and classifying them according to certain specific components (P1, N1, P2, N2, P3).
In 2008 Olofsson et al. (Olofsson, Nordin, Sequeira, & Polich, 2008) wrote an interesting review regarding ERP correlated with affective pictures, where he pointed out, as a kind of watershed, the introduction in 1999 of the International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 2005), a set of 956 pictures, divided in 16 different blocks of 60[1], each of them scored on three dimensions: Valence (Pleasant/Unpleasant), Arousal (Aroused/Calm), Dominance (Controlled/Dominant).
This classification gave a boost to the research in the field as, for the first time, the researchers had a tool for manipulating valence and arousal variables.
Is it possible to have a clear vision of the processes involved if we divide the effects in using the following categories: 1) early or short (P1-N1) and 2) mid/late (P2, N2, P3) components, respectively influenced by valence and arousal.

1) Early latencies are sensitive to physical factors, activate the extrastriate visual cortex and respond to manipulation of selective attention (Clark & Hillyard, 1996; Thorpe, Fize, & Marlot, 1996; Luck, Woodman, & Vogel, 2000; Vogel & Luck, 2000).
It has been found that unpleasant valence of the stimuli generates a larger P1 (Morris, Ohman, & Dolan, 1998; Cacioppo, Gardner, & Berntson, 1999; Ohman & Mineka, 2001; Crawford & Cacioppo, 2002; Smith, Cacioppo, Larsen, & Chartrand, 2003; Carretie, Hinojosa, Martin-Loeches, Mercado, & Tapia, 2004).
Generally the P1 at around 90-120ms is generated over occipital sites (Smith et al., 2003), even if "late P1" (150-160ms) has been proposed a (Delplanque, Lavoie, Hot, Silvert, & Sequeira, 2004).
Carretie (Carretie, Hinojosa, Albert, & Mercado, 2006) found that unpleasant valence pictures generate a larger late P1, but at frontal sites, using a non-emotional discrimination task.
Regarding the early stage ERPs we have to note that they are influenced even by the complexity of the form (Bradley, Hamby, Low, & Lang, 2007) or the colour (Cano, Class, & Polich, 2009).
In any case we have to note some papers in which the results are inconclusive (Keil et al., 2001; A. De Cesarei & Codispoti, 2006), even if we have to keep in mind that there is a huge difference in the kind of stimuli, paradigm and analysis they used.
The N1 ERP is known to reflect early attention allocation facilitating further perceptual processing and classification of stimuli, i.e. to constitute a gating mechanism preparing

[1] those data are from the 2005 revision, but there are other more recent and updated.

efficient conflict processing (Naatanen & Michie, 1979; Luck et al., 2000; Vogel & Luck, 2000; Griffin, Miniussi, & Nobre, 2002).
One important ERP component, that has been claimed to be specific for face elaboration, happens a bit later and is the N170.
Originally Bentin (Bentin, Allison, Puce, Perez, & McCarthy, 1996) observed that this N170 was present with human faces but not with other animated or inanimated stimuli. They observed even that when presented alone, eyes only produced a larger amplitude than the whole face. Even Bötzel (Kai Bötzel, Schulze, & Stodieck, 1995) and George (George, Evans, Fiori, Davidoff, & Renault, 1996) noticed a negativity around 170-200ms in contrast to a better known, until that time, vertex positive potential (VPP) (K. Bötzel & Grüsser, 1989; D. A. Jeffreys, 1989; D. Aled Jeffreys, 1996).
This complex (VPP) is stronger at central sites while the N170 is stronger at occipito-temporal sites and they show identical response properties (Joyce & Rossion, 2005): they are " the two 'faces' of the same brain generators".
Even in functional brain images studies some areas lights up at the same latency and in the occipito-temporal cortex, such as the 'fusiform face area' and the 'occipital face area' ('FFA', 'OFA', (Kanwisher, McDermott, & Chun, 1997; Haxby, Hoffman, & Gobbini, 2000)).
Schupp (Harald T. Schupp et al., 2004) did not find any significant difference in the P1, but only for the N170 (indicated as Early Posterior Negativity - EPN).

2) P2 and N2 (around 150-350ms) mainly reflect early stimulus discrimination (150-200ms) and response selection processes (250-350ms) (Di Russo, Taddei, Apnile, & Spinelli, 2006).
The P2 has been reported as a component that may signal recognition or decision-making processes (Rousselet, Husk, Bennett, & Sekuler, 2008).
Another characteristic of P2 is showed by Carretié (Carretié, Martín-Loeches, Hinojosa, & Mercado, 2001) who states that input processing related attention associated with emotional visual stimulation involves an initial, rapid, and brief 'early' attentional response oriented to rapid motor action, being more prominent towards negative stimulation.
In another study using a dot probe paradigm Rossignol (Rossignol, Campanella, Bissot, & Philippot, 2013b) interestingly found that high social anxious people showed an higher P2 in response to angry faces.
The P2 has been associated with the N2 (Potts, Liotti, Tucker, & Posner, 1996). This relation is postulated to represent the interaction between areas of salience representation and feature representation in the cortex (Potts & Tucker, 2001).
Halgren and Marinkovic (Halgren & Marinkovic, 1995) called the N2-P3a an 'orienting complex', reflecting the afferent (preparation-to-process) and efferent (preparation-to-respond) functions activated by the oddball paradigm (Campanella et al., 2002) a sequence of the same stimulus (auditory and/or visual) interrupted by some infrequent deviant stimulus (Squires, Squires, & Hillyard, 1975; Marton, Szirtes, & Breuer, 1984; Simson, Ritter, & Vaughan, 1985; Acosta & Nasman, 1992; Geisler & Polich, 1994; Romero & Polich,

1996; Ravden & Polich, 1998; Hoffman & Polich, 1999; Katayama & Polich, 1999; Jeon & Polich, 2001; Campanella et al., 2002; Moores et al., 2003; Huettel & McCarthy, 2004; Veiga et al., 2004; Wang, LaBar, & McCarthy, 2006; Aleman & Swart, 2008; Astikainen & Hietanen, 2009; Berti, 2009; Flynn, Liasis, Gardner, Boyd, & Towell, 2009; Li, Lu, Sun, Gao, & Zhao, 2012; Kecskes-Kovacs, Sulykos, & Czigler, 2013; Kimura & Takeda, 2013).

Even in our case there was a selectively attention to the stimuli and the N2 could be elicited by template mismatch, or deviation from a mentally-stored expectation of the standard stimulus (Sams, Alho, & Näätänen, 1983). Investigations in N2 scalp distribution have suggested the centrality of the frontal and superior temporal cortex for its generation (Potts, Dien, Hartry-Speiser, McDougal, & Tucker, 1998). In addition, in association with colour selection, the N2 has also become affiliated with general detection processes controlled at the level of the anterior cingulate cortex (Lange, Wijers, Mulder, & Mulder, 1998).

The P300, first described by Sutton et al. (S. Sutton, Braren, Zubin, & John, 1965), is one of the most studied ERP component in investigations of selective attention and information processing. The P3b, or "classical P3", is more parietal and opposed to the P3a, typified by shorter latencies and frontally-oriented topography. One possible interpretation of the P3 is that it reflects broad recognition and memory-updating processes, with the P3b proposed to reflect match/mismatch with a consciously- maintained working memory trace, while the P3a reflects a passive comparator (Näätänen, 1990). Campanella (Campanella et al., 2002) found that the complex N2/P3a was bigger and faster for more emotional face stimuli. Bobes (Bobes, Quiñonez, Perez, Leon, & Valdés-Sosa, 2007) found that familiar faces elicitate a faster P3a and slower P3b.

What appears to be established is that high arousal pictures should elicitate larger P3 amplitude both in active and in passive paradigms showing affective pictures (Mini, Palomba, Angrilli, & Bravi, 1996; H. T. Schupp et al., 2000; Keil et al., 2002; Delplanque, Silvert, Hot, & Sequeira, 2005) and that these pictures elicit selective attention and influence the motivational system via arousal and resource allocation mechanisms (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Harald T. Schupp et al., 2004)

1.4.1.ERP and distances

Even if it seems quite obviously that bigger stimuli generate a different activation, there are relatively few studies that have dealt with this effect, especially in face elaboration. De Cesarei (A. De Cesarei & Codispoti, 2006) noticed that animal studies and human research on phobic and normal individuals already showed a gradient of behavioural and physiological responses depending on the distance between the organism and the stimuli (Teghtsoonian & Frost, 1982; Fanselow, 1994; D. Caroline Blanchard, Griebel, & Blanchard, 2003).

The retinal size of an object may reveal its distance from the observer, so some researchers have suggested that stimulus size may also play a role in modulating emotional responses (Teghtsoonian & Frost, 1982; Detenber & Reeves, 1996; A. De Cesarei & Codispoti, 2006; Codispoti & De Cesarei, 2007; Andrea De Cesarei & Codispoti, 2010).

Teghtsoonian (Teghtsoonian & Frost, 1982) showed a linear increase of autonomic responses and self-reported fear as a function of distance. Because distance and retinal size are strictly related, it can be expected that changes in stimulus size determine arousal modulations in a way that is similar to those determined by distance (Loftus & Harley, 2005). Moreover, in an evolutionary framework, the physical size of an encountered object or organism may determine the motivational relevance for the observer. The same results seem confirmed by Reeves (Reeves, Lang, Kim, & Tatar, 1999) that showed how bigger stimuli produce more arousal responses. De Cesarei (Andrea De Cesarei & Codispoti, 2011), following their earlier studies, found that distances modulate late positive potentials (P300 and over) especially for affective pictures.

1.5.Psychometrics measures of the r-RST.

At present a widely accepted scale (or scales) of the three systems related to the revision of the theory is still missing. However many scales have been developed, from the original theory, trying to measure the BIS and BAS, mainly looking at anxiety and impulsivity.
One of the first attempts to find a psychometric measure of the RST was developed by Torrubia and Tobena (Rafael Torrubia & Tobena, 1984) with the Susceptibility to punishment Scale mainly focused on BIS (punishment). Later Wilson, Gray and Barrett (Wilson, Barrett, & Gray, 1989; Wilson, Gray, & Barrett, 1990) developed the Gray Wilson Personality Questionnaire (GWPQ). In the same period Ball and Zuckerman (Ball & Zuckerman, 1990) developed the General Reward and Punishment Expectancy Questionnaire (GRAPES) more focused on punishment and rewards.
The questionnaire which is most frequently used for the RST is still the BIS/BAS Scale of Carver and White (Carver & White, 1994). The BIS scale measures concern over the possibility of a bad occurrence and sensitivity to such events when they do occur. The BAS Drive scale reflects the persistent pursuit of desired goals, the BAS Fun Seeking scale reflects a desire for new rewards and the approach to a potentially rewarding event, and the BAS Reward Responsiveness scale reflects a focus on positive responses to the occurrence or anticipation of reward.
Another questionnaire widely used is the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) of Torrubia et al. (R. Torrubia, Ávila, Moltó, & Caseras, 2001).
Researchers tried to overcome the limitation caused by the lack of a scale by utilising different dimensions from different scales. Some examples can be found in Kambouropoulos (Kambouropoulos & Staiger, 2004) who utilised anxiety (Anx) and impulsivity (Imp) from the Extraversion (E), Neuroticism (N) and Psychoticism (P) factors of the Eysenck Personality Questionnaire (EPQ) (Hans Jurgen Eysenck & Eysenck, 1975); the same author (Kambouropoulos & Staiger, 2001) used the Card Arranging Reward Responsivity Objective Test (CARROT) (Powell, Al-Adawi, Morgan, & Greenwood, 1996) to test the responsitivity to reward; others used the State Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) or the Anxiety Scale and the Impulsiveness Scale of the Eysenck Personality Profiler (EPP) (H. J. Eysenck & Wilson, 1991).
In literature there are also some scales specific for the fear: the Fear Survey Scale (FFS) (Wolpe & Lang, 1977); the Threat scenario questionnaire (D C Blanchard, Hynd, Minke, Minemoto, & Blanchard, 2001).
When strictly talking about rRST few are the works taking into consideration the psychometric changes.
In one article of 2007, Cooper et al. (Cooper, Perkins, & Corr, 2007) have tried to overcome the limitations of psychometric scales mainly used in the literature: BIS / BAS, STAI (Y2), FFS using confirmatory factor analysis.

In terms of relations between the latent factors in the four-factor model, the STAI, BIS, and the Social Fear factors tend to have a relatively high intercorrelation, suggesting that the constructs are strongly related. The Social Fear also has a strong positive correlation with the Tissue Damage Fear. The BIS, however, has only shown a positive correlation with the Tissue Damage Fear. These results support the hypothesis that the Tissue Damage Fear is different from the constructs measured by the STAI and BIS.

In an article recently appeared Perkins and his colleagues (Perkins, Cooper, Abdelall, Smillie, & Corr, 2010), confirmed the results of another of his articles (Perkins & Corr, 2006), which states that there is a positive correlation between the questionnaire and fear (the tendency to run away from a threat), and they have also shown that anxiety and fear responses do not act in the same way for all levels of distance from the threat, indeed, escape reactions based on fear will take precedence over an eager approach when the threat is very close or intense (Jeffrey Alan Gray & McNaughton, 2000); in the same article it was shown that individuals, that are more prone to fear, are facilitated to run away from the threat as they perceive a threat in a particularly intense way.

One possible solution could be the one proposed by Corr and Cooper with their new scale: Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ) (P. J. Corr & Cooper, (in prep)).

It is a questionnaire of 84 items[2], with a subdivision including the BAS (in 4 sub- factors: Goal-Drive Persistence, Reward Interest, Reward Reactivity, Impulsivity) the BIS (in 2 sub-factors: Worry/ Risk Assessment, Disengagement/Obsession) and the FFFS (in 2 sub-factors: Flight/Freeze, Avoidance/Panic) (Appendix 1).

One big limitation that this questionnaire has is that the FFFS is only divided in two sub-factors without the Fight dimension, it includes only the anxiety and fear ones.

The other two scales that I am aware of which take in consideration the revised theory are the Jackson-5 scales (J5) (Jackson, 2009) and the Reinforcement Sensitivity Questionnaire (RSQ), recently validated by the same authors (Smederevac, Mitrović, & Čolović, 2014).

The J5 is a 30 items questionnaire with a 5 point Likert scale (from completely agree to completely disagree) (Appendix 2).

The RSQ is a 29 items questionnaire with a 4 point Likert scale (from completely disagree to complete agree) (Appendix 3). It is a quite new scale and has been validated with the unpublished version of RST-PQ and the Carver's BIS/BAS.

Both these scales claim to have separated the domain of BAS, BIS, Fight, Flight, Freeze as proposed by the revision.

[2] As far as I'm concern, this questionnaire has been updated 3 times since I started this PhD programme. I used the first version available but now is quite different from what I described here.

2. The Augmented Reality

One of the most important questions that arise from all the controlled experiments in psychology is how ecological they are, in other words the question is whether they are adherent or maximally similar to reality or not (all the works of James J. Gibson or Roger G. Barker, just to mention the major ones).
Especially in the contest we are analysing, we have to keep in mind that facing a threat in an unknown dark street is quite different from facing it in a university laboratory.
So we had to find a way to conduct our experiment that was as close to reality as possible.
As far as we have understood until now, the FFFS is triggered by some stimuli that suddenly happen in reality which stop the undergoing actions to check if that threat is really something dangerous for survival or not.
Another constraint we had to face when dealing with the revised theory regards the individual perception of the distances.
We decided to use an Augmented Reality (AR) environment trying to mix all the requirements we had.
AR is a way to enrich or augment or supplement the reality you perceive by adding some computer generated information. Usually it is a video recorded from the same location on which there are some targets (pattern recognised by the computer) over which the computer generates some kind of stimuli (video, audio, etc.).
Right now the applications of AR are starting to be quite wide spread: especially for medical, but also for military, industrial and marketing applications.

Fig. 5 - Example of Augmented Reality

Despite the potentiality of this new technology there are still very few works in psychology that use this approach (compared to the better known Virtual Reality).
One the first attempt to treat phobias with AR was from Botella (C. M. Botella et al., 2005) who used AR against cockroach phobia and a few years later Botella (C. Botella, Breton-Lopez, Quero, Banos, & Garcia-Palacios, 2010) further developed his studies.
The treatments of phobias with AR appears in other works (Breton-Lopez et al., 2010; Wrzesien et al., 2013).
A recent review (Baus & Bouchard, 2014) pointed out that AR could be extended to other kinds of phobias (like social one).
The use of AR for children with Autistic Spectrum Disorder (ASD) is also worth mentioning (Chen, Lee, & Lin, 2014).

In the Threat scenario questionnaire (D C Blanchard et al., 2001) many scenes included an aggressors.
We thought that delivering the stimuli in an AR context could emulate what happens in reality and could reproduce a threat that suddenly appears in our environment. So we placed two different targets at different distances in the cabin where the subjects went for the experiment (more information regarding the experimental setup can be found in the chapter Experimental Task).

3.Hypotesis.

According to the revised RST, defensive distance is a cognitive construct of the intensity of the perceived threat (Philip J. Corr, 2008).
Another novelty introduced by the revised theory is that there are different networks between Anxiety (handled by the BIS) and Fear (handled by the FFFS).
From the literature we know that automatic attention is reflected in enhanced amplitudes of the P1 ERP (Smith et al., 2003; Delplanque et al., 2004; Olofsson et al., 2008). In particular, closer threats should elicitate a stronger fight/flight behaviour, especially for the nearer stimuli (A. De Cesarei & Codispoti, 2006).
The N170 should be modulated by more emotional stimuli, in particular for the FFFS and the BIS as an early elaboration of the threatening stimuli.
The manipulation of the distance and the emotional stimuli should affect the complex N2/P3, where the P3 ERP indicates the allocation of capacity-limited attentional resources toward relevant situations (Linden, 2005; Hajcak, Dunning, & Foti, 2009) and the N2 indicates the response inhibition. In particular BIS should intervene in the conflict between the threatening stimuli and the task that requires the subject to press a button (so BIS should mediate the conflict between the FFFS and the BAS).

4.Method

4.1. Subjects.

36 female subjects (Mean age: 24,33 std: 2,38) were recruited, manly from an undergraduate course at the Psychology Department at Sapienza University of Rome as a practical part of the course.
Only females subjects have been selected since it has been demonstrated that there is a gender difference in the oscillatory activity in facial recognition (Güntekin & Başar, 2007), outcome processing (Kamarajan et al., 2008), cognitive tasks (Corsi-Cabrera, Ramos, Guevara, Arce, & Gutierrez, 1993), conflict monitoring (Clayson, Clawson, & Larson, 2011), just to cite a few. A gender difference has been proven also for the kind of task we have chosen (a visual oddball paradigm) (Hoffman & Polich, 1999; Campanella et al., 2004; Vaquero-Casares, Cardoso-Moreno, Vazquez-Marrufo, Gonzalez-Rosa, & Gomez-Gonzalez, 2004; Aleman & Swart, 2008; Jausovec & Jausovec, 2009; Rubia, Hyde, Halari, Giampietro, & Smith, 2010).
Exclusion criteria were visual failure, current or previous psychiatric or neurological diagnosis, traumatic brain injuries, use of psychoactive drugs, dependence or substance abuse, left-handedness. All subjects were asked not to use tobacco or caffeine on the day of the experiment and to avoid drinking alcohol for at least 12 hours prior.
To be consistent with the circadian EEG oscillations the brain registrations have always been performed at 10 a.m. and 3 p.m. randomly assigned.

4.2. Psychometrics measures.

Before the experiment, each subject was asked to answer the following battery of tests via a secure web service (https://freeonlinesurveys.com/).
After a careful selection the questionnaires, we choose to utilise:

- STAI Y1 (pre and post task) (Spielberger et al., 1983), to see the effect of the task on anxiety.
- STAI Y2 (Spielberger et al., 1983), to check the anxiety trait.
- BIS/BAS Scale of Carver and White (Carver & White, 1994) for which we used the Italian validated version of Leone at al. (Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001). As noted before, this is a widely recognise questionnaire for the RST and we used it to check the other rRST questionnaire utilised.
- The Eysenck personality questionnaire – Revised (EPQ-R) (Hans J. Eysenck, 1991), for which we used the Italian validated version of Dazzi (Dazzi, 2011). This questionnaire, again, was used to check the other rRST questionnaire utilised.

- Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ) (P. J. Corr & Cooper, (in prep)), this questionnaire claims to be forged for the revision of the theory.
- Jackson-5 scales (J5) (Jackson, 2009); again this questionnaire should measure the new version of RST.
- Reinforcement Sensitivity Questionnaire (RSQ) (Smederevac et al., 2014); this is the last questionnaire that should measure the rRST.

Regarding the last three questionnaires we have done the Italian translations in house, as validated versions are not available (you can find our translations in Appendix 1, 2, 3).

After checking the results (see later Table 1 and results) we choose, for the analysis, J5 as questionnaire of personality.

4.3.Experimental task:

At the beginning of the PhD course we had thought to test another key concept of the theory: reward and punishment.

We were going to use a modified version of Monetary Incentive Delay Task (MID) (Schultz, Dayan, & Montague, 1997; Knutson, Westdorp, Kaiser, & Hommer, 2000).

Designed in this way, counting all the variables and the randomisations, the experiment was going to be of around 6 hours (instead of 3 without the distance difference).

For the easiness of the subjects we chose to change the MID and opt for a better known and easy Visual Oddball Paradigm and check only attention.

The variables we had to take into considerations were: Distance and Emotion, in addition to the between factor of personality and, of course, the EEG sites.

The participants were asked to take 3 hours free for the experiment; before the experiment, they read and signed informed consent (approved by the Ethics Committee).

They then did a pre task version of the STAI Y1 (always via the web service).

Once the questionnaire were finished, they were prepared and cleaned for wearing the EEG cap.

It took from 25 to 45 minutes to reach the correct impedance (<5kΩ) for each subject.

After that the raw EEG signals were displayed on a monitor used for the impedance and briefly discussed (as part of the teaching course).

Subsequently the monitor was removed from the wall and a little portable desk was placed over the legs of the subjects. A 18.5" Wide Screen TFT Color LED Backlight Monitor (Hanns-g, Mod: HSG1145) was placed on that desk, in front of the subject at a distance of approximately 30 cm. There was a webcam (HD Pro Webcam C920 - Logitech) exactly in the middle of the back part of the monitor with a special basis: in addition to the metal rod that supported the monitor, that could be adjusted to the height of the subject, there was another welded rod, that supported one of the 2 targets, the nearest one, which was situated at a distance of 30 cm from the back of the monitor. The second target, the furtherest one, was placed over the door on the wall in front of the subject (Fig 6).

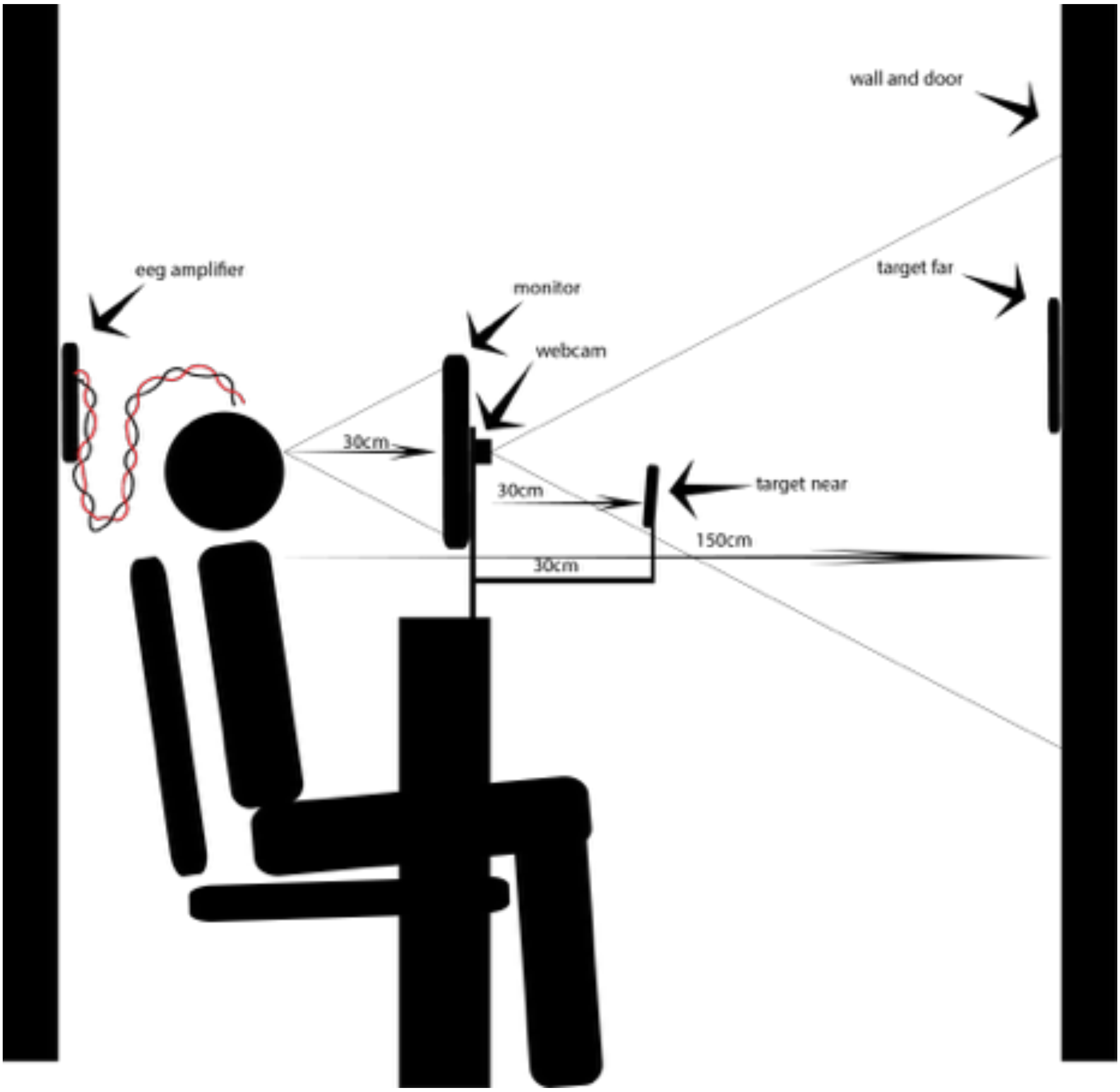


Fig. 6. Representation of the experimental setting.

At the beginning of the PhD we thought to deliver the stimuli with a Head Mounted Display (HMD) Emargin Z800 (at that time in 2009, it was the best solution based on stereoscopy, weight, FOV, price. Nowadays Oculus VR could be a real effective substitute). After many trials and custom modifications we concluded that, even loosing in the stereoscopy the perception of depth was in any case given by the AR setting: the subject saw the same background that she saw in the monitor.

When the subject was ready to start, both oral and written instructions on the monitor were given.

The task was to press a joystick (Logitech Attack 3) button when a coloured face appeared on the screen (see later for the stimuli explanation).

The joystick was modified so that each time any button was pressed a TTL was sent to the amplifier to have the marker for the behavioural responses.

In order to have a sufficient number of trials for the ERP we chose to have 50 trials per condition (neutral near, neutral far, angry near, angry far) that are 200 for the target ones and 3 times more (600) for the standard ones. In total we had 800 trials.

Each trial was composed by (Fig. 7):

1. the onset of a cue for 500ms;
2. a Stimulus Onset Asynchronous (SOA) of 2000-2500ms;
3. the presentation of the stimulus (randomly chosen from all the models, with a constraint of at least two standard stimuli in a row) for 300ms;
4. an Inter Stimulus Interval variable of 2000-2500ms.

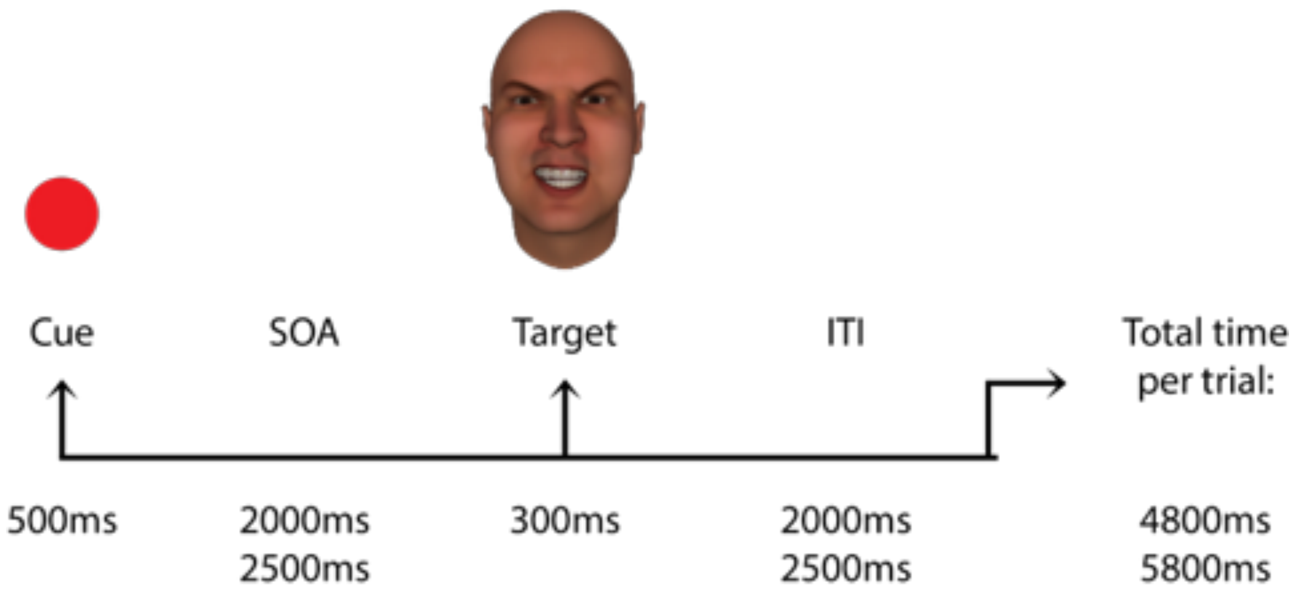


Fig. 7. Schematic representation of a trial.

As we had 800 trials the minimum theoretical time for the experiment was of 64 minutes, the maximum of 77.3, with an average of 70.6 minutes.

All the task part took around one hour and half, because every 15 minutes we gave the subject a break that lasted as long as they wanted.

At the beginning of the task there was a training part so that the subject could become more familiar with it. While the subject was doing the training, we placed a photodiode outside the experimental room over a monitor that had the same splitted signal as the subject, the photodiode gave the exact onset timing for the triggers.

When everything was set and the subject finished the training part, the experiment began.

The cues were randomly chosen between near and far targets, after the SOA, in the same location, a model (randomly chosen between neutral and angry) appeared located in the centre of the target, always oriented with the eye gaze toward the subject (Fichtenholtz, Hopfinger, Graham, Detwiler, & LaBar, 2007; Mogg & Garner, 2007; Holmes, Nielsen, & Green, 2008; Doi & Shinohara, 2009; M. Ewbank & Jennings, 2009; M. P. Ewbank et al., 2009; Hoehl & Striano, 2010; Bauser, Thoma, & Suchan, 2012; Poirier & Faubert, 2012).
Just to have an idea of the final result I am attaching a quite early image I was able to take during the developing of the software that we used at the end (Fig. 8).

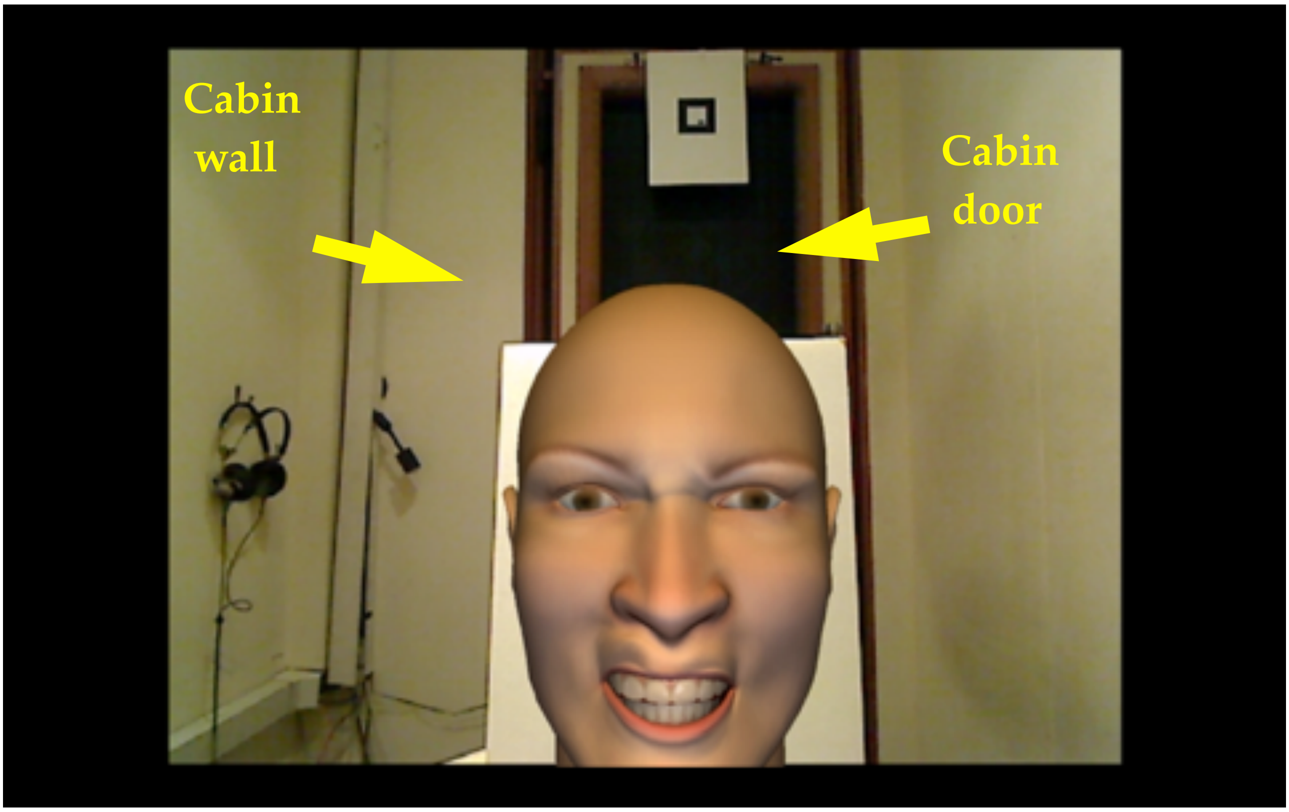


Fig. 8. Screenshot from the AR application when an Angry Near stimulus was delivered.

Unfortunately the version of Unity3D we used had some limitations on recording the second monitor.
When the experiment finished, all the subjects were asked to complete the post task STAI Y1 questionnaire.

4.4.Stimuli:

The selection of the stimuli was a matter of strong discussions. The only clear thing was that we had to show a stimulus that was threatening. At the beginning the first choice was to select some animals, but the problem of selecting animals is that they have different shapes and sizes (so they could create some problems regarding the quantity of the stimulus elicited) and there was a risk of phobias for some kinds of them (like for example spiders or snakes).

At the end we opted for facial expressions.

We chose to use angry faces, instead of fearful ones, because it has been proven that while the former are universally understood as an interpersonal threat, the latter are perceived as an indirect threat (Mogg, 2002; Bar-Haim & Lamy, 2005; Palermo & Rhodes, 2007).

Using FACEGen Modeller (v.3.4 - Singular Inversions - http://www.facegen.com/) we created 150 models to avoid habituation(Jiang, Zheng, & Li, 2013). The models had random features with the following constraints: between very male to male, Age: 25-35, no caricature, 30% asymmetry, European ethnicity left higher.

All these constraints were taken to avoid gender, ethnicity and age bias (D. M. Amodio et al., 2004; Herrmann et al., 2007; Proverbio, 2010; Brebner, Krigolson, Handy, Quadflieg, & Turk, 2011; Cunningham, Van Bavel, Arbuckle, Packer, & Waggoner, 2012; Van Dillen & Derks, 2012; Hehman, Volpert, & Simons, 2014; Wiese, Kaufmann, & Schweinberger, 2014).

Since it is known that hair could create bias (O'Donnell & Bruce, 2001; Wright & Sladden, 2003) we created all the models without them.

We created a copy of each neutral model adding a different expression, using the built in morph expression feature, selecting the angry one.

With Unity 3D we developed a simple program in which, at the beginning, there was a questionnaire (STAI Y1), followed by an evaluation part in which all the models of faces generated were loaded randomly, under each face there was a Self Assessment Manikin (SAM) evaluation set of pictures for the arousal and a SAM like evaluation set of pictures for the anger (Fig. 9).

Fig. 9. Example of the SAM evaluation for the stimuli.

We recruited 50 female subjects (age: 24.79 sd: 5.2) from the university that underwent this test and gave their assessments.
We used the STAI questionnaire as a basis to take away high and low anxiety subjects: we consider as outlier ± 1.5 sd (16) from the mean of the sum of the results (37.85) of the STAI, i.e. 5 subjects.
From there we calculated the 50 higher arousal models (1.93-2.66) and higher anger models (7.91-8.36) and the 50 lower arousal models (0.29-0.48) and lower anger models (5.02-5.11) to be used in the task.
The standard stimuli were taken from the discarded 100 neutral models.
The difference from the target ones was that the standard were models without texture (Fig. 10).

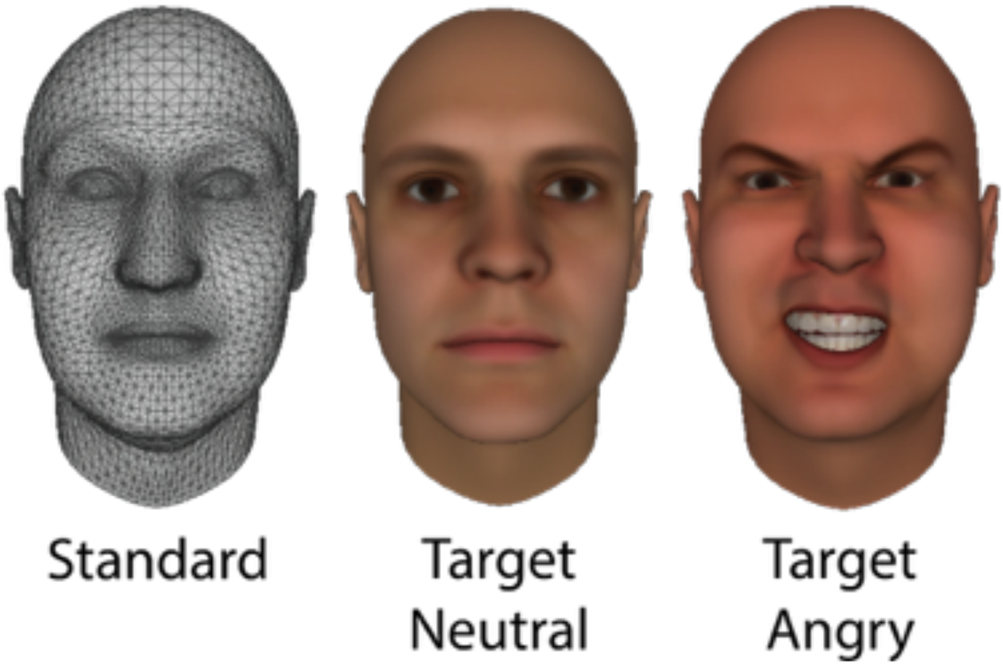


Fig. 10. Types of stimuli utilised.

At a distance of around 30 cm from the face, the perception of the near stimuli were 17 degrees (±2) high and 9.5 degrees (±2.5) wide (the faces size were randomly generated), while the perception of the far stimuli were 7.5 degrees (±2) high and 5.5 degrees (±2.3) wide.

4.5.EEG registration and signal analysis:

Electrophysiological recordings were collected during the experimental task. EEG and Electroculogram (EOG) data were acquired continuously by using a 40-channel NuAmps DC amplifier system (Neuroscan Inc.), set at a gain of 200, sampling rate of 1000 Hz, and with signals band-limited to 500 Hz. In addition, a 50 Hz notch filter was applied. The signals were amplified by NuAmp DC amplifiers (Neuroscan Inc.). Data were recorded and stored on a computer running Neuroscan Acquire 4.4 software. The vertical EOG was mounted with a pair of tin electrodes placed above and below the center of the left eye (HEOL, HEOU). The horizontal EOG was monitored via a pair of tin electrodes placed at the cantor of both eyes (VEOL, VEOR). EEG data were recorded from 30 scalp sites (Fp1, Fp2, VEOU, VEOL, F7, F3, Fz, F4, F8, FT7, FC3, FCz, FC4, FT8, T3, C3, Cz, C4, T4, TP7, CP3, CPz, CP4, TP8, T5, P3, Pz, P4, T6, O1, Oz, O2) using a pure-tin electrode electrocap (Electro-cap international Inc.) (Blom & Anneveldt, 1982) and referenced to digitally linked ears [(A1 + A2)/2] using the Neuroscan Acquire settings. Electrode impedance was lower than 5 kOhm. The ground electrode was located 10 mm anterior to Fz. The EEG was processed, initially, with BrainVision Analyzer 2 (2.0.4) (Brain Products GmbH). The EEG was first resampled to 256 Hz, filtered from 0.1 to 48Hz, then eye blink correction was performed in accordance with Gratton et al.'s procedure (Gratton, Coles, & Donchin, 1983). After the EOG correction, if there was some bad channel, it was reconstructed using a spline reconstruction, then any residual artifact exceeding ±80 uV was checked and dropped. When the signal was cleaned, it was segmented into discrete, single-trial epochs. For each stimulus, an EEG epoch length of 1000ms was used with a 200ms pre-stimulus baseline. Only averages >20 trials per trial type after removing artifacts were considered. The peak detection semi-automatic was carried out with the following temporal windows: P1 (50-120ms), N1 (90-180ms), P2 (130-250ms), N2 (190-330ms), P3 (280-450ms). We checked and corrected manually all the peaks.

4.6.Statistical analysis:

SAS version 9.3 was used for all statistical analyses.
We run different Analysis Of Variance (ANOVA) and Analysis of Covariance (ANCOVA) for behavioural analysis, the P100 and N100 (actually the N170) and the complex P2-N2-P3.
When needed, the significance level was corrected with the Huynh-Feldt's epsilon (Huynh & Feldt, 1970; Vasey & Thayer, 1987) to avoid false significative results.
The post-hoc comparisons were done with *t*-tests with alpha<0.05 (Kirk, 1982, pp. 90-93).
In the case of ANCOVAs, we splitted every personality factor by the median of each group to reach two separate High (Hi) and Low (Lo) group (excluding the median).
For the behavioural analysis we used the Reaction Time (RT) for each condition (Neutral Near, Angry Near, Neutral Far, Angry Far) with an ANOVA with 2 Location (Near, Far) x

2 Emotion (Neutral, Angry). Then we check if any of the Personality Factors could influence the behavioural performance. So we run different ANCOVAs with 2 within factors: 2 Location (Near, Far) x 2 Emotion (Neutral, Angry) and, as between factor and covariate, Personality (J5-BAS, J5-BIS, J5-Fight, J5-Flight, J5-Freeze).

We chose to use only the Jackson-5 scale (J5) (Jackson, 2009) for personality after a careful check of the correlation matrix of all the variables we had (check the correlation table in the results chapter): it is the only scale to have all 5 factors and with the best fit with the other scales.

Regarding the analysis of the ERPs, we were interested in the interaction of personality with the emotional face elaboration and we chose as sites T5-T6 for the N170. Firstly we run an ANOVA with 3 within factors: 2 Location (Near, Far) x 2 Emotion (Neutral, Angry) x 2 sites (T5,T6) and, to that, we added ANCOVAs, as between factor and covariate Personality (J5-BAS, J5-BIS, J5-Fight, J5-Flight, J5-Freeze). We chose as sites T5-T6 because, for the montage we had, should be the best position to record this component (Kai Bötzel et al., 1995).

Another aspect we wished to investigate was how attention is modulated by emotional stimuli from the different traits of personality, so we looked at midline during the complex P2-N2-P3. For each component, we run an ANOVA with 3 within factors: 2 Location (Near, Far) x 2 Emotion (Neutral, Angry) x 6 sites (Fz, FCz, Cz, CPz, Pz, Oz) and, to that, we added ANCOVAs, as between factor and covariate Personality (J5-BAS, J5-BIS, J5-Fight, J5-Flight, J5-Freeze).

5.Results

5.1.Psychometric correlations

The results which emerged from the correlations of the indexes of the different personality questionnaires showed patterns which were mostly awaited (cf: Table 1).
STAI Y1 and Y2 had a positive correlation, as well as STAI and BIS of Carver and STAI and EPQR Neuroticism, while they showed negative correlation with EPQR Extraversion and EPQR Lie.
Regarding Carver's scale, inside BAS Drive was positively correlated with BAS Reward responsiveness, while with the other scales, BAS Drive was positively correlated with EPQR Lie and BAS Fun Seeking with EPQR Extraversion. Clearly Carver BIS was negatively correlated with EPQR Extraversion.
The only inner correlation of the EPQR was a negative one between Psychoticism and Lie.
Regarding the two scales that take into account all the new dimensions of the revision, RSQ and J5, we can see that RSQ has a quite strange behaviour, especially because the main correlations it has are positive between Freeze and its BIS, Carver's BIS and STAI Y1 pre and post. The other correlation was, as awaited, a negative between its BIS and BAS.
We focused our attentions on the correlations between the J5 scale, with its inner scales, and the other better known scales.
As we can see, the first interesting result is that BIS is not correlated with any other scale, but inside the J5, BIS is correlated positively with Fight and Flight and negatively with Freeze: this last negative correlation could be supported with the same negativeness with BIS of Carver, the STAI Y1 pre task and with Flight, which in turn is positively correlated with BIS as already mentioned.
As for the Flight, leaving aside BIS, this showed a strong correlation with Fight; moreover, with other scales, Flight showed a positive correlation with STAI Y1 post task and BIS of Carver, while a negative correlation with EPQR Extraversion. The negative correlation with Age is also interesting.
Looking at the Fight dimension, leaving aside the inner-scale correlation with BIS and Flight, this showed a positive correlation with STAI Y1 post task and a negative correlation with EPQR Psychoticism.

Pearson Correlation Coefficients, N = 36 Prob > |r| under H0: Rho=0																					
	Age	Stai_Y1_pre	Stai_Y1_post	Stai_Y2	Carver_BAS_Drive	Carver_BAS_FUN_SEEK	Carver_BAS_REV_RESP	Carver_BIS	EPQR_E	EPQR_N	EPQR_P	EPQR_L	RSQ_BIS	RSQ_BAS	RSQ_Fight	RSQ_Flight	RSQ_Freeze	J5_BAS	J5_BIS	J5_Fight	J5_Flight	J5_Freeze
Age																						
Stai_Y1_pre	-0,1																					
Stai_Y1_post	-0,13	0,3																				
Stai_Y2	-0,19	0,56***	0,4*																			
Carver_BAS_Drive	0,07	-0,24	-0,02	-0,29																		
Carver_BAS_FUN_SEEK	-0,18	0,15	-0,18	-0,13	0,28																	
Carver_BAS_REV_RESP	0,06	0,06	0,29	-0,08	0,34*	0,13																
Carver_BIS	-0,12	0,36*	0,48**	0,67***	0,05	-0,21	0,31															
EPQR_E	0,02	-0,05	-0,18	-0,42*	0,19	0,45**	0,03	-0,61***														
EPQR_N	-0,24	0,39*	0,34*	0,64***	-0,23	-0,06	0,13	0,43**	-0,11													
EPQR_P	0,12	0,09	0,13	0,22	-0,26	0,14	-0,07	-0,05	0	0,29												
EPQR_L	0,07	-0,2	0,08	-0,47**	0,45**	0,03	0,26	-0,14	0,15	-0,26	-0,35*											
RSQ_BIS	0,25	0,03	0,15	0,27	-0,17	-0,09	-0,02	0,18	-0,13	0,16	-0,1	-0,11										
RSQ_BAS	-0,31	0,19	0,25	-0,05	0,13	0,26	0,1	-0,2	0,32	0,11	-0,02	-0,07	-0,35*									
RSQ_Fight	-0,02	0,07	-0,05	0,01	-0,08	0,23	-0,29	-0,17	0,19	0,28	0,18	-0,08	0,04	-0,02								
RSQ_Flight	0,12	0,23	0,16	0,17	-0,18	-0,14	-0,08	0,09	-0,12	0,07	-0,2	-0,14	0,35*	0,03	0,04							
RSQ_Freeze	0,08	0,44**	0,37*	0,28	-0,21	-0,19	0,1	0,34*	-0,12	0,17	-0,05	-0,03	0,67***	-0,28	-0,04	0,28						
J5_BAS	**-0,21**	**0**	**0,01**	**-0,26**	**0,22**	**0,46****	**0,17**	**-0,28**	**0,47****	**-0,16**	**0,01**	**0,34***	**-0,36***	**0,46****	**-0,08**	**-0,41***	**-0,31**					
J5_BIS	**-0,14**	**0,06**	**0,13**	**0,09**	**0,07**	**-0,14**	**0,21**	**0,24**	**-0,08**	**0,03**	**-0,27**	**0,1**	**0**	**0,05**	**-0,17**	**0,06**	**0,16**	**-0,08**				
J5_Fight	**-0,1**	**0,21**	**0,36***	**0,15**	**0,2**	**-0,02**	**0,24**	**0,28**	**-0,12**	**-0,04**	**-0,45****	**0,17**	**0,07**	**-0,01**	**0,07**	**0,3**	**0,24**	**-0,17**	**0,51****			
J5_Flight	**-0,37***	**0,17**	**0,46****	**0,21**	**-0,04**	**-0,1**	**0,13**	**0,4***	**-0,4***	**0,04**	**-0,28**	**-0,06**	**0,2**	**0,16**	**-0,21**	**0,29**	**0,36***	**-0,15**	**0,59*****	**0,57*****		
J5_Freeze	**-0,02**	**-0,37***	**-0,01**	**-0,31**	**0,15**	**0,07**	**-0,12**	**-0,34***	**0,26**	**-0,17**	**0,25**	**0,19**	**-0,26**	**-0,06**	**0,24**	**-0,23**	**-0,32**	**0,12**	**-0,35***	**-0,13**	**-0,42***	

Note: Stai = State Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) (Y1_pre = Y1 pre task, Y1_post = post task), Carver = BIS/BAS Scale (Carver & White, 1994) (BAS_FUN_SEEK = Bas Fun Seeking, BAS_REV_RESP = Bas Reward responsiveness), EPQR = Eysenck Personality Questionnaire Revised (H. J. Eysenck & Eysenck, 1991) (E =Extraversion, N = Neuroticism, P= Psychoticism, L = Lie), RSQ = Reinforcement Sensitivity Questionnaire (Smederevac, Mitrović, & Čolović, 2014), J5 = Jackson-5 scale (Jackson, 2009).

* $p<0.05$

** $p<0.01$

*** $p<0.001$

Table 1 - Zero order correlations among key variables.

5.2.Behavioural

From the ANOVA we run we have found a general Distance effect [$F_{(1, 35)}$=43.83, p<0.0001, Near M=441.5ms, SD=60.4 vs. Far M=461.4ms, SD=61.7].
The only personality factor interacting was BAS and we had Distance X BAS [$F_{(1, 34)}$=43.83, p=0.031, Near M=417.6ms, SD=41.5 vs. Far M=444.6ms, SD=43.2, Near M=448.8ms, SD=67.9 vs. Far M=461.6ms, SD=76.6, respectively for High- and Low-BAS levels] (Fig. 11).

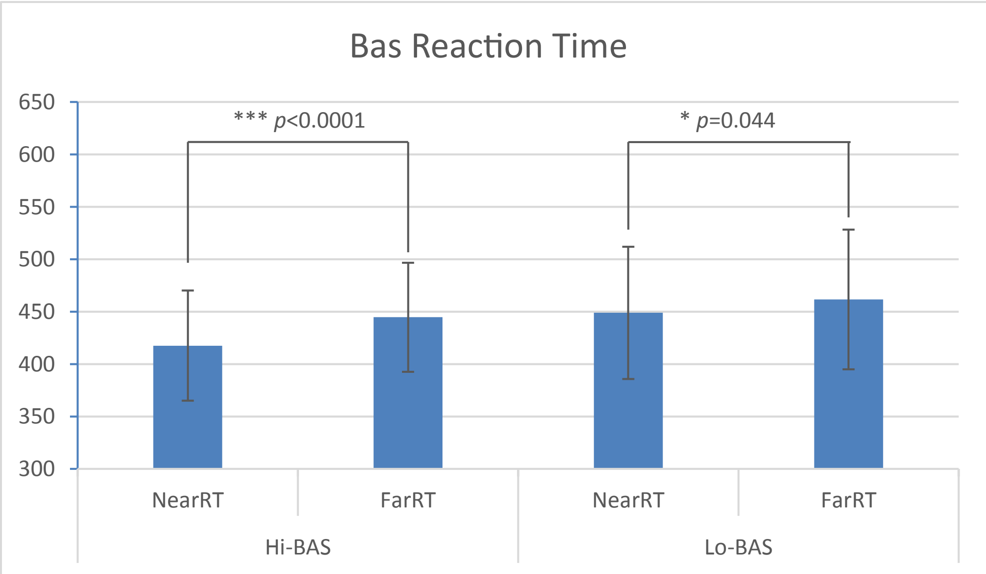


Fig. 11. BAS reaction time.

5.3.ERP

Here we show the results we had for the ERP analysis and, as previously said, we took into in account P100, N100, P200, N200 and P300 components.

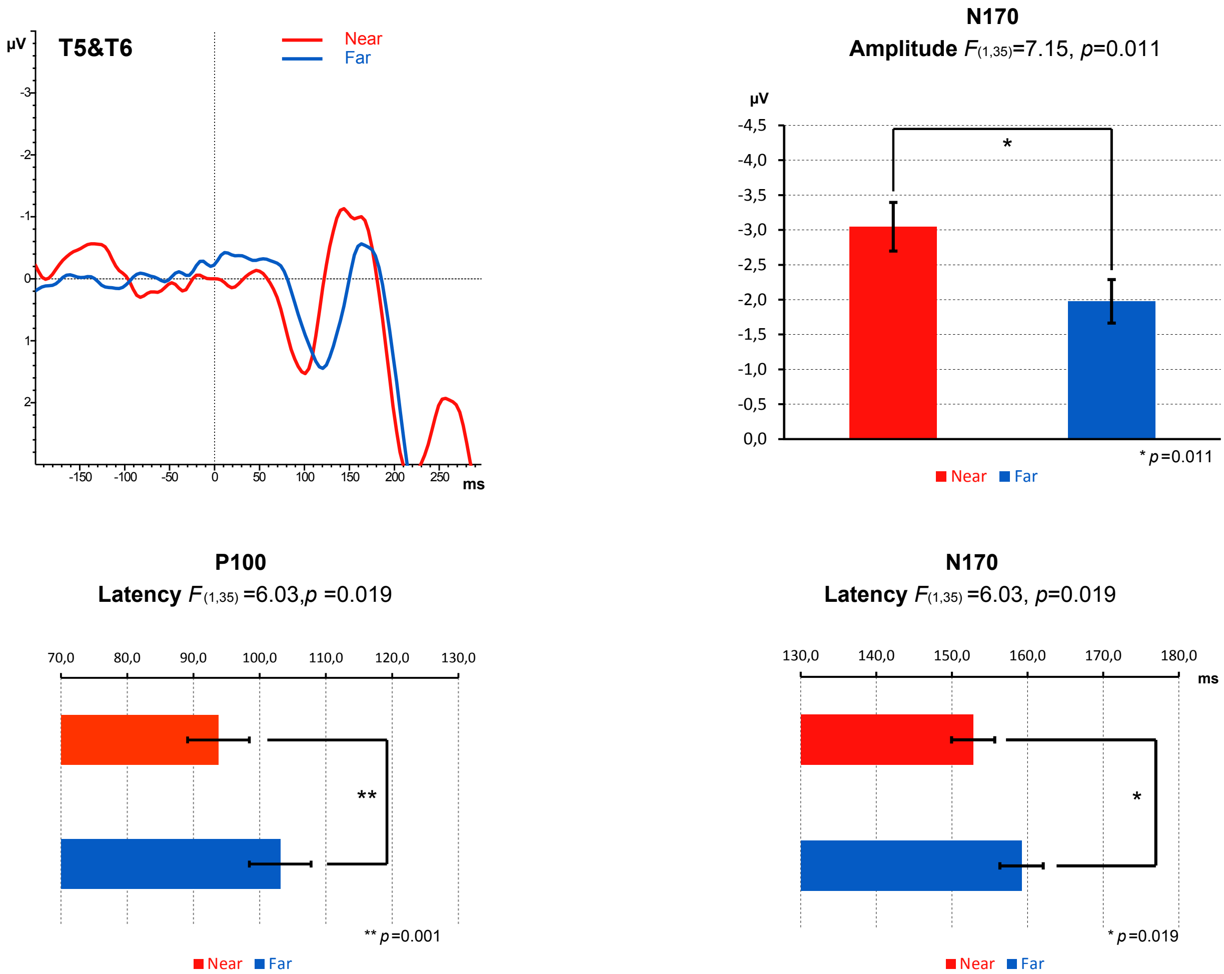
In general we can say that we had an effect of Distance for almost all the components we had taken in exam and we will show here before going in depth with the interactions for each component, following a distinction between P100-N100 and the complex P200-N200-P300.

For the complex P200-N200-P300 we also found main Location effects.

Regarding the latency of the P100 we found a general Distance effect [$F_{(1, 35)}$=6.03, p=0.019]. Post-hoc t-test showed Near (M=93.8ms, SD=15.7, SE=2.62) < Far (M=103.1ms, SD=18.8, SE=3.14) [t=-3.45, p=0.001]. No effect for Distance for amplitude.

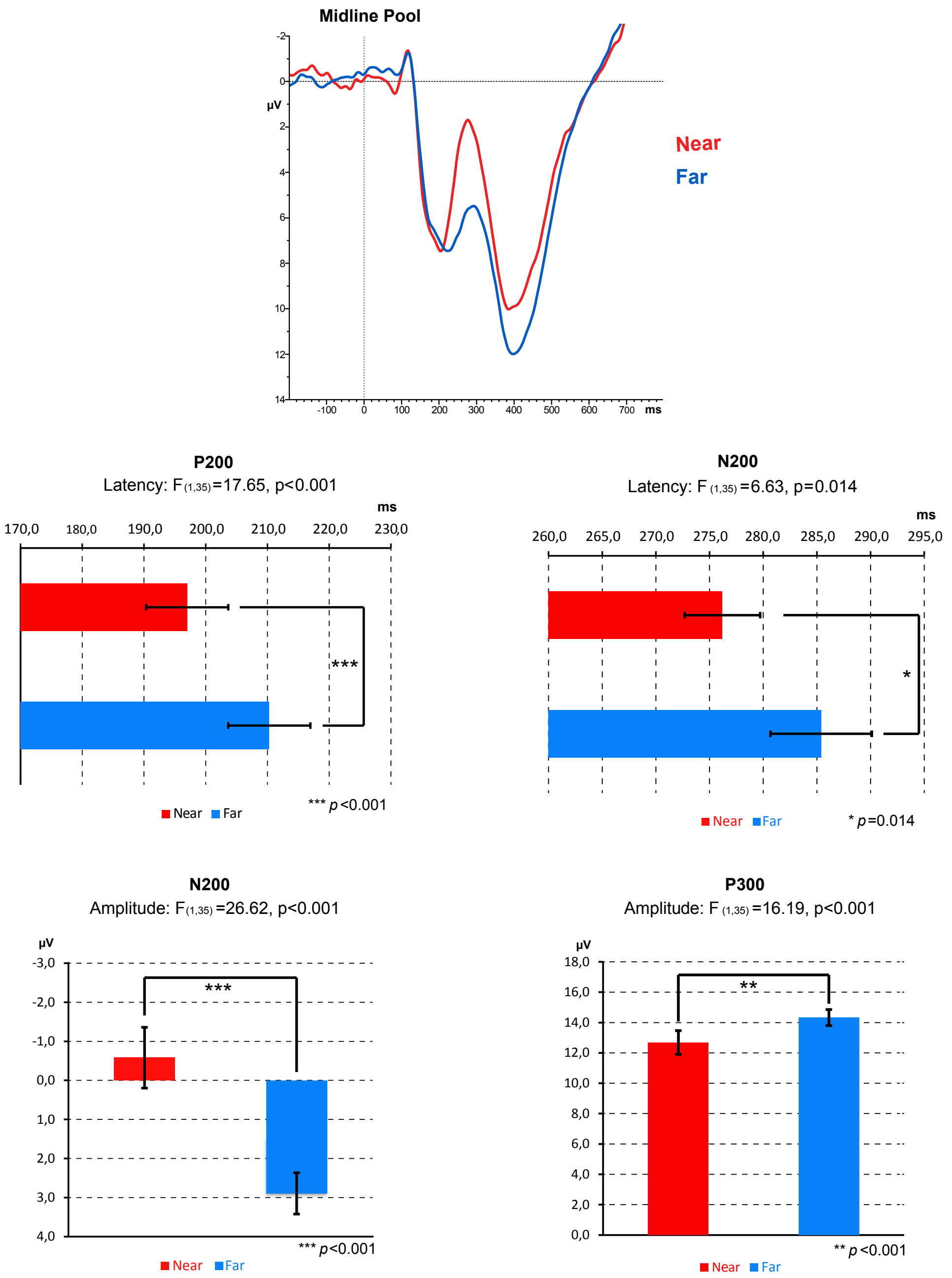
Regarding the latency of the N170, as before, we found a general Distance effect [$F_{(1, 35)}$=6.03, p=0.019]. Post-hoc t-test showed Near (M=152.8ms, SD=17.1, SE=2.85) < Far (M=159.2ms, SD=17.2, SE=2.86) [t=-2.46, p=0.019]. The amplitude of N170 too was interested by a general Distance effect [$F_{(1, 35)}$=7.15, p=0.011]. Post-hoc t-test showed Near (M=-3.05µV, SD=2.09, SE=0.35) < Far (M=-1.98µV, SD=1.87, SE=0.31) [t=-2.67, p=0.011].

Distance effects for P100 and N170



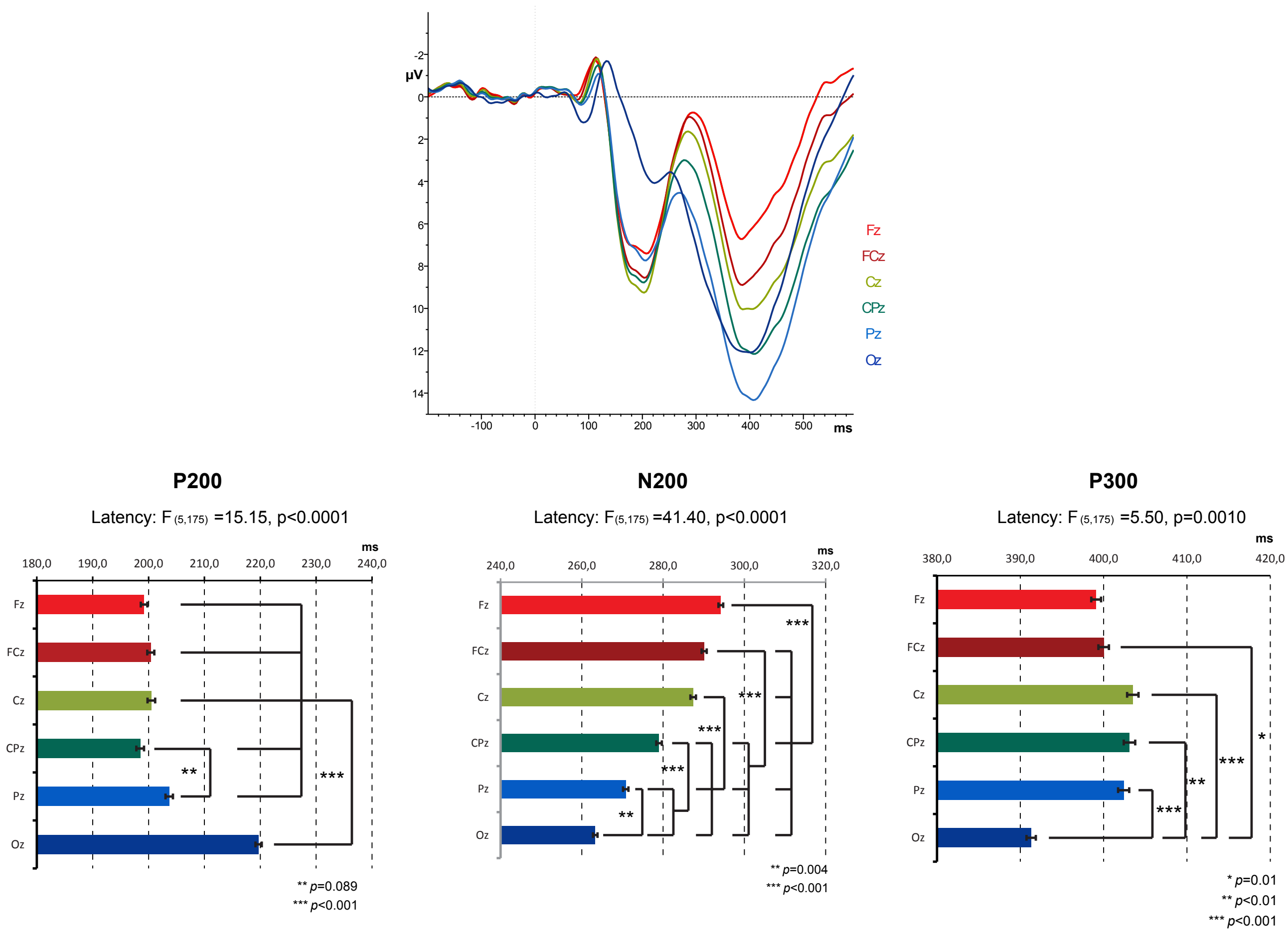
Regarding the complex P200, N200 and P300, for the latency, for the P200 we found a general Distance effect [$F_{(1,\ 35)}$=17.65, p<0.001]. Post-hoc t-test showed Near (M=197.0ms, SD=22.8, SE=3.79) < Far (M=210.3ms, SD=22.3, SE=3.71) [t=-4.2, p<0.001] as well as for the N200 [$F_{(1,\ 35)}$=6.73, p=0.014]. Post-hoc t-test showed Near (M=276.2ms, SD=21.1, SE=3.52) < Far (M=285.4ms, SD=28.3, SE=4.72) [t=-2.59, p=0.014]. No effect was found in the P300.
As regards the effect of Distance, for the amplitude, we did not find any effect for the P200, but we found it for the N200 [$F_{(1,\ 35)}$=26.62, p<0.001]. Post-hoc t-test showed Near (M=-0.58μV, SD=4.67, SE=0.78) < Far (M=2.89μV, SD=3.17, SE=0.53) [t=-5.16, p<0.001] as well as for the P300 [$F_{(1,\ 35)}$=16.19, p<0.001]. Post-hoc t-test showed Near (M=12.69μV, SD=3.51, SE=0.59) < Far (M=14.33μV, SD=3.31, SE=0.55) [t=-4.02, p<0.001].

Distance effects for P200, N200, P300



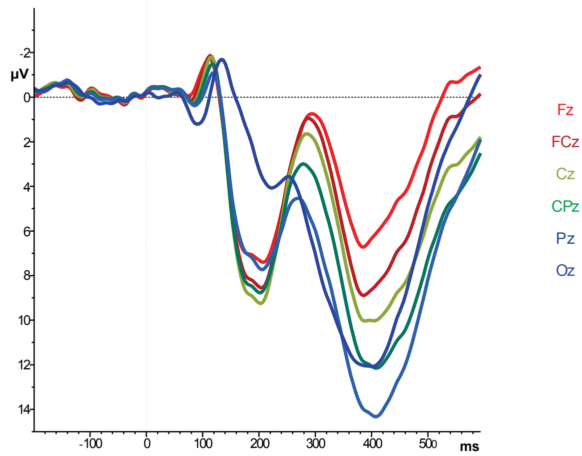
As said we found a general Location effect for the latency of P200, N200 and P300.
P200 showed [$F_{(5, 175)}$=15.15, p<0.001]. Post-hoc t-test showed Fz (M=199.2ms, SD=22.4, SE=3.74) < Oz (M=219.7ms, SD=24.0, SE=3.99) [t=-4.67, p<0.001], FCz (M=200.4ms, SD=22.1, SE=3.68) < Oz [t=-5.28, p<0.001], Cz (M=200.5ms, SD=21.6, SE=3.59) < Oz [t=-5.22, p<0.001], CPz (M=198.5ms, SD=23.7, SE=3.94) < Oz [t=-6.64, p<0.001], Pz (M=203.7ms, SD=26.3, SE=4.38) < Oz [t=-5.14, p<0.001] and CPz < Pz [t=-2.77, p=0.009].
N200 had [$F_{(5, 175)}$=41.4, p<0.001]. Post-hoc t-test showed Fz (M=294.2ms, SD=20.3, SE=3.38) > FCz (M=291.0ms, SD=21.0, SE=3.34) [t=3.72, p<0.001], Fz > Cz (M=287.4ms, SD=22.5, SE=3.75) [t=3.65, p<0.001], Fz > CPz (M=279.0ms, SD=25.9, SE=4.31) [t=6.33, p<0.001], Fz > Pz (M=270.8ms, SD=30.6, SE=5.1) [t=6.95, p<0.001], Fz > Pz (M=270.8ms, SD=30.6, SE=5.1) [t=6.95, p<0.001], Fz > Oz (M=263.3ms, SD=27.0, SE=4.49) [t=8.24, p<0.001], FCz > CPz [t=5.35, p<0.001], FCz > Pz [t=6.41, p<0.001], FCz > Oz [t=7.7, p<0.001], Cz > CPz [t=5.49, p<0.001], Cz > Pz [t=6.08, p<0.001], Cz > Oz [t=7.61, p<0.001], CPz > Pz [t=4.14, p<0.001], CPz > Oz [t=4.77, p<0.001], Pz > Oz [t=3.07, p=0.004].
P300 had [$F_{(5, 175)}$=5.5, p=0.001]. Post-hoc t-test showed Fz (M=399.1ms, SD=35.5, SE=5.92) > Oz (M=391.3ms, SD=30.7, SE=5.11) [t=2.03, p=0.05], FCz (M=400.0ms, SD=32.4, SE=5.4) > Oz [t=2.71, p=0.01], Cz (M=403.5ms, SD=31.6, SE=5.27) > Oz [t=3.99, p<0.001], CPz (M=403.1ms, SD=32.9, SE=5.48) > Oz [t=3.38, p=0.002], Pz (M=402.4ms, SD=31.5, SE=5.25) > Oz [t=3.81, p<0.001].

Location effects for P200, N200, P300 - Latency



Regarding the amplitude of the Location effect for the P200 we had [$F_{(5,\ 175)}$=36.57, *p*<0.001]. Post-hoc *t*-test showed Fz (*M*=9.56μV, SD=3.25, SE=0.54) < FCz (*M*=10.56μV, SD=3.24, SE=0.54) [*t*=-6.76, *p*<0.001], Fz < Cz (*M*=11.13μV, SD=3.42, SE=0.57) [*t*=-5.52, *p*<0.001], Fz < CPz (*M*=10.81μV, SD=3.31, SE=0.55) [*t*=-3.39, *p*=0.002], Fz > Oz (*M*=6.6μV, SD=2.95, SE=0.49) [*t*=4.66, *p*<0.001], FCz < Cz [*t*=-3.45, *p*=0.001], FCz > Oz [*t*=6.73, *p*<0.001], Cz > Pz (*M*=9.95μV, SD=3.10, SE=0.52) [*t*=3.71, *p*<0.001], Cz > Oz [*t*=8.62, *p*<0.001], CPz > Pz [*t*=4.51, *p*<0.001], CPz > Oz [*t*=9.61, *p*<0.001], Pz > Oz [*t*=10.26, *p*<0.001].
Regarding the N200 we had [$F_{(5,\ 175)}$=23.40, *p*<0.001]. Post-hoc *t*-test showed Fz (*M*=-0.32μV, SD=3.52, SE=0.59) < CPz (*M*=1.46μV, SD=4.13, SE=0.69) [*t*=-4.14, *p*<0.001], Fz < Oz (*M*=2.78μV, SD=3.37, SE=0.56) [*t*=-4.80, *p*<0.001], FCz (*M*=-0.24μV, SD=3.79, SE=0.63) < Cz (*M*=0.28μV, SD=4.11, SE=0.68) [*t*=-2.54, *p*=0.016], FCz > CPz [*t*=-5.24, *p*<0.001], FCz < Pz (*M*=2.98μV, SD=4.0, SE=0.67) [*t*=-7.33, *p*=0.001], FCz > Oz [*t*=-4.69, *p*<0.001], Cz > CPz [*t*=-6.69, *p*<0.001], Cz > Pz [*t*=-8.39, *p*<0.001], Cz > Oz [*t*=-4.61, *p*<0.001], CPz > Pz [*t*=-8.28, *p*<0.001], CPz > Oz [*t*=-2.42, *p*=0.021].
The P300 had [$F_{(5,\ 175)}$=23.40, *p*<0.001]. Post-hoc *t*-test showed Fz (*M*=9.41μV, SD=3.05, SE=0.51) < FCz (*M*=11.77μV, SD=3.43, SE=0.57) [*t*=-10.79, *p*<0.001], Fz < Cz (*M*=12.96μV, SD=3.71, SE=0.62) [*t*=-9.10, *p*<0.001], Fz < CPz (*M*=14.93μV, SD=3.93, SE=0.66) [*t*=-11.38, *p*<0.001], Fz < Pz (*M*=16.92μV, SD=3.94, SE=0.66) [*t*=-14.06, *p*<0.001], Fz < Oz (*M*=15.07μV, SD=4.06, SE=0.68) [*t*=-7.28, *p*<0.001], FCz < Cz [*t*=-5.11, *p*<0.001], FCz > CPz [*t*=-9.36, *p*<0.001], FCz < Pz [*t*=-12.86, *p*=0.001], FCz > Oz [*t*=-4.50, *p*<0.001], Cz > CPz [*t*=-10.79, *p*<0.001], Cz > Pz [*t*=-15.00, *p*<0.001], Cz > Oz [*t*=-3.18, *p*<0.001], CPz > Pz [*t*=-11.06, *p*<0.001], Pz < Oz [*t*=3.15, *p*=0.003].

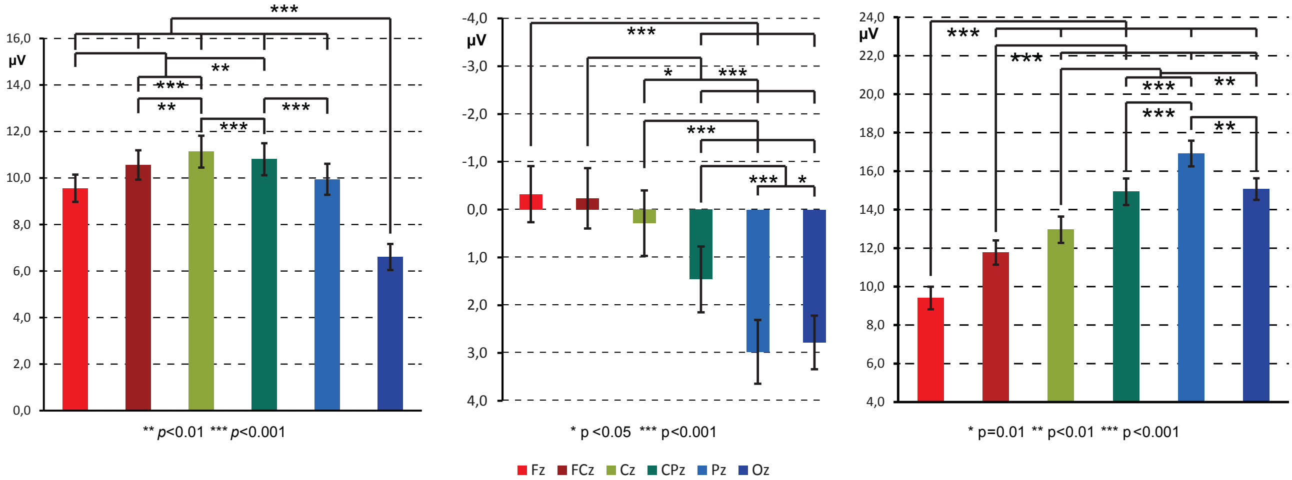
Location effects for P200, N200, P300 - Amplitude

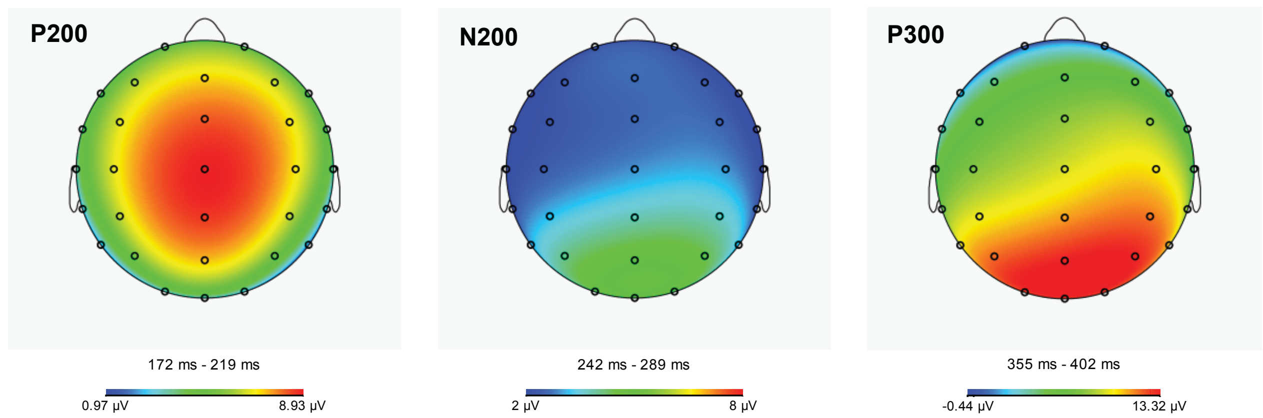


P200 **Amplitude**: $F_{(5,175)}$=37.57, p<0.0001

N200 **Amplitude**: $F_{(5,175)}$=23.40, p<0.0001

P300 **Amplitude**: $F_{(5,175)}$=61.06, p<0.0001





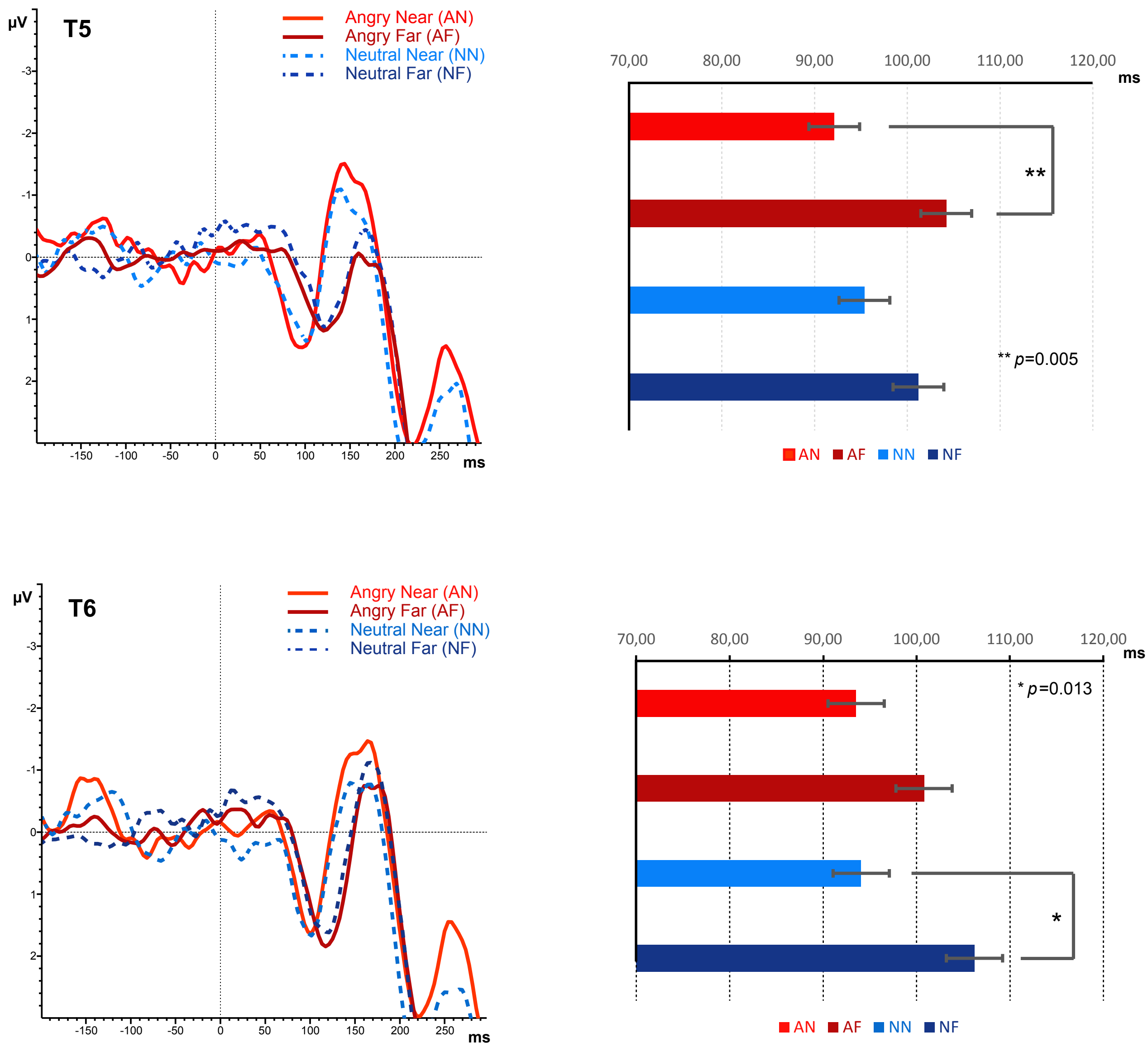
5.3.1.P100

For the latency we found an interaction Emotion X Distance X Hemisphere [$F_{(1, 35)}$=6.64, p=0.014]. Post-hoc t-test showed T5 Angry Near (M=92.1ms, SD=24.8, SE=4.14) < T5 Angry Far (M=104.2ms, SD=28.3, SE=4.72)[t=-2.97, p=0.005] and T6 Neutral Near (M=94.1ms, SD=24.4, SE=4.07) < T6 Neutral Far (M=106.3ms, SD=22.6, SE=3.76) [t=-2.61, p=0.013].

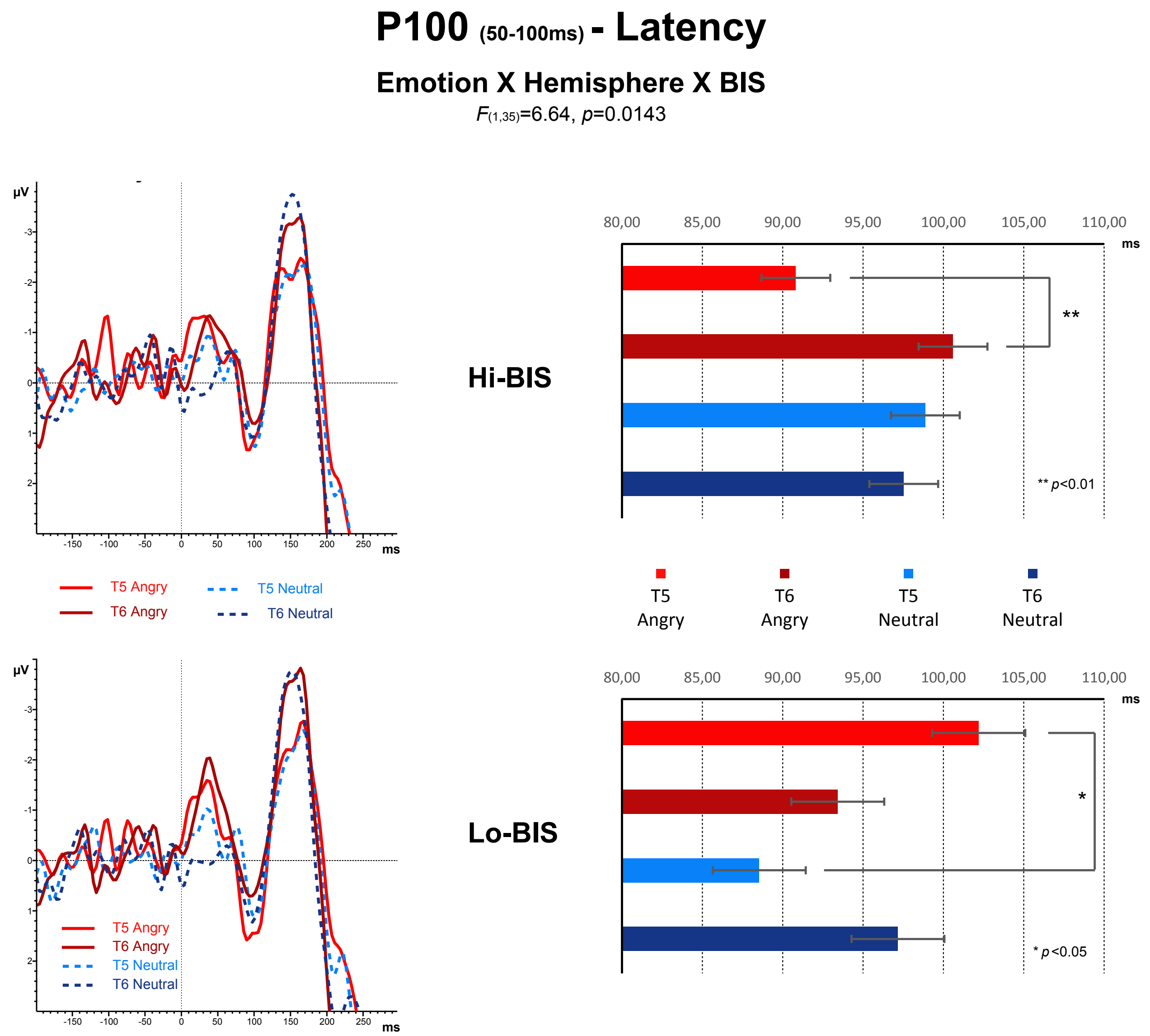
P100 (50-100ms) - Latency

Emotion X Distance X Hemisphere

$F_{(1,35)}$=6.64, p=0.0143



With Personality we had an interaction Emotion X Hemisphere X BIS [$F_{(1, 34)}$=4.73, p=0.037]. Post-hoc t-test showed T5 Angry (M=90.8ms, SD=17.6, SE=0.41) < T6 Angry (M=100.6ms, SD=14.2, SE=3.54) [t=-3.01, p=0.009] for Hi-BIS and a T5 Angry (M=102.2ms, SD=11.9, SE=3.43) > T5 Neutral (M=88.5ms, SD=18.7, SE=5.4) [t=2.45, p=0.032] for Lo-BIS.

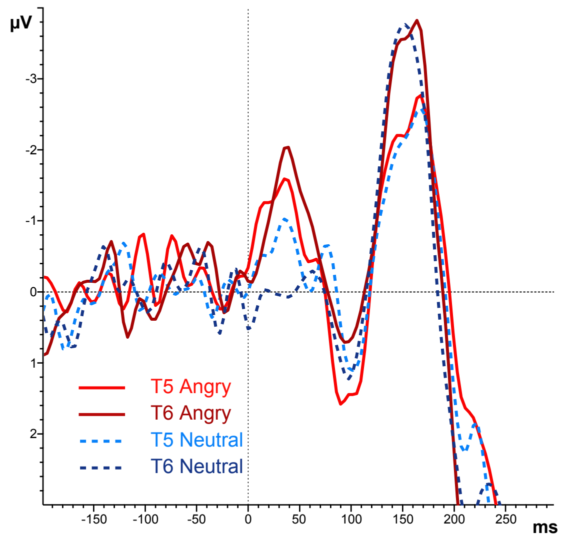


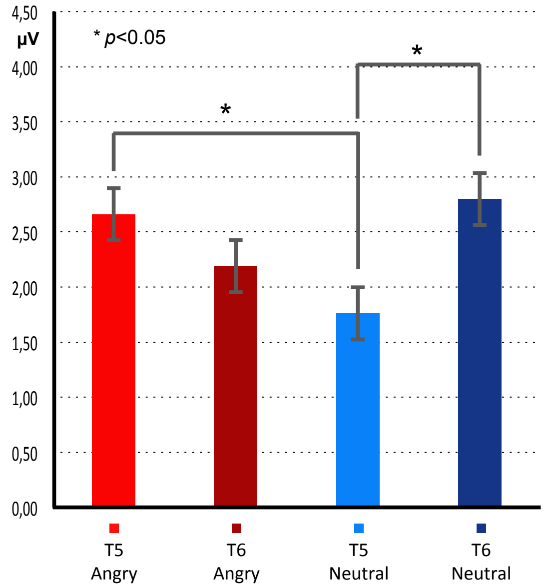
Regarding the amplitude we have not found any interaction in the ANOVA but as we added personality as covariate we found an interaction Emotion X Hemisphere X BIS [$F_{(1, 34)}$=11.93, p=0.001]. Post-hoc t-test showed T5 Angry (M=2.66μV, SD=0.99, SE=0.29) > T5 Neutral (M=1.76μV, SD=0.84, SE=0.24) [t=2.43, p=0.033] and T5 Neutral (M=1.76 μV, SD=0.84, SE=0.24) < T6 Neutral (M=2.80μV, SD=1.34, SE=0.39) [t=-3.01, p=0.012] for Lo-BIS only.

P100 (50-120ms) - Amplitude

Emotion X Hemisphere X Lo-BIS

$F_{(1,34)}$=11.93, p =0.0015



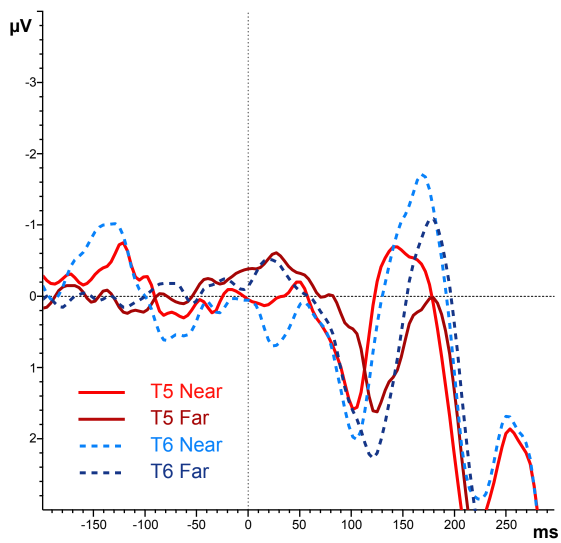


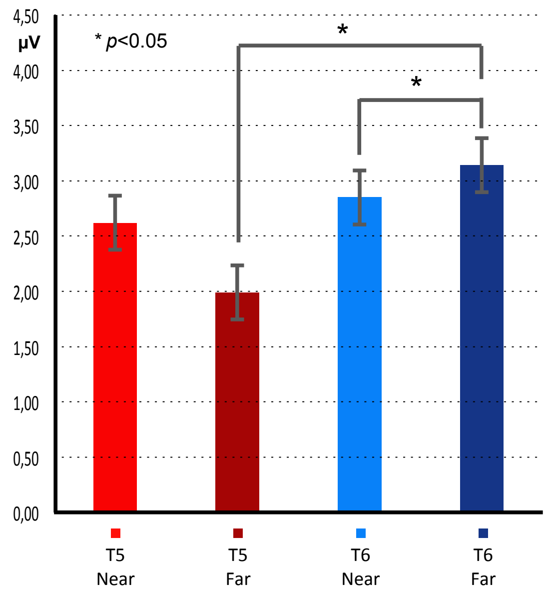
We found another interaction Flight: Distance X Hemisphere X Flight [$F(1, 34)$=8.95, p=0.005]. Post-hoc t-test showed T5 Far (M=1.99 µV, SD=1.63, SE=0.41) < T6 Far (M=3.14 µV, SD=1.91, SE=0.48) [t=-2.21, p=0.043] and T6 Near (M=2.85 µV, SD=1.41, SE=0.35) < T6 Far (M=3.14 µV, SD=1.91, SE=0.48) [t=-2.29, p=0.037] for Hi-Flight only.

P100 (50-120ms) - Amplitude

Distance X Hemisphere X Hi-Flight

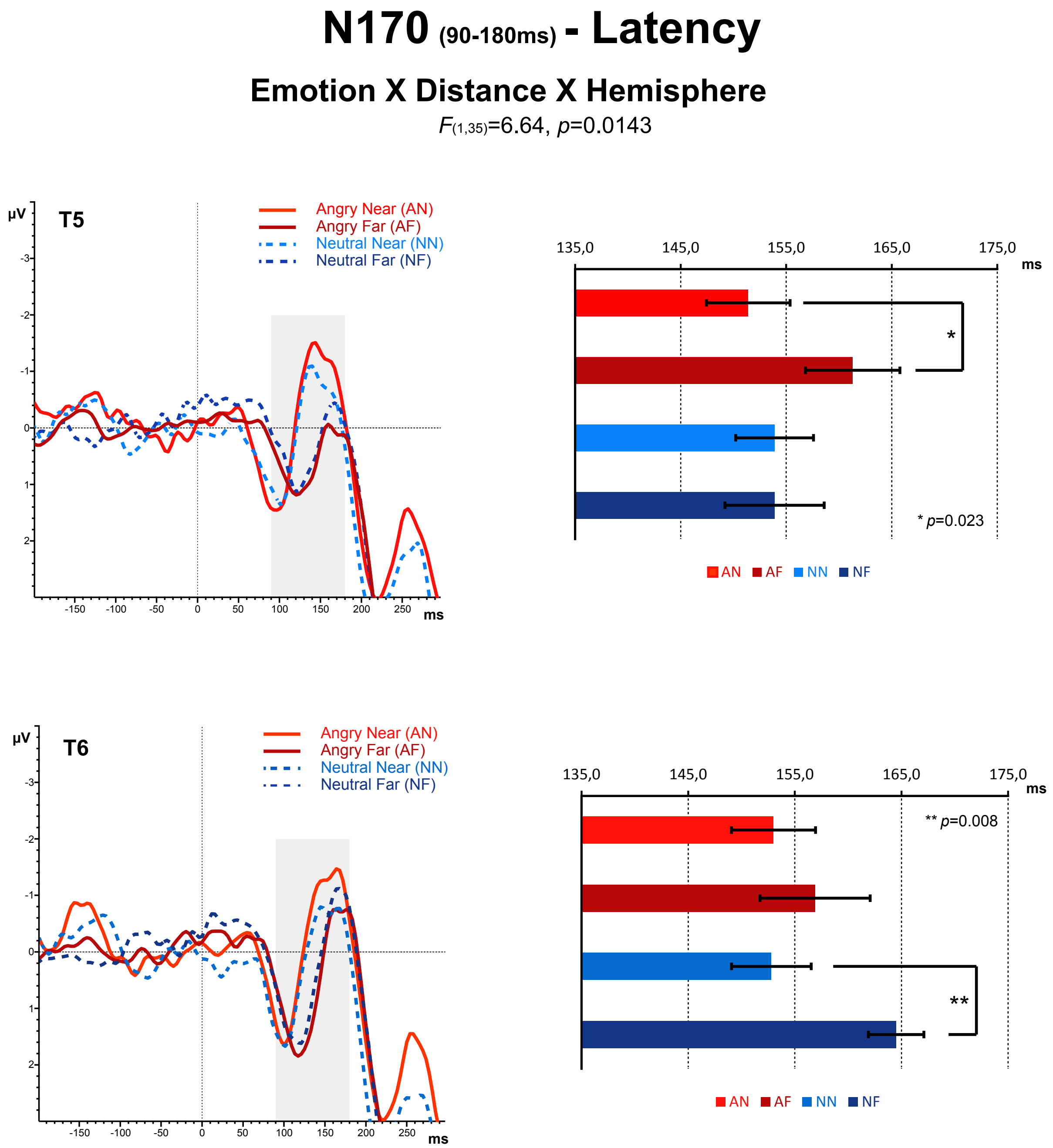
$F_{(1,34)}$=8.95, p =0.0051



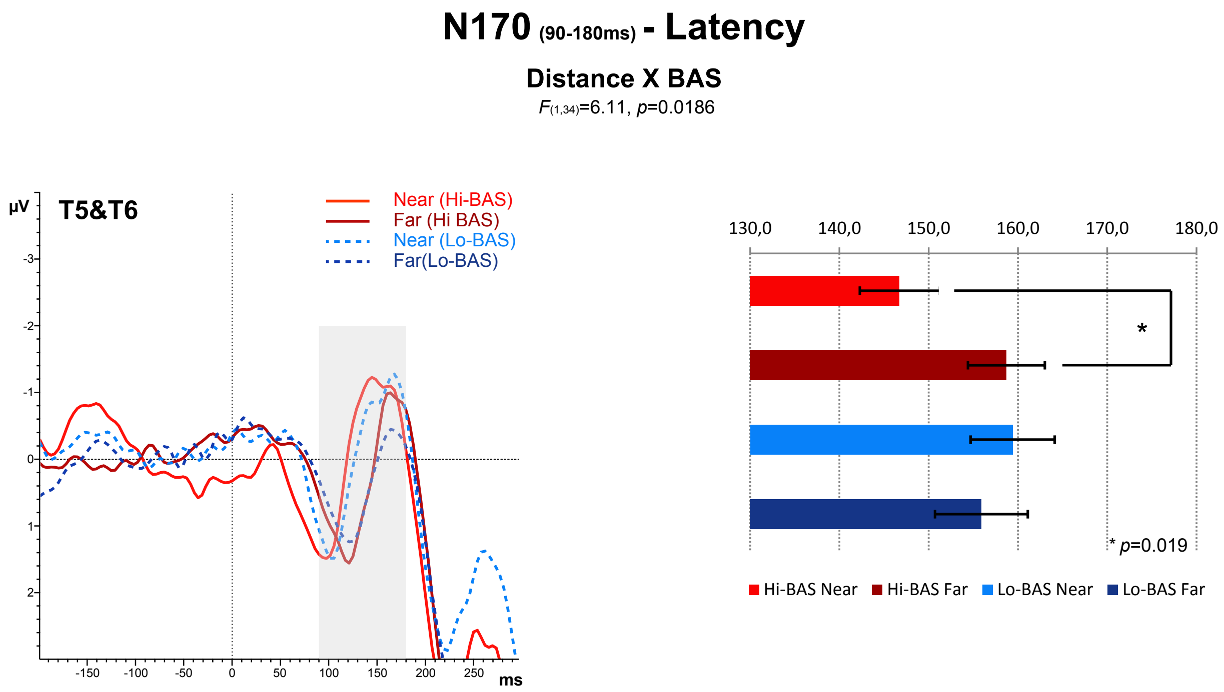


5.3.2.N170

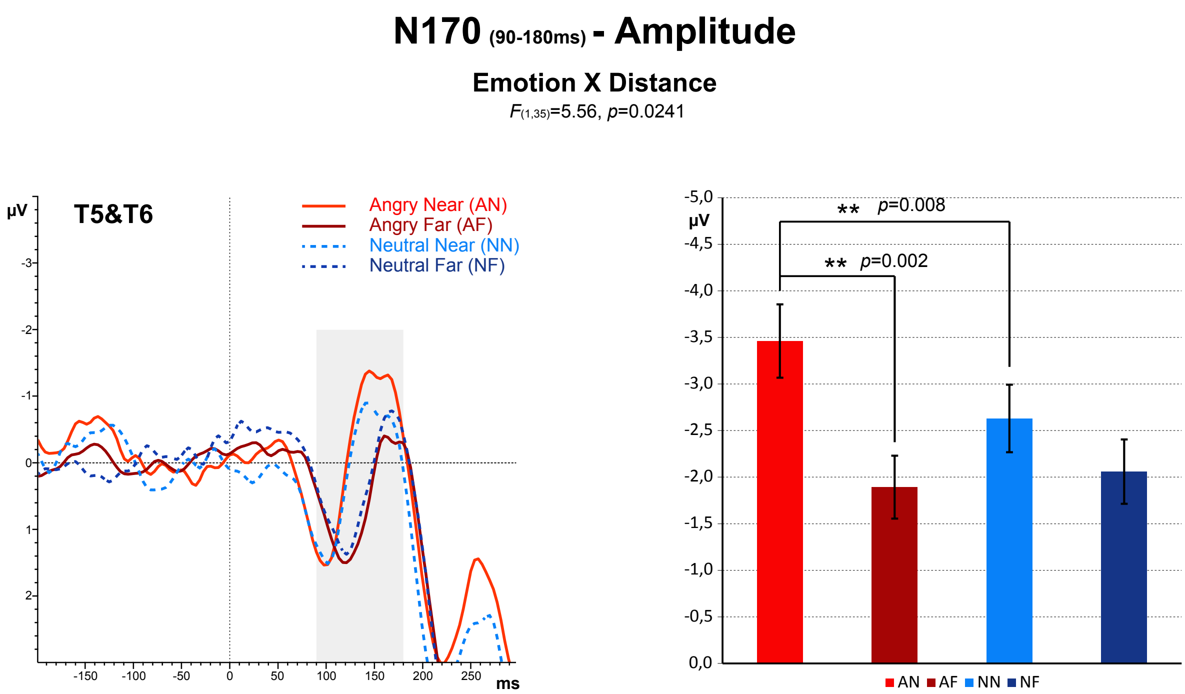
Regarding the latency we found an interaction Emotion X Distance X Hemisphere [$F_{(1, 35)}$=6.64, p=0.014]. Post-hoc t-test showed T5 Angry Near (M=151.4ms, SD=23.8, SE=3.97) < T5 Angry Far (M=161.3ms, SD=26.8, SE=4.48) [t=-2.38, p=0.023] and T6 Neutral Near (M=152.8ms, SD=22.4, SE=3.74) < T6 Neutral Far (M=164.5ms, SD=15.6, SE=2.6) [t=-2.80, p=0.008].



Regarding personality the only interaction we found in latency was Distance X BAS [$F_{(1, 34)}$=6.11, p=0.019]. Post-hoc t-test showed Near (M=146.7ms, SD=17.7, SE=4.42) < Far (M=158.7ms, SD=17.2, SE=4.31) [t=-3.31, p=0.005] for Hi-BAS only.



Regarding the amplitude we found an Emotion X Distance interaction [$F_{(1, 35)}$=5.56, p=0.024]. Post-hoc t-test showed Angry Near (M=-3.46µV, SD=2.36, SE=0.39) < Angry Far (M=-1.89µV, SD=2.03, SE=0.34) [t=-3.38, p=0.002] and Angry Near (M=-3.46µV, SD=2.36, SE=0.39) < Neutral Near (M=-2.63µV, SD=2.18, SE=0.36) [t=-2.83, p=0.008].

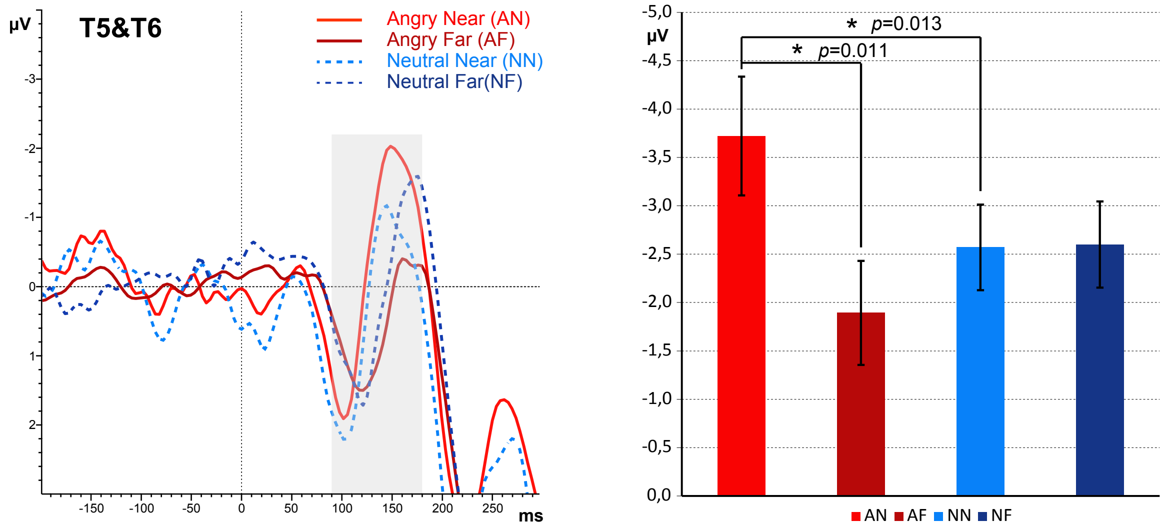


With personality we found an interaction Emotion X Distance X Fight [$F_{(1,\ 34)}$=6.31, p=0.017]. Post-hoc t-test showed Angry Near (M=-3.70μV, SD=2.32, SE=0.58) < Angry Far (M=-1.86μV, SD=2.22, SE=0.55) [t=-2.92, p=0.011] and Angry Near (M=-3.70μV, SD=2.32, SE=0.58) < Neutral Near (M=-2.56μV, SD=1.79, SE=0.45) [t=-2.83, p=0.013] for Hi-Fight only.

N170 (90-180ms) - Amplitude

Emotion X Distance X Hi-Fight

$F_{(1,34)}$=6.31, p=0.0169

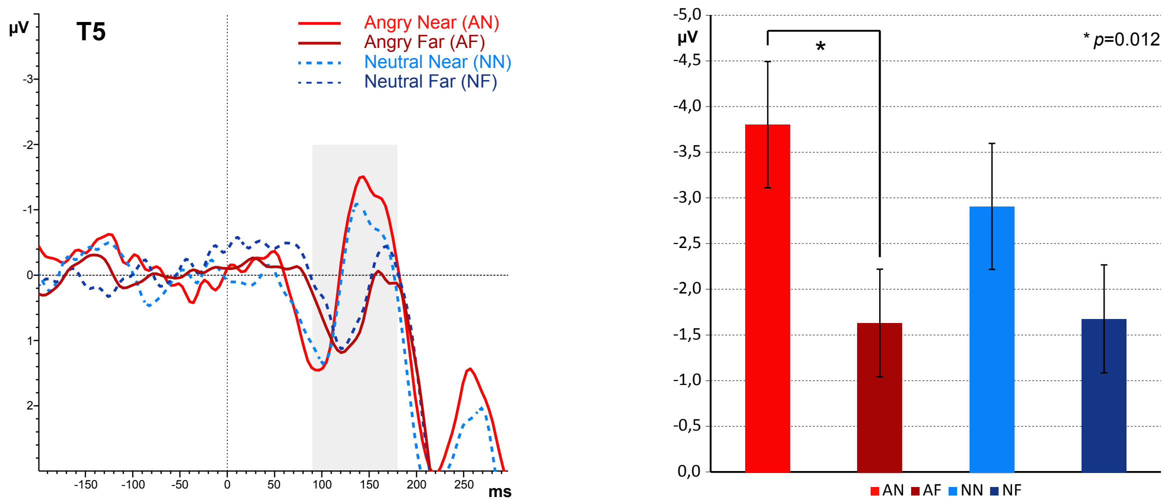


Another interaction with personality discovered was Emotion X Distance X Hemisphere X Freeze [$F_{(1,\ 34)}$=7.08, p=0.012]. Post-hoc t-test showed T5 Angry Near (M=-3.80μV, SD=3.16, SE=0.69) < T5 Angry Far (M=-1.63μV, SD=2.69, SE=0.69) [t=-2.75, p=0.012] for Lo-Freeze only.

N170 (90-180ms) - Amplitude

Emotion X Distance X Hemisphere X Lo-Freeze

$F_{(1,34)}$=7.08, p=0.0118



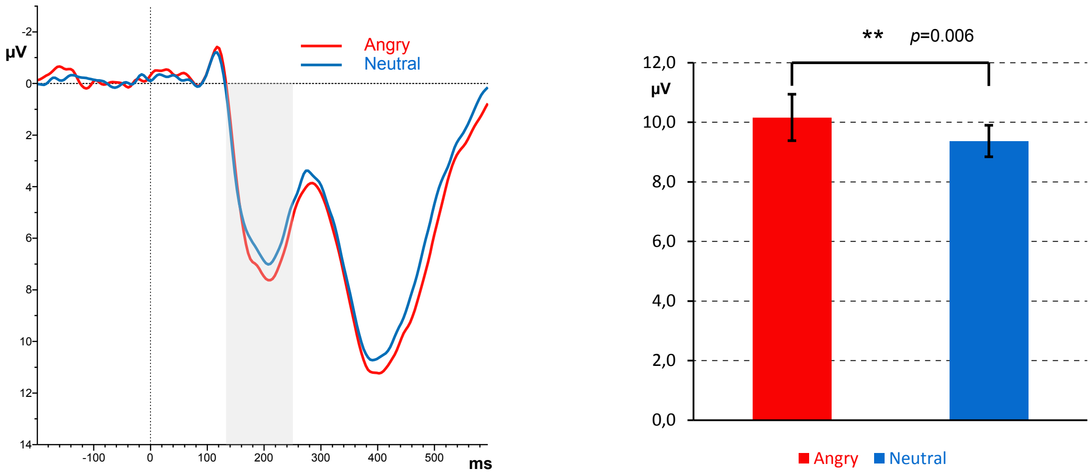
5.3.3.P200

The amplitude of P200 was interested by a general Emotion effect [$F(1, 35)=8.59$, $p=0.006$]. Post-hoc *t*-test showed Angry (M=10.16µV, SD=3.0, SE=0.5) > Neutral (M=9.37µV, SD=2.91, SE=0.49) [$t=2.93$, $p=0.006$].

P200 (130-250ms) **- Amplitude**

Emotion

$F_{(1,35)}=8.59$, $p=0.0059$

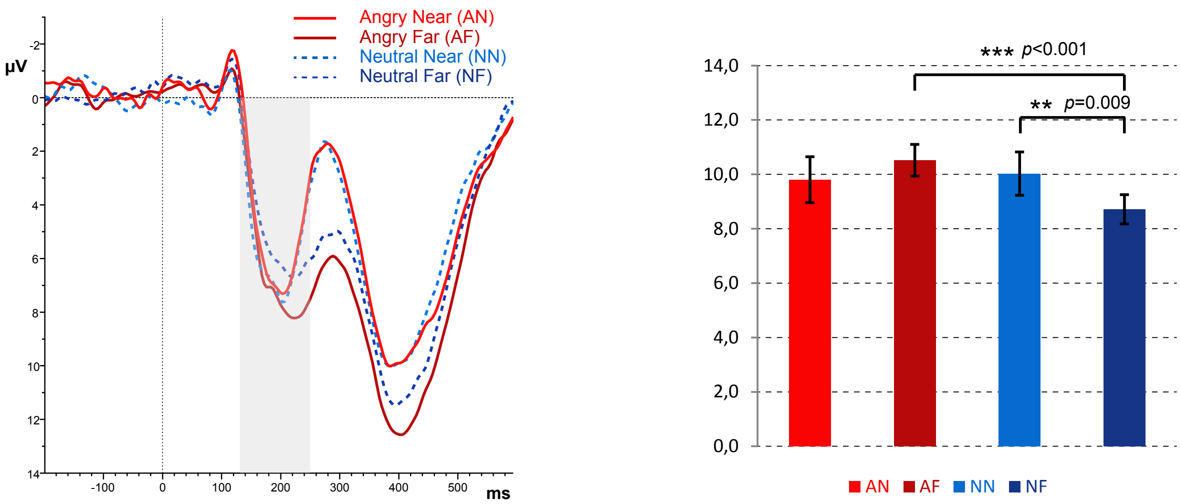


Then we found an interaction Emotion X Distance [$F(1, 35)=13.61$, $p<0.001$]. Post-hoc *t*-test showed Angry Far (M=10.52µV, SD=3.17, SE=0.53) > Neutral Far (M=8.72µV, SD=2.98, SE=0.5) [$t=4.13$, $p<0.001$] and Neutral Near (M=10.03µV, SD=3.47, SE=0.58) > Neutral Far (M=8.72µV, SD=2.98, SE=0.5) [$t=2.79$, $p=0.008$].

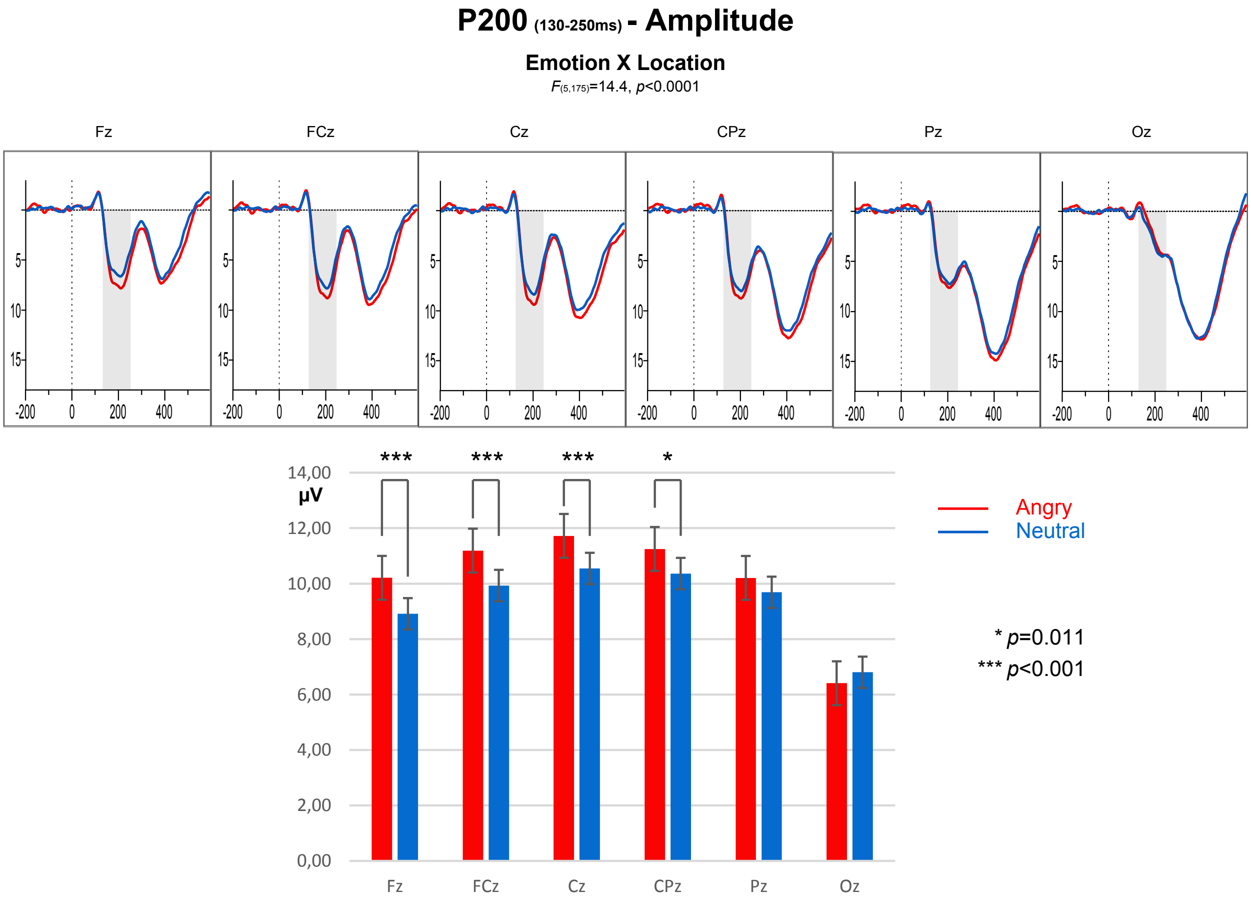
P200 (130-250ms) **- Amplitude**

Emotion X Distance

$F_{(1,35)}=13.61$, $p=0.0008$



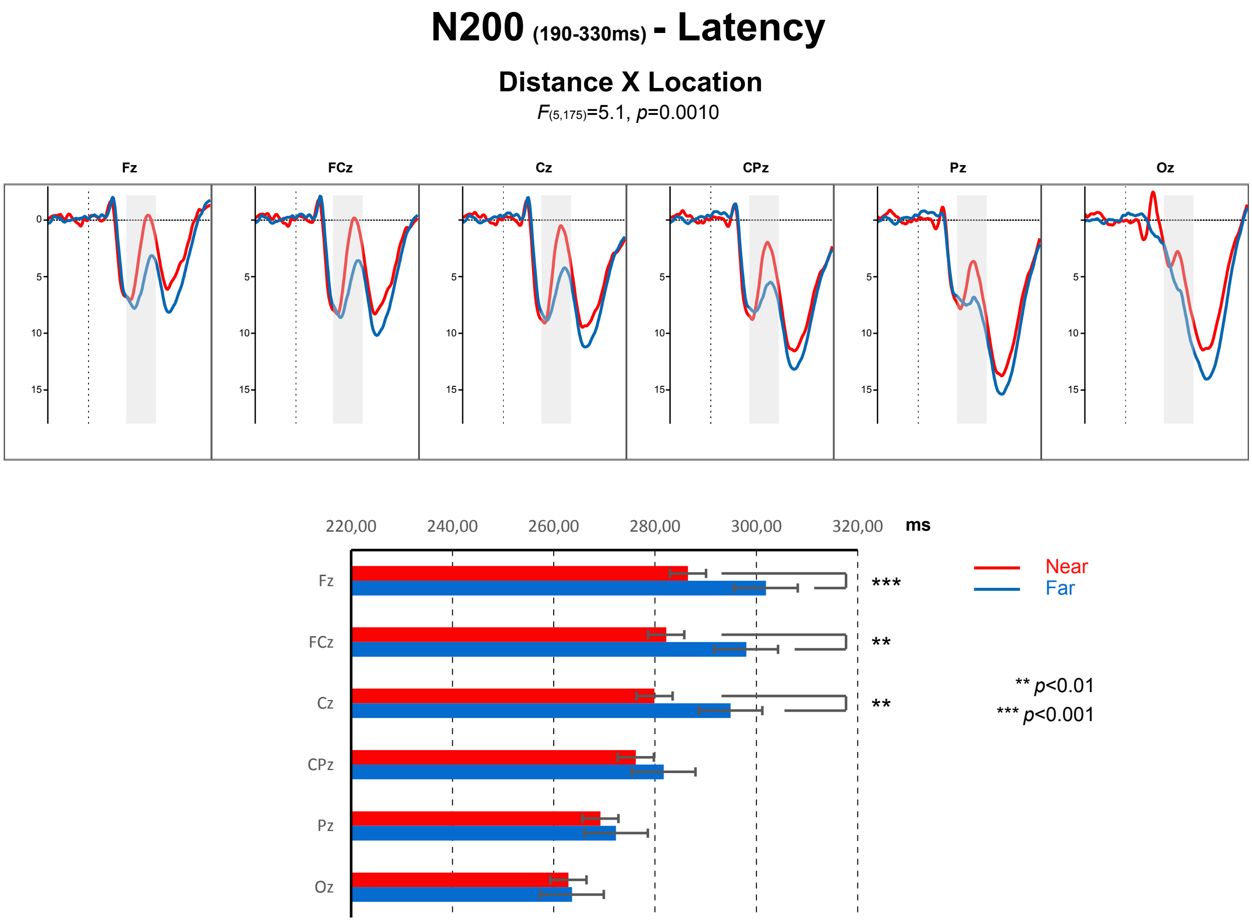
Another interaction we found was Emotion X Location [$F_{(5, 175)}$=14.4, p<0.001]. Post-hoc t-test showed Fz Angry (M=10.21μV, SD=3.0, SE=0.58) > Fz Neutral (M=8.91μV, SD=3.3, SE=0.55) [t=3.96, p<0.001], FCz Angry (M=11.19μV, SD=3.52, SE=0.59) > FCz Neutral (M=9.93μV, SD=3.23, SE=0.54) [t=3.96, p<0.001], Cz Angry (M=11.72μV, SD=3.44, SE=0.61) > Cz Neutral (M=10.55μV, SD=3.44, SE=0.57) [t=3.68, p<0.001], CPz Angry (M=11.25μV, SD=3.53, SE=0.59) > CPz Neutral (M=10.36μV, SD=3.37, SE=0.56) [t=2.67, p=0.011].



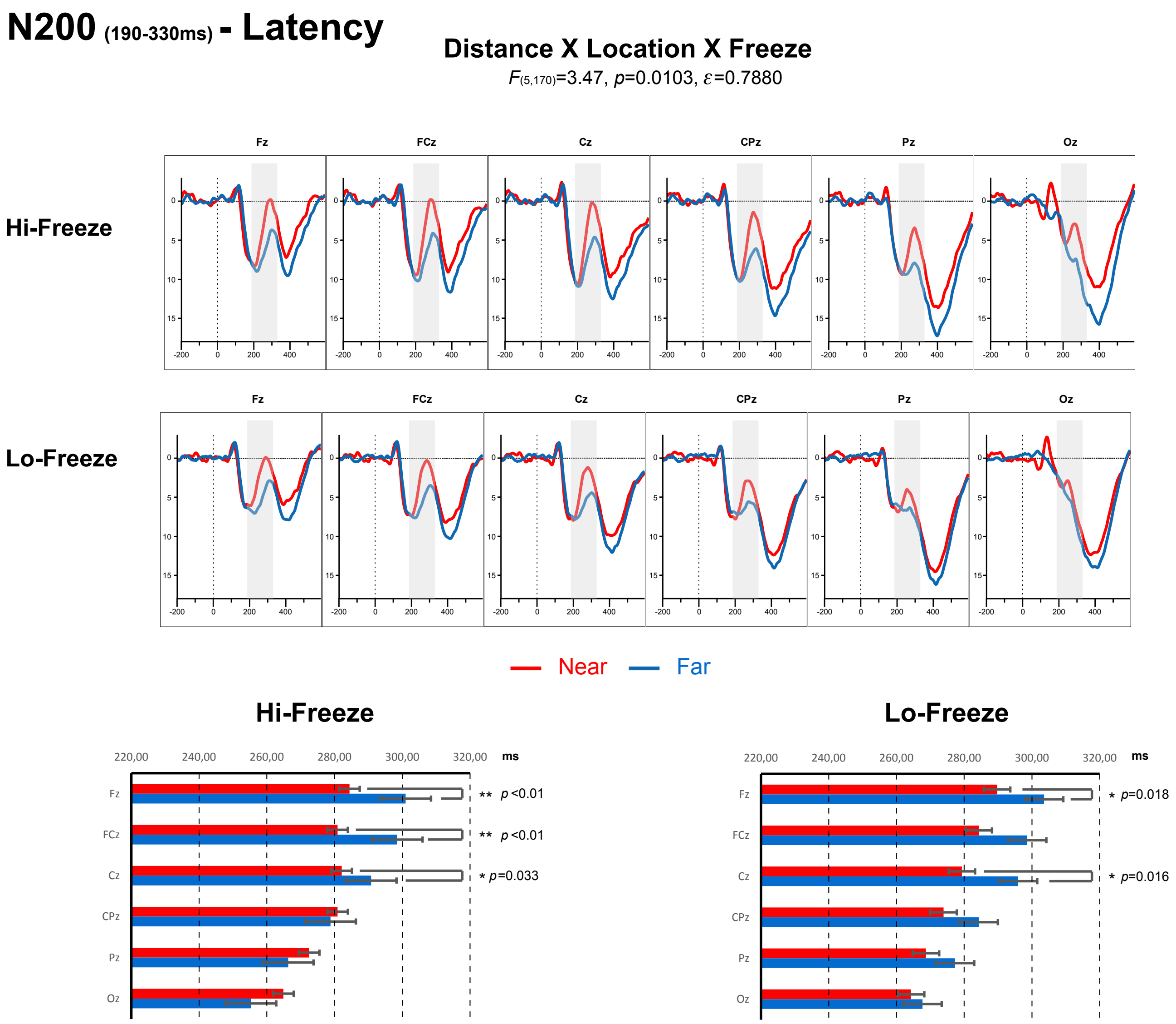
No interactions with personality were found.

5.3.4.N200

In the ANOVA of the N200, for the latency, other than Distance and Location effects, we found an interaction Distance X Location [$F_{(5, 175)}$=5.18, p=0.001]. Post-hoc t-test showed Near Fz (M=286.5ms, SD=21.5, SE=3.58) < Far Fz (M=301.9ms, SD=22.7, SE=4.30) [t=-3.73, p<0.001], Near FCz (M=282.2ms, SD=25.8, SE=3.53) < Far FCz (M=298.0ms, SD=35.3, SE=4.92) [t=-3.19, p=0.003], Near Cz (M=279.9ms, SD=21.2, SE=3.46) < Far Fz (M=294.9ms, SD=29.1, SE=5.19) [t=-3.21, p<0.003].



As we added personality factors, we found an interaction Distance X Location X Freeze [$F_{(5,\ 170)}$=3.47, $p_{(\text{H-F-L})}$=0.01, ε=0.788]. Post-hoc *t*-test showed for Hi-Freeze Near Fz (*M*=284.4ms, SD=23.3, SE=7.02) < Far Fz (*M*=301.0ms, SD=21.6, SE=4.04) [*t*=-3.57, *p*=0.005], Near FCz (*M*=280.59ms, SD=13.4, SE=7.43) < Far FCz (*M*=298.5ms, SD=27.7, SE=4.37) [*t*=-3.89, *p*=0.003], Near Cz (*M*=282.1ms, SD=24.6, SE=6.71) < Far Cz (*M*=290.8ms, SD=20.8, SE=7.47) [*t*=-2.47, *p*=0.033], while, for Lo-Freeze, we found Near Fz (*M*=289.7ms, SD=25.4, SE=4.7) < Far Fz (*M*=303.6ms, SD=21.9, SE=6.03) [*t*=-2.57, *p*=0.018] and Near Cz (*M*=279.3ms, SD=20.8, SE=4.44) < Far Fz (*M*=295.9ms, SD=26.2, SE=6.88) [*t*=-2.63, *p*=0.016].
No other interactions with personality were found for latency.



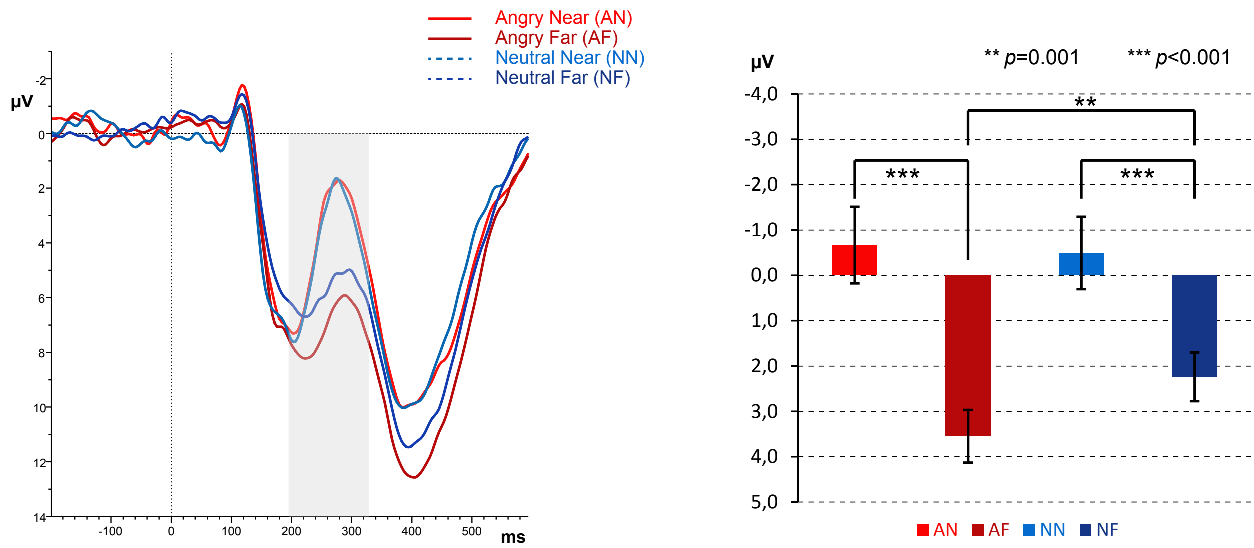
Regarding the amplitude of the N200, for what it concern amplitude, we found a general interaction Distance X Emotion [$F_{(1,\ 35)}$=7.3, *p*=0.011]. Post-hoc *t*-test showed Angry Near (*M*=-0.67μV, SD=5.06, SE=0.84) < Angry Far (*M*=3.55μV, SD=3.49, SE=0.58) [*t*=-5.62,

$p<0.001$], Angry Far > Neutral Far (M=2.24μV, SD=3.22, SE=0.54) [t=3.58, p=0.001], Neutral Near (M=-0.49μV, SD=4.78, SE=0.8) < Neutral Far [t=-3.88, $p<0.001$].

N200 (190-330ms) **- Amplitude**

Emotion X Distance

$F_{(1,35)}$=7.30, p=0.0106

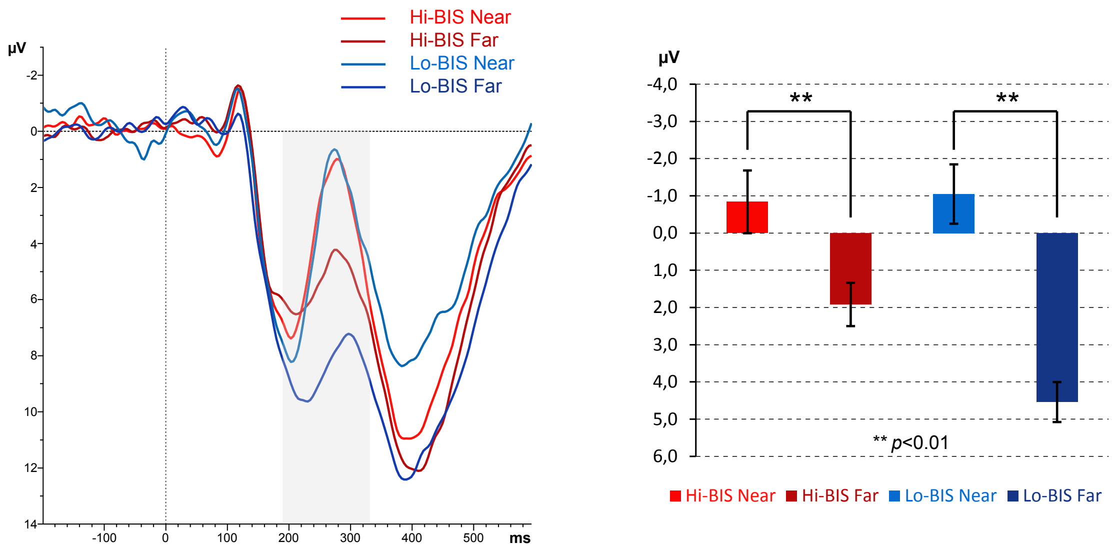


From the ANCOVAs we found an interaction Distance X BIS [$F_{(1, 34)}$=5.08, p=0.031]. Post-hoc t-test showed for Hi-BIS Near (M=-0.84μV, SD=3.84, SE=0.96) < Far (M=1.92μV, SD=2.48, SE=0.62) [t=-3.35, p=0.004], and for Lo-BIS Near (M=-1.05μV, SD=4.88, SE=1.41) < Far (M=4.54μV, SD=2.93, SE=0.85) [t=-4.31, p=0.001].

N200 (190-330ms) **- Amplitude**

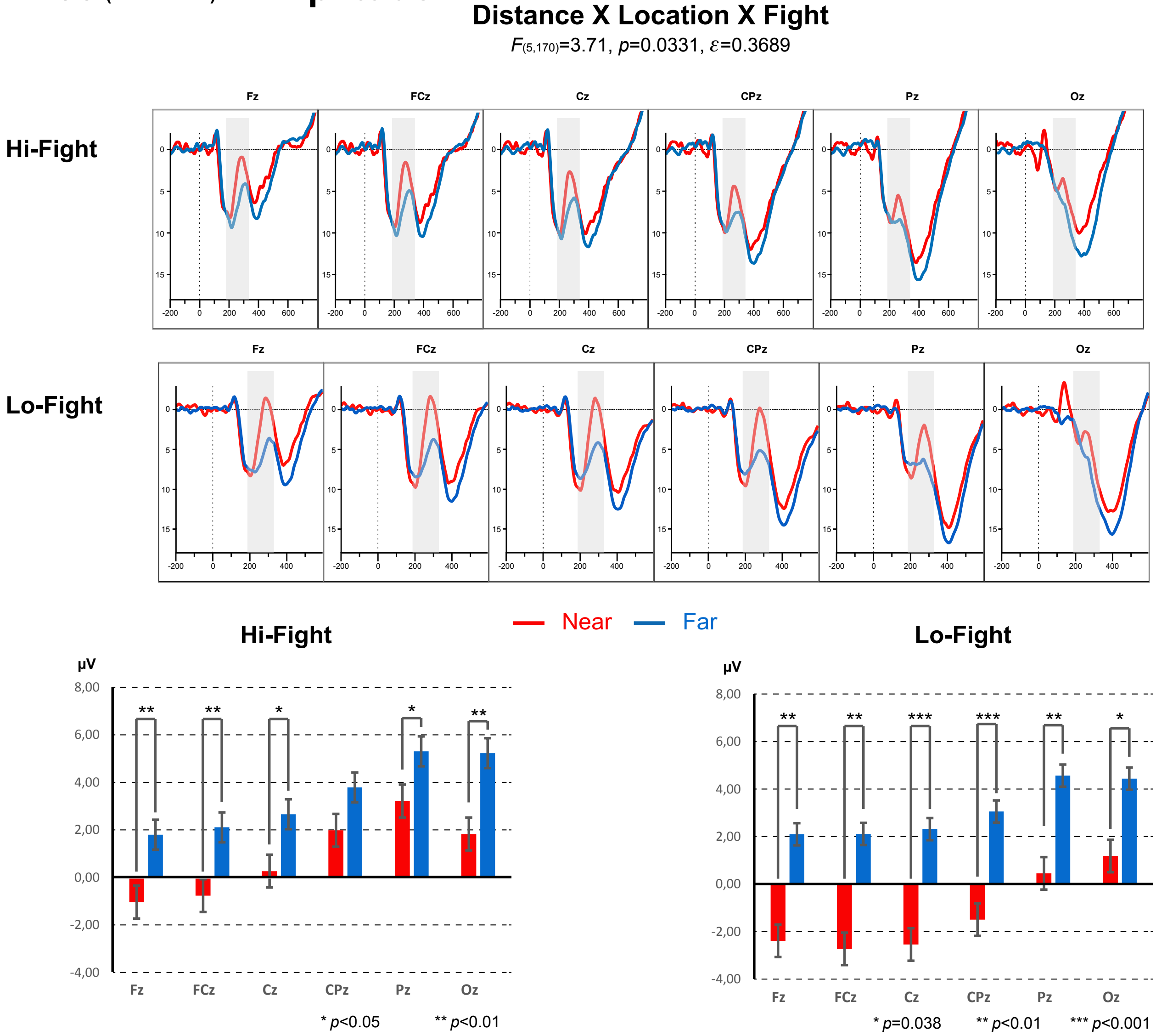
Distance X BIS

$F_{(1,34)}$=5.08, p=0.0307



We found and interaction with Fight dimension too: Distance X Location X Fight [$F_{(5, 170)}$=3.71, $p_{(H\text{-}F\text{-}L)}$=0.033, ε=0.369]. Post-hoc *t*-test showed for Hi-Fight Near Fz (*M*=-2.39µV, SD=4.87, SE=1.22) < Far Fz (*M*=2.10µV, SD=4.69, SE=0.80) [*t*=-3.18, *p*=0.006], Near FCz (*M*=-2.73µV, SD=3.18, SE=1.22) < Far FCz (*M*=2.11µV, SD=4.02, SE=0.88) [*t*=-3.86, *p*=0.001], Near Cz (*M*=-2.54µV, SD=4.71, SE=1.24) < Far Cz (*M*=2.31µV, SD=4.49, SE=0.97) [*t*=-4.48, *p*<0.001], Near CPz (*M*=-1.50µV, SD=3.54, SE=1.24) < Far CPz (*M*=3.06µV, SD=4.24, SE=1.01) [*t*=-4.17, *p*<0.001], Near Pz (*M*=0.45µV, SD=4.96, SE=1.22) < Far Pz (*M*=4.57µV, SD=4.84, SE=1.06) [*t*=-3.92, *p*=0.001], Near Oz (*M*=1.18µV, SD=3.89, SE=1.21) < Far Oz (*M*=4.43µV, SD=3.38, SE=0.84) [*t*=-2.27, *p*=0.038], while for the Lo-Fight Fz (*M*=-1.04µV, SD=4.69, SE=1.30) < Far Fz (*M*=1.80µV, SD=4.92, SE=0.98) [*t*=-3.07, *p*=0.01], Near FCz (*M*=-0.77µV, SD=3.54, SE=1.34) < Far FCz (*M*=2.11µV, SD=3.86, SE=1.18) [*t*=-3.40, *p*=0.005], Near Cz (*M*=0.27µV, SD=4.82, SE=1.36) < Far Cz (*M*=2.66µV, SD=4.38, SE=1.21) [*t*=-2.81, *p*<0.016], Near Pz (*M*=3.21µV, SD=4.91, SE=1.21) < Far Pz (*M*=5.30µV, SD=3.79, SE=1.04) [*t*=-2.55, *p*=0.026], Near Oz (*M*=1.83µV, SD=4.36, SE=1.05) < Far Oz (*M*=5.23µV, SD=3.64, SE=1.01) [*t*=-3.90, *p*=0.002].

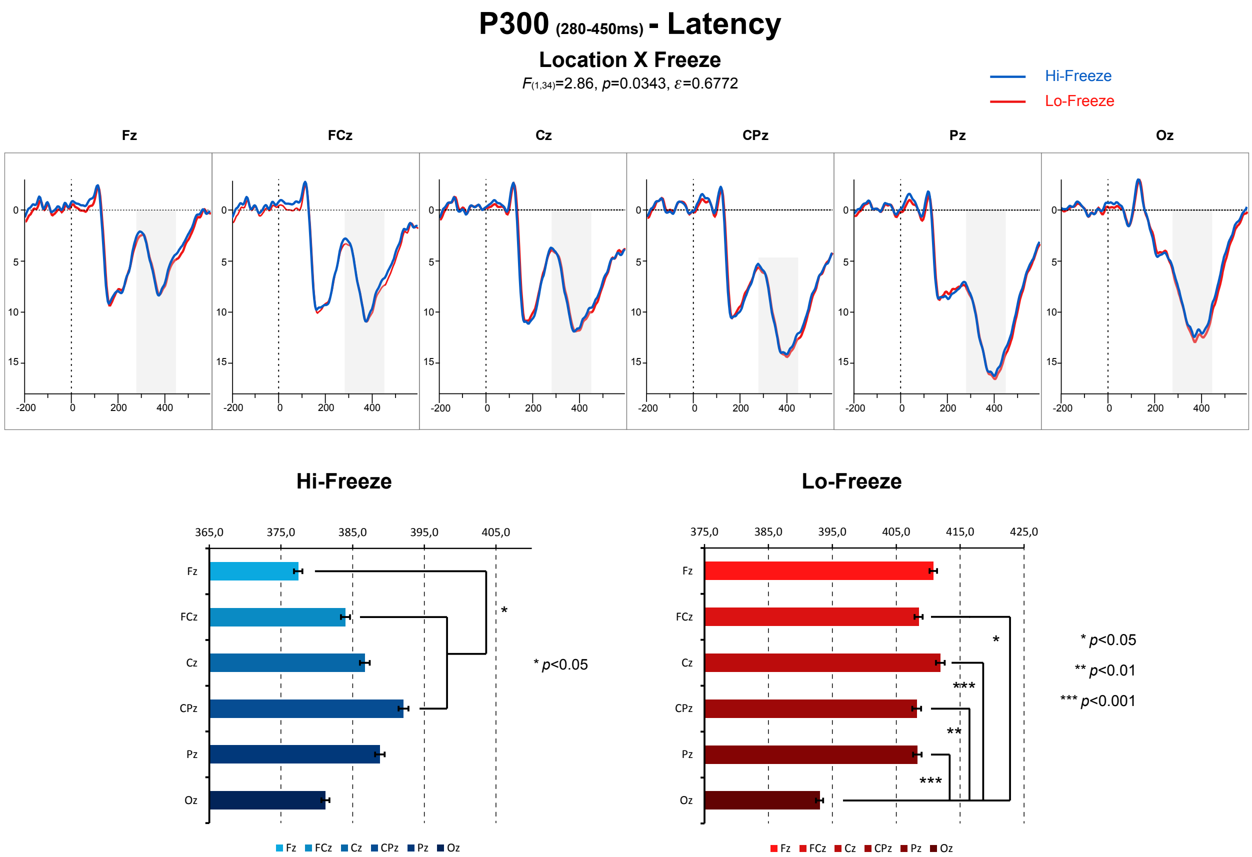
N200 (190-330ms) - Amplitude



5.3.5. P300

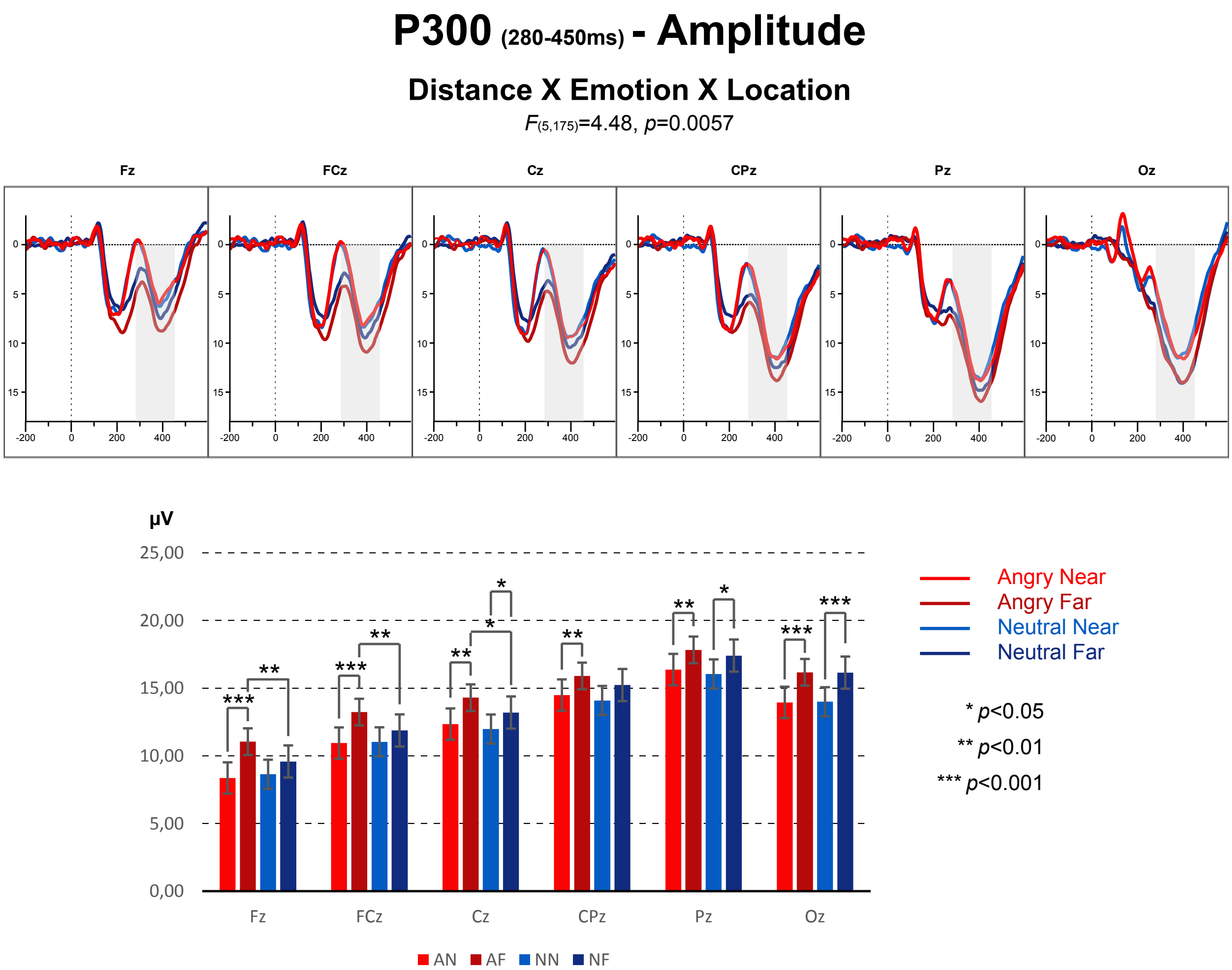
In the latency of the P300, apart from the general Distance and Location effects, from the ANOVA we did not find any other result.

From the ANCOVAs we only found Location X Freeze [$F_{(5, 170)}$=3.47, $p_{(H-F-L)}$=0.01, ε=0.788]. Post-hoc *t*-test showed for Hi-Freeze Fz (*M*=377.4ms, SD=23.6, SE=7.12) < FCz (*M*=384.0ms, SD=20.72, SE=6.25) [*t*=-2.32, *p*=0.043], Fz < CPz (*M*=392.1ms, SD=26.8, SE=8.08) [*t*=-2.29, *p*=0.045],while for Lo-Freeze FCz (*M*=408.5ms, SD=36.9, SE=8.05) > Oz (*M*=393.0ms, SD=33.93, SE=7.40) [*t*=3.84, *p*=0.001], Cz (*M*=411.9ms, SD=33.19, SE=7.24) > Oz [*t*=4.52, *p*<0.001], CPz (*M*=408.2ms, SD=37.2, SE=8.12) > Oz [*t*=3.18, *p*=0.005], Pz (*M*=408.3ms, SD=35.87, SE=7.83) > Oz [*t*=3.95, *p*<0.001].

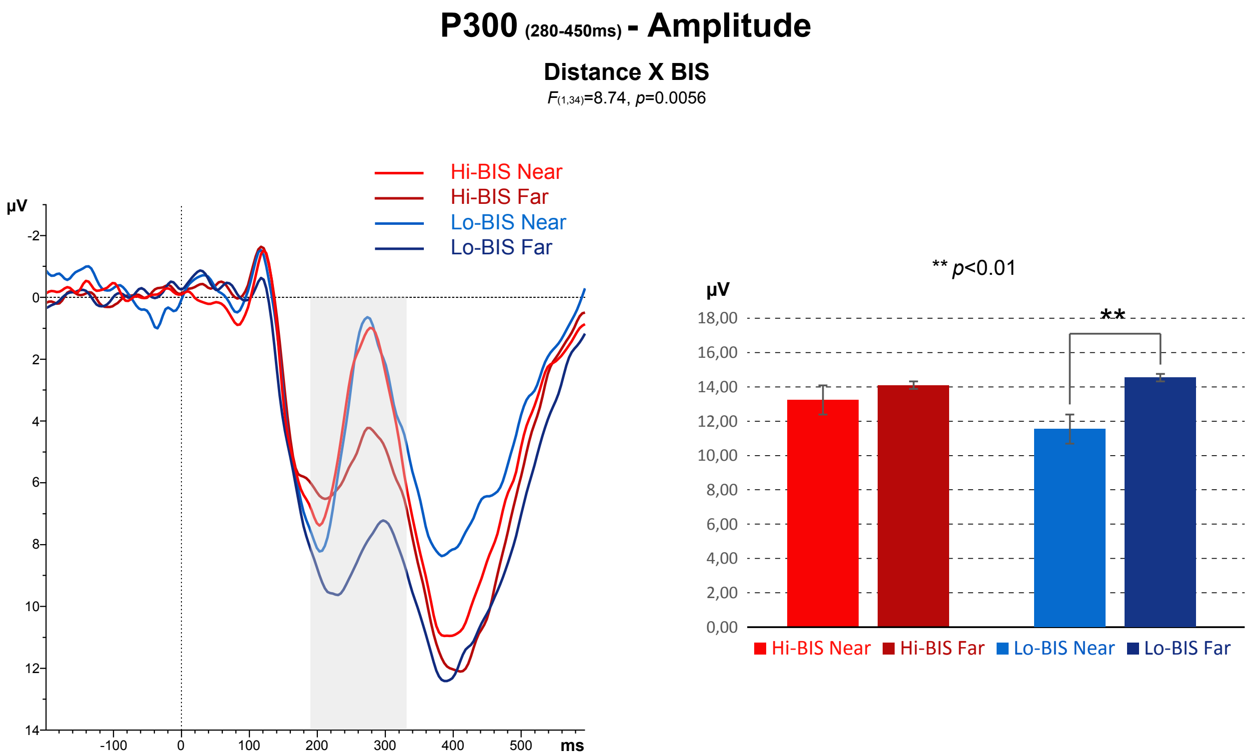


Regarding the amplitude of the P300, other than Distance and Location, we found an interaction Distance X Emotion X Location [$F_{(5, 175)}$=4.48, *p*=0.006]. Post-hoc *t*-test showed no differences between Angry Near vs. Neutral Near; for Angry Far vs. Neutral far the activations were mainly in Fronto-central locations: Fz Angry Far (*M*=11.05μV, SD=3.91, SE=0.65) > Fz Neutral Far (*M*=9.58μV, SD=3.56, SE=0.59) [*t*=3.31, *p*=0.002], FCz Angry Far (*M*=13.23μV, SD=4.08, SE=0.68) > FCz Neutral Far (*M*=11.87μV, SD=3.86, SE=0.64) [*t*=2.91, *p*=0.006], Cz Angry Far (*M*=14.3μV, SD=4.06, SE=0.68) > Cz Neutral Far (*M*=13.2μV, SD=4.02, SE=0.67) [*t*=2.49, *p*=0.018]. The difference between Angry Near and Angry Far was different for all over the Midline: Fz Angry Near (*M*=8.36μV, SD=3.56, SE=0.59) < Fz Angry

Far [t=-4.27, p<0.001], FCz Angry Near (M=10.94μV, SD=3.77, SE=0.63) < FCz Angry Far [t=-3.88, p<0.001], Cz Angry Near (M=12.35μV, SD=4.44, SE=0.74) < Cz Angry Far [t=-3.12, p=0.004], CPz Angry Near (M=14.49μV, SD=4.3, SE=0.72) < CPz Angry Far (M=15.9μV, SD=4.16, SE=0.69) [t=-2.62, p=0.013], Pz Angry Near (M=16.38μV, SD=4.51, SE=0.75) < Pz Angry Far (M=17.83μV, SD=4.31, SE=0.72) [t=-2.59, p=0.014], Oz Angry Near (M=13.95μV, SD=5.3, SE=0.88) < Oz Angry Far (M=16.18μV, SD=3.88, SE=0.65) [t=-3.67, p<0.001]; the difference between Neutral Near and Neutral Far showed a more centro-parieto-occipital with Cz Neutral Near (M=11.98μV, SD=4.72, SE=0.79) < Cz Neutral Far [t=-2.15, p=0.038], Pz Neutral Near (M=16.05μV, SD=4.63, SE=0.77) < Pz Neutral Far (M=17.41μV, SD=4.2, SE=0.70) [t=-2.42, p=0.021], Oz Neutral Near (M=14.0μV, SD=4.92, SE=0.82) < Oz Neutral Far (M=16.15μV, SD=3.9, SE=0.65) [t=-3.72, p<0.001].



From the ANCOVAs we had an interaction Distance X BIS [$F_{(1, 34)}$=8.74, p=0.006]. Post-hoc t-test showed for only Lo-BIS Near (M=11.54µV, SD=4.07, SE=1.17) < Far (M=14.54µV, SD=4.33, SE=1.25) [t=-3.97, p=0.002].



6.Discussion

Before going in depth with into the discussion of the ERP results, I would like to focus on the psychometric results.
We chose to use the Jackson 5 scale (J5) because it is more reliable, if compared to the RST-PQ and RSQ, as it is more similar the better known scales of Carver's BIS/BAS and EPQR, even though we have to say that there are some strange behaviours regarding the Freeze dimension.
We can see that J5-BAS is strongly correlated with Carver's BAS Fun Seeking, which gives us some certainty that the dimension of BAS is what we were looking for.
Regarding the J5-BIS, we can see that is not correlated with any other dimension; this could be due to the fact that now BIS is considered to be a conflict detector system (and J5 claim to reflect this new aspect (Jackson, 2009)) therefore BIS should be different from what it was in the old theory (so it should not be related to the old Carver's BIS). In general we can see that the pattern of positive and negative correlations with the other questionnaires is consistent with what we had expected, even if not significative: they are negative with Carver's BAS and Eysenck's Extraversion, while positive with STAIs, Carver's BIS and Eysenck's Neuroticism.
The J5-FFFS, theoretically, should have the same pattern, as it is a separate system and it is orthogonal to the others, but we can see that the J5-Freeze dimension behave quite differently from the others (Fight and Flight): it is significantly negatively correlated with Carver's BIS, J5-BIS and J5-Flight and, even if not significantly, with J5-BIS and with STAIs, while it is positively correlated with Carver's BAS, Eysenck's Extraversion and J5-BAS. J5-Fight and J5-Flight behave as we had aspected: they are positively correlated with BIS and negatively with BAS. As for last two dimensions we had mentioned it is interesting to note that they are positively correlated with STAI-Y1 post test, indicating that the experiment produced an increase of these dimensions, as the subjects were exposed to threatening stimuli.
Trying to deeply analyse such discrepancies we ran some Cronbach's alphas. With all the variables, as expected, we did not find any significant alpha. As we took away BAS, leaving BIS, Fight, Flight and Freeze, we saw that, if we take away Freeze from this correlation, we find a significative alpha (0.79). The same behaviour occurred with Fight, Flight, Freeze: we had aspected to have a positive alpha, which was reached only if we took away Freeze (0.72). In order to test if BAS and Freeze were the same construct, we ran a Cronbach's alpha but there was no significant level.
Regarding the behavioural results, since Paivio (Paivio, 1975) we know that we should expect a faster RT for bigger (nearer) stimuli and, when dealing specifically with threatening stimuli, we know that nearer ones have a bigger impact (Teghtsoonian & Frost, 1982).
Regarding the interaction with BAS it is known that impulsive/extraverted people have a faster reaction time (Edman, Schalling, & Levander, 1983; Bachorowski & Newman, 1985;

Moltó, Segarra, & Avila, 1993; Dickman, 2000) and, even if we have significative results for both High and Low, in Hi-BAS the effect was stronger.
Keeping in mind the results from the psychometric, we will discuss the results of ERPs.
I have decided to show the Distance and Location results separated from the others because, as far as Location is concern, it is easy to guess that different processes happen at different locations, and, as far as Distance is concern, it is one of the main results for all the components, so it should be easier to have a broad overview of the processes.
In general we can say that we found the same differences that De Cesarei and Codispoti found (A. De Cesarei & Codispoti, 2006; Codispoti & De Cesarei, 2007; Andrea De Cesarei & Codispoti, 2011): further (smaller) stimuli were precessed more slowly, even if this was not true for all the sites and all the components.
For the earlier components (P100-N170), one of the few studies that used Distance and Emotion as variables was De Cesarei and Codispoti (A. De Cesarei & Codispoti, 2006). However, we have to keep in mind the main differences in the method used: we used T5-T6 sites, whereas they used a mean of O1-Oz-O2; we used faces as stimuli, while they used images taken from IAPS.
As for the latency of P100 and its Distance effect, they found that smaller (further) stimuli had a longer latency but we did not find any difference in amplitude.
De Cesarei and Codispoti found an Emotion (Category) effect that we did not find. However, has we had another level of analysis, we found an interaction between Emotion X Distance X Hemisphere, showing that in T5 the significative relation was for Angry Near Vs. Far and not for Neutral, and for T6 the results were the opposite: significative for Neutral Near Vs. Far and not significative for Angry.
This left lateralisation is quite surprising because emotional effects were usually found on the right hemisphere, even if there are cases in which a left activation was found like in Sprengelmeyer (Sprengelmeyer & Jentzsch, 2006) where they found an activation in the left inferior frontal lobe (Brodmann area 47) and in the posterior part of the left temporal lobe (Brodmann area 21) when comparing anger to neutral conditions.
We have to keep in mind that most of the studies that used emotional faces opt for fear instead of anger and another important consideration is that they do not often used coloured stimuli preferring black and white and this could lead to the differences which emerged.
Another aspect we have to notice is that, as Morris (Morris et al., 1998) showed, there is a difference in left/right activation of the amygdala which is due to a conscious or unconscious presentation of the stimuli: they observed a right amygdala activation to unconsciously presented aversively conditioned angry faces and a left amygdala activation to conscious presentations of the same faces.
As for the interactions with personality, we found an interesting interaction in latency, for Hi-BIS the difference was in the right hemisphere with angry stimuli, while for the Lo-BIS the difference was on the left side between angry and neutral. It seems that the Hi-BIS processed angry stimuli in a much faster way in the sites where emotion is relevant and

they did not pay much attention to the neutral ones, while it took the Lo-BIS more time to identify the threatening stimuli than to identify neutral ones.
Regarding the amplitude of P100, for the Lo-BIS, Rossignol (Rossignol, Campanella, Bissot, & Philippot, 2013a) found a similar result with people who have low social anxiety: there was a higher amplitude on the left side with the emotional stimuli.
If we keep focusing on the amplitude of the P100, we see another interaction with personality, the Hi-Flight subjects showed a higher amplitude for the further stimuli than for the nearer ones in the right side and, always for the further ones, higher in the right compared to the left side. This is quite interesting because, as said before, the right side is considered to be the emotional hemisphere: in this case, Hi-Flight people seem to have a more important elaboration for further stimuli therefor giving more importance to the distance rather than to emotion at a level of elaboration where stimuli are still not completely integrated, corroborating the revision of the theory which state that distance is an important dimension for the FFFS. This result, together with the correlation of the post task STAI-Y1 with the Flight, seems to point out that the Flight subjects perceived the Distance dimension and that for them it created an higher anxious state.
If we take a look at the N170 we can see that distance is responsible for the same differences as in the P100, i.e. faster latency for nearer stimuli and, only for the N170, bigger amplitude for the nearer ones. Another similarity with the P100 is the faster latency in the left hemisphere for the angry stimuli opposed to the right that showed this difference in the neutral ones. As we already mentioned these results are in accordance with the literature.
In the latency the only interaction with personality was with BAS and distance, showing that Hi-BAS recognises nearer stimuli more quickly than further stimuli. As for the results in the RT, this is not surprising because Hi-BAS should be more impulsive and for nearer and stronger stimuli it is easy to imagine a faster elaboration. It is interesting to notice, however, that even if not significative, Lo-BAS had the opposite results: further stimuli had shorter latency.
In the amplitude of N170, besides the general Emotion X Distance interaction with the results in accordance with the expectations (i.e. angry near stimuli bigger than angry far and neutrals), it is interesting to notice that only Hi-Fight subjects showed this interaction (i.e. angry near bigger than the others), showing that the Fight dimension is the one which is more affected by emotion and distance: this in accordance with the revision of RST.
Another interesting result in the amplitude of N170 and its interaction with personality is that only the Lo-Freeze subjects showed this interaction in the left hemisphere and only for angry stimuli, suggesting that for Hi-Freeze this difference is not important therefor any kind of stimuli can be dangerous.
It is important to say that the N170 effects are not stable across the literature. In fact in an elegant series of experiments Rellecke et al. (Rellecke, Sommer, & Schacht, 2013) showed that the N170 is strongly related to the reference used and, if it is changed, the results could lead to very different conclusions. They suggested that EPN is a much more stable component to look at for differences in the elaboration of emotion than N170.

For the complex P2-N2-P3 we obtained a general Distance effect that showed how the P2-N2 are elaborated more quickly for nearer stimuli, in particular for the P2, but we did not find the same effect for the P3, while, regarding the amplitude, we found that the nearer stimuli generate a stronger (i.e. more negative) effect for the N2 and this leads to less strong effects into the P3, showing a stronger effect for further stimuli. This seems related to a stronger effect on N2 over nearer stimuli so that the final result seems to be that in the P300 the far stimuli are more positive, but if we take a closer look at the absolute difference between near and far from the N2 to the P3, this difference is stronger in near than it is in far.

Campanella et al. (Campanella et al., 2002) have found a similar effect on the N2/P3a, therefore they were looking at the frontal sites, while we analysed the midline. In any case they suggested that this effect on N2/P3a was extended to P3b and that the target N2 not only reflected the detection of physical change but also the degree of voluntary attention related to visual specific information processing during the target detection task.

For the Location effects in the complex P2-N2-P3 we can see the expected results in a more central location in the P2 both in latency and in amplitude, stronger and delayed in the frontals for the N2 and stronger and delayed over the parietals for the P3.

As we noted in the results for the P2 there were no effects in the latency but we had a general Emotion effect in the amplitude, as we notice before it was stronger for the angry stimuli if compared to neutral ones. It is interesting to note that in the interaction of Emotion X Distance we had a stronger effect for angry far stimuli than the one we had for neutral far and, even if not significative, the amplitude of angry far was bigger than angry near. In this case we have to notice that the distance is an important modulator of emotional elaboration and counterintuitively we registered a bigger effect for further stimuli compared to nearer stimuli. In any case, if we look at the complex we see that, even if in the P2 there is this strange effect, this is mainly due to a bigger effect in the N2 (the nearer angry faces are processed more quickly and give a more negative N2). In the P2 we found another interesting result regarding the different location processing of the emotion: the main differences were on the frontal and central sites, in accordance with Eimer (Eimer, Holmes, & McGlone, 2003).

The most interesting results we had, in any case, were on the N2 component.

The N2 is a component which is affected by arousal and emotional faces (Vilfredo De Pascalis & Morelli, 1990; Streit, Wölwer, Brinkmeyer, Ihl, & Gaebel, 2000; Balconi & Lucchiari, 2006).

The interaction between Distance and Location as far as latency it concern, clearly shows the angry stimuli are processed more quickly in the frontal and central sites and this process is more pronounced if we take into account personality: in Hi-Freeze subjects this effect is much stronger that in Low ones. These results could be read under the initial assumptions that in the case of avoidance the FFFS is activated in a more frontal location, while, in the case of Lo-Freeze, they could experience the situation as an approach and therefor the activation is ventral (McNaughton & Corr, 2004).

The interaction of Distance with BIS was significative in the amplitude for both Hi and Lo-BIS, even if for Hi-BIS the difference between near and far was smaller, clearly showing that for more anxious people the distance is less relevant.
Another very interesting result, that may confirm the revision of the RST is the one regarding the interaction of Distance X Location X Fight in the amplitude, that showed the same pattern of Freeze: Hi-Fight subjects showed a stronger difference between near and far over the frontals sites, while the Lo-Fight showed this difference over the central sites, again leading us to think that a different network could be activated, more frontal for avoidance in Hi-Fight, while more ventral and central for Low ones.
Regarding the results in the P3 component, we had fewer results than we had aspected, especially for the BIS.
As for the latency we only had the interaction between locations and Freeze, where the Hi-Freeze showed a much faster frontal elaboration if compared to the central sites, whereas the Lo-Freeze had this effect over the occipitals. As already mentioned this could be seen more as an avoidance for the Hi-Freeze subjects.
We had an interesting interaction in the P3 was Distance X Emotion X Location where it was quite clear that the difference between angry near and angry far is more frontal, while the difference between neutral near and neutral far was more parieto-occipital, and such result clearly show that for the further stimuli, the difference between angry and neutral is fronto-central. If we consider that the nearer stimuli are too strong to show a difference between the emotions, it is interesting to see that this difference emerged for further stimuli, especially in the frontals locations for the P3(a), showing that a cognitive effect is implicated in this discrimination.
Regarding the effect for Distance and BIS, that show the interaction only for Lo-BIS, it is quite easy to understand that for high anxious subjects an angry stimuli is not modified by distance.

7.Conclusion

With the present work we analysed the different reactions to threatening stimuli of different personality traits at different distances. This was not an easy task first of all for all the technical difficulties we found to set up the experimental task, secondly for all the different approaches used in scientifically literature regarding the kind of stimuli, the paradigms and the analysis of the data.

From our point of view one the main achievements of this work is the integration of Augmented Reality in experimental psychology, a technique that will surely become more frequent with the development of new technologies.

Strictly speaking of the results analysed in the context of the revision of Reinforcement Sensitivity Theory we showed that:

1. The BIS and FFFS are activated both in the earlier components (P1-N1) and in the later ones (P2-N2-P3) showing that those two systems are separate and act in different ways.
2. In particular in the N2 component we found that High Fight and Freeze subjects are activated more frontally if compared to Low ones, suggesting that the neural differentiation proposed by McNaughton and Corr (McNaughton & Corr, 2004) may be correct.

Future works on this topic have to see if frontal asymmetry can be explained using this data, this is an aspect that we have not taken into account, and maybe, in order to be more consistent with the recent literature, another kind of paradigm (e.g. dot probe) and other locations (especially frontal sites) could be used.

8.Bibliography

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Appendix 1

Here you can find our translation for the Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ).

1. Mi sento triste anche di fronte a piccoli ostacoli.
2. Sono spesso preoccupato da pensieri spiacevoli.
3. A volte anche piccole cose possono darmi un grande piacere.
4. Sono molto sensibile alle ricompense.
5. Compio molti sforzi per realizzare gli obiettivi della mia vita.
6. Spesso sono uno dei primi ad individuare una nuova opportunità .
7. A volte mi sento cupo senza motivo.
8. Quando mi sento giù, tendo a stare lontano dalle persone.
9. Spesso sento un flusso di piacere correre attraverso il mio corpo .
10. Mi bloccherei alla vista di un serpente o un ragno.
11. Ho speso molto tempo della mia vita ad evitare tutto e tutti.
12. Sono una persona molto attiva.
13. Sono motivato ad avere successo nella mia vita .
14. Spesso mi isolo dalle situazioni e dalle persone che mi infastidiscono.
15. Sono sempre 'in movimento'.
16. Il mio cuore comincia a battere forte quando mi infastidisco.
17. Regolarmente provo nuove attività soltanto per vedere se mi divertono.
18. Mi faccio coinvolgere da nuovi progetti.
19. Buone notizie mi fanno sentire molto felice.
20. Io sono un tipo di persona che tende a evitare ogni cosa.
21. Pensare di sbagliare nel mio lavoro mi preoccupa .
22. Ho avuto esperienze di intenso terrore.
23. A volte quando sono nervoso mi rendo conto che i miei pensieri si interrompono.
24. Correrei in fretta se, in un centro commerciale, cominciasse a suonare l'allarme anti-incendio.
25. Spesso supero ogni ostacolo per raggiungere le mie ambizioni.
26. A volte mi sveglio in uno stadio di terrore.
27. Trovo utile fare una lista delle coese di cui ho bisogno.
28. Spesso mi sento depresso.
29. Penso che dovrei fermarmi a pensare di più invece di "buttarmi" subito nelle cose .
30. Spesso sento che sono "su di giri".
31. Amo vincere nelle competizioni.
32. Provo delle emozioni speciali quando vengo elogiato per qualcosa che ho fatto bene.
33. Ho molti hobbies ed interessi.
34. I miei amici direbbero che sono una persona cauta.

35. A volte non riesco a smettere di parlare quando so che dovrei tenere chiusa la mia bocca.
36. Spesso faccio cose rischiose senza pensare alle conseguenze.
37. A volte la mia mente è dominata da pensieri sulle brutte cose che ho fatto.
38. Sono molto emozionato quando faccio ciò che voglio.
39. Sento che il successo guida le mie scelte lavorative.
40. Trovo sempre nuove ed interessanti cose da fare.
41. Valuto sempre il rischio che possano accadere cose cattive nella mia vita.
42. Le persone mi dicono sempre che non mi devo preoccupare.
43. Mi piace conoscere a fondo nuove persone, prima di impegnarmi con loro.
44. Sono molto aperto a nuove esperienze nel corso della vita.
45. Festeggio sempre quando ottengo qualcosa di importante.
46. Sono un tipo di persona che va in preda al panico.
47. Reagisco vivamente alle cose piacevoli della vita.
48. Faccio le cose sull'impulso del momento.
49. Spesso mi reputo incapace di raggiungere certi obiettivi.
50. A mio modo cerco di evitare discussioni e confronti con li altri.
51. Dovrei essere molto cauto a viaggiare in paesi stranieri per la prima volta.
52. Mi immobilizzerei immediatamente se aprissi la porta e trovassi un estraneo in casa.
53. Acquisto sempre le cose impulsivamente.
54. Persevero molto nel raggiungere I miei obiettivi.
55. Quando provo a prendere una decisione, tendo costantemente a rimuginarci su.
56. Spesso mi preoccupo di deludere le persone.
57. Andrei in vacanza all'ultimo minuto.
58. Sono fisicamente scosso quando mi agito molto.
59. Provo a raggiungere, piccoli traguardi, prima di affrontare obiettivi più grandi.
60. Correrei lontano se mi rendessi conto che nella notte qualcuno mi sta seguendo.
61. Me ne andrei da un parco se vedessi un gruppo di cani che corrono e abbaiano intorno alla gente.
62. Mi preoccupo molto.
63. Sono bravo a risparmiare denaro per le vacanze.
64. Mi immobilizzerei se mi trovassi in una turbolenza durante un viaggio in aereo.
65. Il mio comportamento si può interrompere facilmente.
66. È difficile tirare fuori delle cose dalla mia mente.
67. Esco fuori di casa dopo un litigio con un familiare o partner.
68. Penso che le serate migliori siano quelle non programmate.
69. Ci sono delle cose a cui non posso avvicinarmi facilmente.
70. Se vedo qualcosa che voglio, agisco prontamente.
71. Penso che sia necessario stabilire dei piani per fare ciò che si vuole nella vita.
72. Spesso penso alla salute dei miei parenti/amici anche se questi non hanno alcuna malattia.
73. Tendo a farmi prendere molto dal panico.

74. Quando sono nervoso, trovo difficile esprimermi con parole giuste.
75. Credo di pensare alle stesse cose più e più volte.
76. Spesso mi alzo con molti pensieri che corrono nella mia mente.
77. Non vorrei tenere in mano un serpente o un ragno.
78. Guardare giù da un'altezza elevata mi bloccherebbe.
79. Spesso mi chiudo in me stesso.
80. La mia mente è dominata da pensieri ricorrenti.
81. Sono un tipo di persona che facilmente si blocca quando ha paura.
82. Impiego molto tempo per prendere delle decisioni.
83. Spesso non trovo le parole.
84. Farò piani per realizzare gli obiettivi della mia vita.

Appendix 2

Here you can find our translation for the Jackson-5 scales (J5)

1. Mi piace fare cose che sono nuove e diverse.
2. Mi propongo di fare meglio dei miei coetanei.
3. Se sono avvicinata da uno sconosciuto sospettoso, scappo.
4. Se c'è una scelta di prodotti in un negozio, faccio fatica a decidere cosa comprare.
5. Risponderei al combattimento se qualcuno mi colpisce per primo.
6. Mi piace fare le cose spontaneamente.
7. Voglio fare bene rispetto a miei coetanei.
8. Probabilmente scapperei se molestata da uno sconosciuto in un luogo sconosciuto.
9. Se mi spaventassi nel mio letto di notte, rimarrei immobile.
10. Quando provocata, entro facilmente in lotta.
11. Sono all'attiva ricerca di nuove esperienze.
12. Mi piace che i miei coetanei sappiano che sto facendo bene.
13. Se un cane mi abbaia, scappo.
14. Non so cosa dire, se uno straniero è scortese con me in strada.
15. Se un ladro irrompesse in casa mia, cercherei immediatamente un’arma.
16. Ho un'idea di come funzionano le cose.
17. Preferisco lavorare su progetti dove posso dimostrare la mia abilità agli altri.
18. Se suonasse l'allarme antincendio, mi precipiterei subito fuori dall’edificio.
19. Se il mio capo mi dicesse di fare due cose contraddittorie, non saprei cosa fare.
20. Se scoprissi qualcuno rubare le mie cose, lo attaccherei.
21. Cerco nuove sensazioni.
22. Voglio evitare di guardare male.
23. Non posso fare a meno di sentirmi terrorizzata se vedo un animale pericoloso.
24. Se qualcosa di molto brutto mi stesse per accadere, vorrei solo che si fermasse.
25. Se penso che qualcuno mi sta per colpire, lo colpisco per primo.
26. Sono eccitato da ciò che è nuovo nel mio campo.
27. Evito il lavoro che mi fa apparire male.
28. Ero solita nascondermi dietro una sedia come un bambino ,quando vedevo uno show televisivo spaventoso.
29. In una folla, la mia mente si blocca e quindi non so mai cosa dire.
30. Se qualcuno mi facesse qualcosa di male, reagirei.

Appendix 3

Here you can find our translation for the The Reinforcement Sensitivity Questionnaire (RSQ)

1. Ogni volta che mi trovo in una situazione pericolosa, faccio del mio meglio per uscirne.
2. Mi preoccupo spesso che possa essere criticata.
3. Ogni volta che sono attaccata, rispondo combattendo senza esitazioni.
4. Quando voglio qualcosa, non penso mai a possibili ostacoli.
5. In effetti "mi congelo" quando sono molto spaventata.
6. Quando la situazione non è chiara, sono pronta a correre dei rischi.
7. Tendo a "congelare" in situazioni di pericolo.
8. Se mi capita di essere intorno a persone aggressive, cerco di allontanarmene.
9. Quando sono criticata da qualcuno, faccio tutto il possibile per reagire.
10. Quando vedo qualcuno che non mi piace per strada, faccio del mio meglio per evitarlo/a.
11. Ogni volta che qualcuno mi fa male, reagisco immediatamente.
12. Ogni volta sono provocata, sono pronta a litigare.
13. E' difficile per me prendere una decisione, perché non sono mai certa che la scelta sia quella giusta.
14. Quando qualcuno mi sgrida, sento come se la mia mente fosse “bloccata".
15. Accetto prontamente nuove ed eccitanti situazioni.
16. Quando qualcuno comincia a insultarmi, mi ritrovo senza parole.
17. Quando devo "scegliere tra due mali", mi turbo molto.
18. Manco molte opportunità pensando a cosa potrebbe andare storto.
19. Sono sempre entusiasta delle nuove sfide.
20. Sono sempre pronta a combattere, se qualcuno mi impedisce di fare ciò che voglio.
21. Avrei perso un'occasione, se fosse stato un po' meno incerta.
22. La sola presenza di alcune persone o cose mi paralizza completamente.
23. Se qualcuno grida in strada, faccio del mio meglio per allontanarmi il più velocemente possibile.
24. Mi creano molta tensione situazioni in cui io possa apparire ridicola.
25. Di solito tendo a iniziare a fare molte cose interessanti allo stesso tempo.
26. Sono preoccupata più spesso di quanto lo sia la maggior parte delle persone che conosco.
27. Altre persone evitano conflitti con me, perché sanno che sono pronta a rispondere combattendo.
28. Faccio del mio meglio per non perdere nessun piacere della vita.
29. Quando mi avvicino camminando ad altre persone che lottano, cerco di scappare il più velocemente possibile.