Psicothema

Neurophysiological indicators of emotional processing in youth psychopathy

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Abstract

Background: Research with psychopathic samples using the technique of evoked potentials is rather limited and almost exclusively concerned with the study of the P300 component; no studies have been found (to date) that assess shorter wave latencies. This research focuses on the emotional and attentional processes in young people with psychopathic characteristics, using the evoked potential technique in short-wave latency (N100). **Method:** The experimental group consisted of 22 subjects; all of them met the psychopathic criteria of the Antisocial Process Screening Device (APSD) and the Psychopathy Checklist: Youth Version (PCL: YV). The control sample consisted of 25 subjects, all of them scoring less than 15 points in APSD. **Results:** In the experimental group, the mechanisms responsible for processing the pleasant stimulation responded earlier and with more intensity (on the N100); premium positivity bias on negativity. **Conclusions:** This emotional deficit found in the literature on psychopathy in adults is also found in young people.

Keywords: Psychopathy, short-wave latency, evoked potential, emotional response.

Resumen

Indicadores neurofisiológicos de procesamiento emocional en psicopatía juvenil. **Antecedentes:** en el campo de la psicopatía muy pocos estudios se han centrado en usar la técnica de potenciales evocados, y los pocos que hay han estudiado casi exclusivamente el componente P300, no encontrándose casi estudios sobre ondas de latencia corta. Este artículo estudia los procesos emocionales y atencionales presentes en jóvenes con características psicopáticas, utilizando la técnica de potenciales evocados en ondas de latencia corta ((N100). **Método:** el grupo experimental estuvo formado por 22 varones, todos ellos cumpliendo los criterios del Antisocial Process Screening Device (APSD) y de la Psychopathy Checklist: Youth Version (PCL: YV). El grupo control estaba formado por 25 varones con puntuaciones inferiores a 15 puntos en el APSD. **Resultados:** el grupo experimental respondió más pronto y con más intensidad (en la N100) ante la estimulación placentera, primando el sesgo de la negatividad. **Conclusiones:** se observa en jóvenes el mismo déficit emocional que se encuentra en la psicopatía adulta.

Palabras clave: psicopatía, ondas de latencia corta, potenciales evocados, respuesta emocional.

Psychopathy is one of the most devastating psychiatric diseases in any society, not only due to the violence and severity of the behaviors but also to the need to use a wide range of social services. Nowadays, psychopathy is considered as a personality disorder composed of two main factors: Factor I includes personality traits such as grandiosity, cruelty, lack of empathy, lack of remorse and feelings of guilt, emotional coldness or the ability to manipulate others. Factor II refers to an antisocial behavioral pattern that can encompass impulsiveness, chronic instability, and criminal versatility.

Children's level of fearfulness is crucial for conscience development; however some children cannot feel guilt or learn from punishment. Therefore, the effects of socialization processes on them are non-existent (Kochanska, 1993, 1997). The development of empathy, one of these effects, would lead children to detect distress and a disturbing mood in others, but psychopathic children do not have this ability.

Gray (cited in Heym, 2010) distinguishes two basic types of system: the first one (BAS, Behavioral Activation System) responds to conditioned appetitive signals (rewarding, non-punishment), activating approximation behavior to those signals or stimuli. In general terms, this system is able to guide an organism towards its goals. The BAS has been linked to positive mood, and its over-activation to impulsive behavior (Newman, MacCoon, & Vaughn, 2005). Due to the impulsive and antisocial component of psychopathy, this disorder (namely, Factor II) has been related to BAS over-activation (Wallace, Malterer, & Newman, 2009). The second system is called BIS (Behavioral Inhibition System) and responds to aversive conditioned stimuli, in other words, to punishment or non-reward signals, or to new stimuli through suppression of behavior. BIS has been linked to negative mood and anxiety (Newman et al., 2005).

Some authors have hypothesized, with regard to psychopathy, that there could be a hypoactive BIS, along with its consequent lack of fear, relating to Factor I (Saltaris, 2002; Wallace et al., 2009). This would lead children to a behavioral profile similar to those described above by Kochanska as "little fearful" children.

Frick, O'Brien, Wootton, and McBurnett (1994) focus on the affective insensitivity component (*callous unemotional*, CU), considered as lack of empathy, lack of guilt or remorse, and insensitivity to others' emotions. In samples of children, both clinical and community, the presence of CU traits emerges as distinctive when compared to other psychopathic aspects such as impulsivity or narcissism (Frick, Bodin, & Barry, 2000). A high level of CU is characteristic of antisocial young people with traits associated with adult psychopathy (Essau, Sasagawa, & Frick, 2006). Moreover, when compared to children who only show behavioral problems, those with high CU tend to minimize the consequences of their aggression on their victims. The possibility of being punished does not intimidate them (Pardini & Byrd, 2012), as they show lower empathy for the emotion of sadness (Wied, van Boxtel, Matthys, & Meeus, 2012) and an atypical neural response to the pain of others (Lockwood et al., 2013). A preference for new and dangerous activities, a lack of emotional response to negative stimuli, and an inability to learn through punishment, which are characteristics of high CU, may be related to the temperamental style described by Kochanska (1997).

Neurocognitive studies focusing on psychopathy have led to the development of two basic models. The first one suggests an attentional failure (Hiatt & Newman, 2006). The second postulates that psychopathy reflects a specific form of emotional dysfunction (Blair, Mitchell, & Blair, 2005; Kiehl, 2006).

In relation to the first model, Newman and colleagues have proposed that psychopathic individuals have abnormally blocked attention that diminishes their ability to process secondary information, focus on a specific goal, and give a more adaptive response (Baskin-Sommers, Curtin, & Newman, 2011; Wolf, Carpenter, Warren, Zeier, Baskin-Sommers, & Newman, 2012).

In relation to the second model, many authors suggest that there is a specific emotional dysfunction in psychopathy (Blair et al., 2005; Frick & Marsee, 2006; Kiehl, 2006; Salekin, 2006) that leads to problems with reactivity and recognition of specific emotions. Children with high CU and psychopathic traits find it difficult to process facial emotions of fear and sadness; hence, they show higher reaction times to recognizing those emotional expressions and make more identification mistakes than a control group (Blair, Colledge, Murray, & Mitchell, 2001; Leist & Dadds, 2009; Marsh & Blair, 2008).

Research on psychopathic samples using the technique of evoked potentials is rather limited and almost exclusively concerned with the study of the P300 component; no studies have been found (to date) that assess shorter wave latencies. Even less research can be found on the study of children with psychopathic features, a field where there is currently very little empirical evidence.

Therefore, the overall objective of this research is to study the emotional and attentional processes in young people with psychopathic traits using the evoked potential technique in short-wave latency (N100).

The N100, which has not been studied in relation to psychopathy, is a negative wave that usually appears at around 100 milliseconds. This potential arises when comparing the activity evoked by attended stimuli with that evoked by unattended stimuli. This negativity seems to be specifically associated with attention (Núñez-Peña, Corral, & Escera 2004).

Some emotional stimuli, usually negative ones such as threat or damage, initiate urgent circuits of processing with an adaptive and evolutionary purpose. These negative stimuli trigger responses, at both a behavioral and cerebral level, faster than positive stimuli (Carretié, Albert, López-Martín, & Tapia, 2009). This is called *negativity bias*; a kind of processing that allows us to react accurately to external dangers and threats (Carretié, 2011). These urgent circuits are also found after exposure to positive stimuli. Nevertheless, if we find ourselves in a high arousal situation with intense positive or negative stimuli, the negativity bias prevails (Cacioppo & Gardner, 1999). As we study the bias of negativity and positivity associated with the presentation of stimuli with emotional content (positive, negative, and neutral), we focus on studying the N100 component that is associated with attentional processes (Carretié, Hinojosa, Martín-Loeches, Mercado, & Tapia, 2004).

Linking studies of temperament in childhood population studies with studies of emotion both in adult and infant psychopathic populations, the two main objectives of this study are: first, to compare latencies, and second, to compare amplitudes generated by the N100 component when the control group and the experimental group are shown pleasant and unpleasant pictures. More precisely, we are interested in analyzing whether or not the subjects with psychopathy show a decreased negativity bias (related to the presence of BIS) and an increased positivity bias (related to the presence of BAS) when compared to a control group (N100).

Method

Participants

The experimental sample consists of 22 subjects, all males aged between 16 and 21 (*M* = 17.36, *SD* = 1.17) and all resident in a Young Offenders Institution in Madrid. The exclusion criteria were: being illiterate, showing evidence of any psychotic disorders or any other mental illness, or currently receiving pharmacological or psychiatric treatment.

The selection of the experimental sample occurred in several stages. First, the psychologists in the Institution filled out the Antisocial Process Screening Device, version for teacher/ psychologists (APSD; Frick & Hare, 2001) for all children in the Institution (*N* = 129). From this application, we selected those children whose APSD scores were equal to or greater than 30 points on the total scale; 24% of all children were selected.

In the second phase, we proceeded to study the reports of the children selected for conducting the interview PCL: YV.

After conducting the interviews (each one lasting approximately an hour and a half), we proceeded to obtain a total score on the PCL: YV. Meanwhile, psychologists from the Institution also completed this scale, taking the total of the two scores on the PCL: YV for each child selected. In order to select the final sample, the first author and psychologists met to reach a consensus on the scores and select those equal to or greater than 30 points on the Psychopathy Checklist: Youth Version (PCL: YV; Forth, Brown, Hart, & Hare, 1996).

This last selection gave a total of 29 (22%) candidates, of whom 4 children had finished their time and were released, 2 children escaped while we were conducting the study, and 1 child refused to participate, resulting in a final total of 22 participants (17%).

The control sample was comprised of 25 participants, all males aged between 17 and 21 (*M* = 18, *SD* = 1.08). The exclusion criteria for the control sample were: evidence of the presence of psychotic disorders or any other mental illness, a history of criminal activity, and receiving any drug or psychiatric treatment.

The selection of the control sample also took place in several phases. Firstly, the voluntary cooperation of students was requested. Secondly, both the mentors of the college students and tutors from the colleges filled out the APSD form (teachers'/ psychologists' version) for the volunteers (*N* = 40). After this application, we selected those children whose APSD scores were less than 15 points on the total scale (Frick and Hare, 2001). Thus, 29 subjects were selected at this first screening (72.5%); four subjects did not come for completion of the experimental work, thereby leaving a final control sample of 25 participants.

Instruments

Stimuli

For the experimental task, 21 slides of the *International Affective Picture System* (IAPS, *Center for the Study of Emotion and Attention*, CSEA, 1999 in Moltó, 2000) were selected; 7 with pleasant emotional content, 7 neutral and 7 with unpleasant emotional content (2165, 4250, 4652, 4659, 4664, 4680, 8200, 7000, 7009, 7025, 7080, 7100, 7233, 7705, 3010, 3060, 3120, 3140, 3170, 9040, 9300).

Variables and Instruments

We established two independent variables: psychopathy—with two levels, control group and experimental group—and the type of emotional stimulation (pleasant, unpleasant, and neutral). As dependent variables, we used the latencies and amplitudes of the N100 wave.

Participants were issued with a set of questionnaires consisting of demographic questions and specific tests, which are summarized below:

- *Antisocial Process Screening Device* (*APSD*; Frick & Hare, 2001). The APSD is composed of 20 items designed to assess psychopathic traits both in child and adolescent populations. The response format is based on a 0–2 point scale (0 = *not true*, 1 = *sometimes true*, 2 = *completely true*). APSD reliability in our study, corresponding to the assessment made by the mentor / psychologist, was α = 0.974.
- *Psychopathy Checklist: Youth Version* (*PCL:YV*; Forth, Kosson, & Hare, 2003). The PCL: YV is a clinical assessment scale consisting of 20 items designed to measure a set of behaviors and personality traits relevant to psychopathy in child and youth populations. The PCL: YV is completed by means of a semi-structured interview with the subject (lasting roughly one and a half hours) and reviewing collateral information on sociodemographic variables, criminal history, and institutional behavior obtained from files from the Young Offenders Institution. The response format is based on a 0–2 point scale (0 = *item does not apply to the subject*, 1 = *item applies to the subject sometimes*, 2 = *the item fully applies to the subject*). The internal consistency of the PCL: YV was very high (α = 0.99).
- *Self-Assessment Manikin* (SAM; Lang, 1980). The emotional experience of the subjects upon seeing pictures with emotional content was assessed using the SAM, a graphical tool with drawings depicting the three affective dimensions of valence, arousal, and dominance. Each of the IAPS images presented was assessed by the subject using a

scale of 1 to 5, where 1 indicates the lowest level of pleasure or arousal and 5 the highest level of pleasure or arousal.

Experimental design

The scheduling of the task was carried out using the computer application Neuronic v Cognitive Stimulation 2.1.0 (Neuronic, SA), subsequently responsible for controlling stimulus presentation and data collection.

The experimental task, specifically designed for this research, was to visualize three types of emotional stimuli. The subjects had 7 pleasant images on screen, 7 neutral and 7 unpleasant, all repeating randomly to generate the evoked potential for a total of 84 times each. Therefore, each block of pleasant, unpleasant, and neutral images consisted of seven different types of photos that were repeated 12 times each to generate a total of 252 images (84 pleasant, 84 unpleasant, and 84 neutral).

The stimulus was shown on the screen for 500 ms with an interval of 800 ms between stimuli (see Figure 1), resulting in a total experiment duration time of 5.46 minutes. The only instructions the subject received were to look at the images shown on the computer screen and to be as still as possible to prevent changes to the record.

Apparatus and recording

A 32 channel electroencephalogram (EEG) was recorded with Medicaid (Neuronic, SA) using a standard 10/20 Electro-Cap. The impedance of the electrodes was kept below 5kΩ. The electrooculogram (EOG) was recorded with two electrodes located in a horizontal (right) and vertical (left) direction to record eye movement. Data were recorded using a reference electrode located in the mastoid (right). The sampling rate was 1000 Hz. The amplifier frequency bands were set between 0.05 and 30 Hz.

EEG analysis was performed with the program Neuronic Psychophysiology v. 3.0 (Neuronic, S.A.). In order to obtain the evoked potential, we proceeded to clean the EEG, first visually (100 μV artifacts were removed) and then by applying an independent component analysis (ICA) decomposition to reduce the artifacts from eye- blink, muscle activities and line-noise. Evoked potentials obtained were averaged separately for each
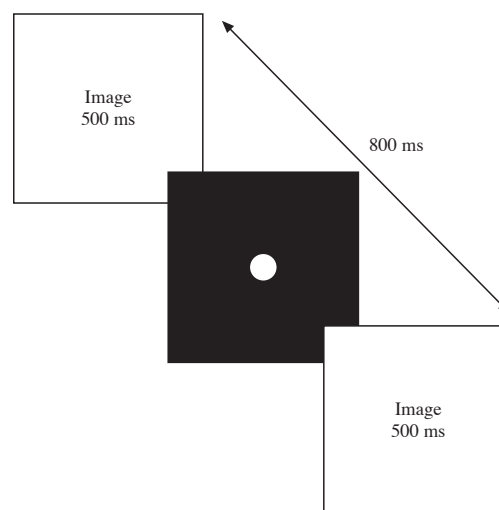

Figure 1. Presentation of the experimental task

condition and each subject. We analyzed latencies and amplitudes in N100 component at electrode Fz between 80-140 ms from the beginning of the stimulus (Ortiz, Poch-Broto, Requena, Santos, Martínez, & Barcia, 2010).

Procedure

The experimental phase consisted of EEG recording while emotion slides were shown. This session, which lasted approximately 30 minutes, began with the placement of a 32 channel mesh, in the same order for all subjects. We then proceeded to verify the impedance of each of the electrodes. Before starting the crossover experiment, two minutes of relaxation were allowed to facilitate the adaptation of the subject. After that, the slides began.

Once the task was completed, all electrodes were withdrawn in the same order for all subjects and the subject was asked to evaluate the valence and arousal of IAPS images shown during the task, using the "Self-Assessment Manikin" (SAM, Lang, 1980).

Data analysis

In order to determine whether the latency to the unpleasant stimulation, as opposed to the pleasant one, was advanced or decreased in subjects with psychopathy compared with the control group, a mixed ANOVA was performed. The emotional condition (pleasant, unpleasant, and neutral) was used as independent intra-group variable; whereas the group itself (experimental or control) was the independent inter-group variable. Two dependent variables were used when analyzing both the latencies and amplitudes. The first one consisted of the remainder of subtracting the pleasant from the neutral condition (A-N); and the second consisted of subtracting the unpleasant condition from the neutral (D-N). This subtraction was performed so that any new variable created allowed us to compare, for each subject, their advancement or delay in pleasant and unpleasant conditions with respect to the neutral condition. In order to check whether there were differences in latencies and amplitudes in the N100, the mixed ANOVA technique was used. We used the statistical package SPSS 19.0.

Results

Analysis of the latencies

In the study of the N100 component, only one significant effect was observed when interaction occurred between the group variable and emotional condition, $F_{\text{Greenhouse-Geisser}(1,45)} = 4.26$, $p = .045$, partial $\eta^2 = .087$ (see Table 1). Neither the group variable nor emotional condition, by themselves, produced a significant effect on the latencies, $F_{\text{Greenhouse-Geisser}(1,45)} = 0.077$, $p = .782$; $F_{\text{Greenhouse-Geisser}(1,45)} = 0.343$, $p = .516$, respectively.

Table 1
N100 component latencies in conditions A-N and D-N

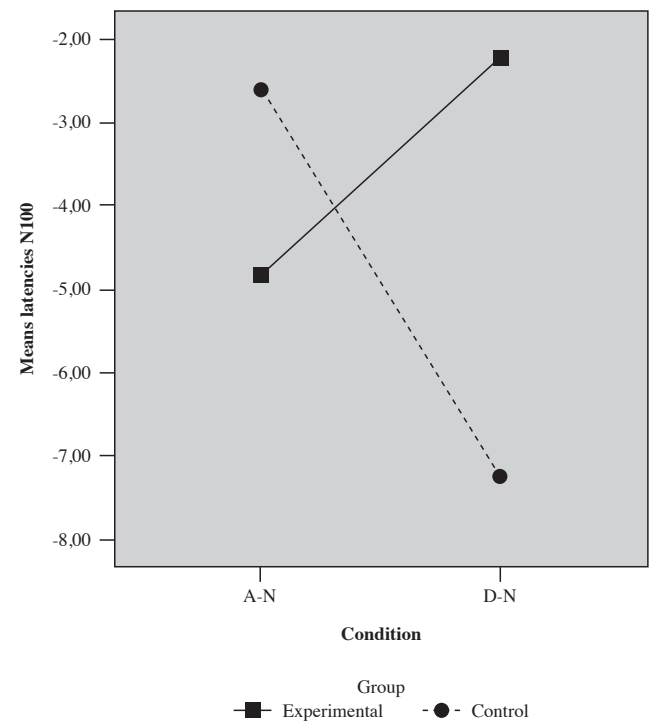| Condition	Group	Mean (standard deviation)
N100 (A-N)	Experimental	-4.81 (16.93)
	Control	-2.60 (21.11)
N100 (D-N)	Experimental	-2.22 (15.32)
	Control	-7.24 (18.41)

As can be seen in Figure 2, there was a significant interaction. The experimental subjects continued to experience a delayed N100 latency component to the unpleasant stimulation (D-N) and an advance of latency to the pleasant stimulation (A-N). This pattern was reversed in the control group.

Analysis of this component suggests an abnormal functioning of emotional processing in individuals with psychopathic features, which supports previous research on this population.

Analysis of the amplitudes

No differences were found in Fz when studying the N100 component; thus we analyzed whether there were differences in amplitudes in the areas of interest (temporal and frontal). The only difference found was in the frontal zones (Fp1 and Fp2).

In Fp1, only one significant effect was observed when interaction occurred between the group variable and the emotional condition,

Figure 2. Effect of interaction between the mean latencies of the N100 component in the A-N and D-N conditions

Table 2
N100 component amplitudes in conditions A-N and D-N in Fp1 and Fp2

Condition	Group	Mean (standard deviation)
Fp1 N100 (A-N)	Experimental	-1.90 (2.80)
	Control	-0.75 (2.82)
Fp1 N100 (D-N)	Experimental	-0.49 (2.53)
	Control	-1.58 (2.26)
Fp2 N100 (A-N)	Experimental	-1.83 (2.76)
	Control	-0.57 (2.89)
Fp2 N100 (D-N)	Experimental	-0.45 (2.56)
	Control	-1.55 (2.24)

$F_{\text{Greenhouse-Geisser}(1,45)} = 4.77$, $p = .034$, partial $\eta^2 = .096$ (see Table 2). Neither the group variable nor condition, by themselves, produced a significant effect on the amplitudes, $F_{\text{Greenhouse-Geisser}(1,45)} = 0.003$, $p = .954$; $F_{\text{Greenhouse-Geisser}(1,45)} = 0.328$, $p = .570$, respectively.

In Fp2, only one significant effect was observed when interaction occurred between the group variable and emotional condition, $F_{\text{Greenhouse-Geisser}(1,45)} = 5.13$, $p = .028$, partial $\eta^2 = .102$ (see Table 2). Neither the group variable nor condition, by themselves, produced a significant effect on the amplitudes, $F_{\text{Greenhouse-Geisser}(1,45)} = 0.021$, $p = .886$; $F_{\text{Greenhouse-Geisser}(1,45)} = 0.153$, $p = .698$, respectively.

Discussion

In the case of the experimental group, we expected to find latency delays when dealing with aversive stimulation and advancement with pleasant stimulation in the N100 component, as well as greater amplitude for the pleasant images and less for the unpleasant images. In the control group, we expected a normal pattern of operation.

The results found in the control sample reflect normal functioning of attention to emotional stimulation. In the D-N condition, latencies are advanced and amplitudes are greater than in the A-N condition, prioritizing negativity bias on positivity bias.

In contrast, in the experimental sample, the opposite is observed: the mechanisms processing the pleasant stimulation respond earlier and with more intensity (on the N100), prioritizing positivity bias on negativity bias. It would be beneficial to analyze the performance of longer latency waves to check whether these differences appear again or if they are compensated for in some way.

These results might explain the presence of traits such as cruelty or emotional insensitivity characterizing CU, which distinguish a group of young people with an underactive BIS whose antisocial behavior could be explained by a manifest inability to experience unpleasant stimulation (both latency and amplitude). As we have seen throughout this paper, many clinical descriptions of psychopathy have emphasized the inability to experience emotions or appreciate the emotional meaning of events (Blair, 1995; Cleckley, 1988; Kiehl, 2006). In this respect, several authors have proposed that psychopathy involves a selective deficit affecting mostly negative emotional reactivity (Marsh & Blair, 2008), and attribute the behavior shown by psychopaths to their insensitivity to punishment signals (Patrick, 1994). Emotional deficits to negative emotional stimuli have been associated with high scores on CU traits, BIS hypoactivity and Factor I (Wallace et al., 2009).

Secondly, these results could also explain the presence of BAS in subjects with these features. Responding sooner and with more intensity (in the case of the N100) to pleasant rather than unpleasant stimuli may be related to scores on Factor II (related to a component of impulsivity and an inability to delay gratification and antisocial personality). Factor II has been linked to BAS hyperactivity (Brenner, Beauchaine & Sylvers, 2005) and thus, is related to the preference for positive emotions (Hundt, Kimbrel, Mitchell, & Nelson-Gray, 2008).

Regarding the limitations of our research, we must first highlight the small sample size. People with psychopathy belong to a population which is very difficult to access and therefore, the information we have obtained is very valuable, even though the generalization of our results relating to the youth population with psychopathy may be compromised due to the small number of subjects. It is surprising to find significant results, as is the case here, with this sample size. Our data indicate good reason to continue this line of research with larger samples.

In summary, our work is one of the few studies (to date) to investigate short-wave latency in young people with psychopathic characteristics. These results represent a significant contribution to the knowledge of psychopathy, as we can observe that the emotional deficits found in the literature on psychopathy in adults are also found in young people.

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