*Especificidades de la reacción emocional en adolescentes y adultos jóvenes: un estudio psicofisiológico**

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* Based on the research project: Specifics of emotional reaction in adolescents and young adults: a psychophysiological study. Ejecutado en el año 2011. Patrocinado por la Universidad Autónoma de Baja California.

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*Specifics of emotional reaction in adolescents and young adults: a psychophysiological study**

Como citar este artículo: **Flores et al. (2013). Specifics of emotional reaction in adolescents and young adults: a psychophysiological study. *Revista Tesis Psicológica*, 8 (2), 120-130.**

Recibido: 22 Enero 2013
Revisado: 20 Febrero 2013
Aprobado: 27 Mayo 2013

ABSTRACT

The passage from age to age depends on multiple cognitive and neurological developmental changes; for affective and social skills, adolescence has proven to be a critical age for making decision, the self-regulation, the monitoring and emotional-affective social analysis. The objective of the study was to compare emotional-affective response between adolescents and young adults. Methods: Subjects had to respond the Self Assessment Manikin (SAM) in a 5 option Likert type scale. Three different scales were presented: happy/unhappy, annoyed/excited, and controlled/in-control. Autonomic EKG, Skin Conductance, Temperature, and EMG response were measured. Results: No statistical differences were shown between age groups in autonomic reaction. The Behavioral response General Lineal Model (GLM) analysis showed significant difference in the subject's responses to various situations, however non age differences were found. Data suggests a similar level of emotional valence recognition and autonomic reaction between adolescents and young adults. These findings can suggest similar autonomic reaction for both studied groups, which leads to the hypothesis about later development in affective processing in higher central nervous structures, but not for peripheral reaction.

Key words: Physiological-reaction, emotion, development, adolescence, self-regulation

RESUMEN

El paso de una edad a otra depende de múltiples cambios en el desarrollo de procesos cognitivos y neurológicos; en el caso de habilidades afectivas y sociales, se ha demostrado que la adolescencia es una edad crítica para tomar decisiones, auto-monitorearse y realizar análisis social afectivo-emocional. El objetivo del estudio fue comparar la reacción emocional entre adolescentes y adultos jóvenes. El estudio se llevó a cabo en dos muestras, constituidas de un grupo control de adultos jóvenes y un grupo experimental de adolescentes, a los que se les solicitó responder el Manikí de Auto-Evaluación (SAM), en cinco opciones, medidas en escala Likert. Se les solicitó elegir entre tres pares de variables: agradable vs desagradable, activado vs anhedónico y controlado vs en-control. Se midió la reactividad autónoma en derivaciones: frecuencia cardiaca, conductancia de la piel, temperatura y la respuesta muscular abdominal. No se observaron diferencias estadísticamente significativas en la reacción autonómica entre grupos de edad. El análisis del Modelo Lineal General de Respuesta Conductual (GLM) mostró diferencias significativas en las respuestas entre los diferentes tipos de estímulos, observadas en la reactividad autónoma y las respuestas asignadas; sin embargo, no se encontraron diferencias significativas. Los datos indican un nivel similar en la reacción de reconocimiento y respuesta autónoma de valencia emocional entre adolescentes y adultos jóvenes. Estos hallazgos pueden indicar la misma reacción de autónoma para ambos grupos estudiados, lo cual conduce a la hipótesis sobre el desarrollo posterior en el procesamiento de afectividad en las estructuras principales nerviosas superiores, pero no en la reacción de dispositivo periférico.

Palabras clave: Reacción fisiológica, emoción, desarrollo, adolescencia, identidad - autorregulación.

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Introduction

The affective reaction and emotion regulation in humans has been studied from different points of view, and have had an increasing evolution toward a large number of studies about the role of affect and emotion in people's lives. Since Walter Cannon´s (1927) theory examination of emotions, the new age of psychophysiology of emotions took place, and changed the history of the emotions and affect understanding. It is worth mentioning the famous Phineas Gage frontal lesion case (for more detailed information see the well explained history in Damasio, 1996), which lead to new questions about the processing of emotions and affect, as well as (Klüver & Bucy, 1939; Davis, 2000; Sabatinelli, Bradley, Fitzsimmons & Lang, 2005; Sabatinelli, Bradley, Lang, Costa & Versace, 2007) amygdale's reports related to the consequences of large bitemporal lesions in monkeys, which lead to attention to novelty, social behavior, and sexual interaction disturbances.

More recent cognitive data from brain damaged aphasic patients has shown that the brain cognitive neuropsychological systems have different levels of processing the emotional affective information from stimuli, for example in (Solovieva, Villegas, Jiménez, Orozco & Quintanar, 2001) the effects of brain damage in the dynamic aphasia caused an impossibility to recognize the observed emotions due to a general absence of dynamic intellectual activity, while in afferent motor aphasia the impossibility was found in the emotional synthesis of intellectual tasks, the efferent motor aphasia showed an analysis of the sense of emotions, and in semantic aphasia the emotional disturbance was found in the impossibility to process verbal complex information. These data suggests that even when emotions are a non-linguistic process, emotions can be disorganized or suffer a disorder, if the ability to make linguistic representations of them is lost. Later on the study of autism and emotion recognition neuroimaging techniques has demonstrated the involvement of brain areas both cortical and subcortical, such as amygdale (Davis 2000; Davis & Lang, 2003; Davidson, 2003), ventral striatum and the prefrontal cortex (Uljarevic & Hamilton, 2012). It is evident that in the presence of autistic disorder there are discrimination deficits in emotional and cognitive control of emotion, both related to the deficiency, even in the face analysis and identification of emotional social contexts.

Recent studies (March, Finger, Schechter, Jurkowitz, Reid & Blair, 2010) suggest that more vulnerable emotional reactions to stimuli in adolescents can be associated to deficit in the subjective experience of fear. These findings can explain the present study sameness between adolescents and young adults, considering it was a non-pathological sample. Besides, other studies have also demonstrated that it is expected to find an increase in the emotional inhibit and regulation, but associated to a more pronounced reactivity to external events compared to those found during childhood (Burnett, Sebastian, Cohen & Blakemore, 2011).

The important aspect of the study of emotions for psychophysiological development is to explain the acquisition of its regulatory role as the basis of *thinking* and its executive function overall the psychological activity. Furthermore, the social and historical influence determines a great part of the characteristics of development of the emotional regulation and affects. Besides, autonomic nervous system regulation has been reported as an efficient technique in correction

of maturation problems in attention deficit disorder with hyperactivity (ADHD) (Musser, Backs, Schmitt, Ablow, Measelle & Nigg, 2011). These data suggests the specificity of autonomic function and its relation with more complex processing such as attention.

When and how do these functions of emotion and affect present critical changes during the development? Which are the main psychophysiological factors that underlie the emotional affective processing necessary for an adequate social behavior?

Physiology of emotions, autonomic reactions studied in adolescent age

Understanding the development of social emotional behavior and self-regulation

Although there are multiple ways of studying emotions, the scope of this work is limited to the factor of the emotions autonomic reaction as a developing function in the adolescent critical age. It is well known that the emotion regulation is a very important skill to act in a social environment (Gross, 2002; Morelen, Zeman, Perry- Parrish & Anderson, 2011). However, it is not an acquired behavior. Studies refer to an important influence of emotional processes over the cognitive processes (Dresler, Meriau, Heekeren, Van Deer Meer, 2009). It has been demonstrated that emotional reaction causes interference on cognitive processes (with the use of emotional content words).

Developing means hemispheric specialization in emotions, recently it has been tried to be proved the specialized role of each frontal lobe to negative and positive emotions and sensitivity to emotional behavior (Harmon, 2003). There are studies that show how neural networks are modified as a result of increased capacity of the teen to inhibit prepotent responses to different emotional contexts (Tottenham, Hare & Cassey, 2011).

Even in adult ages, development demonstrates important differences as it unfolds over time. For example, Dywan (Dywan, Mathewson, Choma, Rosenfeld & Segalowitz, 2008) refers to differences in autonomic and electrophysiological emotional intensity between older and younger adults; they propose a model in which autonomic processes mediate the relationship between cognitive control and affective regulation.

The objective of the study was to compare emotional behavioral response and physiological reaction between normal adolescents and young adults.

Method

Subjects: A sample was selected from two different development ages, group one, adolescents (n = 19, 8 male, 11 female, 13.79 ± 22.4 yr) and group two, young adults (n = 18, 9 male, 9 female, 19.89 ± SD = 19.6 yr). All subjects were present in the laboratory for the study, and were voluntary participants; parents from adolescents group were properly informed about characteristics of the study and asked to sign a participation agreement, as well as study subjects. No conflict of interest were involved in the realization of this work. Both groups had no relevant clinical or psychological disorder antecedents, had normal or corrected normal sight, and had the same social-cultural conditions.

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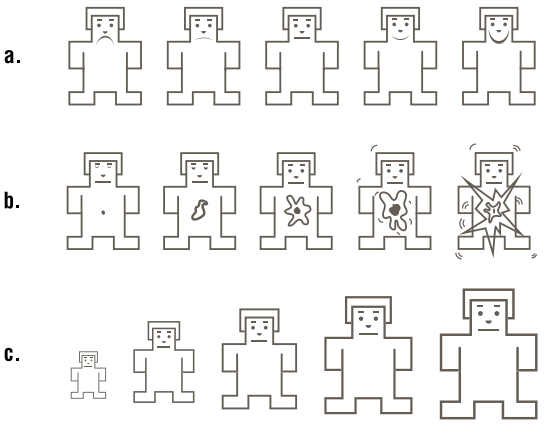
Materials and procedure: 54 pictures[1] from the International Affective Picture System (IAPS) (Lang, Bradley & Cuthbert, 2008) divided in 3 groups of 18 pictures (6 pleasant, 6 neutral, and 6 unpleasant). Each picture was presented for 6 seconds; different standardized sets of IAPS were used for adults and adolescents. Subjects estimated their affective reactions (pleasure, arousal, and dominance) with Self Assessment Manikin (SAM) (Lang, Bradley, Fitzsimmons, Cuthbert, Scott, Moulder & Nangia, 1998; Lang, Bradley & Cuthbert, 2008) nonverbal 5-point scales. All visual stimuli were administrated with the EEGxProc. Autonomic reactions: heart rate, skin conductance, temperature, and abdominal muscle, were measured during emotional stimuli presentation (Fowels, Christie, Edelberg, Grings, Lykken & Venables, 1981).

Procedure: Subjects were volunteers who received invitation via school agreements and were attended to individually. Each participant received first an inclusion criteria questionnaire (e.g. age, clinical history, social conditions). In a quiet room instructions were given using printed version of the SAM, and an anchor training series (with similar examples of the pictures of the experimental task). Two types of data were recorded: a) behavioral data, and b) physiological autonomic reaction.

Affective recognition classifications were compared by using the SAM, instructions were given according to the technical report of the SAM (Bradley & Lang, 2007; Lang, Bradley, & Cuthbert, 2008), and response options were presented in Likert type scales (1-5) with a central tendency and two extremes, containing the following components: pleasure, arousal and dominance. During the training series the subject were informed that some of the pictures to be presented after the warning signal could be *hard* to see, but that it was important to remain watching them while being present. Following this, the SAM scale is was presented to the subjects and they had to choose an option from 1-5 (fig. 1) then they were given a 10 seconds lap to decide as soon as possible the option that better identifies the emotional content in ranks from happy vs. sad, excited vs. annoyed, and dominated vs. in-domain by pressing a number from 1-5 in the numerical keyboard, each affective category took place right after their previous decision.

Fig.1. SAM scales: a) sad vs. happy, b) annoyed vs. excited, and c) dominated vs. in-domain



Source: Lang et al., 2005; Lang et al., 2008

Physiological autonomic reactions were recorded with a *biofeed-back physiolab I-330-C2 + 12ch, J & J Engineering, Bioscope* software, heart rate (HR), skin conductance (SC) temperature

1 International Affective Picture System (IAPS; Lang y cols. 2008) code identifier numbers according to the system: pleasant, 1500, 1610, 2510, 2650, 4608, 4640, 4651, 4653, 5000, 5030, 5300, 5890, 7260, 7270, 7330, 7352, 8120, 8161, 8200, 8300, 8320, 8465, 8502, 8531, neutral, 2190, 2210, 2215, 2221, 2230, 2271, 2280, 2440, 2495, 2516, 2570, 6150, 7010, 7100, 7110, 7130, 7150, 7175, 7211, 7224, 7233, 7235, 7490, 7950, unpleasant, 1120, 1300, 1930, 2120, 2710, 2716, 2717, 2718, 3100, 3168, 3170, 3181, 3550, 5970, 6020, 6230, 6250, 6300, 6370, 9008, 9432, 9440, 9560, 9561. Training series (Bradley y Lang, 2007) 4002 (for male), 4538 (for female), 7010 y 3100.

(Temp), and abdominal muscle activation (EMG). Visual stimuli were presented in a 19 inches screen with a 40 cm distance from subject in a 4 x 6 m quiet room.

Results

To analyze the characteristics of the emotional response factor's between groups, the results were divided in two groups, behavioral and physiological, and then compared within and between groups of age.

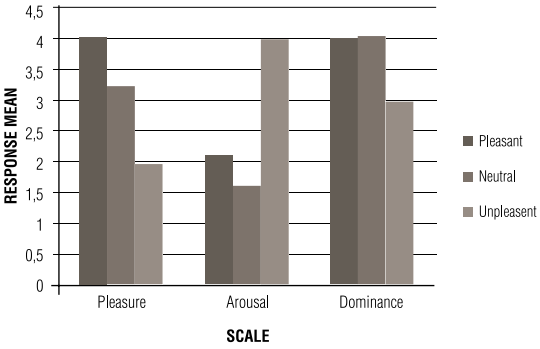
Behavioral results

The first behavioral analysis aimed to compare differences between type of visual stimuli presented divided into the three groups: pleasant, neutral and unpleasant. The subjects' mean responses were taken from the three likert (1-5) scales from the SAM used to assign emotional valence to each picture: pleasure, arousal, and domain. The paired samples T-test showed significant differences between type of stimuli presented for the pleasure scale, between pleasant and neutral images ($t = 11.218$, $df = 35$, $p = .000$). Significant differences were also found for the arousal assessment scale between pleasant and neutral stimuli ($t = 5.378$, $df = 35$, $p = .000$). No significant differences were found for the dominance scale between these types of images.

The comparison between pleasant and unpleasant situations showed significant differences for all the scales assessed: mean reaction in the pleasure scale between pleasant and unpleasant situations ($t = 16.532$, $df = 35$, $p = .000$), mean reaction in the arousal scale between pleasant and unpleasant situations ($t = -5.666$, $df = 35$, $p = .000$), and, finally mean reaction in the dominance scale between pleasant and unpleasant situations ($t = 5.345$, $df = 35$, $p = .000$) (fig. 2).

RM ANOVA statistics showed that behavioral responses depended on emotional valence: unpleasant pictures were recognized like most exciting and less controlled comparing with other type of pictures.

Fig. 2. T-Test for behavioral ranks, in different emotional situations (pleasant, neutral, unpleasant), for both groups (because there were not significant differences between them). RM ANOVA showed significant interactions of within-subjects factor (emotion valance and scales)



Source: Authors

Physiological results

Data Reduction

Four physiological autonomic derivations were registered during the stimuli presentation: Temp, EMG, HR, and SC, between pleasant, neutral, and unpleasant images and were exported to individual databases, then the first 6000 ms of each signal reaction during the presentation of the visual stimuli were averaged with a specially designed MatLab script to acquire the mean of each segment, and each physiological signal individually, and then exported to a SPSS database.

Physiological data was also first studied using both groups. For this analysis the reaction of the four autonomic signals between the three emotional situations were compared. In this case physiological parameters also demonstrated

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the dependence on emotional valence: the temperature raised to its highest value as a reaction to unpleasant pictures (table 1). The General Linear Model (GLM) analysis showed significant difference in the within-subject factor, assuming Sphericity ($F = 4.637$, $df = 2$, $p = .013$). In the EMG analysis the highest value was for pleasant pictures compared with unpleasant and neutral, ($F = 5.669$, $df = 2$, $p = .005$) (table 1). The analysis for SC and HR parameters did not demonstrate emotional-related differences to presented stimuli in these groups. No age-related differences were found neither for behavioral nor for physiological parameters of emotional reactions.

Table 1. Physiological values in the three different situations. SD, standard deviation, Mv: millivolts variability, HR: heart rate in beats per minute, Δs: microsiemmens

	Pleasant		Neutral		Unpleasant	
	mean	**SD**	**mean**	**SD**	**mean**	**SD**
EMG (Mv)	*3.62	2.19	*3.51	2.11	*3.44	2.00
HR (bpm)	86.94	15.65	89.84	31.19	85.61	14.37
Temp (Fahrenheit degrees)	*84.24	1.88	*84.29	1.89	*84.34	1.89
SC (Δs)	28.16	8.11	29.72	9.70	28.57	8.57

* Values with significant statistical difference between situations
Source: Authors

Physiological parameters also demonstrated the dependence on emotional valence: the temperature raised to its highest value as a reaction to unpleasant pictures, EMG value was higher for pleasant pictures than for unpleasant and neutral, and other physiological parameters did not demonstrate emotional-related differences. No age-related differences were found neither for behavioral nor for physiological parameters of emotional reactions.

Discussion

Results in the present study lead to the analysis of affective-emotional regulation in adolescents and young adults, bias self assessment with IAPS and a peripheral physiological recording (EMG, HR, Temp, and SC). It was found that both samples had a significant physiological response to the pictures showing pronounced excitatory content. Other studies have also shown that the adolescents are able to recognize and differentiate emotional reactions, particularly those pleasant emotions such as happiness and surprise, in contrast to fear and sadness (Tottenham et al., 2011) or defensive and appetitive (Bradley, Codispoti, Cuthbert & Lang, 2001; Fanselow, 1994). The statistically significant difference in reaction was also found with differences in the presented emotional situations: pleasant vs. unpleasant. In this study, it was expected to find a significant difference according to age groups factor as significant difference between pleasant and unpleasant visual stimuli. As well as differences between groups in the emotional control measures and physiological response, by considering that the adolescence is characterized by an increase in affect and behavior regulation with long-term objectives, consequences (Steinberg, 2005), as well as hormonal changes, which could be related to sex differences (Bradley, Codispoti, Sabatinelli & Lang, 2001) however these differences were not analyzed for the present study. So as motivated behavior which reflects the typical

development of affective and social cognitive processes approaching to adult-like functioning (Ernst & Hardin, 2010) It is also known that adolescence is a critical age in decision making, self-regulation, and self-emotional monitoring development, which differs from adult performance in which autonomic and electrophysiological differences show an increased intensity (Dywan et al., 2008).

There is also data which shows differences in maturation of visual processing in subjects, which leads to the new suggestion of considering the development of visual processing as a factor of visual analysis and synthesis related to the affective perception (Lang et al.,, 1998; Bradley, Sabatinelli, Lang, Fitzsimmons, King & Desay, 2003).

Conclusions

The development of the three processes involved in emotion such as discrimination, regulation, and cognitive control also have a physiological correlate, and it seems to continue to change as development principles (of the distal to proximal). It's also important to consider that some psychophysiological responses as those identified in this study are control markers associated with age and cognitive gain.

It is expected that during the transition from childhood to adolescence and from adolescence to adulthood the three emotional affective control processes will involve earnings on an upward curve, but the revision of the present study concludes that although this curve could be considered with variables corresponding to autonomic nervous system psychophysiological observation, such as EMG and temperature, having an uneven development, that is, while some variables such as improving the reactivity and emotional discrimination significantly raise on the young. Other conditions such as decision making related to the emotional context (social pressure for example) are still not fully developed in adolescents. These physiological variables may represent clear consolidation of this development, uneven but rising to adulthood.

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