The adaptation of the Affective Norms for English Words (ANEW) for European Portuguese

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Running head: ANEW adaptation for EP

Abstract

This study presents the adaptation of the Affective Norms for English Words (ANEW; Bradley & Lang, 1999a) for European Portuguese (EP). The EP adaptation of the ANEW was based on the affective ratings made by 958 college students who were EP native speakers. Participants assessed about 60 words by considering the affective dimensions of valence, arousal, and dominance, using the Self-Assessment Manikin (SAM) in either a paper-and-pencil and a web survey procedures. Results of the adaptation of the ANEW for EP are presented. Furthermore, the differences between EP, American (Bradley & Lang, 1999a), and Spanish (Redondo, Fraga, Padrón, & Comesaña, 2007) standardizations were explored. Results showed that the ANEW words were understood in a similar way by EP, American, and Spanish subjects, although some sex and cross-cultural differences were observed. The EP adaptation of the ANEW is shown to be a valid and useful tool that will allow researchers to control and/or manipulate the affective properties of stimuli as well as to develop cross-linguistic studies. The normative values of EP adaptation of the ANEW can be downloaded at http://brm.psychonomic-journals.org/content/supplemental.

Introduction

Emotion has a pervasive influence on human cognition. In the last decades, a considerable amount of research has focused on assessing how the processing of emotional evocative stimuli (words, pictures, sounds, odours, and film clips) differs from neutral stimuli at the behavioral and brain levels. The increasing interest in this research area has revitalized the emotion-cognition debate in unprecedented ways, allowing this line of research to gain strength and autonomy within the international literature.

However, despite the growing interest in emotion research, the definition and operationalization of *emotion* is still controversial (see, for example, Mauss & Robinson, 2009, or Scherer, 2005 for a review). In fact, although most researchers agree that emotions are dispositions for action elicited by stimuli perceived as significant by the organism, they disagree about which components are considered intrinsic to emotion (e.g., cognitions, behavioral responses, or neurophysiological processes), and how these different components interact with each other during emotional experience (e.g., do neurophysiological processes precede or follow cognitive processes?; see Moors, 2009 for a review). For example, discrete emotion theories state that emotions are better conceptualized as a set of discrete sensory-motor programs, with each of these programs consisting of a coherent brain circuit that elicits and links together cognitions and somatic responses into a single neural system (e.g., Ekman, 1992; LeDoux, 1996; Ohman & Wiens, 2004). In turn, dimensional theories argue that, rather than consisting of discrete motor-programs, emotions are simply cognitive labels that we apply to physiological activation, characterized by few basic dimensions (e.g., valence and arousal), and suggest that it is the assessment of each of these dimensions that underlies emotional responses (e.g., Bradley & Lang, 2000; Russell, 2003).

This dimensional perspective, dominant in current accounts of emotion, has its historical roots in Wundt's (1896) work. However, it was the work developed by Osgood, Suci and Tannenbaum (1957) that has consolidated this perspective and allowed its measurement. Using the semantic differential method, Osgood et al. (1957) performed factorial analyses over a large number of verbal judgments of a wide variety of stimuli (paintings, words, sounds) and observed that most of the variance of subjects' responses could be explained by two major affective dimensions: *valence* - represents the way a subject judges a situation, from unpleasant to pleasant-, and *arousal* - expresses the degree of excitement or activation a subject can feel towards a given stimulus, varying from calm to exciting. They have also identified a third dimension, which was called *dominance* - reflects the degree of control a subject feels over a specific stimulus, varying from "in control" to "out of control".

Following this original work, Bradley and Lang (1994) developed a nonverbal pictographic self-report measure, the Self-Assessment Manikin (SAM – see Fig. 1), to assess the valence, arousal and dominance dimensions. As pointed out by Mauss and Robinson (2009), even though not all individuals may be aware of and/or capable of reporting their momentary emotional states, the self-report of emotion seems to be a reliable measure to assess emotions, correlating strongly with different peripheral physiological measures as skin conductance responses (e.g., Bradley & Lang, 2000; Codispoti, Ferrari, & Bradley, 2006), startle response (e.g., Bradley, Cuthbert, & Lang, 1999; Bradley, Miccoli, Escrig, & Lang, 2008) and, although less consistently, the heart rate response (e.g., Bradley & Lang, 2000).

Based on this pictographic measure, Lang and colleagues developed different sets of emotional stimuli that are internationally available and that provide normative ratings of valence, arousal, and dominance for words (the Affective Norms for English

Words – ANEW; Bradley & Lang, 1999a), pictures (the International Affective Picture System - IAPS; Lang, Bradley, & Cuthbert, 1999) and sounds (the International Affective Digitized Sounds - IADS; Bradley & Lang, 1999b). In the present, these datasets represent fundamental tools for research on the neural correlates of emotional processing (e.g., Anders, Eippert, Weiskopf, & Veit, 2008; Junghofer, Schupp, Stark, & Vaitl, 2005; Kensinger & Schacter, 2006; Lewis, Critchley, Rotshtein, & Dolan, 2007), as well as for the development of studies that aim at exploring the influence of emotion in cognitive processes such as attention (e.g., Fox, Griggs, & Mouchlianitis, 2007; Schimmack, 2005; Schupp et al., 2007), memory (e.g., Bradley, Greenwald, Petry, & Lang, 1992; Mickley & Kensinger, 2008), and language (e.g., Scott, O'Donnell, Leuthold, & Sereno, 2009; Zhang, Lawson, Guo, & Jiang, 2006).

Even though most of the studies on affective processing have used pictures rather than words and sounds as experimental stimuli, words have been selected as stimuli of choice by an increasing number of researchers. In fact, words provide greater experimental control of stimulus characteristics that may affect cognitive processing, such as frequency, imagery, concreteness, familiarity, and age of acquisition (available in several lexical databases). In addition, the use of words avoids some confounding properties of pictures such as complexity, brightness, color, and contrast (e.g., Forsythe, Mulhern, & Sawey, 2008). Moreover, using words allows researchers to overcome other constraints such as the difficulty associated with the graphic representation of some abstract emotional concepts as "beauty", "truth", "disgust" or "unhappiness". Hence, due to these experimental advantages, and to their lower visual complexity, words are exceptional stimuli for the investigation of the neural correlates of emotion and the effects of emotion on cognitive functioning.

Despite the fact that emotional properties of verbal stimuli (especially arousal) seem to be less pronounced when compared with pictorial stimuli (e.g., Carretié et al., 2008; Gibbons, 2009; Kesinger & Schacter, 2006), there is evidence for emotional effects in word processing as well. Emotional words seem to more readily attract attention and cause more interference during ongoing tasks compared to neutral ones (e.g., Anderson, 2005; Dresler, Mériau, Heekeren, & van der Meer, 2009; Pratto & John, 1991). However, they are more easily remembered and recognized both in immediate (e.g., Hadley & MacKay, 2006; Monnier & Syssau, 2008), and delayed memory tests (e.g., Doerksen & Shimamura, 2001; Ferré, 2003). Moreover, distinct psycholinguistic tasks as lexical decision (e.g., Carretié et al., 2008; Hofmann, Kuchinke, Tamm, Võ, & Jacobs, 2009; Wentura, 2000), pronunciation (e.g., de Houwer & Randell, 2004; Spruyt, Hermans, de Houwer, Vandromme, & Eelen, 2007), and evaluative categorization (e.g., de Houwer, Hermans, Rothermund, & Wentura, 2002; Gibbons, 2009; Hermans, de Hower, & Eelen, 2001; Spruyt et al., 2007; Wentura & Degner, 2010), showed that positive and negative words elicit lower reaction times and higher accuracy rates than neutral words. Emotional words have also been shown to induce affective priming both in masked (e.g., Gibbons, 2009; Wentura & Degner, 2010) and unmasked (e.g., Hermans et al., 2001; Spruyt et al., 2007) designs.

In neuropsychological research, event-related potentials (ERPs) studies showed distinct patterns of activation for emotional words relative to neutral ones. Compared with neutral words, emotional words tend to elicit enhanced amplitudes not only in early stages of processing - including the early posterior negativity (EPN) component (e.g., Herbert, Junghofer & Kissler, 2008; Kissler, Herbert, Winkler, & Junghofer, 2009; Scott et al., 2009), and the P300 component (e.g., Liu, Jin, Wang, & Hu, 2010; Scott et al., 2009) -, but also in later potentials, such as the N400 component (e.g.,

Herbert et al., 2008; Zhang et al., 2006), and the late positive component (LPC) (e.g., Carretié et al., 2008; Gibbons, 2009; Herbert et al., 2008; Kissler, et al., 2009; Liu et al., 2010). Additionally, functional magnetic resonance imaging (*f*MRI) studies revealed that emotional words enhance activity in the amygdala (e.g., Kensinger & Schacter, 2006; Lewis et al., 2007), and in the prefrontal cortex (e.g., Kesinger & Schacter, 2006; Lewis et al., 2007; Posner et al., 2009), when compared with neutral words. Therefore, neuroscience studies have contributed to a better understanding of the neural correlates of affect processing, providing evidence that supports the existence of different mechanisms underlying the processing of emotional words.

Considering the increased interest in the study of emotional processing as well as the advantages associated with the use of words in terms of experimental manipulation/control, this paper presents a study aimed at adapting the Affective Norms for English Words (ANEW; Bradley & Lang, 1999a) to European Portuguese (EP). Based on a tri-dimensional perspective of emotions (e.g., see Bradley & Lang, 2000), this wordset, which has been used in several recent studies, provides affective norms for valence (which ranges from *pleasant* to *unpleasant*), arousal (which ranges from *calm* to *excited*), and dominance (ranging from *in control* to *out of control*), for 1034 words (including verbs, nouns, and adjectives), (e.g., Kesinger & Schacter, 2006; Lewis et al., 2007; Mickley & Kensinger, 2008; Scott et al., 2009; Zhang et al., 2006).

The assessment of each word in each of these three affective dimensions by using the SAM scale is particularly relevant since recent studies suggest that the affective representations of words' intensity (arousal) and their affective content (valence) may rely on distinct cognitive, temporal and spatial neural substrates (e.g., Dresler et al., 2009; Hinojosa, Carretié, Méndez-Bértolo, Míguez, & Pozo, 2009; Kensinger & Schater, 2006; Lewis et al., 2007; Mickley & Kensinger, 2008). In

particular, valence seems to affect early stages of affective processing (e.g., Kissler et al. 2009; Scott et al., 2009; see however Hoffman et al., 2009, for early effects of arousal), and to activate neural circuits that are distinct from those associated with arousal: for example, the prefrontal cortex tends to respond mainly to emotional stimuli in a valence-based manner, whereas the amygdala tends to respond in a arousal-based manner (e.g., Kesinger & Schacter, 2006; Lewis et al., 2007; Posner et al., 2009). Therefore, the lack of simultaneous control of these two affective variables can lead to confounding effects in neurocognitive research.

For example, in the emotional Stroop task (in which participants are asked to name the color of both emotional and control words, while ignoring their semantic meaning), Pratto and John (1991) found that color latencies were longer for negative relative to positive words. This finding has been interpreted as an allocation of additional attentional resources for negative stimuli processing, as they have greater significance for the individual (*negativity bias*). However, as Schimmack (2005) points out, it is unclear whether valence or arousal of the emotional stimuli explains that effect, since negative words tend to show higher levels of arousal when compared with positive words. Indeed, a recent study of Dresler et al. (2009), using positive and negative words matched for arousal, showed that, irrespective of valence, emotional words elicited emotional interference (i.e., both highly positive and negative arousing words produced longer response latencies relative to neutral words).

Moreover, recent studies on affective priming showed that arousal and valence have a differential effect on word processing. Although most studies have focused on valence (showing that there is a facilitated processing when primes and targets are both pleasant or unpleasant – the so called *affective priming effect*), the words' degree of arousal also seems to play an important role. In an ERP study aiming at analyzing the

contributions of arousal to affective priming, Hinojosa et al. (2009) found that the processing of positive, high-arousal targets was facilitated by a previous exposure to a congruent prime (i.e., a positive, high-arousal prime), as reflected by a reduction in the amplitude of the LPC. The modulation of the amplitude of the LPC by arousing congruent stimuli was interpreted as an index of a new emotional effect called the *arousal priming effect*.

As shown earlier, the simultaneous control of valence and arousal seems critical for current research, and the ANEW dataset stands out as a valuable resource for that purpose. Another advantage is that it provides words' affective norms for males and females separately. This is particularly important since previous studies have shown that males and females may respond to emotional stimuli in different ways. Relative to males, females have been shown to rate unpleasant stimuli as significantly more arousing and more unpleasant, demonstrating larger changes in the corrugators electromyographic (EMG) activity, greater fear bradycardia (sustained cardiac deceleration in the context of aversive stimuli), and larger skin conductance response changes in response to unpleasant than to pleasant and neutral stimuli (Bradley et al., 2000a, 2001b). Moreover, imaging studies provided evidence for increased defensive activation in females, as suggested by greater activation in the right hemisphere in response to unpleasant stimuli compared to males (e.g., Lang et al., 1998).

It is also worth noting that in addition to the original American version (Bradley & Lang, 1999a), the ANEW was already adapted to other languages (Spanish: Redondo et al., 2007) and, beyond this three-dimensional assessment, a categorical assessment of the ANEW words along five discrete categories (happiness, sadness, fear, disgust, and anger) is also available, which corresponds to the basic universal emotions (see Stevenson, Mikels, & James, 2007). Hence, the adaptation of this dataset for EP will

constitute an important resource to promote cognitive and psychophysiological research in the domain of emotional processing in Portugal. In particular, it will allow researchers to control and/or manipulate the affective properties of words to be used in different experimental research paradigms, and also to develop cross-linguistic studies matching words in the same affective dimensions in the languages for which this dataset is already available (American, Spanish and now EP). Even though high cross-linguistic correlations between words' affective ratings have been found in different languages (see Eilola & Havelka, 2010; Redondo et al., 2007; Whissell, 2008), the geographic and cultural similarities between Portugal and Spain led us to hypothesize a greater similarity in the findings between EP-Spanish than between EP-American English ANEW standardizations.

Method

Participants

A total of 958 undergraduate and graduate students (325 male and 633 female; mean age=22.82; SD=5.41) from different disciplines (Humanities, Economics, Sciences, and Technologies) in several public and private universities from the North to the South of Portugal (Note 1) participated in the study. All participants were native EP speakers and were selected from all Portugal districts, including Madeira and Azores islands (Note 2). The majority was right-handed (92.1%) and had normal (54.6%) or corrected-to-normal visual acuity (45.4%).

Materials and Procedure

The words included in the dataset were based on the EP translation of the 1034 words used in the original ANEW (Bradley & Lang, 1999a). This translation was done by two professional philologists specialized in English language and with a deep knowledge of the American culture. During translation of the words, an inter-judges agreement was obtained for 90% of words. For the 106 words for which there was not agreement, resolution was obtained through consensus between the two judges and the psycholinguistic researcher responsible for the adaptation of ANEW for EP. It is worth noting that during words' translation, the original English word was considered as well as its translation to Spanish (Redondo et al., 2007). Therefore, when a word was difficult to translate (due to word's polysemy, syntactic ambiguity or to the lack of lexical parallelism between the languages – i.e., when a word in a given language could be translated into several other in the other language or vice-versa), we often decided to use a translation of the English word that was similar to the translation of the same word to Spanish language. For example, the words "assassin" and "murder" are translated into the same word ("*assassino*") in EP, as in Spanish. Therefore, since that in the Spanish version the word "murder" was translated into the word "*assassino*" and the word "assassin" was translated into "*assassinar*". This option was kept in EP, to assure the comparability of ANEW's words across languages. Once the 1034 words have been translated, two procedures of data collection were developed in order to increase the efficiency of the process: a traditional paper-and-pencil procedure and a web procedure (on-line survey).

Web survey procedure: on-line or web surveys have been increasingly used in current psychological research due to its advantages, as speed, accuracy, and low cost (see Couper, 2000 for a review). Particularly within an HTML format, they allow an easy access to a larger number of participants. Therefore, acknowledging these

advantages, we developed a web-based application using standard technologies (i.e., a Computer Gateway Interface – CGI - that used cookies to identify sessions, and server-side sessions to store user data), following the recommendations of Burke and James (2006), namely: (i) making explicit the purposes of the research and emphasizing the importance of users' collaboration; (ii) identifying the survey and the research team by providing e-mail contacts so that users could request more details about the research and/or a copy of the findings; (iii) including clear filling instructions and an estimate of time to complete the survey; and (iv) informing about privacy policy and data confidentiality.

An invitation with a hyperlink to an on-line questionnaire was sent via e-mail to the addresses of students who were attending different courses of Portuguese universities. It is worth noting that this procedure was previously authorized by the administration of each institution. In addition, in-person contacts were made with teachers of different institutions in order to ask them to encourage the participation of their students in the study. After a first e-mail inviting the students to participate in the research study, two remainders were sent: the first was sent approximately one month after the first e-mail, and the other one was sent 6 months after the first notification. Seven hundred and sixty students (291 male and 469 female; M = 23.06 years; SD = 5.43) answered to the request (8% were excluded because they did not complete the entire survey and/or did not indicate that EP was their native language).

After each user accessed the on-line survey (via the URL link) and completed the registration data, a set of 60 words was drawn randomly from the full set of words (1034). Then, the user was asked to classify each word (one at a time) in each affective dimension using the SAM. In the SAM measurement scale (see Figure 1), each affective

dimension is represented by 5 figures and participants have to use a 9-point scale to assess their affective response to an emotion-evocative word.

<INSERT FIGURE 1 ABOUT HERE>

During the assessment procedure, each word was presented on the center of the screen until participants' response. Before words' presentation, participants were instructed to rate each word in the three affective dimensions as in the Bradley and Lang's (1999a) original procedure. It is worth noting that an additional instruction was added to the original procedure: participants were instructed to use a specific response key if they did not know the meaning of a particular word. This aimed at increasing the validity of results, avoiding participants' random responses. As soon as the participant rated a given word, the following word was presented in the screen, and the previous rating was automatically stored. All procedures took about 20 minutes to be completed.

Paper-and-pencil procedure: In addition to the web-survey procedure, a paper-and-pencil procedure was developed. In this case, assessments were done collectively in a classroom in each of the courses that participated in the study. This procedure included 198 graduate and undergraduate students (34 male and 164 female; $M = 21.92$ years; $SD = 5.26$) of the total sample (6% were eliminated because they did not complete the entire survey and/or did not specify EP as their native language). Similarly to the on-line procedure, participants rated about 60 words in the abovementioned affective dimensions using the SAM system. However, different from the web procedure, 17 random lists were created from the total 1034 words (with 60 words each).

In each experimental session and before data collection, the aim of the study was presented to the students, and the volunteer nature of their participation, as well as results' confidentiality, were emphasized. Subsequently, the affective assessment task was explained, by describing the use of the SAM scale, as in the original study of Bradley and Lang (1999a). Similarly to the web procedure, we added the instruction that subjects could mark a specific response whenever they did not know the meaning of any of the presented words. Finally, one of the 17 lists was distributed to each subject. In the booklet, participants also answered to socio-demographic information (e.g., sex, age, course, place of birth) and to questions about their language history (e.g., native language, second languages learned). No time limit was defined, but the participants were encouraged to answer as quickly as possible. The entire process took about 20 minutes. Each word in the dataset was rated by at least 25 participants (*M* = 50, *range* = 25 - 81).

Results and discussion

The affective norms of valence, arousal, and dominance of the 1034 Portuguese words that constitute the adaptation of the ANEW (Bradley & Lang, 1999a) for EP language can be downloaded as a supplemental archive from http://brm.psychonomic-journals.org/content/supplemental. The supplemental archive shows the mean values (*M*) and standard deviations (*SD*) for valence (*Val*), arousal (*Aro*), and dominance (*Dom*) for each of the 1034 words of the adaptation of the ANEW to EP, considering the total sample (*All*) as well as female (*Fem*) and male (*Mal*) samples separately. Words were organized considering their original number (*Number*) in the ANEW dataset (Bradley & Lang, 1999a). After its number, the original English word is presented (*E-word*) followed by the EP word (*EP-word*). Similarly to the American

(Bradley & Lang, 1999a) dataset, values of word frequency (*Freq*) are shown after the presentation of means and standard deviations for each word in each affective dimension both in the total sample and in the sub-samples of females and males separately. These values were computed with the P-PAL web application (Soares et al., 2010) based on the CORLEX EP *corpus* (Bacelar do Nascimento, Casteleiro, Marques, Barreto, & Amaro, 2000). As in the Spanish adaptation of the ANEW (Redondo et al., 2007), four additional objective psycholinguistic indexes were included: Number of letters (*Nlett*); Number of orthographic syllables (*Nsyll*), Grammatical class [*GClass*: noun (N), adjective (Adj), adverb (Adv), verb (V) or Interjection (I)], and Number of orthographic neighbors (*Neigh*: defined as the number of words that differ on a single segment either by substitution, deletion or addition) based on the PORLEX database (Gomes & Castro, 2003) and P-PAL web application (Soares et al., 2010).

It is worth noting that, as a preliminary step, before the computation of the normative values of the ANEW dataset for EP, we compared the mean values obtained through the on-line (web survey) and the paper-and-pencil procedures, in order to estimate if the ratings of the 1034 EP words on the three affective dimensions differed by test format. Because of the different sample size for each procedure (paper-and-pencil = 198 *vs*. on-line survey = 760), we decided to select a random sub-sample of participants from the on-line procedure's sample with the same size and characteristics of the paper-and-pencil procedure's sample (N = 198: 34 males and 164 females). The independent *t*-tests conducted showed no statistically significant differences between the paper-and-pencil and on-line procedures in each of the three affective dimensions (valence: $t(2066) = 1.32$, $p = .187$; arousal: $t(2066) = 1.41$, $p = .159$; and dominance: $t(2066) = -1.22$, $p = .22$). This finding justified our decision of combining both data sets into one for data analysis.

First, we present and discuss the descriptive results obtained in the adaptation of the ANEW dataset for EP, considering the three emotional dimensions (valence, arousal and dominance), and exploring, as in other studies (e.g., Bradley et al., 2001; Eilola & Havelka, 2010; Redondo et al., 2007; Võ et al. 2009; Whissell, 2008), the relationship between the valence x arousal dimensions in the bidimensional affective space, as well as sex differences in distribution of those results. Second, with the aim of exploring inter-cultural differences, we present and discuss the results based on the comparison of ratings obtained in the Portuguese adaptation of the ANEW with the ratings obtained in the original American English standardization (Bradley & Lang, 1999a) and in the Spanish adaptation (Redondo et al., 2007). The statistical package IBM SPSS 19 was used for the conduction of these analyses.

The ANEW adaptation for the EP

Figure 2 shows the distribution of the 1034 EP word ratings (mean values) in the bidimensional affective space of valence x arousal both for males and females.

<INSERT FIGURE 2 ABOUT HERE>

This distribution fits the typical boomerang shape previously found by Bradley and Lang (1999a) and by Redondo et al. (2007) in the Spanish adaptation of the ANEW. As in the American (Bradley & Lang, 1999a) and in the Spanish (Redondo et al., 2007) standardizations, this boomerang-shaped distribution shows that the words rated as either highly pleasant or highly unpleasant, were also rated as more arousing. This is shown by both positive pairwise linear correlations between valence and arousal for pleasant words (i.e., words with valence ratings above 5, the midpoint of the 9 point-

scale used, M = 6.41, SD = .90, *range* = 5.00 - 8.46), r = .27, $p < .001$, and the distinct negative correlation between valence and arousal for unpleasant words (i.e., words with ratings below 5 points, M = 3.22, SD = .87, *range* = 1.34 – 4.98), r = -.58, $p < .001$). This negativity bias for unpleasant stimuli and positivity offset for pleasant words (Cacioppo, Gardner, & Berntson, 1997) was captured, in the EP adaptation as in the American (Bradley & Lang, 1999a) and in the Spanish (Redondo et al., 2007) standardizations, by the significant quadratic relationship between valence and arousal (R = .62, $p < .001$) that explains 39% of the variance (valence was considered as an independent factor and arousal as a dependent factor in the regression analysis conducted).

Nevertheless, it is important to note that the negative association between valence and arousal for unpleasant words is stronger than the positive association between valence and arousal for pleasant words. Indeed, as seen in Figure 2, most of the pleasant words (that are located in the upper half of the chart) were distributed along the arousal dimension (M = 4.38, SD = .96, *range* = 1.79 - 7.65), which seems to indicate that for this group of words, valence is independent of arousal. However, the ratings for the unpleasant words (that are located in the lower half of the chart) were more concentrated in the right inferior quadrant of the chart (M = 5.53; SD = 1.02, *range* = 2.34 - 7.77). This situation showed that in the ANEW adaptation for EP, it is easier to find pleasant than unpleasant words with lower scores of arousal [$t(1032) = 18.58$, $p < .001$]. Indeed, if we assume, as for valence, 5 as the cutoff value in the classification of arousing (above 5) and not arousing (below 5) words, it is possible to observe that in the adaptation of the ANEW for the EP, there is not only a higher number of words classified as pleasant than unpleasant (579 *vs*. 455, respectively), but also, for the unpleasant ones, a higher number of words classified as high- (319) than low-arousing

(136) [$\chi^2(1) = 210.88$, $p <. 001$]. For the pleasant words, we observed the opposite pattern, i.e., more words were assessed as low-arousing (435) than high-arousing (144). This finding, which has been observed in other datasets of affective words (e.g., Võ et al., 2009), may hinder research using pleasant or unpleasant words when the manipulation of level of arousal is intended.

Nonetheless, it is worth noting that besides this asymmetry, the dispersion of results observed both for valence (*range* = 1.34 - 8.46) and arousal (*range* = 1.79 - 7.77) dimensions will allow EP researchers to control and/or manipulate the affective properties of words that fit their research interests.

Table 1 presents means, standard deviations and the range values (minimum and maximum) for each of the affective dimensions of valence, arousal and dominance, for females and males separately.

<INSERT TABLE 1 ABOUT HERE>

To investigate sex differences in EP ratings of valence, arousal, and dominance for pleasant and unpleasant words (classified on the basis of the ratings of the global sample), a multivariate analysis of variance (MANOVA) was conducted with sex (females *vs*. males) and words' valence (unpleasant *vs*. pleasant) as between-subjects factors and the three affective dimensions of valence, arousal and dominance as dependent variables. The MANOVA analysis showed a main effect of sex in assessments of arousal [$F(1, 2064) = 11.76$, $p < .001$], and a marginally significant effect in assessments of valence [$F(1, 2064) = 3.50$, $p = .062$]. Also, it showed a main effect of words' valence in the affective dimensions of valence [$F(1, 2064) = 6216.03$, $p < .001$], arousal [$F(1, 2064) = 502.99$, $p < .001$], and dominance [$F(1, 2064) = 1542.66$,

$p < .001$]. A significant sex x words' valence interaction for the valence dimension [$F(1, 2064) = 27.18$, $p < .001$] was also observed.

Therefore, contrarily to the original American version (Bradley & Lang, 1999a), in which statistically significant differences were only observed for the dominance dimension (see Note 3), and contrarily to the Spanish standardization in which sex differences have not reached statistical significance (see Redondo et al., 2007), Portuguese females rated words as significantly more arousing than males ($p < .001$), and Portuguese males tended to rate the words as more positive than females ($p = .062$). Even though the effect of sex on valence was only marginally significant, the sex x words' valence interaction observed for this affective dimension revealed an interesting pattern of results. On the one hand, Portuguese males rated unpleasant words as significantly more positive than Portuguese females ($p < .001$); and on the other hand, Portuguese females rated pleasant words as significantly more positive than Portuguese males ($p < .05$).

Therefore, and consistent with previous studies (e.g., Bradley et al., 2001a, 2001b; Lang et al., 1998), these findings suggest that Portuguese females reveal higher levels of reactivity towards emotional stimuli than Portuguese males, rating the words of the EP adaptation of the ANEW not only as more arousing, but also with more extreme values of the valence scale, i.e., rating unpleasant words as more negative and pleasant words as more positive. For example, females rated the pleasant word *casa* [house], ($M_{females}$: 3.85, $SD_{females}$: 2.71; M_{males}: 1.90, SD_{males}: 1.45), and the unpleasant word *trauma* [trauma], ($M_{females}$: 7.14, $SD_{females}$: 1.81; M_{males}: 5.50, SD_{males}: 2.31), as significantly more arousing than males [$t(35) = .15$, $p < .05$, $t(41) = 2.54$, $p < .05$, respectively], whereas males rated the unpleasant word *trauma* [trauma] as more positive [$M_{females}$: 2.18, $SD_{females}$: 1.36; M_{males}: 3.12, SD_{males}: 1.88, $t(57) = -2.25$, $p <$

.05], and the pleasant word *casa* [home] as more negative than females [$M_{females}$: 8.00, $SD_{females}$: 1.12; M_{males}: 6.56, SD_{males}: 1.65, $t(44) = 3.54$, $p < .001$]. As a consequence, the sex differences observed for valence and arousal affective dimensions in the adaptation of the ANEW for EP constitute a significant source of between-subjects variation, and should be considered during the experimental selection of word stimuli for conducting research on affective processing.

Finally, the main effect of words' valence on the affective dimension of valence showed, as expected, that pleasant words were assessed more positively than unpleasant words ($p < .001$). Also, in line with the abovementioned findings, unpleasant words were assessed as significantly more arousing than pleasant words ($p < . 001$), and additionally with significantly lower dominance ratings ($p < .001$). These findings confirm, in the adaptation of the ANEW for EP, the previously reported asymmetry between valence and arousal for pleasant and unpleasant words (i.e., stronger associations for negative stimuli – see Cacioppo et al.,1997; Võ et al., 2009). However, the interpretation of results regarding the affective dimension of dominance should be made with caution. Even though we consider that, in general, negative stimuli may elicit subjective feelings of lower control (see LeDoux, 1996), especially when, as observed in our study, negative stimuli present higher arousal levels, the scarce research on this affective dimension does not allow stronger conclusions. Indeed, dominance is typically considered the least important dimension in terms of the variance explained in emotional ratings (see Bradley & Lang, 2000), and is one of the most neglected topics in contemporary research on emotion. Future research should attend to this variable, in order to clarify the dominance effects on emotional ratings.

The ANEW standardizations for EP, American and Spanish languages

In order to explore the inter-cultural differences observed in the three ANEW standardizations, Figure 3 presents the distribution of the mean results found in the ratings of the 1034 words in the American English (USA), Spanish (SP) and European Portuguese (EP) standardizations in the bidimensional affective space of valence x arousal.

<INSERT FIGURE 3 ABOUT HERE>

The visual inspection of Figure 3 indicates a great overlap in distribution of the valence x arousal results in the three languages, with all revealing the expected boomerang-shape. Both in the American original version (Bradley & Lang, 1999a) and in the Spanish adaptation (Redondo et al., 2007) it was possible to observe, on one hand, positive linear correlations between valence and arousal for pleasant words (American: $r = .64$, $p < .001$; Spanish: $r = .45$, $p < .001$) and, on the other hand, negative correlations between valence and arousal for unpleasant words (American: $r = -.46$, $p < .001$; Spanish: $r = -.57$, $p < .001$), which were captured by the significant quadratic relationship between valence and arousal in American ($R = .54$, $p < .001$) (see Note 4) and Spanish ($R = .54$, $p < .001$) standardizations. Nonetheless, the comparison of the correlations suggests that in the EP standardization pleasant words were rated as less arousing ($r = .27$, $p < .001$) - as indicated by the green dots in the left upper quadrant of the Figure 3 - , while unpleasant words were rated as more arousing ($r = -.58$, $p < .001$) - as revealed by the green dots of the right lower quadrant of the Figure 3.

In spite of these differences, the proximity between ratings in the three languages can be highlighted, as suggested by Table 2 that presents the results for *Pearson* correlations between the assessments for Portuguese (EP), American English (USA) and Spanish (SP) languages in each of the three affective dimensions.

<INSERT TABLE 2 ABOUT HERE>

All correlations were positive and highly significant ($p < .001$ in all comparisons), which seems to suggest that the ANEW words were understood in a similar way by EP, American, and Spanish subjects, eliciting similar emotional reactions (see Table 2). It is important to highlight that, as expected, this agreement is higher in EP-SP comparisons than in EP-USA comparisons, which seems to confirm the hypothesis that the geographical proximity and cultural similarities between both countries may promote more similar emotional responses. It is also worth noting that, in spite of the high correlations found for all affective dimensions in the three ANEW standardizations, the valence dimension is the one that showed lower cross-language variability. Therefore, and consistent with the findings reported by Redondo et al. (2007) with American English and Spanish speakers, by Whissell (2008) with American English and Canadian English speakers, as well as by Eilola and Havelka, (2010) with British English and Finnish speakers, the assessment of a specific word in the pleasant-unpleasant continuum (i.e., valence) seems to be more consensual than its assessment in the control-out of control continuum (i.e., dominance), and especially than in the continuum calm-excited (i.e., arousal). It is also worth noting that even though this pattern applies to both sexes in the three ANEW standardizations, stronger correlations were observed in females than in males.

To obtain a more detailed appreciation of the inter-cultural differences observed in each of the three affective dimensions of the ANEW, we conducted a multivariate analysis of variance (MANOVA) with ANEW standardization (EP *vs*. USA *vs*. Spanish) and sex (females *vs*. males) as between-subjects factors and the affective dimensions of

valence, arousal and dominance as dependent variables. Table 3 presents means, standard deviations and range scores, for each of the affective dimensions under analysis for the sub-samples of females and males separately.

<INSERT TABLE 3 ABOUT HERE>

The MANOVA analysis showed a main effect of the ANEW standardization in the three affective dimensions: valence [$F(2, 6198) = 24.12$, $p < .001$], arousal [$F(2, 6198) = 179.10$, $p < .001$], and dominance [$F(2, 6198) = 64.83$, $p < .001$)]. A main effect of sex was also found in the affective dimensions of arousal [$F(1, 6198) = 13.66$, $p < .001$], and dominance [$F(1, 6198) = 6.76$, $p < .001$], being marginally significant in the valence dimension [$F(1, 6198) = 2.91$, $p = .09$]. A significant ANEW standardization x sex interaction was also observed in the affective dimension of dominance [$F(2, 6198) = 6.67$, $p < .001$].

The *post-hoc Scheffé* contrasts for the main effect of the ANEW standardization revealed that, in terms of valence, EP subjects rated the ANEW words using higher scores than Spanish subjects ($p < .001$) and lower scores than American subjects, although in this case the difference was only marginally significant ($p = .074$). In the arousal dimension, EP subjects rated the ANEW words as less arousing than both American ($p < .001$) and Spanish ($p < . 001$) participants. Finally, in the dominance dimension, no differences were observed between EP and American subjects ($p = .216$), even though EP subjects presented higher scores than Spanish subjects ($p < .001$). The main effect of sex revealed that, irrespectively of the ANEW standardization and similarly to what was observed in the Portuguese sample, female participants rated ANEW words as higher arousing than males ($p < .001$). In addition, male participants

compared to females participants scored ANEW words with higher levels of dominance ($p < .010$). Finally, the ANEW standardization x sex interaction for the dominance dimension, revealed that, even though sex differences did not reach statistical significance in the EP and Spanish ANEW standardizations, in the original American standardization dominance levels were significantly higher for males than for females ($p < .001$).

Overall, these results suggest that Portuguese subjects tend to manifest lower emotional reactivity to ANEW words than American subjects and that, even though they assessed words as less arousing than Spanish subjects (with the latter presenting the highest scores in this dimension), they have used higher scores for valence and dominance than the Spanish participants. Therefore, although the ANEW constitutes a very useful dataset composed by words that elicit similar emotional responses in people from different countries and cultures (as evidenced by the high and statistically significant correlations between EP-USA and EP-SP – see Table 2), it is important to highlight that these findings point to important socio-cultural differences in the way American, Spanish, and Portuguese individuals respond to the words that are part of the ANEW dataset. The affective assessment of emotionally evocative words, as the ANEW words, seems to be language- and culture-specific. Thus, caution is needed in the development of cross-linguistic studies on affective processing, which should be based on a careful selection of stimuli derived from normative data that fit the socio-cultural context of each research.

Finally, future developments of the standardization of the ANEW for EP should consider the possibility of providing reliable discrete emotion norms (namely in the discrete emotion categories of happiness, anger, fear, disgust, and sadness), following the previous works of Stevenson et al. (2007) with the original version of the ANEW,

and of Briesemeister, Kuchinke & Jacobs (2011) with the Berlin Affective Word List Reloaded (BAWL-R; Võ et al., 2009). Combining the norms presented in this paper (based on a dimensional perspective of emotions), with the discrete or categorical perspective of emotions that has been acknowledged by those studies, may contribute significantly to the development of research on affective processing in Portugal. In particular, the combination of these two approaches may help the development of studies that aim to compare the affective processing from both perspectives and to explore sex and cross-cultural differences in that processing. A single dataset would also benefit the development of studies focused on the effects of discrete emotions in word recognition, a promising line of research in contemporary affective research (see Briesemeister et al., 2001; Hofmann et al., 2009; Stevenson et al., 2007).

Conclusion

This work aimed to adapt the ANEW dataset (Bradley & Lang, 1999a) to the EP language. The use of standardized emotionally evocative stimuli is a major need to effectively support current cognitive and psychophysiological research. Therefore, given the scarcity of these stimuli in EP, the increasing interest in the study of affective processing that has been observed in the international literature, and the broad utilization of ANEW in studies using emotional words, we have adapted this tool for the EP context.

This study was conducted with a large sample of undergraduate and graduate students (N=958) and will be a useful tool for the development and internationalization of Portuguese research both on the neurophysiological correlates of emotion and on the influence of emotions in cognitive processing. Similarly to the results obtained with the original American version (Bradley & Lang, 1999a) and with the Spanish adaptation

(Redondo et al., 2007), results for the adaptation of the ANEW for EP revealed that the 1034 words generate emotional responses that were appropriately distributed in the bidimensional affective space of valence x arousal. Therefore, these norms will allow a more appropriate selection of emotional words as a function of the orthogonal manipulation that researchers may want to apply in different paradigms of experimental research on affective processing (although, as mentioned before, the negative words tended to be rated with higher arousal scores, which can make the conduction of studies aiming at manipulating arousal in that group of words difficult). In this way, the ANEW seems to be a valid and useful measure for the study of emotions in a national context, allowing the comparability of results with other international studies that have used the same dataset for stimuli selection.

The comparison of results in the three available standardizations (American, Spanish and now EP) revealed that, although the ANEW words have elicited similar emotional responses in Portuguese, American, and Spanish subjects, cross-cultural differences were identified. Globally, our findings indicate that EP subjects reveal lower emotional reactivity to ANEW words than American subjects (i.e., EP subjects rated the ANEW words as less arousing and lower in valence and dominance than American participants – even though these differences have only reached statistical significance for the arousal dimension) and that, when compared with Spanish subjects, they assessed the words as less arousing, even if with higher scores of valence and dominance. Thus, this finding seems to indicate the existence of important socio-cultural specificities in the way ANEW words are understood across languages/cultures, which might be acknowledged by future studies.

Finally, it is worth noting that contrary to what was observed in the American original (Bradley & Lang, 1999a) and in the Spanish (Redondo et al., 2007) ANEW

standardizations, and consistently with literature on sex differences on affective responses (e.g., Bradley et al., 2000a, 2001b; Lang et al., 1998), the adaptation of the ANEW for EP was characterized by statistically significant sex differences for words' valence and arousal affective dimensions (i.e., higher arousal ratings by EP females than by EP males; higher valence ratings by EP males than by EP females for unpleasant words, and higher valence ratings by EP females than by EP males for pleasant words). As a consequence, during the development of studies on emotional processing, Portuguese researchers should base the selection of word stimuli on the norms that best suit the sex specificities of their samples. Future developments of the adaptation of the ANEW for EP should also consider the possibility of combining these norms with others based on discrete perspective of emotions.

Author Note:

This work is part of the research project “Procura Palavras (P-Pal): A software program for deriving objective and subjective psycholinguistic indices for European Portuguese words” (PTDC/PSI-PCO/104679/2008), funded by FCT (Fundação para a Ciência e Tecnologia), and FEDER (Fundo Europeu de Desenvolvimento Regional) through the European programs QREN (Quadro de Referência Estratégico Nacional), and COMPETE (Programa Operacional Factores de Competitividade).

Notes:

(1) University of Minho, University of Beira Interior, University of Porto, University of Aveiro, University of Coimbra, University of Lisboa, University of Évora, University of Algarve; University of Madeira, University Lusófona, University Fernando Pessoa, University Aberta, University Católica Portuguesa, Porto Polytechnic Institute and Viseu Polytechnic Institute.

(2) Viana do Castelo, Braga, Vila Real, Bragança, Porto, Aveiro, Viseu, Guarda, Coimbra, Leiria, Castelo Branco, Santarém, Portalegre, Lisboa, Setúbal, Évora, Beja e Faro.

(3) Although Bradley and Lang (1999a) did not report these results, we have calculated them from the normative data included in their study. The mean comparisons (independent *t*-tests) for females and males revealed that American males rated the ANEW words with higher levels of dominance [$t(2066) = 4.42$, $p < .001$]. American females tended to rate ANEW words as more arousing [$t(2066) = -1.89$, $p = .059$] and American males as more positive [$t(2066) = 1.83$, $p = .068$], although these differences were only marginally significant.

(4) Although Bradley and Lang (1999a) did not report correlational and regression analyses in their study, we have calculated these analyses based on the normative data they have published. Also, in the adaptation of the ANEW for Spanish, Redondo et al. (2007) did not present values for the correlational analysis between valence and arousal affective dimensions attending to words' valence (unpleasant *vs*. pleasant). Thus, in this work we have additionally computed these analyses based on the normative data they have published.

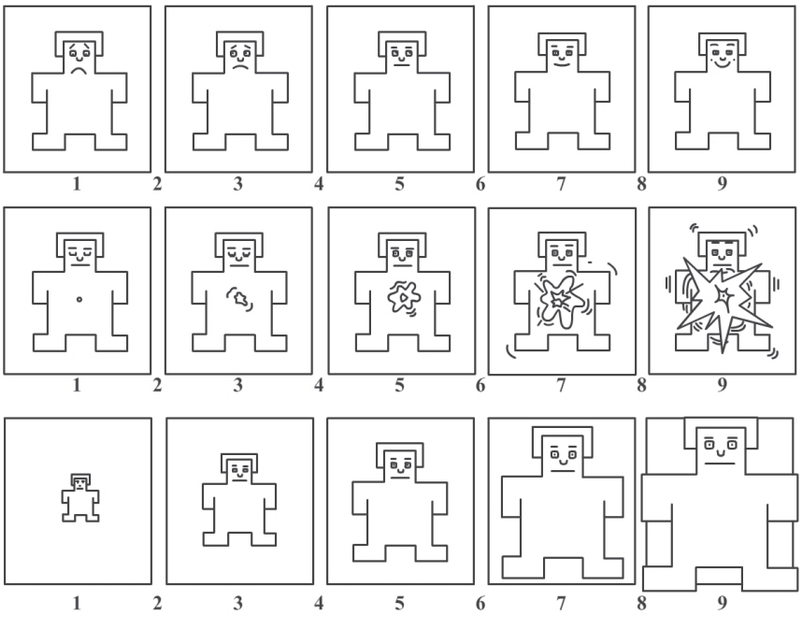

Figure 1. Self-Assessment Manikin (SAM).

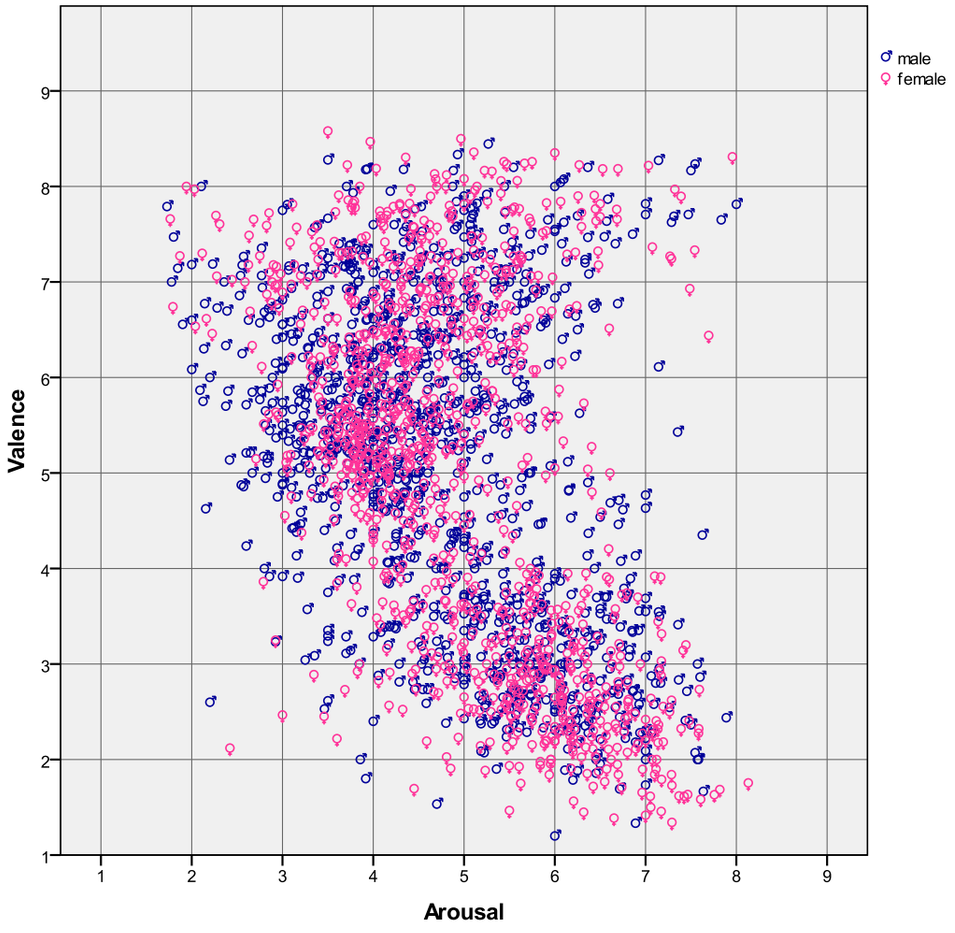

Figure 2. Distribution of means values (male and female) for the 1034 words of the EP adaptation of the ANEW in the valence and arousal affective dimensions.

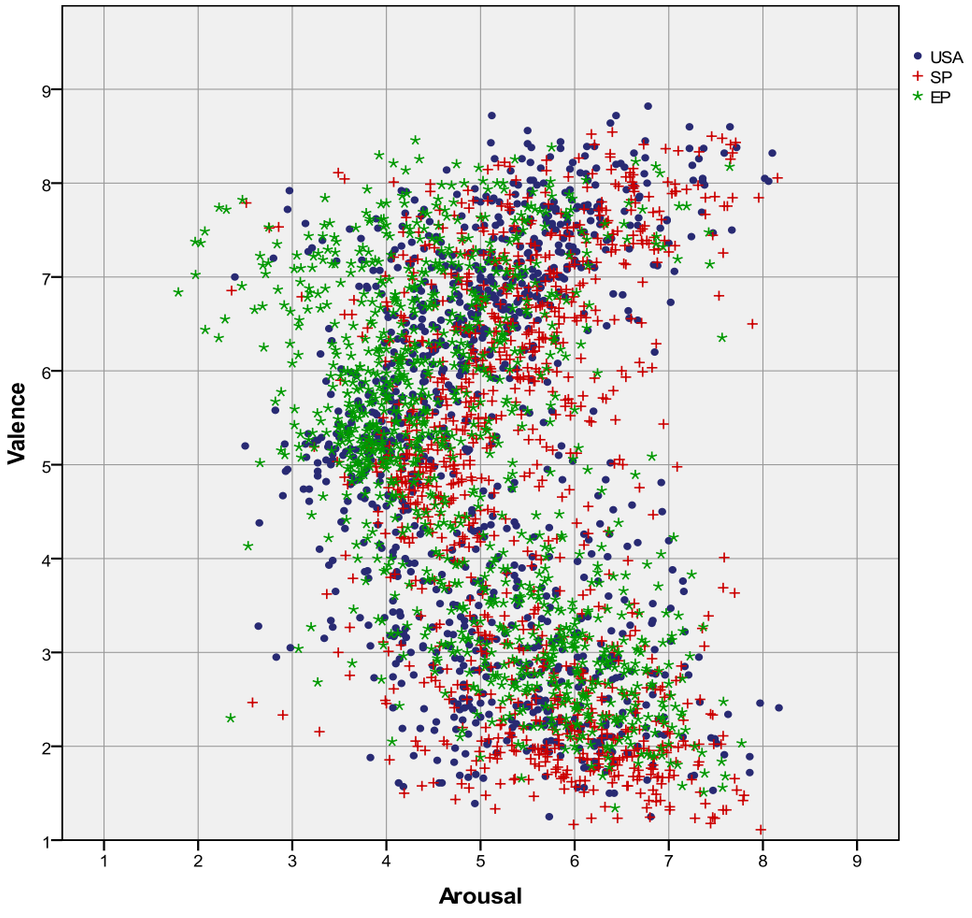

Figure 3. Distribution of mean values for the 1034 ANEW words in USA, SP and EP for valence and arousal affective dimensions.

Table 1. *Means (M), Standard Deviations (SD) and range values (minimum-maximum) of the 1034 words ratings of the EP adaptation of the ANEW for females and males in three affective dimensions.*

Affective dimensions	Females			Males		
	M	*SD*	*Range*	*M*	*SD*	*Range*
Valence	4.98	1.91	1.34-8.58	5.07	1.69	1.20-8.44
Arousal	4.94	1.19	1.76-8.13	4.77	1.24	1.73-8.00
Dominance	4.96	.95	2.00-7.70	4.97	1.04	1.57-8.17

Table 2. *Linear correlations between European Portuguese (EP), American (USA) and Spanish (SP) ANEW word ratings in the three affective dimensions for all subjects, and for females and males separately.*

Affective	All subjects		Females		Males	
dimensions	USA	SP	USA	SP	USA	SP
Valence	.92**	.94**	.92**	.94**	.88**	.90**
Arousal	.65**	.75**	.66**	.72**	.47**	.60**
Dominance	.73**	.78**	.70**	.74**	.51**	.60**

** $p < .001$

Table 3. *Mean, Standard Deviations (SD) and range for the European Portuguese (EP), American (USA), and Spanish (SP) ANEW word ratings in the three affective dimensions for females and males.*

Affective dimensions	Females									Males								
	EP			USA			SP			EP			USA			SP		
	M	*SD*	*range*	*M*	*SD*	*range*	*M*	*SD*	*range*	*M*	*SD*	*range*	*M*	*SD*	*range*	*M*	*SD*	*range*
Valence	4.98	1.91	7.24	5.08	2.18	7.85	4.74	2.16	7.51	5.07	1.69	7.24	5.24	1.79	7.40	4.74	2.10	7.65
Arousal	4.94	1.19	6.37	5.16	1.17	6.63	5.54	1.02	5.87	4.77	1.24	6.27	5.07	1.08	6.11	5.49	1.05	5.70
Dominance	4.96	.95	5.70	4.92	1.16	6.43	4.68	1.09	5.79	4.96	1.04	6.60	5.12	.95	5.23	4.67	1.07	6.10

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