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Electrodermal and behavioral response to emotional Spanish words in native speakers.

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Original Article

Abstract

The present study aimed to validate a Spanish-word database that elicits different levels of emotional response. To control subjects' engagement to the stimuli, an emotional Stroop task was administered to Spanish-speaking population. In order to assess to which extent valence and emotionality are automatically processed when reading a word, participants' reaction time was recorded as a complement of their electrodermal response. These measurements were used to rank the words into two different lists, conforming the set of Spanish-words. The reaction time to negative words were only significantly slower to reaction times of positive ones (and not to the neutral ones).
We found that words with a negative emotional content elicited higher skin conductance responses (SCR) and longer reaction time than those with neutral and positive emotional content. These findings are consistent with previous literature and therefore supports word's emotionality of the implemented database.

Keywords:
Spanish words, emotion, Emotional Stroop task, skin conductance, spanish-speaking population.

Resumen

Respuesta Electrodérmica y Conductual Frente a Palabras Emocionales en Español en Hablantes Nativos. El presente trabajo tuvo como objetivo validar una base de palabras en español que elicitaran diferentes niveles de respuesta emocional. Para controlar el compromiso de los sujetos con los estímulos, se administró una tarea de Stroop emocional a una población de hispanohablantes nativos. Se midió el tiempo de reacción y la respuesta electrodérmica de los sujetos. Posterior al experimento se interrogó a los participantes por la valencia emocional de cada estímulo evaluado. Finalmente, estas medidas se utilizaron para jerarquizar las palabras en dos listas, elaborando una base final de 30 palabras en español. Se encontró que las palabras con valencia negativa elicitaron mayores respuestas de conductancia de la piel y tiempos de reacción más lentos en comparación con las palabras de valencia neutra y positiva. Estos datos son consistentes con los reportados por la literatura y, por lo tanto, respaldan la emocionalidad elicitada por las palabras de la base implementada.

Palabras claves:
Palabras en español, emoción, Stroop emocional, conductancia de la piel, población hispanohablante.

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The Stroop Paradigm

The Stroop task consists of presenting the participants with visual stimuli involving words whose meanings refer to colours. Some of these words are written in a font colour that matches the colour the words refer, while others are written in a different colour. The task consists of naming the font colour in which the word is written as fast as possible (Stroop, 1935). The results of this task show that participants' responses are significantly slower when the word is written in a different colour, that is, when the font

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colour and meaning of the word are incongruent (MacLeod, 1991). This implies that, in the presence of a word called "incongruent" (as the case of the word "red" written in blue font) the response time (RT) is significantly higher compared to the response to a sequence of letters Xs or the word "blue" written in blue font. In this way, despite the fact that participants are being asked to ignore the meaning of the word, the verbal content is analysed anyway, interfering with other less automatic cognitive processes that occur simultaneously, such as stating the colour's name. (Brown, Roos-Gilbert, & Carr, 1995; LaBerge, 1990; Posner & Dehaene, 1994).

Previous work has found that words with unpleasant content such as "war" interfere more with the task of naming colours compared to to neutral words such as "table" (MacKay et al., 2004; Mathews & MacLeod, 1985). This phenomenon has been called "emotional Stroop effect" (Williams, Mathews, & MacLeod, 1996). In these studies, the task has the same instructions as the conventional Stroop task - to name the colour of the words - but the words presented have emotionally positive, negative, or neutral meanings. Previous results indicate that reaction times are higher for words with emotional content compared to words with neutral content. This effect, at the same time, is greater in the case of words with negative valence (Williams et al., 1996).

In this way, while the original Stroop task compares words with congruent colours("blue" written in blue font) with words with incongruous colours ("blue" written in red font), in the emotional Stroop task words with emotional content are compared with words with neutral content. The interference effect on the Emotional Stroop task is a result of the emotional content of the words and not of the incongruity of the words presented. Therefore, the emotional Stroop task provides an experimental measure of selective attention to emotional information (Sutton, Altarriba, Gianico, & Basnight-Brown, 2007).

Also, Frings, Englert, Wentura and Bermeitinger (2010) concluded that responses to colour words with negative valence are generally slower and more prone to error regarding words with neutral content, since attention is assigned in parallel to emotional stimuli. Some authors suggest that the mechanism responsible for the processing of information with negative emotional valence has the characteristics of being automatic, faster, and occurring earlier in the processing compared to neutral ones (Bargh & Chartrand, 1999; Williams, Watts, MacLeod, & Mathews, 1988).

It is therefore assumed that this task interferes differentially with the naming of colour through a distinct capture of attentional resources. This difference is interpreted as an attentional bias of the processing of information (Mathews & MacLeod, 1994). For example, Bailey and Bartholow (2016) studied this phenomenon using a task known as "Alcohol Stroop task" comparing the response between alcohol-related words and neutral words. Other authors suggest that is possible to implement others tasks, in order to assess the attentional bias phenomena, such as the "Dot Probe Task" (Van Bockstaele et al., 2014).

Physiological correlates

Wallin (1981) demonstrated that with normal room temperature ranges and thermoregulatory states of the subject, there is a high correlation between the level of activation of sympathetic nerve activity and skin conductance response (SCR).

The SCR is a psychophysiological measure with a high level of sensitivity (Wieland & Mefferd, 1970). Changes in this signal can be understood as evidence of changes in the cognitive or emotional state of the subject (Hugdahl, 1995). The recording of SCR is considered to be one of the most sensitive physiological measurements of emotional and cognitive activation (Hugdahl, 1995).

The autonomic nervous system is known to give an estimate of the subjects' arousal levels especially through autonomic tonic changes (Boucsein, 1993; Collet, Petit, Priez, Dittmar, 2005; Vernet-Maury, Deschaumes-Molinaro, Delhomme, & Dittmar, 1993). The physiological arousal of the subjects can be evaluated by recording the SCR during the performance of a task. As a result, the influence of the performance in arousal variation can be precisely determined. This technique provides several advantages compared to behavioral measurement methods, such as self-report, considering that this last one is a record influenced by a large number of biases, including the effects of memory (Stone, Turkkan, Bachrach, Jobe, Kurtzman, & Cain, 2000). On the other hand, the use of self-reports captures declarative states and conscious acts. However, it does not evaluate the unconscious, automatic and procedural processes that also affect behavior and mood (Bargh & Chartrand, 1999).

Skin conductance response in the emotional Stroop task

Segerstrom (2001) postulates that the use of SCR measurements makes possible to study this phenomenon that otherwise, using self-report questionnaires, would be biased. In this study, the author focused on analyzing the optimism and pessimism of different subjects regarding attentional bias towards positive and negative words, when compared to neutral words. The emotional Stroop task was used combined with the recording of participant's SCR. A significant interference effect was found in reaction times in both positive and negative words. Additionally, those negative words produced higher SCR values than positive words in both groups, but this effect was more pronounced in pessimists. These results suggest that both positive and negative words may be associated with increased electrodermal activity in an emotional Stroop task, but this effect is less in positive words than in negative words. However, other studies suggest that interference in response to words with negative emotional content does not seem to occur when using words with positive emotional content or neutral words (Eilola, Havelka, & Sharma, 2007; McKenna & Sharma, 1995). Nevertheless, these studies did not use electrophysiological measures.

Some authors have proposed cognitive theories suggesting that attentional biases for information management play an important role in the development and maintenance of anxiety disorders (MacLeod, Rutherford, Campbell, Ebsworthy, &Holker, 2002). Therefore, SCR measurements can be very useful in the study of the emotional response of humans and for the understanding of related disorders, such as borderline personality disorder (BPD), phobias, or anxiety disorders.

After a thorough review of the existing literature, it could not be found any study that have analyzed the SCR to words of the Spanish. Therefore, in order to carry out studies of the aforementioned disorders, it would be necessary to validate which words show the highest sympathetic activation effect. By doing that, it would be a first step towards future studies in Spanish-speaking populations.

The current study

Several studies (Altarriba & Basnight-Brown, 2010; Sutton et al., 2007) have analysed the emotional Stroop task with words in Spanish but only analyzing their reaction times against stimuli, showing that those times were longer for negative words.

It can be argued that a word with emotional content in a language may not have a single translation that has the same meaning in another language. For example, Altarriba (2003) described that most Spanish speakers agreed that the Spanish word "cariño" does not have an equivalent of a word in English. Therefore, a Spanish translation of the stimuli used by Eilola et al. (2007) was used to verify that its emotional assessment to the population evaluated is consistent with the assessment given to the population of the city of Buenos Aires, Argentina. Although, and as it has been mentioned before, there are studies that use lists of words with emotional content in Spanish (Altarriba & Basnight-Brown, 2010; Sutton et al., 2007), these words were not classified as "positive", "negative" and "neutral". Is for this reason that it was decided to use the list of words of Eilola et al. (2007).

The current experiment seeks to verify whether words with negative emotional content generate a greater physiological activation as well as a longer reaction time, compared to words of neutral content, as it was observed in previous works in the English language (Egloff & Hock, 2003; Eilola & Havelka, 2010).

We aimed to generate a stimuli database that elicits different levels of emotional response. In order to that, first we measure the SCR and RT to each word, and then we validate each word activation using a self-report. This database seeks to rank these stimuli so that they can be used in future studies related to emotion and language in Spanish-speaking populations. Unlike the aforementioned studies, this is the first work that performs a word analysis in Spanish by registering the SCR.

Materials and methods

Participants

We evaluated 70 subjects, four of which were discarded, due to technical problems, leaving a total of 66 subjects. All of them were university students from Universidad del Salvador, native Spanish speakers, aged between 18 and 40 years, with a mean age of 21.71 (+/- 6.38), 58 of which were women. The subjects participated voluntarily and received university credits in exchange for their participation. All subjects reported having slept at least 5 hours the night before the experiment. All were correctly informed of the objectives and characteristics of the study. The following exclusion criteria were used: 1) History of sensorimotor or neuropsychiatric diseases, 2) substance abuse, 3) knowledge about the experimental paradigms used in the experiments.

The subjects signed an informed consent of their participation in the experiments. Both consent and the methodology employed were approved by the Research department, from the Faculty of Psychology of Universidad del Salvador. International recommendations for human experimentation (American Psychological Association, 2002) were strictly followed.

Instruments

Stimuli

Stimuli consisted of 60 words extracted from Eilola et al (2007). They were sorted in three lists of 20 words each, based on their emotional content: positive, neutral and negative (see appendix A and B). All words were translated from the original base in English to Spanish by the first two authors (both native Spanish speaker), thus forming another three lists of word stimuli. The Spanish translations were matched groupwise with English words in their lexical features. We performed an analysis of the frequency, familiarity and length of the words used in the study due to these lexical features contribute to slower word recognition and therefore, are likely to contribute to delayed latencies in colour naming (Larsen, Mercer, & Balota, 2006). Lexical features analysis was performed by using the "Web interface to Spanish word frequency data and other word properties based on written and subtitle corpora" (Duchon, Perea, Sebastián-Gallés, Martí & Carreiras, 2013). Frequency was analysed using a one-way ANOVA, with emotional content as a factor (positive, neutral, negative). There was no significant difference between the conditions, F (2.57) = 1.984, p = .147. The same procedure was performed in order to analyse familiarity, showing no significant difference between the conditions, F (2.42) = 0.73, p= .488; Also, there no significant differences during the length analysis F (2.57) = 0.367, p= .694. Lexical features of the different conditions did not differ between them.

The words were presented in lower-case, in the centre of the screen with a font size 20 (Arial font). Participants were seated 60 cm from a 15-inch monitor in a room with sound and light attenuation. The computer used for the experiment was an Intel (R) Pentium (R) CPU N3540@2.16 GHz processor. The experimental tasks were programmed in Python language, using the package PsychoPy 1.81.02 (Peirce, 2009). Subjects' responses were recorded by the computer keyboard and coded as correct or incorrect.

Task

Stroop Task instructions were provided by successive messages that were presented on the PC screen, as well as verbally before the start of each task.

To record participants' SCR, their fourth and fifth finger middle phalanx of the non-dominant hand were cleaned with a disposable tissue before placing the electrodes. By doing this, the index and middle fingers of both hands were left free to press the response keys (Coen et al., 2011; Eilola & Havelka, 2010; Hamann, Monarch, & Goldstein, 2002).

Subjects were told to remain as still as possible during the task to avoid SCR recording artifacts and to maintain their visual gaze at the centre of the screen where a fixation cross was displayed (Wong, Shevrin, & Williams, 1994).

Participants performed a practice phase to learn the correspondence between colours of the words (red, green, blue, yellow) and their respective keyboard keys ("D", "F", "J ", "K"). After a one-minute break, the experimental phase began. Finally, there was an assessment phase where subjects had to rate all the words they had seen during the experimental phase.

Procedure

Practice phase

The experimental design was inspired on previous emotional Stroop studies (Mckenna, 1986; McKenna & Sharma, 1995; Sharma & Mckenna, 2001). At the presentation onset of each word, the subjects had to respond with one of four possible keys to the colour in which the word was written (Red: "D", Green: "F", Blue: "J", Yellow: "K"). They were explicitly told to ignore the meaning of the words. To begin, the first screen informed the subject that a series of words would appear, one at a time, and that they should indicate the colour of the words, ignoring the verbal content of the same. To respond, subjects were informed which keyboard button they should press depending on the colour in which the word was written. On the right side of the computer screen, a memory aid sheet with the keyboard keys corresponding to each colour was left. Subjects were told to respond as quickly and accurately as possible. If the response was incorrect, or the trial time limit was reached (3000ms), the word "error" would appear on the screen (Janczyk, Augst, & Kunde, 2014).

After the instructions were displayed on the screen, the practice phase started. In this phase, numbers (written in words, from one to twelve) were presented as stimuli. Each number was shown twice, giving a total of 24 stimuli (Egloff & Hock, 2003). The time between the onset of one stimuli and the following one was set to 7000 ms (see section Data recording). First, a fixation cross was displayed on the screen (500ms), then a black screen (500 ms), followed by the stimulus presentation (3000ms), and finally a black screen (3000 ms). If the answer was incorrect, instead of displaying the black screen for 3000ms, an error message was shown for 2000ms followed by 1000ms of a black screen. Subject's response window started at the word onset and finished at its offset, limiting the trial time to a maximum of 3000ms (Janczyk et al., 2014). Each stimulus was present at fixed time (3000 ms) regardless the subject's response. The layout of the experimental phase was identical to the practice phase (See figure 1).

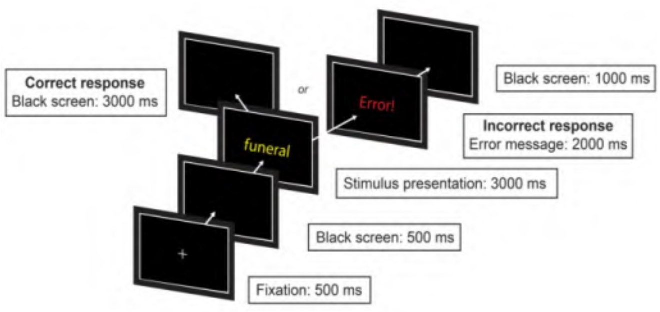

Figure 1. Schematic illustration of the experimental phase procedure. The only difference between experimental phase and practice phase was in the stimuli used at the Stimulus Presentation.

Experimental phase

Four blocks, each of 60 words, were used. All of them were randomized to avoid an order effect. Thus, on each block participants observed the set of 60 stimuli, giving as final result four responses to each *word-colour* combination.

Every word was displayed on each of the colours used in the practice block. Displaying all the possible *word-colour* combinations allowed to control for specific colour influences on subjects' reaction times (Egloff & Hock, 2003; Eilola & Havelka, 2010).

The experimental phase consisted of four blocks, interleaved by two-minute breaks. In each block 60 stimuli were presented (20 words with positive emotional content, 20 words with negative emotional content, 20 words with neutral emotional content). In this way, by the end of this phase, each participant observed 240 stimuli (attending four times each of the 60 stimuli). The experiment lasted 30 minutes on average.

Assessment phase

At the end of the experimental phase, an instruction screen appeared explaining the subjects that the words they had seen during the experiment would be displayed, one at a time. For each stimulus, they had to rate on a 5-point Likert scale, the emotional intensity perceived (1 being "Very unpleasant", 3 "Neutral" and 5 "Very pleasant") using the computer's mouse. Once this task reached its end, subjects were told that the experiment was finished. The electrodes were removed and the subjects were thanked for their participation.

Data recording

During the experimental phase, reaction times and physiological responses were recorded for each stimulus. The SCR was obtained using a constant-voltage device (NeuLog galvanic skin response logger sensor NUL-217), which is commonly used in studies of this kind (Mõttus, Lamas, & Tokranova, 2014; Kumar & Kumar, 2015). It was measure with application of direct current (exosomatic method). The sampling rate was set to 5 cycles per second, with an Analog Digital Converter (ADC) resolution of 16.0 bits (Boucsein, 1992). The electrodes were placed in the medial phalanx of the fourth and fifth fingers of the non-dominant hand of the participants. (Coen et al., 2011; Eilola & Havelka, 2010; Hamann et al., 2002)

According to Eilola and Havelka (2010), the SCR occurs between 1 and 1.5 seconds after the stimulus and can last from 2 to 6 seconds. Therefore, the time between consecutive stimuli should be at least 6 seconds long.

In the present work, the window of interest began one second after the stimulus onset (base point) and lasted 6 seconds (see figure 2). To obtain the activation level produced by each stimulus, the base point was subtracted from the maximum peak within the window of interest (Harris, Aycicegi, & Gleason, 2003; Jay, Caldwell-Harris, & King, 2008).

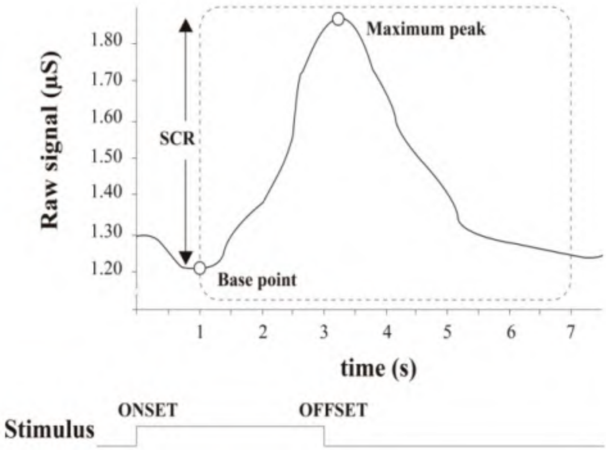

Figure 2. Schematic representation of the SCR in a single trial. The activation level was defined as the difference between the maximum value of the window of interest and the base point.

Results obtained from the physiological activation recorded by the skin conductance sensor were logarithmized in order to improve the characteristics of the distribution of electrodermal activity data (Boucsein, 2012). Also, the SCR data was transformed into Z-score as postulated by Braithwaite, Watson, Jones and Rowe (2015) in order to standardize the individual differences.

Results

All subjects achieved at least 95% of correct trials. Only correct answers were included in the analysis. Data whose RT were less than 300 ms were discarded.

Assessment phase results

Means and standard deviations of the assessment phase scores to the different conditions were as follows: stimuli with positive emotional content (*M*=4.31; *SD*=0.41), stimuli with neutral emotional content (*M*=3.17; *SD*=0.29) stimuli with negative emotional content (*M*=1.47; *SD*=0.24)

The analysis of the results obtained during the assessment phase, allowed us to exclude words that, our sampled population, rated with a different emotional content compared to Eilola et al. (2007) study. Specifically, it was observed that the stimuli "fragancia" and "campo" ("fragance" and "field", in English), which belonged to the neutral words list, scored on average higher than "Dicha" and "Acuerdo" ("blossom" and "agreement", in English), which belonged to the positive words list. This was also reflected in greater SCR in the former words compared to the latter. The threshold to be considered as a positive word was to be higher than 3.7 and the threshold to be considered as a negative word was to be lower than 2 (Check appendix to see average score per word).

Analysis of response latencies

RT's were analysed using a repeated measures ANOVA, with emotional content as a factor (positive, neutral, negative).

A main effect of emotional content was observed (F (2.65) = 5.429, p<.01, n^2p = .076). Tukey's HSD post hoc test revealed that RT's during the positive condition, were significantly faster than RT's during the negative condition (p<.01) and the neutral condition (p<.02), whereas no significant differences were found between RT's during negative and neutral conditions (see Table 1, Figure 3).

Table 1.
Mean reaction times in milliseconds of each emotional content group of words

Condition	Mean (ms)	Standard Deviation (ms)
Negative	952	187
Neutral	951	179
Positive	933	171

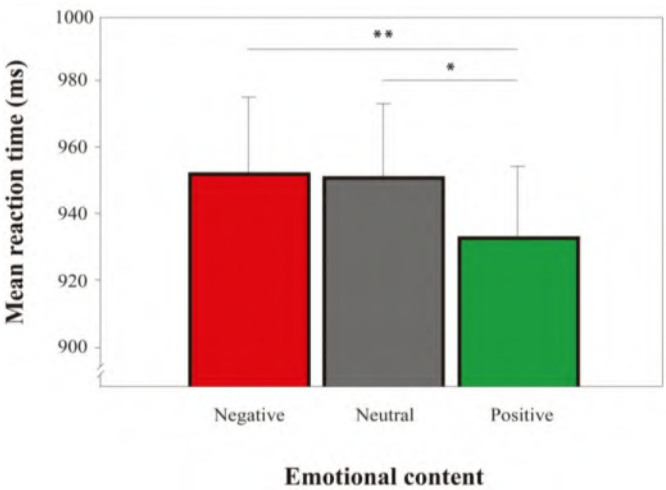

Figure 3. Mean reaction divided by emotional content. Error bars shows the standard error in each condition (N = 66). * indicate p-value < .05. ** indicate p-value < .01.

Analysis of skin conductance response

Table 2 shows, in decreasing order, the selected words ordered by their SCR.

SCRs were analysed using repeated measures ANOVA with emotional content as a factor (positive, neutral, negative). Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (2) = 6.324, p< .05), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = 0.915).

A main effect of emotional content was observed (F (2.65) = 4.793, p <.02, n^2p = ε = .915). Tukey HSD post hoc tests revealed that SCR during the negative condition had significantly greater activation than during the neutral condition (p <.01) and the positive condition (p<.04). There was no significant difference between the neutral and positive condition (p> .05) (See Table 3, see Figure 4)

Lastly, there was a positive correlation between SCR and reaction time, r = .876, p< .03.

Table 2.
Word ranking according to Skin Conductance Response

Positive				Neutral				Negative			
Word	log (µS)	Valence	RT (ms)	Word	log (µS)	Valence	RT (ms)	Word	log (µS)	Valence	RT (ms)
risa *	0.0231	4.821	944	motor *	0.0142	2.940	930	vomito	0.0250	1.537	940
paz	0.0229	4.716	909	habito *	0.0146	3.000	913	tortura	0.0232	1.194	919
recompensa *	0.0223	4.089	978	túnel	0.0147	2.835	961	abuso	0.0227	1.164	941
acuerdo	0.0209	3.611	914	gelatina	0.0148	3.238	968	funeral *	0.0225	1.313	968
vacaciones *	0.0205	4.746	948	unidad *	0.0159	3.552	929	soledad	0.0218	1.686	927
sueño	0.0202	3.776	921	taza	0.0160	3.074	967	sufrimiento	0.0215	1.313	947
alegría *	0.0200	4.746	945	vehículo *	0.0173	3.223	937	dolor *	0.0215	1.373	952
placer	0.0197	4.567	917	barril	0.0177	2.910	972	cáncer *	0.0212	1.223	990
beso *	0.0192	4.462	964	maquina *	0.0180	2.240	923	pobreza *	0.0211	1.447	953
milagro *	0.0189	4.283	958	habitante	0.0180	3.119	982	deuda *	0.0210	1.805	949

Note. Selected words ranked by their skin conductance response. Positive and negative words were arranged in increasing order, meanwhile neutral words were arranged in decreasing order. Words found in both tables (3 and 4), are marked with an asterisk (*) and therefore would reflect greater emotional response due to high SCR and large reaction times. Skin conductance response was logarithmized

Table 3.
Mean Skin Conductance Response of each emotional content group of words

Condition	Mean log(µS)	Standard Deviation log(µS)
Negative	0.020	0.014
Neutral	0.017	0.012
Positive	0.019	0.014

Discussion

The present study aimed to generate a word stimuli database in Spanish that elicits different levels of emotional response in an emotional Stroop task. By doing this, future studies on Spanish-speaking populations, related to emotion and language, could benefit from it.

For this purpose, the first step was to translate to Spanish the list of words published by Eilola et al. (2007). Next, they were ranked by their elicited SCR on a Spanish-speaking population sample. For each emotional category, ten words with the highest SCR (in the case of positive and negative words) were selected; in contrast, for the neutral category, we picked ten words with the lowest activation level (Table 2). As a result, a final list of 30 words (ten positive, ten negative and ten neutral) was obtained.

The associative effect interacts with the personal history of each subject (Acero & Morales, 2003), as shown in our sample database: verbal stimuli "fragancia" and "campo" were not valued in self-report questionnaires as neutral (as it could be expected) but as words with positive emotional content. This is possibly due to the cultural characteristics of the subjects themselves.

Other studies (Kekecs, Szekely & Varga, 2016; Moya-Albiol et al., 2001) measured the skin conductance level (SCL) during the exposure to certain stimuli. This is obtained by averaging within a block the SCR to same stimuli type. On the contrary, analyzing each stimulus based on their activation level allowed us to evaluate each word separately and generate a stimuli list of its own. Hence, it was possible to rank stimuli based on their activation level, which couldn't be possible with a SCL analysis.

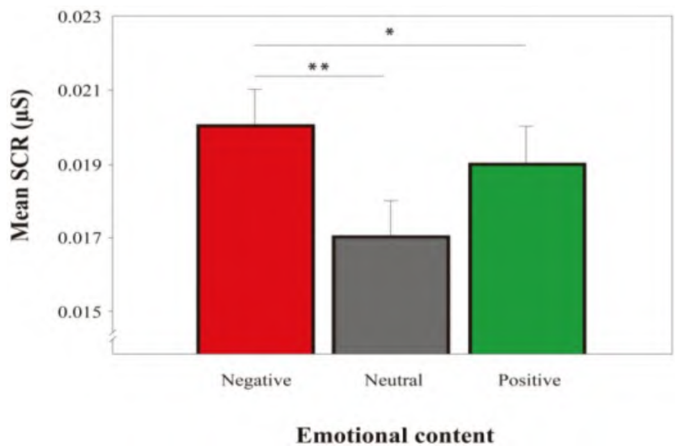

Figure 4. Mean SCR divided by emotional content. Error bars shows the standard error in each condition (*N* = 66). * indicate *p*-value < .05 ** indicate *p*-value < .01.

To support the choice of words based on SCR rank, the same selection procedure described above was followed, but now using reaction times as a measurement unit. Table 4 shows in decreasing order, the 10 chosen words for each category. Words found in both lists, are marked with an asterisk (*). Marked verbal stimuli reflect greater emotional response due to high SCR and large reaction times. As reported in the results section, there was a high correlation between these two variables and therefore, we recommend their use. However, this is not a perfect positive correlation. Therefore, although there are words that are found in both lists, the order of these does not necessarily match. This is consistent with what is proposed by Mauss, McCarter, Levenson y Wilhelm (2005) who postulate that there is not necessarily a coherence in changes across experiential, behavioral, and physiological response systems referred to emotions. In this way, for example, affective response (measured by self-reports) do not correlate necessarily with psychological arousal (SCR) and behavior (RT) (Blanchette & Richards, 2013). In addition, we must consider the influence of the variability of the technique as well as interindividual differences.

Table 4.
Word ranking according to Response Time

Positive				Neutral				Negative			
Word	RT (ms)	Valence	log (µS)	Word	RT (ms)	Valence	log (µS)	Word	RT (ms)	Valence	log (µS)
recompensa *	978	4.089	0.0223	habito *	913	3.074	0.0146	violación	1017	1.104	0.0185
beso *	964	4.462	0.0192	rociar	913	2.940	0.0188	cáncer *	990	1.223	0.0212
milagro *	959	4.283	0.0189	maquina *	924	2.940	0.0180	funeral *	968	1.313	0.0225
vacaciones *	949	4.746	0.0205	unidad *	929	3.552	0.0159	incomodidad	967	1.746	0.0164
alegría *	945	4.746	0.0200	motor *	931	2.294	0.0142	suicidio	961	1.253	0.0169
risa *	944	4.820	0.0231	cabaña	931	3.477	0.0224	perdedor	955	1.850	0.0181
emocionante	933	4.283	0.0156	vehículo *	938	3.223	0.0173	pobreza *	953	1.447	0.0211
gloria	933	4.089	0.0184	campo	940	3.716	0.0189	dolor *	952	1.373	0.0215
cariño	932	4.716	0.0172	pasillo	941	2.910	0.0213	deuda *	950	1.805	0.0210
confortable	927	4.119	0.0166	aparato	943	2.970	0.0215	matanza	950	1.402	0.0151

Note. Selected words ranked by their response time. Positive and negative words were arranged in increasing order, meanwhile neutral words were arranged in decreasing order. Words found in both tables (2 and 4), are marked with an asterisk (*) and therefore would reflect greater emotional response due to high SCR and large reaction times.

The fact that subjects performed a subjective assessment of the Spanish-translated words database, allowed us to verify that most of the stimuli (except the four cases explained in the results section) were valued with the same emotional valence as in Eilola et al., (2007). This correspondence was also reflected in their physiological activation pattern (see figure 4). Together, these findings demonstrate the reliability of the current database, reflecting a high degree of consistency between the two cultures and languages evaluated so far.

The results obtained in the present study are coherent with the results observed in previous works in English-speaking population. The stimuli with negative emotional content reflected a greater physiological compared to the other conditions (Egloff & Hock, 2003; Segerstrom, 2001). However, regarding the methodological limitations, this results can be also explained by a gender bias in the experimental sample. Fraga et al. (2011) demonstrate that females paid more attention to threatening words than to neutral ones. In addition, according to Ruskin & Talbott (1996) interindividual differences would be found mostly in females. The results of this study were obtained from a population of university students where almost 90% were women. It would be advisable for future studies to examine this results in a more heterogeneous population or to divide the sample by gender or/and educational level. This would be beneficial to improve and enlarge the current database.

The colours chosen (red, green, blue, yellow) are colours normally associated with positive valences rather than with negative or with different types of emotions (Cheng, 2002; Ou, Luo, Woodcock, & Wright, 2004). Therefore, the effect of the colours used (or of most of them) with the positive words would be congruent but negative words would be incongruent. This fact could explain the differences in RT. Therefore, we cannot discard that colour may have had an influence in the intrinsic valuation of the stimuli during the task, so it is possible that stimuli could have affected the emotional valence of the words and so, the RT. Despite this possible bias, we used the original colours according to a long tradition of Stroop task articles (Altarriba, 2003; Eilola et al, 2007; Eilola & Havelka, 2010; McKenna, 1986; McKenna & Sharma, 1995; Sharma & Mckenna, 2001). However, the reported valences (Appendix B) were not influenced by this possible bias. This is due to the valence of the stimuli was assessed without any colour (white font with black background). In any case it would be advisable in future studies to take into account this bias, and perhaps be able to balance it by introducing colours normally associated with negative stimuli (i.e. gray, brown).

Also it is important to consider that associative factors can affect performance in a Stroop task (Dalrymple-Alford, 1972). This can be seen in words associated with a particular colour (e.g., the word "grass" written in green) as they show faster responses compared to the same words displayed in other colours (e.g., the word "grass" written in blue). In order to reduce this "word-colour pairing" effect, verbal stimuli were presented in each of the four possible colours. Through previous assessment of possible biases within specific colours and words (before selecting the stimulus for the experimental task), future studies could benefit by checking that there is no confound effect in this aspect.

The small difference in RT between the negative against the neutral condition could be explained due to the fact that subjects had a considerably large time window to response (3 seconds). To be able to analyze the SCR signal, the technique requires at least 3 seconds after the stimulus onset (see section Data Recording). One possibility is that having a large inter-trial window could have diminished the Stroop task effect. Sharma & Mckenna (2001) have found that the emotionally charged words significantly slowed down the response times relative to neutral words when the stimuli were presented 32 ms after the response was given but not when the presentation interval was 240 ms or longer. This is also congruent with variations in performances measures in Traditional stroop task (Renaud & Blondin, 1997). Egloff & Hock (2003) reported results similar to ours, they do not find differences among aversive words (social threat) and neutral words in an emotional Stroop task with a 1000 ms intertrial window. A smaller response window could lead to bigger differences in RT of words with negative emotional content against words with neutral emotional content.

Finally, collecting SCR from one hand could induce a laterality bias, as suggested by Mangina and Beuzeron-Mangina (1996) and Picard, Fedor and Ayzenberg (2016). Future research recording this measure simultaneously on both hands could verify if this bias was present or not.

Summary

To summarize, the present study aimed to generate a hierarchical stimuli database of Spanish words based on their emotional response and compare it to experimental evidence from another languages. To achieve this goal, we classified the stimuli set according to their emotional valence (positive, neutral, negative) through a self-report questionnaire. Also SCR and RT were measured in order to conform the database ranking. We applied this procedure by using the emotional Stroop paradigm in a sample from the City of Buenos Aires, Argentina.

We consider the proposed methodology as a first step in the development of an useful tool for measuring emotional response to verbal stimuli. Despite the limitations mentioned above, we believe that the stimuli database can be useful for future research with Spanish-speaking population.

We expect that our study can contribute to expand the knowledge achieved so far in English-speaking cultures. Also, it opens the door to further investigation in subject's automatic response, including the study of disorders related to emotional response such as BPD, phobias, or anxiety disorders on Spanish-speaking population.el original.

Conflict of Interest.

The authors declare that they have no conflict of interest.

Ethical approval.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and the International recommendations for human experimentation from the American Psychological Association.

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