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SEÇÃO: ARTIGOS

Viver ou morrer? A influência das emoções desencadeadas por palavras nos tempos de reação manual

Living or dying? The influence of emotions triggered by words on manual reaction times

¿Viviendo o muriendo? La influencia de las emociones provocadas por las palabras en los tiempos de reacción manual

Paulo Frassinetti Delfino do Nascimento[1]
orcid.org/0000-0001-6754-3948
paulodelfinonascimento@gmail.com

Nelson Torro Alves[1]
orcid.org/0000-0003-3678-5762
nelsontorro@gmail.com

Allan Pablo do Nascimento Lameira[2]
orcid.org/0000-0001-8644-526X
allanpablolameira@gmail.com

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Resumo: Estímulos afetivos influenciam o comportamento devido a facilitações/inibições que ocorrem no sistema sensório-motor. Para estímulos positivos, respostas ipsilaterais tendem a ser facilitadas e as contralaterais inibidas. Para estímulos negativos, o padrão é invertido. Atualmente, 34 voluntários foram submetidos à Tarefa de Compatibilidade Espacial Afetiva, cujos estímulos de valência inata foram as palavras "viver" e "morrer". No mapeamento 1, executaram-se respostas ipsilaterais para a palavra "viver" e respostas contralaterais para a palavra "morrer". No mapeamento 2, ocorreu o inverso. Através da análise temporal, investigamos se e como palavras que desencadeiam emoções inatas modulam a resposta motora. No mapeamento 1, constatamos respostas ipsilaterais mais lentas à palavra "viver" do que contralaterais à palavra "morrer" (a partir do 3° quintil). Porém, no mapeamento 2, houve diferença apenas no 3° quintil. Os efeitos facilitadores da resposta contralateral ao estímulo negativo estão possivelmente associados a mecanismos automáticos de vigilância para detectar/evitar estímulos de ameaça.

Palavras-chave: tarefa de compatibilidade espacial afetiva, valência afetiva, dinâmica temporal

Abstract: Affective stimuli influence behavior due to facilitations/inhibitions that occur in the sensory-motor system. For positive stimuli, ipsilateral responses tend to be facilitated and contralateral inhibited. For negative stimuli, the pattern is reversed. Currently, 34 volunteers were submitted to the Affective Spatial Compatibility Task, whose innate valence stimuli were the words "living" and "dying". In mapping 1, ipsilateral responses were executed for the word "living" and contralateral for the word "dying". In mapping 2, the reverse occurred. Using temporal analysis, we investigated whether and how words that trigger innate emotions modulate the motor response. In mapping 1, we found slower ipsilateral responses to the word "living" than contralateral responses to the word "dying" (from the 3rd quintile). However, mapping 2 revealed a difference only in the 3rd quintile. The facilitating effects of the contralateral response to the negative stimulus are possibly associated with automatic vigilance mechanisms to detect/avoid threatening stimuli.

Keywords: affective spatial compatibility task, affective valence, temporal dynamics

Resumen: Los estímulos afectivos influyen en el comportamiento debido a las facilitaciones/inhibiciones que se producen en el sistema sensoriomotor. Para los estímulos positivos, las respuestas ipsilaterales tienden a ser facilitadas y las contralaterales inhibidas. Para los estímulos negativos, el patrón se invierte. Actualmente, 34 voluntarios fueron sometidos a la Tarea de Compatibilidad Espacial Afectiva, cuyos estímulos de valencia innata fueron las palabras "vivir" y "morir". En el mapeo 1, se ejecutaron respuestas ipsilaterales para la palabra "vivir"

[1] Federal University of Paraiba (UFPB), João Pessoa, PB, Brazil.
[2] Universidade Federal de Campina Grande (UFCG), Cajazeiras, PB, Brasil.

y contralaterales para la palabra "morir". En el mapeo 2, ocurrió lo contrario. Mediante un análisis temporal, investigamos si las palabras que desencadenan emociones innatas modulan la respuesta motora y cómo lo hacen. En el mapeo 1, encontramos respuestas ipsilaterales más lentas a la palabra "vivir" que respuestas contralaterales a la palabra "morir" (del tercer quintil). Sin embargo, el mapeo 2 reveló una diferencia sólo en el 3er quintil. Los efectos facilitadores de la respuesta contralateral al estímulo negativo están posiblemente asociados a mecanismos automáticos de vigilancia para detectar/evitar estímulos amenazantes.

Palabras clave: tarea de compatibilidad espacial afectiva, valencia afectiva, dinámica temporal

Most of the time, we are surrounded by numerous and varied stimuli that recruit our attention, demanding a cognitive and behavioral control of the individual to execute an appropriate response (Beatty & Janelle, 2020; Imbir et al., 2020). Given that attentional resources are not unlimited, some stimuli will gain preference, such as those with affective characteristics (Pool et al., 2016; Todd et al., 2018).

Affective stimuli are considered important biological sources of information, processed efficiently even in patients with damage to the striate cortex, involving vision-related processes (Gauer et al., 2019). Several theories have been proposed to explain how the emotional properties of the stimulus influence decision making. According to appraisal theories, organisms have developed a system to quickly detect stimuli that are relevant to the individual's current concerns (Moors et al., 2013; Pool et al., 2016). The amygdala quickly detects the relevance of the stimulus and increases cortical perceptual representation, making it more salient and likely to divert attention (Brosch, et al., 2013, 2011; Verhage et al., 2018). On the other hand, the basic theory of emotion proposes that emotions are sustained by distinct psychological mechanisms (Ekman, 1992). Positive and negative stimuli, such as joy and fear, have different routes of attentional engagement and motivate approach and avoidance reactions, respectively (Blakemore & Vuilleumier, 2017; Estes & Verges, 2008; Krieglmeyer & Deutsch, 2013, 2010).

In order to understand how emotional stimuli influence inhibitory control (the ability to control attention, thoughts and behaviors while ignoring internal impulses or the automatic capture of attention by external stimuli), varied classes of stimuli have been used, such as emotional faces (Nascimento et al, 2018; Heyes & Catmur, 2022; Shaham, Mortillaro & Aviezer, 2020), pictures (Cavallet et al., 2016, Conde et al, 2018, 2014a,b, 2011; Yamaguchi et al., 2019, 2018), auditory (Carlson, Conger & Sterr, 2018; Ferri et al., 2015) and linguistic stimuli (emotional words) (Arioli, et al., 2021; Imbir et al., 2020; Nascimento et al., 2020; Robinson & Fetterman, 2015).

The preference for the processing of emotional stimuli, especially the negative ones, is possibly linked to evolutionary strategies that deal with threats (Flykt, 2006; Ohman & Mineka, 2001; Zsido et al., 2019). According to Bebbington et al. (2017), we are more attentive, and prepared to defend ourselves, in dangerous situations than in positive settings. Thus, organisms have developed an innate and automatic system orchestrated by the amygdala, responsible for directing attentional resources toward biologically relevant threats (e.g., snakes, spiders, guns) (Åhs et al., 2018).

Using different experimental paradigms, such as the spatial compatibility task, several studies have reported the influence of affective features on inhibitory control. Essentially, the appearance of a neutral stimulus in the right or left visual hemifield triggers the automatic orientation of attention to its position, facilitating motor responses on the same side (Azaad et al., 2019; Lameira et al., 2015; Umiltà & Nicoletti, 1990). However, through the use of an experimental protocol developed by Conde and collaborators (2014a), the Affective Spatial Compatibility Task, studies have found that the emotional properties of the stimulus may modulate the behavioral responses. In general, ipsilateral responses are faster to positive stimuli than to the negative ones, while an opposite pattern occurs to negative stimuli, with faster contralateral responses to the stimulus position (Cavallet et al., 2016; Conde et al., 2014a, 2011; Nascimento et al., 2020; Yamaguchi et al., 2019, 2018).

Recently, using the same protocol, Nascimento et al. (2020), evaluated behavioral tendencies to words with affective valence. Unlike previous studies that used pictures as emotional stimuli (silhouettes of soccer players, flowers, and spiders), they used the names of the candidates for the presidency of Brazil in the 2018 elections, selected according to the participant's preference (favorite/positive candidate and rival/negative candidate). The results were similar to the aforementioned studies, showing that ipsilateral responses for the favorite candidate (positive valence) were faster and more accurate than contralateral responses. For the least preferred candidate (negative valence), on the other hand, responses were faster and more accurate when made with the contralateral key. In other words, they found that words, more precisely, the names of people relevant to the individual, were sufficiently strong to modulate the spatial compatibility effect.

Lucas et al. (2019) found that the name of someone known elicits emotional reactions associated with the person, similar to the view of the face. Other works have shown an increase in heart rate and skin conductance, as well changes in the P300 and P200 components, when individuals see the names of relevant people to themselves (Doradzińska et al., 2020; Kotlewska & Nowicka, 2015; Tacikowski et al., 2014, 2013).

Unlike previous studies, which analyzed responses to learned affective stimuli, such as names of favorite and rival candidates, here we evaluated responses to linguistic stimuli with innate valence (living and dying), situated at the extremes of affective polarity. Volunteers were submitted to the Affective Spatial Compatibility Task, consisting of four experimental blocks. In two blocks, volunteers were instructed to press the ipsilateral key for the word "living" and the contralateral key for the word "dying"; and, in the other two blocks, the rule was inverted.

Method

Participants

Thirty-four participants (17 males, 18 to 26 years old, mean age = 21.4 years, SD = 1.75) performed the experiment. All were right-handed, assessed by the Edinburgh Handedness Inventory (Oldfield, 1971), had normal visual acuity or were wearing corrective lenses at the time of the experiment, and were naïve about the main purpose of the study. The research was conducted according to the most recent version of the Helsinki declaration and approved by the ethics committee of the institution, under the protocol CAAE: 95153218.2.1001.5188 (Approval Opinion: 2.924.896).

Apparatus and Stimuli

The experiment was conducted in a quiet, dimly lit room. A desktop computer was used for presenting the stimuli and recording the responses. Participants were positioned on an adjustable forehead and chin rest, so that the distance between their eyes and the screen remained at about 57 cm. The stimuli were displayed on a 28'' HDMI monitor with a resolution of 1024 by 768 pixels and a refresh rate of 100hz. The presentation of the stimuli and data collection were performed using E-Prime version 2.0 (Psychology Software Tools, Pittsburgh, Pa). Responses occurred by pressing the "A" (left) and "6" (right) keys of a standard ABNT2 keyboard.

The stimuli used were the words "LIVING" and "DYING", which were 1.5° in height and different in width due to the number of letters. The largest (DEAD) was 8.3° wide, and the smallest was 6.9° wide. All words were written in black, capital letters and against a light gray background.

Procedure

We applied a procedure similar to that used by Nascimento et al. (2020). The volunteers started the experimental session consisting of four blocks, each with 80 trials. Before the first and third block, everyone underwent a training block consisting of 40 trials. Each trial started with the fixation point (+) remaining in the center of the screen for 500ms, followed by the appearance of the stimulus in the right or left visual hemifield that remained on the screen until the participant's response and/or up to 1000ms. After responses, a 250ms feedback in the center of the screen revealed the reaction time in blue for the correct response or the word "error" in red for an incorrect response.

In two blocks of 80 trials, participants were instructed to respond according to mapping rule 1: Press the key located on the same side of the stimulus when viewing the word "LIVING" (ipsilateral response/compatible condition) and press the key on the opposite side of the stimulus when viewing the word "DYING" (contralateral response/incompatible condition). In the other two blocks, the inverse rule was used (mapping rule 2): Press the key on the opposite side of the stimulus when viewing the word "LIVING" (contralateral response/incompatible condition) and press the key located on the same side of the stimulus when viewing the word "DYING" (ipsilateral response/compatible condition). It is worth noting that the sequence of presentation of the trials (stimuli) occurred randomly and the order of the blocks in each task was counterbalanced across all participants (Figure 1).

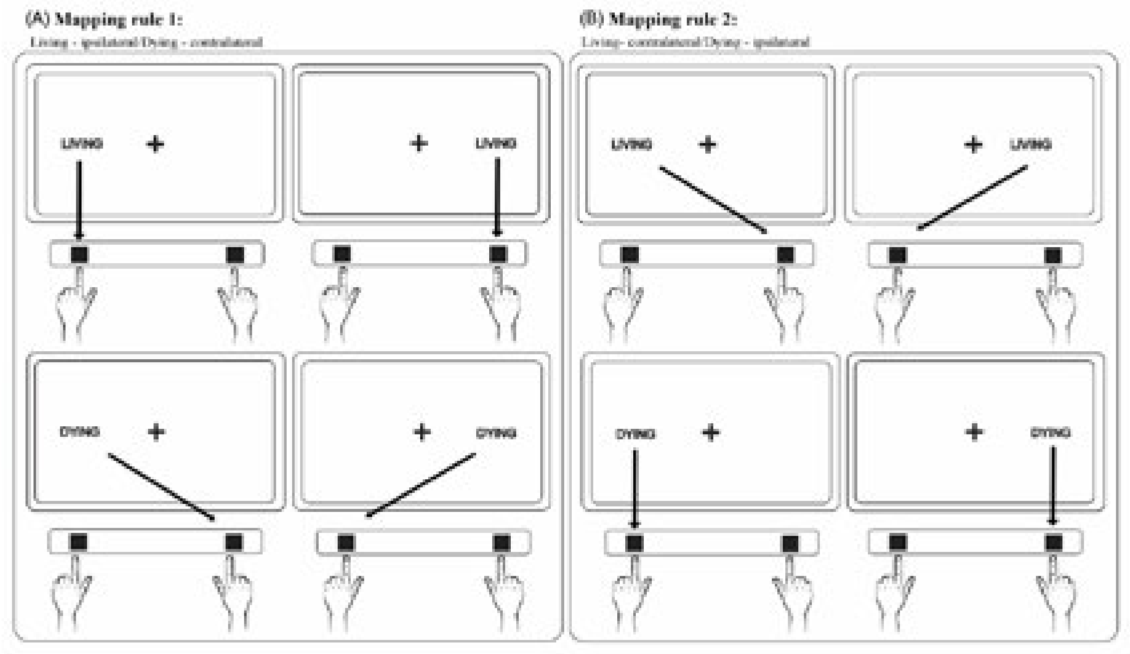

Figure 1. schematic showing the two mapping rules used in the experiment. In Mapping Rule 1, the instruction was "Press the key located on the same side of the stimulus when the word "LIVING" appears (Ipsilateral Response/Compatible Condition) and press the key located on the opposite side of the stimulus when the word "DYING" appears (Contralateral Response/Incompatible Condition). In mapping rule 2, the reverse rule was used.

Analysis

The TRM obtained in each experimental condition were submitted to temporal dynamics analysis that makes it possible to distinguish the mechanisms responsible for the spatial compatibility effect, such as the interference of affective valences on the TRM. In experimental psychology, reaction times analyses are usually performed with the mean value of the responses. However, the analysis of overall averages for each experimental condition, with the inclusion of outliers, may camouflage significant differences (Leys et al., 2013). According to Ratcliff (1979), distributional analyses are important tools to understand the mechanisms at work in reaction times tasks, because mean-based models may falsify the real behavior of the volunteer. In other words, the analysis of performance cannot be based only on the accuracy of a response, but must take into account the time required to capture, process, and produce a response to a target stimulus.

In this process, the distributional analysis of the TRMs (Ridderinkhof, 2002) occured through the Vincentization procedure (Ratcliff, 1979), followed by the construction of Delta-plots (De Jong et al., 1994). This analysis consists in ordering the TRMs in each experimental condition, divided into percentiles. By using the average of each percentile, the differences between incompatible and compatible conditions are calculated and represented as to the amplitude of the spatial compatibility effect. Next, after obtaining the averages in each percentile, the TRMs were submitted to an ANOVA with the following factors: Mapping Rule (mapping rule 1 and mapping rule 2), Compatibility (compatible and incompatible conditions), and bin (from 1º to 5º). Finally, planned comparisons were used for further analysis of the differences between conditions (Tagliabue et al., 2007). All analyses were performed using the statistical software SPSS version 25.0 and Statistica version 10.0 (StatSoft, Inc. 2007, www.statsoft.com) and differences were considered statistically significant with a value of $\alpha < 0.05$.

Results

Considering the factors of Mapping Rule, Compatibility and Bin, the ANOVA revealed a significant three-way interaction [$F(1,33) = 3.377$ $p = .01$, $\eta 2 = 0.92$]. To explore the sources of the interactions between Mapping Rule, Compatibility, and Bin, planned comparisons were made and showed that:

1. For mapping rule 1, the TRMs were faster for the word "dying" (contralateral response/incompatible condition) than for the word "living" (ipsilateral response/compatible condition) with significant difference from the third temporal interval on: 3º quintile (p=0.04) and 4º quintile (p=0.01), with TRMs of 596ms (live) and 582 ms (die) for the third interval (SCR effect - stimulus-response compatibility: 14ms), 651ms (live) and 635ms (die) for the fourth temporal interval (SCR effect of 16ms);

2. For Mapping 2, the TRMs were faster for the word "living" (contralateral response/incompatible condition) than for the word "dying" (ipsilateral response/compatible condition) with significant difference only in the third time interval: 3º quintile (p=0.039), 593 (living) and 607 (dying) (Figure 2);

3. the TRMs for the incompatible condition with the word "dying" in mapping rule 1 are faster than for mapping rule 2 (compatible condition), with significant differences in the third and fourth interval: 3º quintile (p=0.03) and 4º quintile (p=0.005), with TRMs of 578ms (mapping rule 1) and 607 ms (mapping rule 2) for the third interval (SCR effect of -29ms), 635ms (mapping rule 1) and 664ms (mapping rule 2) for the fourth temporal interval (SCR effect of -29ms);

4. No significant difference occurred between responses in mapping rule 1 (ipsilateral key/compatible condition) and mapping rule 2 (contralateral key/incompatible condition) for the word "living".

Error analysis

The TRMs of the wrong answers (corresponding to 8% of the total) were submitted to an ANOVA with the factors of Mapping Rule (mapping rule 1 and mapping rule 2), Compatibility (compatible and incompatible conditions) and Bin (from 1º to 5º). We found no significant effect for the main factors or interactions. The percentages of errors were 3% and 4% for mapping rules 1 and 2, respectively. For both stimuli (living and dying), the error percentage remained at 4%. The absence of significant effects indicates that stimulus valence, mapping rule, and spatial compatibility do not affect participants' judgment errors.

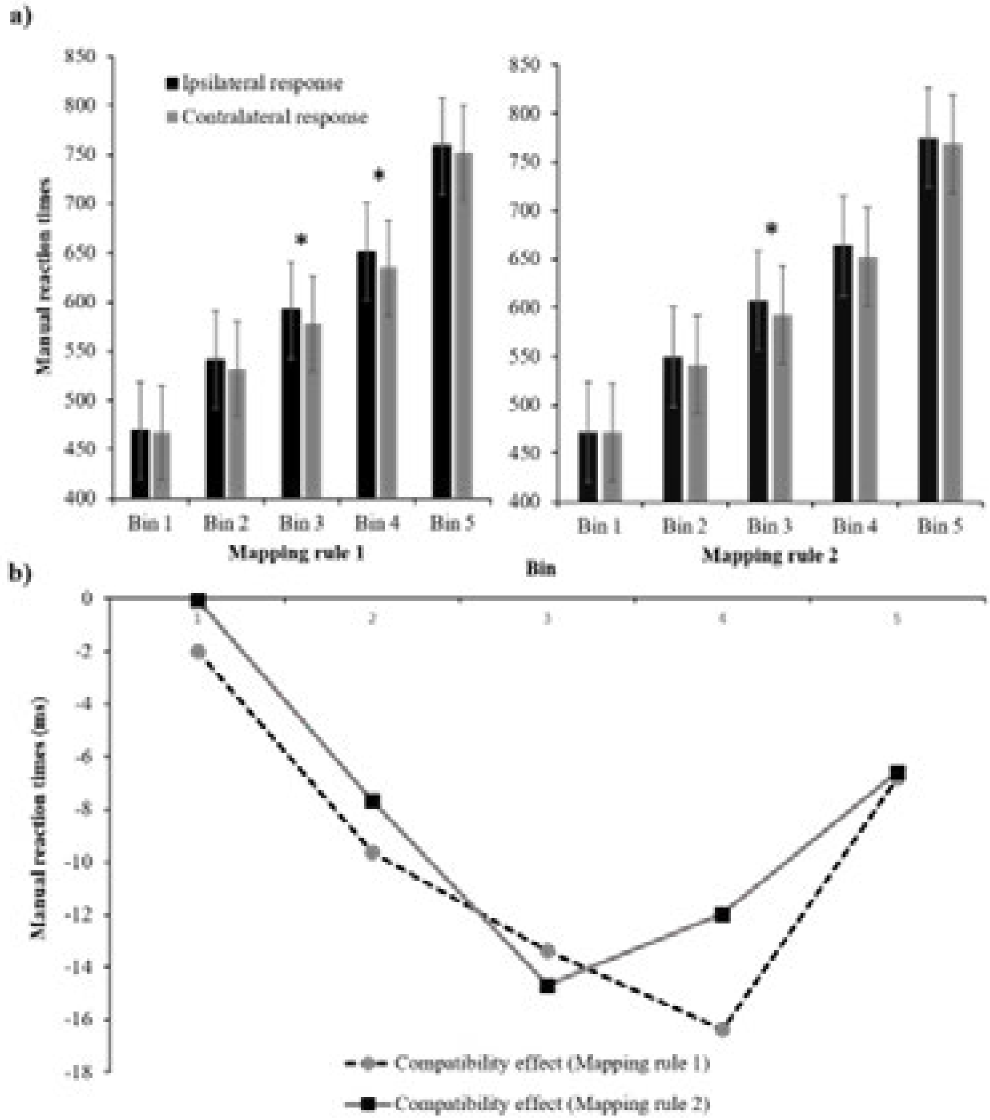

Figure 2. Interaction between mapping rule, compatibility, and bin. A) Anova of repeated measures (n = 34). Bars represent the standard error and the symbol (*), the significant differences (p < .05); B) Delta-plot representing the difference between incompatible and compatible conditions in each mapping rule.

Discussion

The planning of motor actions is strongly dependent on the spatial position of the target. Even when irrelevant to the response selection, spatial location cannot be ignored (Fraga-Filho et al. 2018; Tsal & Lavie, 1993). For example, manual responses are more accurate and faster to visual stimuli presented ipsilaterally compared to that presented contralaterally. However, in addition to the spatial position, stimuli may have an emotional meaning for the individual, either with a positive or a negative valence. Studies show that affective stimuli interfere in decision making, inducing approach and avoidance reactions to positive and negative stimuli, respectively (Cavallet et al., 2016; Chen & Bargh, 1999; Conde et al., 2011; Nascimento et al., 2020; Torro-Alves et al., 2008).

Studies have shown that different affective stimuli (pictures of soccer players, spiders, and flowers) may modulated the spatial compatibility effect. TRMs were faster and more accurate when ipsilateral responses were performed for the positive stimulus and contralateral for the negative stimulus, compared to the opposite pattern (for more details see Conde et al., 2014a, b, 2011; Yamaguchi et al., 2018). However, differently from previous studies, which used linguistic stimuli of learned valence (candidate names), we investigated here the motor responses to linguistic stimuli with innate valence ("living" and "dying").

The analysis revealed no differences between ipsilateral and contralateral responses for the word "living". However, for the word "dying", ipsilateral responses (compatible condition) were slower than the contralateral ones (incompatible condition). By analyzing the results within the same block, we found that, for the mapping 1, the ipsilateral responses to the word "living" were slower than contralateral responses to the word "dying". On the other hand, for the mapping 2, the contralateral responses to the word "living" were faster than the ipsilateral responses to the word "dying", but with a statistically significant difference found only in the third temporal interval.

Although our results disagree with other studies using the Affective Spatial Compatibility Task, such as when names of presidential candidates were used as affective stimuli (Nascimento et al., 2020), there is evidence that the modulation of response times may be greater to negative stimuli compared to the positive ones (Joseph et al., 2020; Holas et al., 2018; Smith et al., 2003). Basically, negative stimuli, such as the word "death", attract more quickly and accurately the attention due to the automatic processes of detection and avoidance of danger (Estes & Verges, 2008; Fazio, 2001; Neumann et al. 2003). In other words, the action of avoiding danger recruits greater attentional resources to generate accurate and immediate responses. However, for positive values, such as eating, dancing or living, the responses become less immediate compared to warding off a negative result (Flykt, 2006; Ohman & Mineka, 2001; Pratto & John 1991).

In order to contrast the work of Nascimento et al. (2020) to the present study, we need to consider two main aspects of the emotional stimulus: 1) the valence, which correspond to how positive and negative someone feels about the stimulus; and 2) the arousal, which correspond to physiological reactions induced by the stimulus (Nealis et al., 2016). In other words, in addition to having different polarities, words vary in relevance for the subject, influencing the attentional recruitment and emotional arousal. In a neurobiological model, during the view of a negative stimulus, the amygdala has excitatory efferences on the lateral and dorsolateral regions of the periaqueductal gray, stimulating the pyramidal tract to produce fight and/or escape reactions (Berne & Levy, 2018; Burke, 2007; Hall & Guyton, 2017; LeDoux, 2003).

Therefore, the divergence between the results may be due to the use of not innate affective signs (names of the political personalities) by Nascimento et al. (2020), that resulted in a lower level of excitement and emotional value, compared to the words "living" and "dying". In that case, the emotional value attributed by the volunteers may be a result of several factors, such as family influence, media, lived experiences, and future hopes. Thus, the speed of response of the individual to stimuli related to politics varies depending on how politically involved the participants are (Huckfeldt et al., 1999).

In the present study, the faster contralateral responses to the word "dying" than ipsilateral responses to the word "living", in mapping rule 1, may have resulted from the high level of excitability to innate stimuli. Because of its relevance to the individual, the attentional mechanisms remain active (automatic vigilance), favoring a preparation of the motor system to the negative stimulus (dying) that overcomes the facilitation of ipsilateral responses to the positive stimulus (living) (Estes & Verges, 2008). For mapping rule 2, the attention recruitment for the word "dying" remains, but ipsilateral responses are strongly suppressed, causing slowness of response (higher TRMs) compared to the contralateral response to "living".

Finally, the analysis of temporal dynamics revealed that the mechanisms of processing and integration of the characteristics relevant to the response (affective valence, spatial location of the stimulus, and response key) takes time to be effective. As TRMs increased, responses were influenced not only by the automatic orientation of attention to the stimuli, but also by its valence/excitability, resulting in the modulation of the spatial compatibility effect, potentiated by the automatic vigilance for negative stimuli that enables faster motor reactions.

Conclusion

In the present study, we analyzed the influence of linguistic elements with innate emotional valence on cognitive-behavioral control. Results showed that words with strong emotional value may modulate the spatial compatibility effect, generating effects equivalent to those observed in studies that used pictures as affective stimuli. However, lower motor latency responses for the word dying indicate that the influence of valence does not occur equally for any class of stimulus but depends on the degree of representativeness/excitability to the individual (greater for innate affective stimuli compared to the acquired ones).

Finally, results shed light on the role of the affective valence on the inhibitory control, which evidences the applicability of the Affective Spatial Compatibility Task as a sensitive protocol to analyze how the mechanisms of automatic orientation, spatial localization and processing of affective features interact with each other. This protocol may have clinical applicability, for example, to understand the suppressive mechanisms in syndromes, such as Asperger's, Autistic Spectrum Disorder and Parkinson's Disease. Likewise, it is possible to be applied in sports (training of attentional capacity, agility, motor efficiency in the presence of affective stimuli) and health (evaluating the impact of work stress on cognition of health professionals).

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Paulo Frassinetti Delfino do Nascimento

Mestre em Neurociência Cognitiva e Comportamento pela Universidade Federal da Paraíba (UFPB), em João Pessoa, PB, Brasil; graduado em Enfermagem pela Universidade Federal de Campina Grande (UFCG), em Cajazeiras, PB, Brasil. Doutorando em Neurociência Cognitiva e Comportamento pela Universidade Federal da Paraíba (UFPB), em João Pessoa-PB; bolsista Capes e pesquisador do Laboratório de Ciências Cognitivas e Percepção (LACOP/UFPB) e do Laboratório de Cognição e Comportamento (LaCC/UFCG).

Nelson Torro Alves

Doutor e mestre em Psicobiologia pela Universidade de São Paulo (USP), em Ribeirão Preto, SP, Brasil; graduado em Psicologia pela Universidade de São Paulo (USP), em Ribeirão Preto, SP, Brasil. Professor da Universidade Federal da Paraíba em João Pessoa, PB, Brasil; coordenador do Laboratório de Ciências Cognitivas e Percepção (LACOP/UFPB).

Allan Pablo do Nascimento Lameira

Doutor em Neurociência pela Universidade Federal Fluminense (UFF), em Niterói, RJ, Brasil; mestre em Neuroimunologia pela Universidade Federal Fluminense (UFF), em Niterói, RJ, Brasil. Professor da Universidade Federal de Campinas Grande (UFCG), em Cajazeiras, PB, Brasil; coordenador do Laboratório de Cognição e Comportamento (LaCC/UFCG).

Mailing address

Paulo Frassinetti Delfino do Nascimento

Universidade Federal da Paraíba

Campus I, Bloco C - CCHLA, LACOP

Castelo Branco, 58051-900

João Pessoa, PB. Brasil

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