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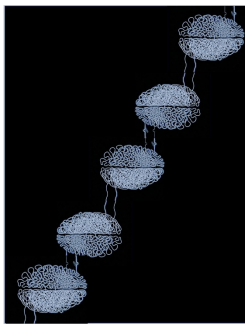

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Is Negative Affect that Bad? The Effect of Affective States on Conventional and Unconventional Creative Thinking in University Students

¿Es el afecto negativo tan malo así? El efecto de los estados afectivos en el pensamiento creativo convencional y no convencional en estudiantes universitarios.

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Abstract.
Introduction. The role of affective states on the creative process has been receiving the attention of researchers and has led to contradictory results. Most research in creativity has emphasized the role of affective states, mainly positive ones, on creativity levels, namely those resulting from divergent thinking tasks that reveal the unconventional way of thinking in the creative process. However, there are no studies to date that focus on the impact of affective states on conventional and unconventional thinking, during the same creative process, which consider a single creative assessment task. The aim of this experimental study was to analyze the effect of induced affective states on both conventional and unconventional thinking of creativity in adults by using the TCT-DP (Test for Creative Thinking-Drawing Production). **Method.** Seventy-five university students, mostly female, with a mean age of 26.95 years, were randomly assigned into three affect elicitation conditions (pleasant vs. unpleasant vs. neutral). **Results.** Results indicated that the negative affective state led to higher levels of conventional thinking when compared to positive and neutral affective states. However, no significant differences were found on unconventional thinking across the three conditions. **Conclusions.** Our results do not support the assumption that the negative affect has a hindering effect on creativity nor the positive affect increases creativity. Negative affect seems to promote conventional thinking, perhaps due to its cognitive correlates, which can be manifested in focusing attention and analytic thinking. Practical and theoretical implications for future research on the role of affective states on creativity are discussed.

Resumen.
Introducción. El papel de los estados afectivos en el proceso creativo ha sido objeto de atención por parte de los investigadores y ha dado lugar a resultados contradictorios. La mayor parte de la investigación en creatividad ha hecho hincapié en el papel de los estados afectivos, principalmente los positivos, sobre los niveles de creatividad. A saber, los resultantes de las tareas de pensamiento divergente que revelan la forma no convencional de pensar en el proceso creativo. Este estudio tuvo como objetivo analizar el efecto de los estados afectivos inducidos en dos dimensiones distintas del pensamiento creativo en adultos. **Método.** Setenta y cinco voluntarios, en su mayoría mujeres, con una edad media de 26.95 años, fueron asignados aleatoriamente a tres condiciones de elicitación de estados afectivos (agradable vs desagradable vs neutral), justo antes de realizar una tarea de creatividad figurativa. **Resultados.** Los resultados indicaron que el estado afectivo negativo condujo a niveles más altos de pensamiento convencional. **Conclusiones.** Nuestros resultados no apoyan ni la hipótesis de que el afecto negativo tiene un efecto perjudicial sobre la creatividad ni la de que el afecto positivo aumenta la creatividad. El afecto negativo parece promover el pensamiento convencional, quizá debido a sus correlatos cognitivos, que pueden manifestarse en la atención focalizada y el pensamiento analítico. Se discuten las implicaciones prácticas y teóricas para futuras investigaciones sobre el papel de los estados afectivos en la creatividad.

Keywords.
Creativity; Conventional Thinking; Unconventional Thinking; Affective States; TCT-DP; Eye Tracking.

Palabras Clave.
creatividad, pensamiento convencional, pensamiento no convencional, estados afectivos, TCT-DP, seguimiento ocular.

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1. Introduction

Nowadays, creativity is one of the most highly appreciated thinking skills, for society, in general, and for organizations (Glaveanu et al., 2020). Organizational and educational systems are interested in the development of creative performance, seeking excellence and competitiveness (Amabile et al., 2005; Conner et al., 2016; To et al., 2021). Thus, there has been increasing efforts in creativity research, trying to both define and assess it (Lúcio & Chiodi, 2021).

Considering the creative process, many authors focus on the definition of its several dimensions. Guilford (1950) named fluency, flexibility, elaboration and originality which seem to be present and possibly investigated and stimulated in every one of us. Therefore, should be investigated further to understand its potential.

This type of creativity, the Little-C creativity, had the merit of being able to look beyond Big-C, considered the exclusive creativity of the great geniuses of science, art, or technology (Beghetto & Kaufman, 2007; Kaufman & Beghetto, 2009). Other dimensions of divergent thinking were pointed out, such as insight (Baas et al., 2008), remote association (Mednick, 1962) or openness and tolerance to ambiguity (Zenasni et al., 2008). Other researchers regarded the creative process as a problem-solving process. More recently, Mumford et al. (2012) pointed out a sequence of eight cognitive processes, in addition to the process of generating ideas, emphasizing, for example, the process of evaluating ideas or their implementation. The neglect of the idea evaluation process has been particularly criticized (e.g., Amabile, 1996; Lai et al., 2020; Watts et al., 2019; Zeng et al., 2011).

Despite the complexity of the operationalization of creativity, there has been extensive research into the effect that affective states might have on creativity (Biss et al., 2010; Forgas & George, 2001; Zenasni & Lubart, 2008). However, contradictory results have emerged where some results support that positive affect facilitates creativity (Forgas, 2000; Shin et al., 2016) and others do not (Watts et al., 2019). Yet, others defend that negative affect has a damaging effect (Kaufmann & Vosburg, 2002), namely on cognitive flexibility (Isen et al., 1987), whereas some authors (George & Zhou, 2002, 2007) suggest the benefits of the negative affect. Still, there are other researchers who have pointed out the contradictory results concerning the effect of neutral affective states on creativity (Bass, 2019).

To clear up these contradictions, several approaches have emerged. The dual pathway to creativity model developed by De Dreu et al. (2008) considers that creativity can be achieved through different paths, depending on two affective dimensions: the hedonic valence (e.g., pleasantness) and the level of arousal. In the case of high-arousal positive affective states, namely happiness and elatedness, creativity can be achieved through enhanced cognitive flexibility, set-breaking and cognitive restructuring, which manifests itself in the use of broad and inclusive cognitive categories or remote associations (a signal of flexibility). According to Fiedler (2000) and George and Zhou (2007), a positive affective state can lead individuals to feel safe and problem free, less constrained to take risks, and to explore new possibilities in a loose way, relying on heuristics processing styles. Inversely, the high-arousal negative affective states, such as anxiety and fear, could lead to narrow cognitive categories, lower ability to attention shift, and lower cognitive flexibility (De Dreu et al., 2008). However, creativity could be achieved in this case through enhanced perseverance and persistence, which manifests itself in prolonged effort, long time-on-task, and more insights within a low number of cognitive categories.

Kaufmann (2003) also tries to solve the apparent contradiction between studies, considering the interaction effect between the hedonic valence (positive/pleasant and negative/unpleasant) of affective states and the nature of creative tasks. A positive affective state seems to benefit creativity within tasks that require the generation of ideas, cognitive flexibility, and originality. Yet, a negative affective state induces a careful and cautious strategy that aims to correct something that is wrong, which would be more suitable when the creative task is a problem-solving one, demanding a detailed information-processing style for an optimal solution.

Furthermore, affect induction techniques have also been questioned and their greater complexity has been highlighted. Walla and Panksepp (2013) questioned about the emotions actually elicited, beyond what the researchers specifically wanted to elicit. Also, according to Bledow et al. (2013), the impact on creative performance also depends on the amplitude of the affective shift. A change from a negative to a positive affect would have more impact on the production of flexible ideas than a change from a neutral to a positive affective state. Experiencing each of the affective states would allow simultaneously accessing remote associations (in positive affective states) and analyzing possible limitations or gaps in possible solutions (in negative affective states). Lai et al. (2020) found positive effects in the first phase of idea generation for subjects who were induced into a positive affective state. However, they did not find differences between subjects as a function of shift amplitude. Furthermore, the authors explored the impact of shifting to a negative affect on the evaluation process, but the results did not support the affective shift.

The complexity of the relation between affective states and creativity also arises from the fact that creativity can no longer be seen as merely dependent on divergent thinking, often called unconventional thinking, but as equally dependent on convergent thinking or conventional thinking that has the function of analyzing, evaluating, and selecting the best among all the novel ideas (e.g., Guilford, 1950; Jaarsveld et al., 2012; Kim, 2006; Runco, 2007;

Shavinina, 2001; Sternberg, 2006). Most traditional assessment creativity tasks give quantitative information about restricted aspects of creativity and do not allow us to assess crucial aspects of unconventional and conventional thinking. In order to surpass these limitations, the Test for Creative Thinking-Drawing Production (TCT-DP; Urban & Jellen, 1996) has been used in creativity studies to explore the potential different levels of both unconventional and conventional thinking, whether in the employed population (Ibérico Nogueira et al., 2019; Ibérico Nogueira & Almeida, 2019), university population (Ibérico Nogueira et al., 2017b), or in school population (Ibérico Nogueira et al., 2017a, 2018).

Acknowledging the relationship between creativity and affective states, we believe that it is necessary to explore another gap. Thus, the aim of the present study is to investigate whether different induced affective states impact both on conventional and unconventional dimensions of creative thinking, assessed at the same time by the same instrument, the TCT-DP, in university students. We used the concept of affective states as the most generic term that can be defined as the conscious experience of feeling that blends the two dimensions of hedonic valence and arousal (Russell, 1980).

2. Method

2.1 Participants

Our convenience sample consisted of 75 university students, with ages ranging from 18 to 55 years old (M = 26.95; SD = 8.33). Of these, 61.3% were female ($n = 46$) and 38.7% were male ($n = 29$). Most participants were from social sciences (61.2%; $n = 41$), 17.9% from engineering ($n = 12$), 10.4% from natural sciences ($n = 7$), 6.0% from economics ($n = 4$), and 4.5% from arts ($n = 3$). Regarding the year of study, most participants were in the second year (54.2%; $n = 39$), 27.8% in the first year ($n = 20$), 15.3% in the third year and 2.8% in the fourth year ($n = 2$). Participants were recruited by announcement in the classroom and were not paid for their participation. All participants reported normal medical history with no visual problems and were not aware to the experimental procedure. Participants reported normal medical history with no visual problems. All participants were treated in accordance with the American Psychological Association's ethical code (2017) and provided informed consent prior to the experiment. Participants were not aware of the experimental procedure to come while completing this phase.

2.2 Measures and Materials

2.2.1 Sociodemographic Questionnaire

The following sociodemographic information was collected: sex, age, citizenship, area of study, year of study, and medical history.

2.2.2 Test for Creative Thinking-Drawing Production (TCT-DP) of Urban and Jellen (1996)

The TCT-DP is based on a componential model of creativity with six components that are responsible for creative performance, namely divergent thinking, general knowledge base, specific skills, task commitment, motives and openness, and tolerance of ambiguity. Usually, it is considered a culture-fair test because of its figurative nature, demanding for an elaboration of a drawing from six basic fragments on a sheet of paper. It aims to evaluate the creative potential, based on composition, elaboration, gestalt, breaking limits, risk-taking, unconventionality, humour and affectivity. There are two parallel forms (A and B), with opposite patterns that are 180 degrees reversed, which supports both the pre and post-test assessment phases. The Portuguese version of the TCT-DP supports a two-factor structure that seems to represent the unconventional and the conventional ways of thinking (see Ibérico Nogueira et al., 2017a). TCT-DP has shown good psychometric properties (e.g., Almeida & Ibérico Nogueira, 2010; Ibérico Nogueira, et al., 2017a). TCT-DP overall score varies from 0 to 66. The higher the TCT-DP score, the higher the creativity level. In the present study, Form A showed acceptable internal consistency for both conventional ($\alpha = .61$) and unconventional ($\alpha = .61$) (DeVellis, 1991). Form B also showed acceptable internal consistency for both dimensions ($\alpha_{\text{conventional}} = .64$; $\alpha_{\text{unconventional}} = .78$).

2.2.3 Positive Affect and Negative Affect Schedule (PANAS) - Watson et al. (1988)

The PANAS is a bidimensional measure that was developed to assess emotional states, consisting of a 20-item list of positive and negative adjectives. Participants used a five-point Likert type scale that ranged from 1 = "not at all" to 5 = "extremely". The Portuguese version of PANAS has presented good internal consistency from .85 to .89 (Galinha & Pais-Ribeiro, 2005). In the present study, the internal consistency of the positive affect subscale was adequate, ranging Cronbach's alpha from .72 (pre-assessment) to .83 (post-assessment). Similar internal consistency was found for the negative affect subscale (Cronbach's alpha = .79 for both pre- and post-affective elicitation task).

2.2.4 Pupil size as a psychophysiological index

The pupil size is a very sensitive psychophysiological index, which reflects autonomic activation due to emotional arousal and presents three main advantages to other psychophysiological measures (see Gamito & Rosa, 2014): 1) it is an unobtrusive measure as the participant do not need to be attached to any device, which is a protective action against COVID-19; 2) enables the recording of implicit measures (participants are not aware that their eye movements are being recorded), preventing social desirability (Carvalho & Rosa, 2020); 3) we are able to calculate participants' eye-gaze direction while record-

ing pupil size, allowing us to control the quality of eye data (Rosa et al., 2017).

2.2.5 Stimuli Material

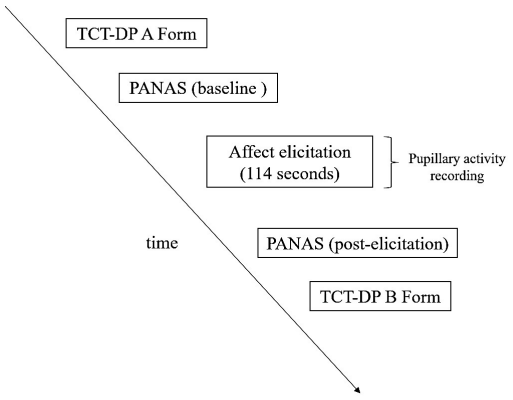
A total of 57 images were taken. 42 images were selected from the IAPS (Lang et al., 2005) and 15 images were taken from Internet websites. All images for the affective elicitation task consisted of three categories (pleasant vs. unpleasant vs. neutral), which were previously validated in a pilot study according to the following criteria: pleasant (valence >7), unpleasant (valence <3), or neutral (valence 4 – 6.5). All images were colorized and resized to 1280×1024 resolution, in a Joint Photographic Experts Group (JPEG) image file format.

2.3 Procedure and Apparatus

The institutional review board of the institution reviewed and approved this study at the proposal stage for adherence to ethical standards of the rights and welfare of human participants. After giving their informed consent, participants were randomly assigned to three affect elicitation conditions (positive vs negative vs neutral). All groups had the same sample size ($n = 25$). The study was carried out in a soundproof and constant lightroom (42 Lux) during only one session. Previously to the affective elicitation task, PANAS (baseline) and TCT-DP (Form A) were individually administered. The sequence of pictures (slide show format) with a total time length of 114s —19 static images with a 5 s duration each + 1s interstimulus interval (blank screen)— was presented through Tobii Pro Studio presentation software, running in an Intel core2duo 6550 desktop computer connected to a Tobii -T60 Eye Tracking System (Tobii Technology AB, Sweden), as depicted in Figure 1.

Figure 1

Scheme of the Experimental Procedure



Prior to presentation of the sequence of pictures, the eye-tracker was calibrated using the 9-point calibration routine. The whole sequence of pictures was displayed in full-screen mode. Participants were seated at approximately 60 cm from the eye tracker and were recorded individually. The pupillary activity was binocularly measured at a sample rate of 60 Hz with a bias error of .5°. At the end, participants were thanked and dismissed.

2.4 Data Preparation and Statistical Analysis

Regarding pupil size, data reduction was performed as previously described by Rosa et al. (2015). Pupil data were smoothed using a 7-point moving and peak dilations were computed as described in detail by Rosa et al. (2014). All sociodemographic variables were examined across experimental conditions to ensure that experimental groups were equivalent for comparison and therefore to control a possible source of variation in results due to confounding factors. No statistically significant differences were found (all $p_s > .05$) on sociodemographic variables across the experimental conditions. The analytical plan was performed as follows: 1) an assessment of affective modulation was performed comparing explicit measures (PANAS) and implicit measures (pupil change), and all participants had at least 90% of good eye data per recording file; 2) Analysis of Covariance (ANCOVA) was performed to evaluate the effect of the experimental condition on creative thinking (TCT-DP overall score); and 3) a Multivariate Analysis of Covariance (MANCOVA) was conducted to examine the effect of the experimental condition on both unconventional and conventional thinking, the two dimensions of the TCT-DP. Age and PANAS scores (positive and negative affect dimensions) after post-affect elicitation were entered into ANCOVA and MANCOVA as covariates. Prior to that, ANCOVA and MANCOVA parametric assumptions were assessed. In case outliers were found, they were excluded from statistical analysis (Tabachnick & Fidell, 2012). The multivariate test Pillai's Trace was interpreted as it is robust with respect to heteroskedasticity (Field, 2009) and unequal sample sizes (Tabachnick & Fidell, 2012). Sidak correction was applied to all post-hoc tests. Effect sizes were interpreted according to Cohen (1988). Statistical analyses were performed using JASP 0.16.2 software (JASP Team, 2022) for Windows with a level of significance of 5%.

3. Results

3.1 Assessment of Affect Elicitation

The effectiveness of the affect elicitation was assessed with explicit (subjective) and implicit (objective) measures. In terms of explicit measures, we used the positive affect and negative affect PANAS subscales scores to examine whether positive and negative affect has changed because of the affective elicitation task. As the positive affect —$F(2, 72) = .16$, $p = .852$, $\eta^2 = .00$— and negative affect —$F(2, 72) = .42$, $p = .657$, $\eta^2 = .01$— scores did not significantly differ between experimental conditions at baseline level, we used post-elicitation absolute values for positive and negative affect scores (Rosa et al., 2020). As expected, the results revealed that posi-

tive affect was significantly higher in the positive affect elicitation condition ($M = 27.19$; $SD = 6.69$) than in the negative affect elicitation condition ($M = 24.27$; $SD = 7.61$; $d = .41$), but not significantly higher than the control or neutral condition ($M = 26.88$; $SD = 5.12$; $d = .1$), $F(2,72) = 3.23$, $p = .045$, $\eta^2 = .08$. Regarding the negative affect, we found that it was significantly higher in the negative affect elicitation condition ($M = 14.78$; $SD = 4.94$) than in positive affect elicitation condition ($M = 11.59$; $SD = 1.80$; $d = .85$) but, similarly to positive affect, the negative affect score did not significantly differ from control condition ($M = 13.50$; $SD = 4.84$; $d = .26$), $F(2,72) = 3.84$, $p = .026$, $\eta^2 = .10$.

Regarding the implicit measure, no effect of the affective elicitation task was found on pupil size $F(2,72) = .326$, $p = .723$, $\eta^2 = .01$ (see Table 1).

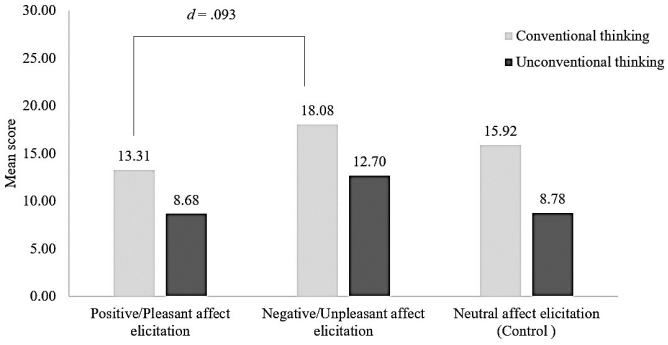
3.2 Effect of Affective States on Creative Thinking

As the TCT-DP overall score (Form A) did not significantly differ between experimental conditions at baseline, the effect of affective states on the creative process was assessed through TCT-DP overall score (Form B). Univariate skewness and kurtosis values of the TCT-DP overall score (Form B) were within the recommended range $|Skewness| < 3$ and $|Kurtosis| < 10$, satisfying univariate normality assumption (Hair et al., 2010). The ANCOVA results showed no effect of experimental condition on TCT-DP (Form B) overall score, $F(2,69) = 3.10$, $p = .051$, $\eta_p^2 = .08$, after controlling the effects of the covariates. However, we examined whether the affective state differently affected the two dimensions, conventional and unconventional thinking, of the TCT-DP (Form B) through a MANCOVA.

A MANCOVA was performed using the between-subjects factor experimental condition (positive affect vs negative affect vs control) with the TCT-DP (Form B) subscales, conventional and unconventional thinking, as dependent variables. Univariate skewness and kurtosis values of each TCT-DP (Form B) subscale were within the suggested range $|Skewness| < 3$ and $|Kurtosis| < 10$ (Hair et al., 2010). Regarding multivariate normality, Mahalanobis distance values evidenced no outliers — values larger than the critical value $\chi^2(2) = 13.82$; $\alpha = .001$)—. The results revealed a significant effect of the experimental condition on TCT-DP (Form B) composite variable after controlling for the covariates: $Pillai's\ Trace = .15$, $F(4,138) = 2.81$, $p = .013$, $\eta_p^2 = .08$. Univariate analysis revealed a significant effect of the experimental condition on conventional thinking $F(2,69) = 4.62$, $p = .012$, $\eta_p^2 = .12$, showing that participants from the negative affect elicitation group ($M = 18.09$; $SD = 5.30$) showed significantly higher mean scores on conventional thinking than participants from the positive affect elicitation group ($M = 13.31$; $SD = 5.19$, $d = .93$). No other significant differences were found as shown in Figure 2.

Figure 2

Conventional and Unconventional Thinking Mean Scores across Experimental Conditions, after Controlling for Age and PANAS Scores



4. Discussion

This study aimed to investigate the effect of different induced affective states on conventional and unconventional dimensions of creative thinking, both considered crucial for creative thinking (Sternberg, 2006), simultaneously assessed by the same instrument, the TCT-DP. Other authors emphasized the need of considering several cognitive processes involved in creative thinking, such as the evaluation and implementation of ideas, besides their fluency and originality (Amabile, 1996; Lai et al., 2020; Mumford et al., 2012; Watts et al., 2019; Zeng et al., 2011). This constitutes another alert to consider the possibility of having different effects on different creative processes and dimensions arising from the type of affective induction.

Considering the existence of different cognitive processes and the nature of the task, it is pertinent to emphasize that TCT-DP presents two dimensions, conventional thinking and unconventional thinking, which might be differently impacted by the induction of affective states. Our results do not support previous evidence suggesting the benefits of inducing positive affective states in the ideation of ideas (e.g., Bledow et al., 2013; Lai et al., 2020), as no significant effect of positive affect on creativity was found. According to the interaction effect between hedonic valence and the nature of the creative tasks, as stated by Kaufmann (2003), it was expected that a positive induced affect would have a positive effect on creativity level, namely on unconventional thinking dimension. In particular, the unconventional thinking items of TCT-DP (e.g., New Elements, Boundary breaking, Humor) reveal a less conventional way of looking at the task and it was expected a significant effect of the induced positive affect. More specifically, the positive affect would lead the participant to a feeling of security, less constrained and a willingness to explore and take risks (Fiedler, 2000; George & Zhou, 2007),

Table 1

Mean and Standard Deviation for Explicit and Implicit Measures after Affect Elicitation

Condition	Positive Affect (PANAS)	Negative Affect (PANAS)	Pupil Size (mm)
	$M(SD)$	$M(SD)$	$M(SD)$
Positive/pleasant affect elicitation	27.19(6.96)	11.59(1.80)	3.74(0.70)
Negative/unpleasant affect elicitation	24.27(7.61)	14.78(4.94)	3.85(0.57)
Neutral affect elicitation (control)	26.88(5.12)	13.52(4.94)	3.85(0.73)

and thus, to higher flexibility, originality, and breaking boundaries (Kaufmann, 2003). That was not our case.

Simultaneously, we expected that a negative induced-affective state would lead to a higher conventional thinking level. The results were in this direction. In particular, the TCT-DP items of the conventional thinking dimension (e.g., Continuations, Completions) appeal to a sense of continuity and elaboration of ideas on a common theme. Maybe, the perception of this goal may have led to greater levels of effort, perseverance, and commitment (Anderson & Rodin, 1989), to a careful and cautious strategy, a detailed information processing strategy looking for a very appropriate solution (De Dreu et al., 2008). Thereby, it seems that the negative affect promotes systematic problem identification (Schwarz & Skurnik, 2003), supported by cognitive correlates that are manifested in focused attention and analytic thinking, based on simplifying heuristics (Kaufmann, 2003; Schwarz & Clore, 2003). As such, our results partially support the dual-tuning model (George & Zhou, 2007), reinforcing that negative affect is also linked to creativity. Specifically, the negative affective state might have narrowed attention to visual elements that are threatening, being processed in a bottom-up fashion, for example, in an isolated and sequential way (Spering et al., 2005).

However, despite interesting, our results should be interpreted with caution due to the effectiveness of the picture sequence that was developed for the purpose of affective elicitation. The sequence of pictures led the corresponding affective state as supported by PANAS score ratings, that is, negative/unpleasant pictures led to higher negative affect ratings and positive/pleasant pictures led to higher positive affect ratings. However, in relation to neutral pictures, none of the picture affective sets (positive and negative) differed significantly in terms of PANAS scores. It is important to clarify that the meaning of the term "affect" in the present study assumed that all affective states arise from cognitive interpretations (post-cognitive) of core neural sensations that are the product of two independent neurophysiological systems (Posner et al. 2005; Russel, 1980), and its modulation induced by unimodal visual stimuli (pictures), expressed as an explicit measure that was captured by PANAS ratings. However, affect can be also considered to be precognitive, that is, affective reactions may occur without extensive perceptual and cognitive encoding, as they are under the control of separate and partially independent systems (Zajonc, 1980; Walla & Panksepp, 2013).

Furthermore, we assumed the possibility of inducing affective states considering two central affective dimensions, hedonic valence and arousal, forming the bidimensional emotional space (e.g., Russell, 1980; Russell & Bullock, 1985). However, some observations should be noted. Assuming the existence of basic, distinct, and universal emotions (Ekman, 1992), we absolutely and specifically cannot be sure which emotion or emotions were elicited. Besides several non-controlled contextual factors, it is necessary to consider that emotions can be thought of as a set of discrete sensory-motor programs with distinct brain structures and circuits (LeDoux, 1996; Öhman & Wiens, 2004). In the present study, the experimental manipulation of valence and arousal levels may, in part, have been compromised. Based on PANAS ratings, neutral stimuli were perceived as relatively positive (and not merely neutral) and positive stimuli were perceived, in a certain way, as neutral. These results can be explained by Wilder's (1962) law of initial value (*Ausgangswertgesetz*), which means that the higher the initial value, the smaller the response to function-raising. Therefore, it might be that participants were already in a mildly positive affect right before performing the experimental task, which might be due to the perspective of being able to participate in a laboratory experiment. Furthermore, it could have happened that the induced in both positive and neutral induction conditions was completely with the motivated participant's positive affective state, producing a ceiling effect. Therefore, their affective state arousal could not, on average, have been increased to a higher and statistically significant level by the experimental manipulation (Uhrig et al., 2016). On the contrary, the effectiveness of the negative/unpleasant condition could have been greater. Probably, as Westermann et al. (1996) stated, it may be easier to experimentally produce negative affective states than positive ones. Additionally, even though the pupil size is an implicit and reliable measure of autonomic activity, it is quite sensitive to stimuli's physical features such as apparent luminance, contrast and complexity (Delplanque et al., 2007; Rosa et al., 2016) or even to cognitive load (Cosme et al.,

2021). As these factors were not controlled in this study, it might be possible they had an effect on pupil size and masked the differences between conditions. Future studies should perform multimodal physiological recording (e.g., electrodermal and cardiac activity combined with eye-movement recording), in order to produce more robust results (Rosa et al., 2012, 2015; Rosa et al., 2017). As video stimuli are dynamic and thus thought to be more similar to real life (ecological validity), they can be used for more effective affect elicitation (Devilly & O'Donohue, 2021). Equally important, further research needs to be done to see whether these results can be replicated by the same creativity assessment instrument, the TCT-DP with other age groups and professional samples. Also, the question if the effects we found for the explicit measures are also true for implicit measures (e.g., brain and peripheral responses), needs to be further investigated.

5. Conclusions

This study examined how different affective states impact on both conventional and unconventional thinking creative dimensions (overcoming the limitations of a simple global score for creativity), considering a single creative assessment task, the TCT-DP. Our results support neither the assumption that the negative affect has a hindering effect on creativity nor that the positive affect increases creativity. Negative affect seems to promote systematic problem identification (conventional thinking), perhaps aided by its cognitive correlates, which can be manifested in attentional processes and logical thinking. With regards to positive affect, the findings are less straightforward, as no effect on creativity was found. In order to address this, studies using a within-subjects crossover design should better explore the dynamic interplay of positive and negative affect on conventional and unconventional thinking dimensions.

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