Effects of Expressive Writing and Self-Distancing on Electrodermal Activity During Writing

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Abstract: Writing about traumas can influence mood and bodily changes. In three studies we researched the influence of writing on affective and physiological changes by measuring electrodermal activity (EDA) during expressive writing sessions and manipulating self-distancing. In Study 1, we randomly assigned 57 participants to write about control or expressive topics using a first-person perspective (I). In Study 2, we assigned 55 participants to write about control or expressive topics using a third-person perspective (She/He). And in Study 3, we compared the effects of perspective (first or third-person) in the data collected in the preceding studies. Across Study 1 and 2 results showed that EDA consistently rose at the beginning of the writing session, reached a plateau, and then rose again upon completing the writing task, irrespective of the writing topic or perspective. While the initial EDA increase seems related to the start of a demanding task, the post-writing increase might signal reward-seeking behavior upon task completion. Results of Study 3 confirmed that EDA increases in the beginning and upon writing completion are magnified by adopting a third-person perspective. These results show that expressive writing and self-distancing have measurable impacts on writers' electrodermal activity.

Keywords: electrodermal activity, skin conductance level, expressive writing, and self-distancing

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1. Introduction

A conspicuous observation is that humans tend to sweat not only when it is hot, but also when facing emotionally provoking events, such as novel situations which might give rise to emotions like fear, stress, surprise, and joy (Kreibig et al., 2010; Nikula, 1991). The adaptive nature of emotions in the face of different situations, thoughts and memories can prepare the body for action (Hwang & Matsumoto, 2018), and have a physical effect on the eccrine sweat glands (Dawson et al., 2007). This occurs because of the eccrine sweat glands in the human body. Besides controlling body temperature, they are also activated by emotional contexts. Such contexts are deemed to happen during expressive writing. In expressive writing, individuals are asked to write about one's deepest feelings and thoughts related to a traumatic event that was previously concealed (Pennebaker & Beall, 1986). Expressive writing should, therefore, have a strong impact on the sympathetic nervous system (SNS), which can be measured by changes in electrodermal activity (EDA) of the eccrine sweat glands (Dawson et al., 2007). Broadly put, in three studies we investigated factors affecting EDA during an expressive writing exercise. In the first study, we used the typical expressive paradigm (expressive vs. control groups writing in first person perspective, I, also known as self-immersion). In the second study, we used self-distancing expressive writing (expressive vs. control groups writing in the third-person perspective, he/she, also known as self-distancing). In the third study, we looked at the interaction between topic and perspective.

1.1 Electrodermal activity

The sympathetic nervous system (SNS) and parasympathetic nervous system (PNS) are two branches of the autonomic nervous system (ANS). SNS activation leads to overall elevated activity and attention, commonly known as "fight or flight" responses; and PNS activation leads to "rest and digest" processes (Waxenbaum et al., 2022). Each of these systems affects various organs and parts of the body. However, they might affect the same organs in different ways, for example the heart, with heart rate variability (HRV), which can be affected by the SNS, the PNS or both (Molins et al., 2021).

Electrodermal activity is a psychophysiological measurement (Boucsein et al., 2012) considered a direct measure of SNS, that is not influenced by the PNS (Dawson et al., 2007). An increase in EDA signifies increased SNS activation. Similarly, decreases in EDA represent decreases in SNS activation. EDA is typically measured in microsiemens (µs) with bipolar measurement of eccrine sweat glands (Shields et al., 1987). EDA can be expressed by three metric parameters: (i.) non-specific skin conductance responses (NS-SCR, also known as spontaneous skin conductance response), electrodermal activity in the absence of any identifiable stimulus, measured by rate per minute which usually is between 1-3 minutes while the participant is at rest; (ii.) skin conductance responses (SCR), the fast-varying phasic activity that change in the face of a stimulus. It typically has a minimum amplitude of .05 µs and a latency window between 1-3 seconds after the stimulus. SCR shows a fast rise to the peak and a slow decrease towards the baseline; and (iii.) skin conductance level (SCL), the slowly changing tonic level. Which is the average of SCRs in a longer latency window (longer than 5 s, Benedek, & Kaernbach, 2010; Dawson et al., 2007). Introducing a new stimulus typically causes a rise in EDA and repeating it leads to habituation (gradual decrease of EDA). Habituation to a repetitive stimulus happens frequently in EDA measurement, as participants become less responsive to familiar stimuli (Dawson et al., 2007).

Even though EDA is measured by the activation of the eccrine sweat glands which are responsive to psychological stimuli, it can also be a reliable index of attention, task effort and arousal. Arousal can be defined as the opposite of sleepiness (Braithwaite et al., 2013; Dawson et al., 2007; Russell, 1980). Although EDA does not specify the direction of arousal, it is an indicator of nonvoluntary nervous activation. Emotional states, such as shame, anxiety, joy, pride, and surprise (Harley et al., 2019; Kreibig, 2010) are typically reflected in changes in EDA.

In an interesting study on EDA changes during piano performance, Dean and Bailes (2015) recorded SCL during sound and silent performances (playing without sound on keyboard). The average SCL was analyzed, along with SCR for specific skin responses to body movement or audio feedback. They found that simply moving the fingers on a piano keyboard layout (silent performance) caused changes in EDA the same way as sounded performance.

Stadler et al. (2018) recorded EDA during a one-hour session of art and craft activities. SCR was analyzed to find peaks of EDA during the session. A week after the art session, participants were asked to talk about their experience, what they felt, and their EDA was measured again. They found that by remembering the emotions and experiences lived one week before, participants showed similar SCR raises as in the activity itself. This was confirmed in another study, in which a pair of friends talked about the importance of shared emotional experiences. Wood and Kenyon (2018) found that sharing memories and remembering them together triggers not only changes in EDA (average SCL and SCR peaks), but also makes it more intense compared to the real event.

In the current study, we measured EDA during 15 minutes of writing. As we were interested to study the changes in tonic level during a longer latency window (longer than 5 s), we analyzed SCL in each 5 minutes of writing. We expect that EDA would rise as a result of attention and arousal in the face of a writing exercise and emotional load.

1.2 Expressive Writing

Expressive writing implies writing about emotions and intimate thoughts. A considerable number of studies indicated that putting emotions into language has positive impacts on physical, social, cognitive (working memory) and psychological wellbeing in both adults and children (Pennebaker & Chung, 2007; Fartoukh & Chanquoy, 2020). Pennebaker and Beall (1986) conducted the first experimental study on the effect of expressive writing on health. They asked participants to write about a traumatic event or about a superficial topic for four days, 15 minutes each day. Results showed that writing about trauma was immediately accompanied by negative emotions, but later, it was associated with long-term health benefits, such as fewer visits to the health center, reduced mood symptomology, and less aspirin use. In another study, Lepore (1997) measured depressive symptoms related to an important academic examination. Participants in the expressive writing group, who wrote about the exam, showed lower depressive symptoms in comparison to the control group, who wrote about a trivial topic. Interestingly, in this study expressive writing did not reduce the amount of negative ruminative thoughts but attenuated its negative emotional impact.

Very few studies have looked at the relation between expressive writing and EDA. In a study about the effects of expressive writing on the immune system, Petrie et al. (1995) measured SCL during writing sessions. Participants wrote for 4 consecutive days about the most traumatic event of their lives (expressive group) or about how they use their time (control group). Results showed that SCL had a significant continuous decrease in the expressive group upon four days of writing compared to the control group which showed a continuous increase in SCL starting from the second day of the writing assignment. Moreover, participants in the expressive group produced more antibodies against the hepatitis B vaccine as compared to controls. In another study on individuals with elevated blood pressure, McGuire et al. (2005) measured SCL for 15 minutes, one week before the expressive writing sessions, and at 1- and 4- months follow-ups. Participants wrote on 3 consecutive days about a trauma (expressive group) or about how they spend time (control group). Results showed that expressive writing helped decrease blood pressure, but there were no differences in the SCL of the expressive and control groups in both follow-ups. Nevertheless, on average, SCL increased from the first half to the second half of each 15 minutes writing session.

In the studies mentioned above, SCL was measured during four consecutive days or before and after the writing session. As EDA is a short term electrodermal response to the presented stimulus and it has a latency window between 1s and 5s, in the present study we measured SCL during a single writing session. We believe that immediate measure of SCL during and after the writing session can give us more information about the emotional effect of expressive writing on SNS activation. We expected that participants in the expressive group showed increases in EDA during the writing task.

1.3 Self-distancing

Typically, when writing about upsetting events, people use a first-person perspective, which seems to immerse the person in the traumatic event. Perhaps asking individuals to write using third person pronouns might help psychologically distance themselves from the event (self-distancing; Kross & Ayduk, 2017). Kross and Ayduk (2017) have argued that writing in the third person helps writers to take a step back and reason more rationally and therefore experience less anxiety. McIsaac and Eich (2004) have shown that recalling traumatic events from a self-distanced perspective was associated with less emotional and anxiety provoking thoughts, and with less negative affect, as compared to a first-person perspective. Furthermore, Seih et al. (2011) found that writing about traumas in third-person perspective was associated with less emotional involvement and use of fewer cognitive mechanism words (e.g., because, realize, understand), compared to using first- or second-person perspectives.

Wisco et al. (2015) studied the effect of changing perspective on physiological and emotional reactivity in PTSD patients. Patients were asked to think about a traumatic situation either in self-distancing or self-immersion perspectives. Results of average of SCRs per minute showed that heart rate and skin conductance of participants in the self-immersion group increased significantly while recalling the event, whereas the self-distancing group remained stable.

In the current Study 1 and Study 2, we collected EDA during the expressive writing exercise in both first-person and third-person perspectives, respectively. Participants were randomly assigned to expressive groups writing about traumatic experiences or to control groups writing about daily routine. We examined SCL before, during, and after the writing tasks. To the best of our knowledge, only two other studies have measured EDA changes during writing (see McGuire et al., 2005; Petrie et al., 1995). Based on the limited literature available, we expected participants in both studies to show: (i) increased skin conductance level (SCL) upon starting the writing task as a result of receiving the writing prompt; (ii) perhaps due to habituation, the initial rise in SCL might decrease throughout the writing session; (iii) due to the emotional load of the traumatic event, the expressive groups might exhibit higher SCL than the control groups, and (iv) finally in post writing, as a consequence of resting, SCL might decrease to baseline in both groups, since the SNS is expected to decrease activity during periods of rest and relaxation. In Study 3, we expect the participants in self-distancing group to be less emotionally involved and therefore to show less SCL compared to the self-immersion group.

Study 1: Expressive writing

2. Method

2.1 Participants

Fifty-seven first-year psychology students (9 males; age range = 17-51, age mean (*M)* = 20.04, standard deviation (SD) of age = 5.56) from University of Porto participated in this study in exchange for course credit. All the participants were native Portuguese speakers, none had written language problems, and none had currently diagnosed psychiatric disorders. They were randomly assigned to a control (*n* = 28; 5 males; age range = 18-39, *M* = 19.89, SD = 4.54) or expressive group (*n* = 29; 4 males; age range = 17-51, *M* = 20.10, SD = 6.50). They were asked to write freely without being worried about writing a correct text, orthographic errors or the structure of the sentences and the grammar, the only important thing was to write until they are asked to stop writing. Ethical clearance for the study was obtained from the faculty's ethics committee.

2.2 Material

EDA. Skin conductance level (SCL) was collected via disposable electrodes (EL507 Biopac) and isotonic gel (GEL101). Data was gathered using a Biopac logger (Biopac Systems, Goleta, CA) with a high pass filter of 0.5-35Hz and a sampling rate of 1000 Hz. Besides EDA data, ECG was also collected in this study but is not reported here (see Jacques et al., 2020).

SCL data was processed and analyzed with AcqKnowledge 5.0.2 software. SCL was measured at baseline (B) during 10 resting minutes, during the writing exercise (W) for 15 minutes, and at post-writing (PW) during 5 resting minutes. For EDA analysis, data was separated into five, five-minute parts; baseline (B; to measure NS-SCR for individual differences and physical changes in each participant in the absence of any identifiable stimulus; see Dawson, Schell & Filion, 2007); three writing segments (W1, W2, W3); and post-writing (PW). Average SCL was calculated for each 5-minute segment.

PANAS. The positive and negative affect schedule (PANAS; Watson et al., 1988) is a short self-report scale comprised of 10 items for positive affect (PA) and 10 items for negative affect (NA). Participants rated their feelings before and after the task on a 5-point Likert scale (1 = *not at all to* 5 = *very much*). Example items of PA are enthusiastic and excited. Example items of NA are nervous and guilty. We used the Portuguese version of PANAS (Galinha & Pais-Ribeiro, 2005), which has a Cronbach's alpha reliability of α = 0.86 for PA and α = 0.89 for NA. The scoring range for positive and negative affect can vary from 10 to 50 points.

2.3 Procedure

Data collection for the writing task and psychophysiological measurements were done in a laboratory setting during an individual 45-minute session. Upon entering the lab, participants received information about the study, signed the informed consent and completed the PANAS scale. EDA electrodes were placed on the volar surface of medial phalanges of the two first fingers from the non-dominant hand. Following the EDA electrodes placement participants were instructed to relax for 10 minutes (baseline EDA). After baseline recording, the experimenter, who was blind to the participants' conditions, delivered the writing instructions in closed envelopes, which were previously shuffled. Instructions for the writing tasks were derived from Pennebaker and Beall (1986) study. Participants in the control group were asked to write about their daily routine from the moment they woke up until going to sleep, as objectively as possible using the 'I' pronoun. Participants in the expressive writing group were asked to write about the most traumatic experience in their lives. They were asked to write about their deepest thoughts and feelings using 'I' pronoun. Upon receiving instructions, they wrote for 15 minutes (writing task) until they were told to stop writing. After writing, they were told to relax for 5 minutes (post-writing). Finally, they filled in the PANAS again. All participants were debriefed and thanked at the end of the experiment.

Content analysis of the texts confirmed that participants in the expressive group wrote about bullying, death, disease, romantic and intimate relationships, harassment or sexual abuse, threat to physical integrity, domestic violence, divorce and/or parental conflicts, family conflicts, and mental health at risk. Participants in the control group wrote about daily routine (for further details on this content analysis, see Jacques, et al., 2023)

3. Results

Analysis of variance were conducted comparing control and expressive groups on PANAS scores and SCL. As a manipulation check, pre- and post-writing PANAS scores were analyzed for both groups using mixed analyses of variance (ANOVA) with an alpha threshold set at .05. To examine the impact of writing topic on SCL, a mixed design ANCOVA was conducted, with baseline SCL as covariate. For all variables we checked for skewness and kurtosis, all values were within ± 3.29 suggesting normal distribution for medium-sized sample ($50 < n < 300$; Kim, 2013). Outliers were identified through boxplot analysis with interquartile range of 1.5, and missing values were given to the outlier measurements. To reduce the type I error associated with multiple comparisons (see Holm, 1979), Bonferroni post hoc correction was used. In all comparisons, significant differences remained significant after using the Bonferroni correction with an alpha level of .05.

3.1 Manipulation check

To test that the experimental topic manipulation had the intended impact on the participants' mood, we conducted a 2 x 2 mixed ANOVA on PANAS scores (see Table 1 for descriptive statistics), with group (control vs. expressive) as between-subjects factor and time (pre-writing vs. post-writing) as within-subjects factor.

Table 1: PANAS scores for negative and positive affect

		Pre-writing M(SD)	Post-writing M(SD)
Expressive	Positive affect	26.24 (7.41)	22.76 (8.79)
	Negative affect	13.76 (3.62)	21.72 (9.13)
Control	Positive affect	25.61 (5.97)	28.86 (6.60)
	Negative affect	13.71 (3.63)	11.25 (1.64)

Note. n (Control) = 28; n (Expressive) = 29

The main effects of time, $F(1, 55) = .018$, $p = .89$, $\eta_p^2 = .00032$, and group, $F(1, 55) = 2.514$, $p = .11$, $\eta_p^2 = .04$, were not significant for positive affect (PA). But the interaction of Time Ч Group was significant for positive affect, $F(1, 55) = 14.87$, $p < .001$, $\eta_p^2 = .213$. After writing the control group increased positive mood (3.25 points average gain in PA) and the expressive group decreased (3.48 points). However, the pairwise comparison did not reach statistical significance ($p = .119$) perhaps due to a lack of statistical power. Regarding negative affect (NA), the main effect of time, $F(1, 55) = 9.5$, $p = .003$, $\eta_p^2 = .147$, and the main effect of group, $F(1, 55) = 23.041$, $p < .003$, $\eta_p^2 = .29$, were significant. As well as the interaction of Time Ч Group for negative affect, $F(1, 55) = 34.12$, $p < .001$, $\eta_p^2 = .383$. Results of pairwise comparison for groups were significant ($p < .001$) with the expressive group reporting higher NA at post-writing than the control group, an average difference of 10.47. After writing, the expressive group showed increased negative affect. As it is shown in Figure 1 and Figure 2 about changes in PANAS before and after writing, results revealed that writing about daily routine increased positive mood in the control group (3.25 points average gain from pre-writing to post-writing in PA), whereas writing about traumas and emotional experiences increased negative mood in the expressive group (7.96 points average gain from pre-writing to post-writing in NA).

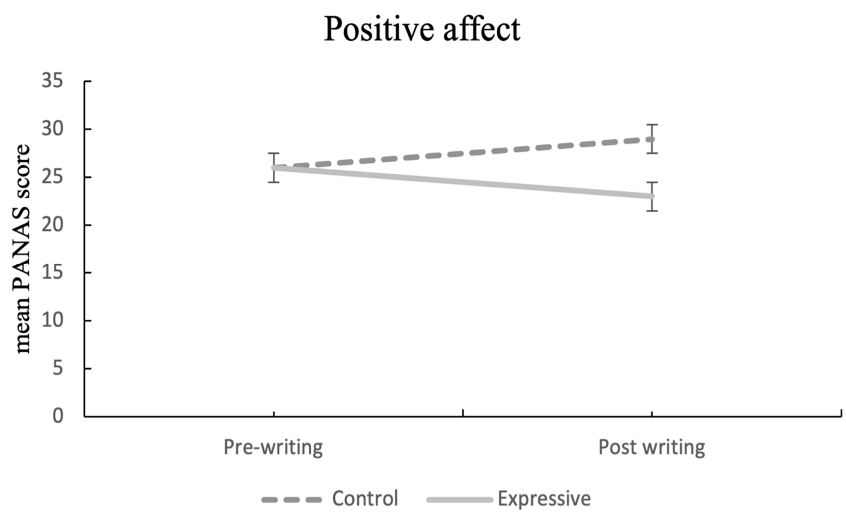

Figure 1. Positive affect scores in both control and expressive groups from pre-writing to post-writing.

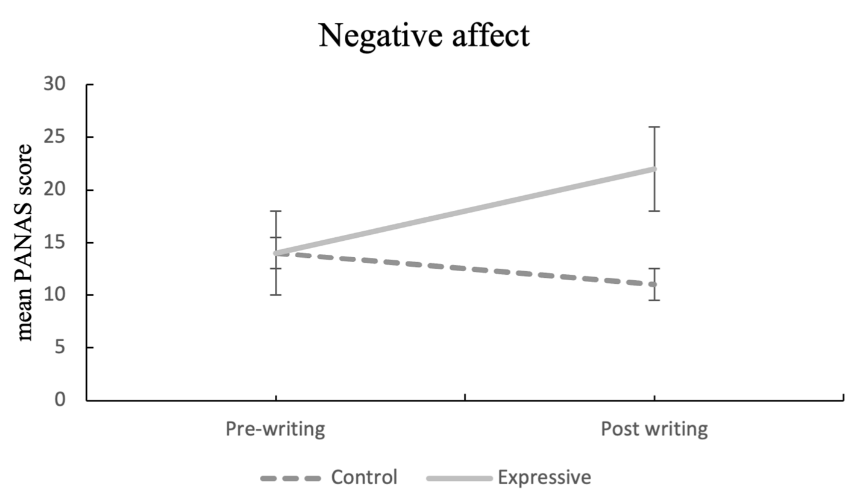

Figure 2. Negative affect scores in both control and expressive groups from pre-writing to post-writing.

3.2 Impact of writing topic on EDA

Changes in EDA throughout the writing assignment were analyzed by conducting 2 Ч 4 mixed ANCOVA with baseline SCL as covariate, group (control or expressive) as between-subject's factors and time (W1; W2; W3; PW) as within-subjects factor, see Table 2 for descriptive statistics.

Table 2: Descriptive statistics of SCL in different moments

	Both groups		Control		Expressive	
Time	M	SD	M	SD	M	SD
B	8.36	4.36	8.2	4.78	8.51	4.01
W1	9.15	4.19	8.67	4.21	9.59	4.19
W2	8.04	4.08	8.02	4.37	8.05	3.85
W3	8.62	4.85	8.23	4.58	8.99	5.13
PW	9.81	4.56	9.5	4.62	10.1	4.56

Note. SCL was measured in microsiemens; n (Both groups) = 56; n (Control) = 27; n (Expressive) = 29

Mauchly's test indicated that the assumption of sphericity was violated ($\chi 2(5) = 35.73$, $p < .001$). Therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .084$). Analysis revealed no statistically significant interaction between Time × Group, or Time × Baseline. Suggesting the writing topic did not affect SCL during the writing task. Between subjects results showed no significant effect of Group, $F(1, 51) = 0.26$, $p = .61$, $\eta_p^2 = .005$, suggesting that SCL changes were similar in control and expressive groups. Moreover, results showed significant main effect of time, $F(2.52, 128.8) = 8.91$, $p < .001$, $\eta_p^2 = .149$, revealing that SCL changed across time. Results of pairwise comparison revealed a significant difference between W1 and W2 ($p < .001$) with W1 being higher with a mean difference of .811, W1 and W3 ($p = .004$) with W1 being higher with a mean difference of .684 and, W1 and PW ($p = .036$) with PW being higher with a mean difference of .552; significant difference between W2 and PW ($p < .001$) with PW being higher with a mean difference of 1.363; significant difference between W3 and PW ($p < .001$) with PW being higher with a mean difference of 1.236.

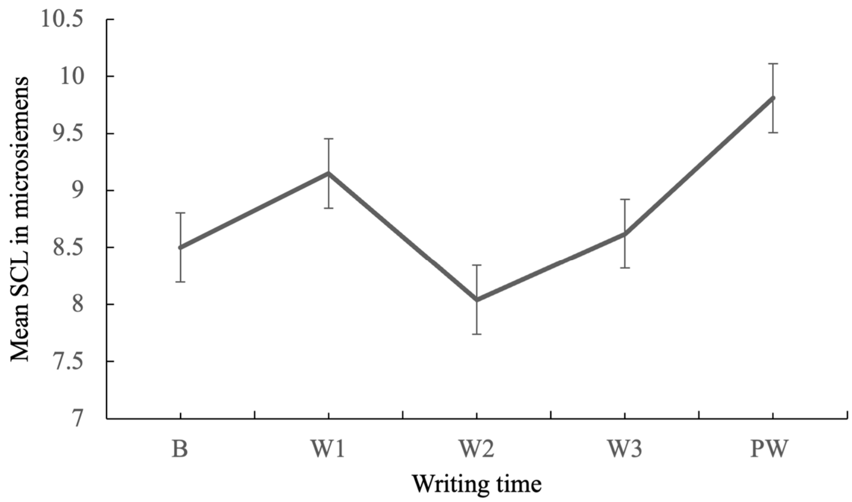

Figure 3. SCL average from baseline to post-writing with standard error bars of the mean in the whole sample.

Results revealed a significant increase from baseline to W1 (+0.746 µs) a significant decrease from W1 to W2 (- 1.11 µs), no significant change from W2 to W3, and a significant increase from W3 to post-writing (+1.19 µs). Results showed that SCL increased upon starting the writing task, decreased after five minutes of writing, remained stable for the remaining of the writing session, and increased significantly on post-writing. Figure 3 displays SCL changes before, during and after the writing task for both groups.

4. Discussion

Fifty-seven first year psychology students were randomly assigned to control or expressive groups. Results of the manipulation check showed that the experimental condition had the intended effect on the participants mood, the expressive group felt more negative affect upon the writing exercise.

As expected, our results showed that starting a writing task increased SCL in both groups. SCL was significantly higher in the first five minutes of the writing task compared to the baseline (an average increase of 0.746 µs). This is in line with previous findings that starting a task generally increases EDA and continuing it typically leads to habituation (Dawson et al., 2007). Habituation was shown by a decrease of SCL, five minutes after the start of the writing activity. Contrary to what we expected, SCL did not decrease during post-writing, instead it rose significantly (an average of 1.19 µs) in both groups upon completing the text. Also contrary to our prediction 3, the high emotional load on the expressive group did not translate into higher SCL in the expressive group. Both groups showed similar levels of SCL during and after writing the texts. This finding is similar to the result of McGuire et al. (2005), who also did not find a change in SCL induced by the writing topic.

Study 2: self-distancing expressive writing

In Study 1, we found that writing in the first person (regardless of expressive or control) increased sympathetic activation at the beginning of the task and upon finishing writing. Also, the expressive group showed more negative affect compared to the control. Study 2 was conducted one year later, and the procedure was similar to Study 1, but participants wrote their texts using a third-person perspective. In Study 2, we tested the same four predictions as formulated above at the end of the introduction.

5. Methods

5.1 Participants

Fifty-five first-year psychology students (8 males; age range = 18-53, *M* = 20.30, standard deviation (SD) of age = 5.17) University of Porto, Portugal, participated in this study in exchange for course credits. All the participants were native Portuguese speakers, none had written language problems, and none had currently diagnosed psychiatric disorders. Participants were randomly assigned to a control (*n* = 27; 5 males; age range = 18-53, *M* = 20.96, SD = 6.53) or expressive group (*n* = 28; 3 males; age range = 18-26, *M* = 19.62, SD = 2.11). They were asked to write freely without being worried about writing a correct text, orthographic errors or the structure of the sentences and the grammar, the only important thing is to write until they are asked to stop writing. Ethical clearance for the study was obtained from the faculty's ethics committee.

5.2 Procedure

The procedure for the lab data collection and psychophysiological measurements were the same as in Study 1, differing only in the writing instructions. Participants in the control group were asked to write about their daily routine in the third person singular, using she or he pronouns. Participants in the expressive group were asked to write about the most traumatic experience in their lives. They were asked to write about their deepest thoughts and feelings in the third person singular, using she or he pronouns. For all variables we checked for skewness and kurtosis, all values were within ±3.29 suggesting normal distribution for medium-sized sample ($50 < n < 300$; Kim, 2013).

6. Results

6.1 Manipulation check

To test if the experimental manipulation had the intended impact on the participants' affect, we conducted a mixed ANOVA on pre- and post-writing PANAS scores (see Table 3 for descriptive statistics), with time (pre-writing vs. post-writing) as within-subjects factor and group (control vs. expressive) as between-subjects factor.

Table 3: PANAS scores for negative and positive affect

		Pre-writing M(SD)	Post-writing M(SD)
Expressive	Positive affect	25.93 (7.25)	21.68 (8.4)
	Negative affect	13.64 (3.54)	18.21 (7.61)
Control	Positive affect	26.48 (5.54)	28.86 (8.42)
	Negative affect	13.48 (3.31)	11.86 (3.58)

Note. n (Control) = 27; n (Expressive) = 28

The main effect of time was not significant for positive affect, $F(1, 55) = 1.51$, $p = .22$, $\eta_p^2 = .027$. But the main effect of group was significant, $F(1, 55) = 4.44$, $p = .04$, $\eta_p^2 = .075$. The interaction of Time Ч Group was also significant for positive affect (PA); $F(1, 55) = 19.04$, $p < .001$, $\eta_p^2 = 313.03$. Results of the pairwise comparison for group was significant ($p = .026$), with control group being higher in post-writing PA than expressive group with a mean difference of 4.21. Regarding the negative affect, the main effect of time was not significant, $F(1, 55) = 3.95$, $p = .052$, $\eta_p^2 = .067$. But the main effect of group was significant, $F(1, 55) = 9.73$, $p = .003$, $\eta_p^2 = .15$. The interaction of Time Ч Group was also significant for negative affect (NA); $F(1, 55) = 17.40$, $p < .001$, $\eta_p^2 = 273.1$. Result of pairwise comparison for group was significant ($p = .003$), with expressive group being higher in post writing NA than control group with a mean difference of 3.31.

After writing the control group showed increased positive affect and the expressive group showed increased negative affect. As seen in Figure 4 and Figure 5 about changes in PANAS before and after writing, writing about daily routine affected positive mood in the control group (2.38 points average gain from pre-writing to post-writing in PA) whereas writing about traumas and emotional experiences affected negative mood in the expressive group (4.57 points average gain from pre-writing to post-writing in NA).

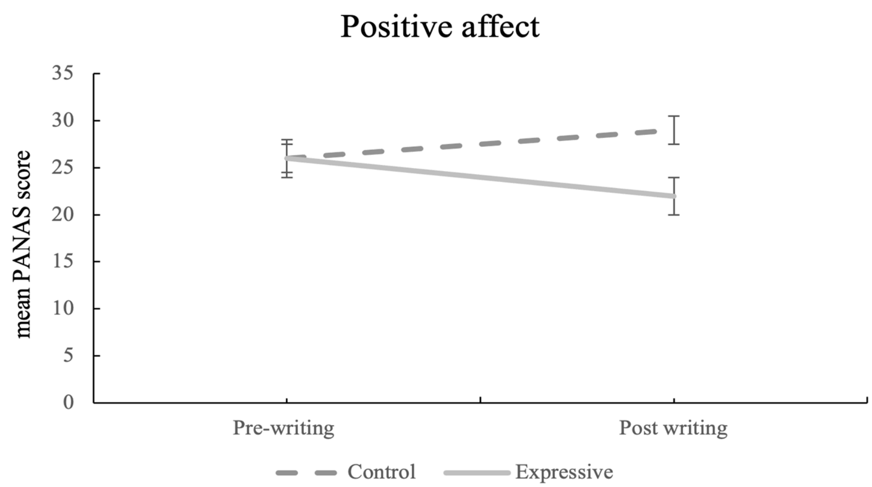

Figure 4. Positive affect scores in both control and expressive groups from pre-writing to post-writing.

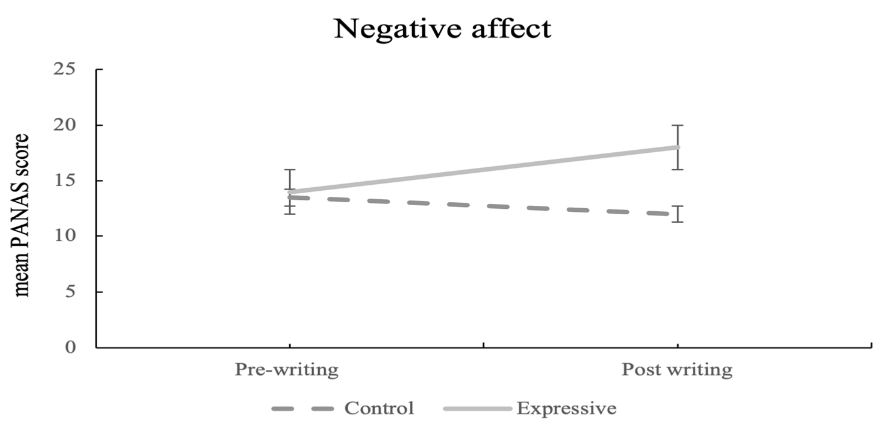

Figure 5. Negative affect scores in both control and expressive groups from pre-writing to post-writing.

6.2 Impact of writing topic on EDA

Changes in EDA throughout the writing assignment were analyzed by conducting 2 Ч 4 mixed ANCOVA with baseline SCL as covariate, group (control or expressive) as between-subject's factors and, time (W1; W2; W3; PW) as within-subjects factor. Table 4 shows means and standard deviations of EDA before, during and after writing.

Table 4: Descriptive statistics of SCL in different moments

	Both groups		Control		Expressive	
Time	M	SD	M	SD	M	SD
B	8.17	4.32	9.36	4.4	6.93	3.94
W1	9.65	4.18	10.9	4.08	8.31	3.91
W2	8.73	4.37	9.97	4.45	7.45	3.97
W3	8.83	4.67	10.27	4.62	7.35	4.32
PW	10.26	4.52	11.83	4.2	8.63	4.33

Note. SCL was measured in microsiemens; n (Both groups) = 55; n (Control) = 28; n (Expressive) = 27

Mauchly's test indicated that the assumption of sphericity was violated, χ2(5) = 29.06, $p < .001$. Therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .86). Analysis revealed no statistically significant interaction between Time × Group, $F(2.607, 135.49) = 1.64$, $p > .05$, $\eta_p^2 = .031$, or Time × Baseline, $F(2.605, 135.47) = 1.226$, $p > .05$, $\eta_p^2 = .023$, suggesting that SCL changes were not different between control or expressive group during the writing task or from baseline. Between subjects results showed no significant effect of group ($F(1, 52) = 1.85$, $p > .05$, $\eta_p^2 = .034$) suggesting that SCL changes were similar in control and expressive groups. However, a significant main effect of time was found, $F(2.605, 135.47) = 11.88$, $p < .001$, $\eta_p^2 = .186$, revealing that SCL changed across time. Results of pairwise comparison revealed a significant difference between W1 and W2 ($p < .001$) with W1 being higher with a mean difference of .961, W1 and W3 (p = < .001) with W1 being higher with a mean difference of .861; significant difference between W2 and PW ($p < .001$) with PW being higher with a mean difference of 1.59; significant difference between W3 and PW ($p < .001$) with PW being higher with a mean difference of 1.45.

Results for SCL changes were similar to Study 1. SCL significantly rose from baseline to W1 (+1.48µs), significantly decreased from W1 to W2 (-0.92 µs) and increased significantly from W3 to post-writing (+1.43 µs). Figure 6 depicts these changes.

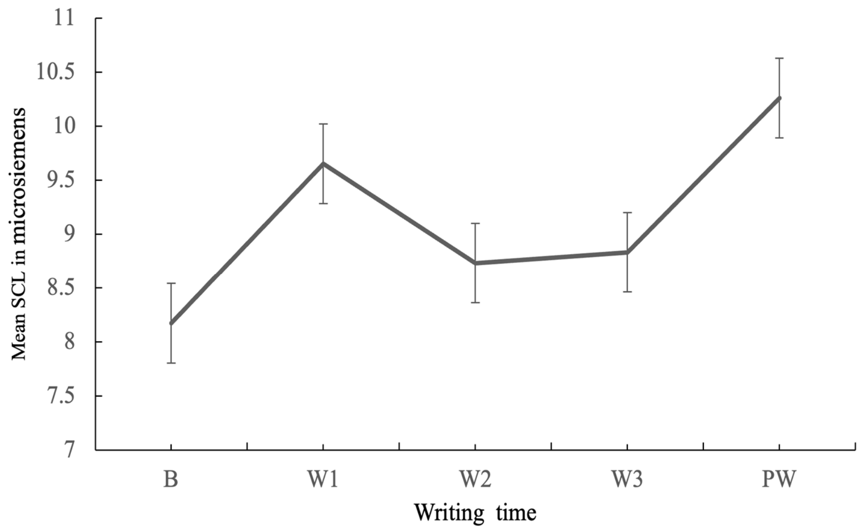

Figure 6. SCL average from Baseline to post-writing with standard error bars of the mean in the whole sample.

7. Discussion

In Study 2, fifty-five participants were randomly assigned to control or expressive groups, writing about their daily routine or the most traumatic event in their lives using a third-person perspective. Results of this study mirror those of Study 1, both regarding the manipulation check (the expressive group had higher negative affect after writing), and EDA changes during writing.

As in Study 1, starting the writing task increased SCL for both groups (an increase of 1.48 µs compared to the baseline). Subsequently, habituation resulted in a SCL decrease observed in W2 and stabilization in W3. Again, contrary to our predictions SCL was not influenced by the writing topic. Both control and expressive groups showed similar SCL during and after writing. And finally, SCL increased significantly upon finishing the writing task, as in the first study.

Study 3: Interaction between topic and perspective

In the previous studies, we analyzed the effect of writing topic (control and expressive) on affective and EDA changes. Results showed that writing topic caused affective changes especially in the negative affect which increased significantly after expressive writing, and in positive affect which increased after writing about the control topic. Starting to write had an impact on skin conductance, irrespective of writing topic. To have a better understanding about the interaction between group and perspective and their role on emotions during writing, in this study we analyzed the effect of group (control or expressive) and perspective (first-person or third-person) on the data collected in the two previous studies (n = 112, SD = 4.5).

As previous research showed, writing from a third-person point of view can help to cope with the negative experiences and stimulate emotion regulation (Nook & Schleider, 2017). Distancing oneself from a negative experience seems to reduce the emotional intensity of it and lessens physiological reaction (including heart rate and skin conductance; Verduyn et al., 2012; Wisco et al., 2015). Therefore, based on published studies we expected participants in the third person perspective to show less negative affect and lower SCL compared to the first-person perspective, and first-person expressive to show more negative affect and ~~lower~~ higher SCL compared to third-person expressive.

For this, a two 2 x 2 ANOVA was conducted on pre- and post-writing PANAS scores, with perspective (first-person vs. third-person) and group (control vs. expressive) as between-subjects factor and time (pre-writing vs. post-writing) as within-subjects factor. For analyzing SCL, 4 Ч 4 ANCOVA was conducted with SCL baseline as covariate, perspective (first-person vs. third-person) and group (control vs. expressive) as between-subjects factor and time (W1; W2; W3; PW) as within-subjects factor.

8. Results

8.1 PANAS changes

Two ANOVA repeated measures was conducted on pre- and post-writing PANAS scores (see Table 5 for descriptive statistics on perspective) with perspective (first-person vs. third-person) and group (control vs. expressive) as between-subjects factor and time (pre-writing vs. post-writing) as within-subjects factor.

For positive affect, The analysis showed that there was a significant effect of Time x Group, $F(1, 110) = 33.34$, $p < .001$, ηp =0.23. Pairwise comparisons showed no differences in pre-writing, but significant differences between expressive and control in post-writing (p < .001), with the expressive group having lower positive affect.

Table 5: PANAS scores for negative and positive affect

		Pre-writing M(SD)	Post-writing M(SD)
First-Person	Positive affect	25.93 (6.96)	25.75 (8.31)
	Negative affect	13.74 (3.59)	16.58 (8.42)
Third-Person	Positive affect	26.21 (6.39)	25.33 (9.09)
	Negative affect	13.56 (3.39)	14.98 (6.68)

Note. n (1st-Person) = 57; n (3rd-Person) = 55

For negative affect, the analysis showed that there was a significant effect of *F*(1, 110) = 13.25, $p < .001$, ηp =0.11, with post-writing being higher than pre-writing ($p < .001$). There was also a significant effect of Time x Group, *F*(1, 110) = 51.25, $p < .001$, ηp =0.32. Pairwise comparisons showed no differences for the control group, but the expressive group had higher negative affect from pre-writing to post-writing ($p < .001$).

The interaction of Time x Perspective was not significant for PA, *F*(1, 110) = 0.501, $p = .481$, ηp =0.005, and there were no significant interactions between Time x Group x Perspective, *F*(1, 110) = .002, $p = .964$, ηp =0.00001. The interaction of Time x Perspective was also not significant for NA, *F*(1, 110) = 1.207, $p = .274$, ηp =0.011, and there was a marginal interaction effect between Time x Group x Perspective, *F*(1, 110) = 3.33, $p = .071$, ηp =0.029. Pairwise comparisons showed expressive groups, compare to control groups, in both first-person and third-person perspective had higher NA in post-writing ($p < .001$).

Results confirmed the findings in Study 1 and Study 2. Negative affect increased after finishing the writing task, in the expressive group, and contrary to our expectation perspective didn´t have a significant effect on PA or NA.

8.2 EDA changes

The interaction between group and perspective and their effect on EDA changes throughout the writing assignment were analyzed by conducting 4 Ч 4 mixed ANCOVA with baseline SCL as covariate, perspective (first person vs. third person) and group (control vs. expressive) as between-subjects factors and, time (W1; W2; W3; PW) as within-subjects factor. Table 6 shows means and standard deviations of EDA before, during and after writing in perspective.

The analysis showed that there was a significant effect of time, *F*(2.49,261.39) = 24.01, $p < .001$, *ηp* =0.19. Pairwise comparison showed that, all moments were significantly different from each other except for moment 2 and 3, with EDA being higher in PW in comparison to all other moments ($p < .001$). There was also a marginal interaction effect of Group X Time, *F*(2.49,261.39) = 2.73, $p = .055$, *ηp* =0.025.

Table 6: Descriptive statistics of SCL in different moments

	1st-Person		3rd-Person	
Time	*M*	*SD*	*M*	*SD*
B	8.36	4.36	8.49	4.93
W1	9.15	4.19	9.99	4.82
W2	8.25	4.33	9.21	5.01
W3	8.62	4.85	9.3	5.21
PW	9.81	4.56	10.67	4.95

Note. SCL was measured in microsiemens; n (1st-Person) = 57; n (3rd-Person) = 55

This marginal interaction showed that for the control group, all moments were significantly different from each other except for moment 2 and 3, with EDA being higher in PW in comparison to all other moments ($p < .001$). For the expressive group, W1 and PW were similar, and they were equally higher than writing moments 2 and 3 ($p < .001$). In addition there were differences between groups for perspective, $F(1,105) = 6.240$, $p = .014$, ηp =0.056, with the 3rd person showing higher EDA ($p = .014$), in comparison to first person, by .659µs. Results showed no significant interaction between group and perspective ($F(1,105) = 2.089$, $p = .151$, ηp =0.020).

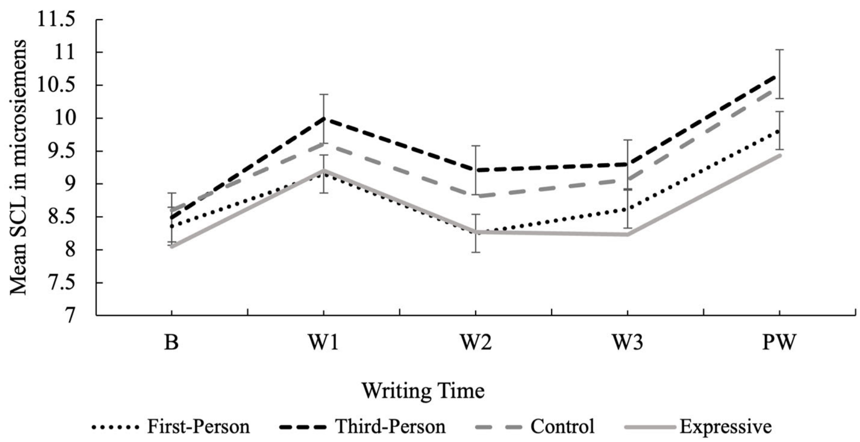

Figure 7. SCL average from Baseline to post-writing with standard error bars of the mean.

Results on the effect of group was the same as Study 1 and 2. Contrary to our expectations, participants who wrote in the third-person showed higher SCL compared to the participants who wrote in the first-person. This result runs against ~~to~~ what was reported by Wisco et al. (2015), who have found a significant increase in SC of the self-immersion group whereas the self-distancing group remained stable. Figure 7 depicts the changes in 4 lines, control, expressive, first-person and third-person.

9. Discussion

In the third study we analyzed the interaction between topic (control vs. expressive) and perspective (first-person vs. third-person) on affective and EDA changes in the data collected from the two previous studies ($n = 112$, SD = 4.5). Regarding affective changes, measured by PANAS, we found an increase in NA from baseline to post-writing, which is in line with what we found in both Study 1 and Study 2, viz. participants in the expressive groups showed higher NA after finishing the writing task. Contrary to our prediction there were no significant differences due to writing perspective. Similar to

Kross et al. (2005) and Orvell et al. (2020), we expected that recalling memories in a self-distancing perspective should decrease negative affect compared to the self-immersion, but that was not the case. Interestingly, aligned with the current findings, Kross et al. (2012) showed that self-distancing reduced negative affect only in depressed individuals, but had not significant effect on healthy individuals. As noticeable our current sample is of healthy university students with no diagnosed psychiatric disorders.

Regarding EDA changes, SCL results showed that participants who wrote in third-person had higher SCL compared to the first-person perspective in the first ten minutes of the writing task (W1, W2), and in the post-writing (PW) regardless of the topic (control or expressive). Typically, when people focus on past experiences, they do it from a first-person or self-immersed perspective (Kross et al., 2005). Perhaps, being asked to remember memories from a third-person perspective is an unexpected demand, thus leading to increased arousal.

10. General Discussion

In this research, we looked at affective and EDA changes across three studies looking at: self-immersion expressive writing, self-distancing expressive writing, and the interaction between writing perspective and writing topic (control and expressive). Across studies, the most interesting findings were that irrespective of topic (control or expressive), simply being asked to write caused a rise in SCL as clearly seen from baseline to W1. Furthermore, SCL also increased significantly in the post-writing period. We expected a decrease in SCL during the resting period after the writing exercise, but we found a surprising raise in SCL upon completion of the writing task. These results were found in Study 1 and replicated in Study 2. In Study 3, we found that writing in the third-person compared to first-person perspective was associated with higher SCL in W1, W2, and PW.

10.1 Affective and EDA changes

As expected, results of the PANAS confirmed that expressive writing increased negative affect in the participants. This is in line with many previous findings showing that expressive writing has an immediate negative effect on mood (see McGuire et al., 2005; Pennebaker & Beall, 1986). Additionally, writing about daily routine increased positive affect in the control groups.

Contrary to previous studies that writing in the third person perspective was associated with less negative affect (Kross et al., 2005; McIsaac & Eich, 2004), our findings showed that writing perspective had no significant effect on participants' mood. Perhaps this is due to the different procedures across the studies. In our studies participants wrote either of control or expressive topics; whereas, in the cited self-distancing studies (Kross et al., 2005; Kross et al., 2012; Orvell et al., 2020), all participants wrote about emotional topics and there was no control group. Future studies can test if it is indeed the presence of neutral topics that mask the reported diminishing impact of self-distancing on negative affect.

As the results showed, writing, regardless of the topic, increased SNS activation. Moreover, SCL showed a significant increase in both groups at post-writing. While the first rise in SCL was expected due to the necessary SNS activation to perform a new task, the second observed SCL rise is puzzling as post-writing was meant as a relaxing period for the participants. A previous study on goal attainment and its psychophysiological effects revealed that task completion and achievement can trigger sympathetic activation (Kreibig et al., 2010). Kreibig et al. found increased sympathetic activation (including SCL) after emotional response to a success experience. Similarly to our results, they reported a rise in SCL during the task, upon receiving feedback and in the recovery period among participants who reported surprise. Kreibig et al. interpreted these findings as showing the impact of achievement and emotions in SCL changes. Additionally, rise in EDA upon completing a task might also signal reward-seeking behavior (Patterson et al., 2002). Perhaps, upon completing the writing task, the participants in our study felt a sense of achievement and reward-seeking, which translated into increased SCL. Indeed, it seems a common experience that writers do feel a sense of accomplishment upon composing and completing a text.

Alternatively, increased post-writing SCL might signal arousal due to mental preparation to continue for impending daily activities following the finished task. McGuire et al. (2005) recorded EDA in resting time without introducing any stimulus. Results showed that on average, in 15 minutes time of recording biofeedback, EDA increased from the first half of the 15 minutes to the second half. Perhaps in the current studies, EDA rose at the end of the task because participants were thinking and getting ready for their next planned activity. As shown in a study by Nikula (1991), thinking about current concerns can cause arousal and a significant increase in EDA activation. Due to the limited number of empirical studies in this topic, future studies could more thoroughly explore the impact of completing different tasks on SNS activation.

As EDA does not indicate the positive or negative valence of SNS activation (Raphelson, 1957), the rise of SCL in post-writing may have been caused by different reasons in the control and expressive groups. For example, SCL rise in the control group might have been due to writing task completion; and in the expressive group might have been due to remembering traumas and negative feelings. The results of the manipulation check were in line with this, as the expressive group showed higher negative affect. Future studies could clarify this by asking participants for the content of their thoughts during the post-writing period.

A final important result was that participants who wrote in the third-person showed higher EDA than participants who wrote in first-person. Increased EDA was found in the beginning and at the end of the writing task (W1, W2, and PW). This might be related to the well-known effect of novelty on EDA. Novel stimuli can capture attention and as a result lead to raises in EDA (Bradley, 2009; Verastegui-Tena et al., 2018). As noted by Kreibig et al. (2010) participants who reported surprise had higher SCL during and even after task completion. Our participants might have felt surprised by being asked to write in third person, instead of the more common and familiar first-person perspective. Thus, creating a novelty context, which was then expressed in increased SCL. Future studies could directly inquire participants about how they felt about the writing prompts they were given.

11. Limitations and future directions

Results from this study should be carefully interpreted and having in mind three main limitations: (i) lack of research in this field (SNS activation during and after writing) meant that we have a limited research base to interpret our findings, therefore future research is necessary to overcome this limitation. (ii) In this study we only measured SCL. Measuring both SCL and SCR could provide a better perspective of tonic and phasic changes of EDA (Benedek, & Kaernbach, 2010). (iii) Finally, our study did not include a follow up questionnaire. Future studies should add an additional moment to access if there was any change in emotion after the experimental session.

While unexpected, the finding of increased EDA in post-writing seems to be a reliable one since a standard methodology and equipment were used for data collection, and critically the same results were replicated across Study 1 and Study 2. Future studies might consider using EDA wristbands as they can provide data collection for longer periods of time and assure high ecological validity (Poh et al., 2010). EDA could also be measured during and after completing many different tasks (e.g., drawing and writing) to have a better understanding of cognitive, affective, and physiological connections underlying SNS activation.

12. Conclusion

Three studies were designed to improve understanding about the affective and physiological changes of expressive writing and writing perspective. We used PANAS to measure affective changes and EDA to measure sympathetic activation during and after writing exercises. Participants were randomly assigned to control or expressive groups, writing either about daily routine or the most traumatic event of their lives in first or third-person perspective. EDA was measured before, during, and after writing. Results of Study 1 and Study 2 indicated that writing about traumas lead to more negative affect compared to writing about daily routine. Writing topic did not affected EDA neither in the control nor in the expressive group. EDA rose in the beginning of writing and after concluding the writing task for both groups. EDA raises upon task completion might have been due to task achievement, reward-seeking, or mental preparation of subsequent planned tasks. This seems to be an important finding, and as far as we know reported here, in a writing study, for the first time. Furthermore, results of Study 3 showed that writing perspective (first or third person) had no significant effect upon participants mood. This study also revealed that EDA was higher in participants who wrote in the third-person perspective than those writing in the first-person in W1, W2, and PW. This seem to have been due to the novelty of writing from an observer's point of view. To the best of our knowledge very few studies investigated writing and skin conductance. This line of research seems valuable because it sheds light on the immediate changes of the SNS during and after writing tasks, thus helping to advance knowledge about writing and some of its specific influences on the body.

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