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Colors of perfectionism - How experimental feedbacks change physiology using Mandalas

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ABSTRACT

Although the link between perfectionism, performance, and feedback has been widely studied, findings remain inconclusive, partly due to the lack of objective assessment methods. Biological correlates, such as heart rate variability, may help clarify these relationships. This study investigates physiological responses to performance feedback during a coloring task and examines the association between perfectionism and task performance.

Eighty-three participants (Mage = 20.74, SD = 3.41), including 64 females, completed the study, with perfectionism assessed using the Short Almost Perfect Scale (SAPS). Heart rate variability (HRV) was recorded to assess autonomic nervous system activity. Participants took part in an experimental intervention involving a 10-min mandala coloring task, during which they received positive, negative, and neutral performance feedback.

Higher High Standards scores were significantly associated with fewer correctly colored pixels ($\tau = -0.161$, $p = .036$) and reduced overall coverage ($\tau = -0.153$, $p = .046$), and these associations remained significant after controlling for age and gender. Higher Discrepancy scores were also significantly associated with fewer correctly colored pixels ($\tau = -0.153$, $p = .046$) and reduced overall coverage ($\tau = -0.150$, $p = .049$), although these associations were no longer significant after controlling for age and gender. Neither perfectionism dimension was significantly associated with HRV responses to evaluative feedback. Exploratory analyses revealed associations between HRV responses to evaluative feedback and overall coloring performance.

The results suggest that different dimensions of perfectionism are associated with task performance, while physiological responses to evaluative feedback are related to overall coloring performance.

1. Introduction

The prevalence of perfectionism among youth has increased steadily over recent generations, reflecting heightened perceptions of demanding standards from both oneself, from others and toward others (Curran & Hill, 2019). Perfectionism is characterized as a multidimensional personality construct involving unrealistic performance standards and excessively critical self-evaluation (Frost et al., 1990; Harper et al., 2016). This construct is typically conceptualized as comprising two distinct dimensions: adaptive and maladaptive perfectionism (Stoeber & Otto, 2006). Adaptive perfectionism, which is linked to intrinsic motivation (Mills & Blankstein, 2000), involves setting high but achievable standards and deriving satisfaction from success, and is often associated with positive psychological outcomes such as increased self-efficacy (Stoeber et al., 2008) and well-being (Kamushadze et al., 2021). Conversely, maladaptive perfectionism, rooted in extrinsic pressures and an inability to experience satisfaction, correlates with negative psychological traits and disorders, such as heightened stress, anxiety, and depression (Bieling et al., 2004; Stoeber, 2011). Perfectionistic strivings, generally associated with the adaptive dimension, encompass high personal standards and self-oriented perfectionism, whereas perfectionistic concerns, associated with the maladaptive dimension, include concerns over mistakes, doubts about actions, socially prescribed perfectionism, perceived discrepancy, and negative reactions to imperfection (Stoeber & Otto, 2006; Madigan, 2023; Bartos & Schwartz, 2026 recently reconsidered this distinction from a process-oriented perspective.

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Distinguishing between the dimensions of perfectionism is particularly relevant, as they may be associated with different responses to stressful and evaluative situations at both psychological and physiological levels. Examining biological correlates of stress reactivity may therefore provide complementary information about the physiological processes accompanying perfectionistic responses to such situations, alongside established self-report measures of trait perfectionism.

1.1. Biological correlates of stress reactivity in perfectionism

Research examining biological correlates of stress reactivity in relation to perfectionistic traits has yielded inconsistent findings. Psychophysiological methods employed in this context include heart rate variability (HRV) (Nealis et al., 2022), skin conductance response (SCR) (Hasel & Besharat, 2011), electromyography (EMG) (Ioannou et al., 2016), event-related potentials (ERPs) (Isheqlou et al., 2023), functional magnetic resonance imaging (fMRI) (Barke et al., 2017), and cortisol level analysis (Page et al., 2018). These methods allow physiological and neural responses associated with stress to be examined in relation to perfectionistic traits. Importantly, physiological responses observed in such contexts cannot necessarily be attributed specifically to perfectionism, as they may reflect broader stress-reactivity processes. Stress, while correlated with both adaptive and maladaptive perfectionism, appears to exacerbate negative outcomes primarily in the maladaptive form (Bieling et al., 2004). While numerous studies have identified a relationship between perfectionism and physiological stress responses, significantly fewer have specifically examined this association in the context of performance feedback. One study found that high levels of socially prescribed perfectionism (SPP), when combined with low self-confidence, were associated with a significant increase in heart rate and a notable rise in systolic blood pressure specifically in response to negative feedback, whereas these effects were reduced or absent following positive feedback (Besser et al., 2008). In contrast, other research has found that perfectionists did not exhibit significantly reduced heart rate variability in response to stress compared to either a control group or their own baseline levels, suggesting distinct patterns of physiological adaptation to stress (Azam et al., 2015). These inconsistent findings highlight the importance of examining physiological stress responses in relation to perfectionism within specific evaluative contexts, including performance feedback.

1.2. Present study

Based on current knowledge, no empirical study has investigated how a coloring-based task, combined with both positive and negative performance feedback, affects individuals with perfectionistic traits by examining biological correlates. This study addresses this gap by examining heart rate variability – a marker of autonomic nervous system activity and emotion regulation - in response to evaluative feedback during the task, while also investigating the relationship between different dimensions of perfectionism and task performance. Accordingly, the following hypotheses were formulated:

H1. The relationship between the High Standards dimension of perfectionism and task performance is positive.

H2. The relationship between the Discrepancy dimension of perfectionism and task performance is negative.

H3. Different dimensions of perfectionism are associated with heart rate variability (HRV) in response to evaluative feedback.

In addition to these hypothesis-driven analyses, the study included exploratory analyses examining associations between HRV responses and task performance, as well as a group-based comparison of perfectionism.

2. Methods

2.1. Participants

A total of 83 participants took part in the study (*M*age = 20.74, *SD* = 3.41; age range = 18–48), including 64 females and 19 males. The vast majority were Hungarian university students, with only two participants not enrolled in higher education. Four participants were excluded from HRV-specific analyses due to unprocessable HRV data. One participant was identified during the post-task interview as being aware of the feedback manipulation but was already among these four exclusions. Thus, HRV-specific analyses included 79 participants, while all other analyses were conducted with the full sample ($N = 83$).

Participants were recruited primarily among university students through online mailing lists and online and offline advertisements, with recruitment extended beyond the university setting through social media. Interested individuals contacted the research team via email and received a detailed study description, informed consent form, and data protection notice. Eligibility (age > 18 years) was confirmed during email communication. Exclusion criteria were a current or past diagnosis of a neurological or psychiatric disorder, ongoing treatment for such conditions, or related medication use.

Participation required a signed informed consent form, after which participants were assigned unique identification codes to ensure anonymity during data processing. Participation was voluntary and uncompensated. The study was approved by the Research Ethics Committee of the Faculty of Education and Psychology at ELTE Eötvös Loránd University (2024/392-2).

2.2. Procedure

Following recruitment, participants completed questionnaires in the laboratory using a computer-based interface on the Qualtrics online platform. Each participant was then guided to a separate room, where a gender-matched lab assistant helped apply the chest band for heart rate variability (HRV) measurement. Participants were instructed to remain seated, still, and silent during a 3-min baseline recording period, as illustrated in the experimental procedure shown in Fig. 2. The experimenter then introduced the mandala coloring task and provided the materials (mandala and pastel set). After the 10-min coloring task, participants were informed that the performance-related feedback was fabricated and did not reflect their actual coloring. Following this debriefing, their participation in the study ended.

2.3. Questionnaire

Perfectionism was assessed using the Short Almost Perfect Scale (SAPS; Rice et al., 2014), an 8-item self-report measure derived from the 23-item Almost Perfect Scale-Revised (APS-R; Slaney et al., 2001). The SAPS comprises two subscales, High Standards and Discrepancy, rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree), with subscale and total scores calculated. High Standards reflects individuals' expectations for themselves and represents a more adaptive form of perfectionism associated with motivation and achievement, whereas Discrepancy reflects self-critical evaluation arising from the perceived gap between personal standards and perceived performance and indicates maladaptive perfectionism (Bieling et al., 2004; Reinhardt, 2022; Stoeber, 2011). The validated Hungarian version was used (Reinhardt et al., 2019).

The two SAPS subscales were primarily analyzed as continuous variables, as recommended in the absence of established cut-off points (Reinhardt, 2022). To complement the continuous analyses, an exploratory profile-based approach was also used. Participants were classified relative to the SAPS scores reported for the Hungarian sample by Reinhardt et al. (2019): those characterized by High Standards scores of 20 or above and Discrepancy scores below 20 were classified as adaptive

perfectionists, whereas those with scores of 20 or above on both dimensions were classified as maladaptive perfectionists. Accordingly, 49 participants meeting these profile criteria were included (26 adaptive, 23 maladaptive), while the remaining 34 participants did not meet the criteria for either profile and were therefore excluded from this exploratory group comparison. This profile-based comparison allowed the examination of distinct configurations of High Standards and Discrepancy and is consistent with previous experimental studies using group-based approaches to examine perfectionism in relation to feedback and psychophysiological responses (Azam et al., 2015; Isheqlou et al., 2023, 2022).

2.4. Mandala coloring

Mandala coloring was selected for its practicality and has been successfully used in previous experimental studies (Curry & Kasser, 2005; Van Der Vennet & Serice, 2012). It may also capture individual differences potentially related to perfectionistic tendencies. Participants were given 10 min and eight colors to color a mandala printed in black on white A4 paper. The selected mandala, obtained from an open-access source free of copyright restrictions, had a suitably intricate and detailed pattern. Participants were instructed to use multiple colors; identical adjacent shapes could be colored the same, whereas different adjacent shapes had to be colored differently (demonstrated visually by pointing to the relevant shapes on the mandala); and coloring over one color with another was prohibited. Identification markers enabled precise software analysis and a consistent coloring framework across participants. The selected mandala with these markers is shown in Fig. 1.



Fig. 1. Raw Mandala Template with Identification Markers for Software Analysis.

A chalky pastel medium was used because its texture generates dust, limits precision, and creates smudges, allowing potential frustration to be examined in individuals with perfectionism who may be particularly sensitive to "imperfect" and less controllable task elements (Gerdan & Salcioglu, 2025; Shafran et al., 2002).

2.5. Feedback valence and implementation strategy

The feedback manipulation was grounded in theoretical and empirical work on feedback processes (Ajjawi et al., 2022; Chester & Lasko, 2021; Kluger & DeNisi, 1996) and was consistent with a recent systematic review of experimental feedback in perfectionism (Bartos et al., 2026). During the 10-min coloring task, participants received positive, neutral, and negative performance feedback at 2.5, 5, and 7.5 min, with the feedback periods marked in the HRV coding. The order of positive and negative feedback was randomized for each participant, while neutral feedback was always presented between them to enhance authenticity. The exact feedback was: negative - "*Oh, I see you went outside the lines there; others didn't do that!*" (while pointing to the visible error); neutral - "*I see you're using multiple colors.*"; and positive - "*So far, I like yours the most!*".

Pilot testing confirmed the clarity of feedback valence and situational plausibility without exaggerated differences. Feedback content was tailored to characteristics of perfectionism, while neutral feedback was affect-free and repeated a previous task instruction to avoid evaluative content. Pre-recorded feedback was initially tested to standardize delivery but was perceived as unnatural and disconnected from the task; therefore, feedback was delivered live by the experimenter to enhance authenticity.

2.6. Physiological data

Heart rate variability (HRV) is a widely used physiological marker of autonomic nervous system activity and stress responses and has also been used in perfectionism research (Azam et al., 2015). HRV data were collected using a Polar H-10 chest strap positioned on the participant's sternum by a gender-matched lab assistant to ensure standardized placement. The Polar H-10 has been validated against electrocardiography (ECG) for heart rate and HRV assessment (Chung et al., 2026; Blalock et al., 2026). R-R intervals were recorded directly from the sensor using the Polar Sensor Logger app and analyzed with the validated Kubios HRV 2.2 software (May 2014, Biosignal Analysis and Medical Software) (Tarvainen et al., 2014). R-R intervals were checked for artifacts in Kubios, and artifact-free data were used for analysis. A 3-min resting baseline was recorded, from which a 2-min segment was extracted for HRV analysis. HR mean, SD HR, RMSSD, and pNN50 were computed, while HF was derived using Fast Fourier Transformation, with HF power reflecting vagally mediated respiratory sinus arrhythmia (RSA). Descriptive statistics were calculated for the HRV measures. For each feedback condition, HRV measures were derived from an identical 2-min window beginning immediately after the feedback ended. HRV changes in response to positive and negative feedback were calculated by subtracting baseline HRV values from those measured during the respective feedback conditions.

2.7. Statistical analysis

The analyses were conducted using JASP software (Version 0.19.3) (JASP Team, 2024). Normality of the data was tested using the Shapiro-Wilk test. As the assumption of normality was not met, correlations were examined using Kendall's tau-b, and partial correlations controlling for age and gender were also conducted. Additionally, one exploratory group comparison was conducted using an independent-samples *t*-test.

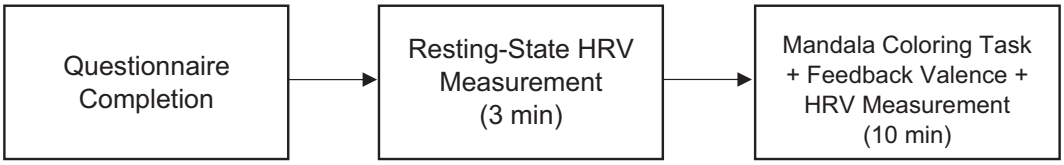


Fig. 2. Explaining the flow of the procedure.

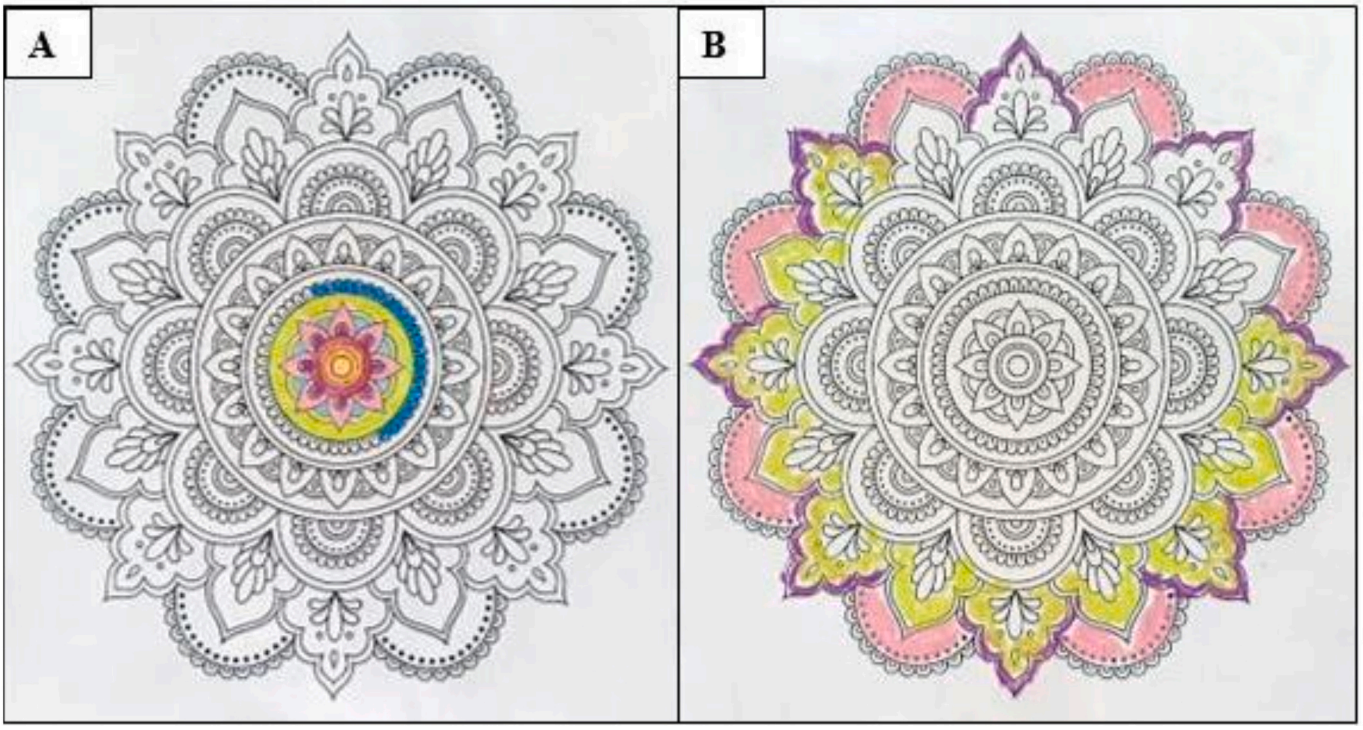


Fig. 3. Exploratory group comparison: Picture A: Adaptive Perfectionist (Correct colored pixels: 172.96; Overflow pixels: 51.33; Overall coverage: 9.01%) and picture B: Maladaptive Perfectionist (Correct colored pixels: 471.41; Overflow pixels: 144.41; Overall coverage: 24.14%).

2.8. Open science practices

The JASP file containing the data and corresponding analyses is provided as Supplementary Material. Deposition of the data in a public online repository is currently in progress. The study was not preregistered, and no preprint is currently available.

3. Results

3.1. Relationship between perfectionism and mandala coloring performance

To examine the relationship between participants' perfectionism and their performance during mandala coloring, Kendall's tau-b correlations were calculated between the SAPS subscales and the mandala coloring performance indicators: the number of correctly colored pixels, overflow pixels, and overall coverage of the figure.

For High Standards, significant negative correlations were found with the number of correctly colored pixels ($\tau = -0.161$, $p = .036$, $n = 83$) and overall coverage of the figure ($\tau = -0.153$, $p = .046$, $n = 83$). No significant association was found with overflow pixels. Thus, Hypothesis 1, which predicted a positive relationship between High Standards and task performance, was not supported. After controlling for age and gender, the negative associations of High Standards with correctly colored pixels ($\tau = -0.192$, $p = .014$, $n = 78$) and overall coverage ($\tau = -0.185$, $p = .018$, $n = 78$) remained significant, while a significant negative association with overflow pixels also emerged ($\tau = -0.162$, $p = .038$, $n = 78$).

For Discrepancy, significant negative correlations were found with the number of correctly colored pixels ($\tau = -0.153$, $p = .046$, $n = 83$) and overall coverage of the figure ($\tau = -0.150$, $p = .049$, $n = 83$). No significant association was found with overflow pixels (for descriptive statistics, see Table 1). Thus, Hypothesis 2, which predicted a negative relationship between Discrepancy and task performance, was supported. After controlling for age and gender, the associations of Discrepancy with correctly colored pixels ($\tau = -0.143$, $p = .068$, $n = 78$) and overall coverage ($\tau = -0.141$, $p = .073$, $n = 78$) remained negative but were no longer statistically significant. The association with overflow pixels also remained negative and non-significant ($\tau = -0.079$, $p = .312$, $n = 78$).

As an exploratory analysis, participants were classified into two groups based on the dimensions of perfectionism: 26 participants were classified as adaptive perfectionists and 23 as maladaptive perfectionists. The classification and corresponding performance outcomes are presented in Table 3. An independent-samples *t*-test revealed a significant difference between the adaptive and maladaptive perfectionism groups in overflow pixels, $t(47) = -2.312$, $p = .025$, $d = 0.66$. No significant group differences were found in correctly colored pixels, $t(47) = -0.973$, $p = .336$, $d = 0.28$, or overall coverage, $t(47) = -0.961$, $p = .341$, $d = 0.28$. Two distinct examples are shown in Fig. 3.

Table 1
Descriptive statistics.

	Median	Mean	SD	Min	Max	n
Coloring task performance						
Correctly colored pixels	238,700	279,300	178,400	49,370	1.073 × 10^6	83
Pixels that are overflow	78,650	89,860	45,670	26,170	2.183 × 10^5	83
Overall cover of the figure	12.20	14.11	8.498	2.661	51.04	83
SAPS						
High Standards	21.00	20.40	5.28	8.00	28.00	83
Discrepancy	16.00	15.45	5.37	5.00	28.00	83
Total Score	35.00	35.84	9.32	13.00	55.00	83
Log HRV Change (Positive feedback)						
mean HR	0.03489	0.03236	0.02960	−0.03380	0.1225	79
RMSSD	−0.1637	−0.1735	0.2185	−0.8762	0.4006	79
PNN50	−0.2735	−0.3224	0.4428	−1.694	0.8527	79
HF	−0.3561	−0.3700	0.4806	−2.818	0.7599	79
Log HRV Change (Negative feedback)						
mean HR	0.03374	0.03151	0.03387	−0.03326	0.1409	79
RMSSD	−0.1619	−0.1885	0.2730	−1.178	0.6995	79
PNN50	−0.2432	−0.1644	0.7956	−1.953	3.321	79
HF	−0.3890	−0.4168	0.5496	−2.694	0.7487	79

Abbreviations: SAPS = Short Almost Perfect Scale; HR = heart rate; RMSSD = Root Mean Square of Successive Differences; PNN50 = percentage of successive RR intervals that differ by more than 50 ms; HF = High Frequency.

3.2. Heart rate variability during the coloring task

To test Hypothesis 3, we examined associations between the dimensions of perfectionism and HRV in response to positive and negative evaluative feedback. Neither High Standards nor Discrepancy showed significant associations with any of the HRV measures following either negative or positive feedback. Thus, Hypothesis 3, which predicted associations between different dimensions of perfectionism and HRV in response to evaluative feedback, was not supported. After controlling for age and gender, the results remained unchanged.

As part of the exploratory analyses, we examined associations between HRV responses and coloring performance. During positive feedback, only RMSSD was significantly and negatively associated with overflow pixels ($\tau = -0.155$, $p = .043$, $n = 79$), and this association remained significant after controlling for age and gender ($\tau = -0.161$, $p = .046$, $n = 74$). No other significant associations were observed. During negative feedback, RMSSD showed significant negative correlations with all three performance indicators: correctly colored pixels, overflow pixels, and overall coverage. HF also showed significant negative correlations with all three performance indicators (see Table 2). After controlling for age and gender, the negative associations of RMSSD with all three performance indicators remained significant. For HF, the negative associations with correctly colored pixels and overall coverage remained significant, whereas the association with overflow pixels was no longer statistically significant.

4. Discussion

Contrary to Hypothesis 1, higher High Standards scores were associated with fewer correctly colored pixels and reduced overall figure coverage, indicating negative rather than the predicted positive relationships with task performance. These associations remained significant after controlling for age and gender, and a significant negative association with overflow pixels also emerged. This finding is consistent with Nols et al. (2024), who similarly found a negative rather than the hypothesized positive linear relationship between perfectionistic strivings and task performance. In support of Hypothesis 2, higher Discrepancy scores were associated with fewer correctly colored pixels and reduced overall figure coverage. However, after controlling for age and gender, these associations remained negative but were no longer statistically significant. Nols et al. (2024) likewise reported performance-related disadvantages involving perfectionistic concerns. Taken together, the present findings may suggest that an emphasis on accuracy limits the extent to which individuals color the figure, resulting in incomplete task execution - a pattern that has similarly been observed in a coloring task (Basak, 2016).

As an exploratory analysis, participants were classified into adaptive and maladaptive perfectionist groups, an approach previously used in perfectionism research (Isheqlou et al., 2022; Lo, Abbott, 2019b), while the primary analyses treated perfectionism as a continuous variable. Of the three performance indicators, only overflow pixels differed significantly between the groups, with maladaptive perfectionists making more errors than adaptive perfectionists. This finding is particularly noteworthy because overflow pixels directly capture coloring errors, which are relevant to perfectionism given its emphasis on mistake avoidance and flawless performance (Frost et al., 1990).

Although evidence regarding whether maladaptive perfectionism is associated with poorer performance and adaptive perfectionism with better performance remains inconclusive (Stoeber, 2012), the higher error rate in the maladaptive group is consistent with this proposed pattern. Previous findings suggest that perfectionistic strivings predict task performance and greater time investment (Stoeber et al., 2010), and that adaptive perfectionists place greater emphasis on accuracy (Isheqlou et al., 2023). Accordingly, the higher error rate in the maladaptive group may reflect greater prioritization of accuracy over speed

Table 2
Correlation between HRV changes in response to the positive and negative feedbacks and coloring performance.

	Correctly colored pixels			Pixels that are overflow			Overall cover		
	Kendall Tau	p	n	Kendall Tau	p	n	Kendall Tau	p	n
Log HRV Change (Positive feedback)									
mean HR	0.011	0.89	79	0.07	0.38	79	0.014	0.85	79
RMSSD	−0.13	0.08	79	−0.16	0.04*	79	−0.13	0.09	79
PNN50	−0.14	0.06	79	−0.12	0.13	79	−0.15	0.05	79
HF	−0.09	0.24	79	−0.08	0.31	79	−0.09	0.25	79
Log HRV Change (Negative feedback)									
mean HR	0.09	0.21	79	0.13	0.09	79	0.10	0.19	79
RMSSD	−0.20	0.01*	79	−0.18	0.02*	79	−0.19	0.01*	79
PNN50	−0.12	0.13	79	−0.12	0.13	79	−0.12	0.12	79
HF	−0.21	0.01*	79	−0.15	0.047*	79	−0.21	0.01*	79

Abbreviations: HR = heart rate; RMSSD = Root Mean Square of Successive Differences; PNN50 = percentage of successive RR intervals that differ by more than 50 ms; HF = High Frequency, * $p < .05$.

Table 3
Descriptive statistics for the exploratory perfectionism groups and coloring performance.

	Group	N	Mean	SD	SE	Coefficient of variation
Correctly Colored Pixels	Adaptive	26	239,227.000	119,902.451	23,514.805	0.501
	Maladaptive	23	284,296.826	198,997.671	41,493.883	0.700
Pixels that are overflow	Adaptive	26	70,513.846	35,257.873	6914.638	0.500
	Maladaptive	23	98,986.870	50,428.585	10,515.087	0.509
Overall cover of the figure	Adaptive	26	12.217	5.804	1.138	0.475
	Maladaptive	23	14.344	9.454	1.971	0.659

among adaptive perfectionists, consistent with evidence that adaptive perfectionists retrospectively report valuing accuracy more than rapid task execution (Stoeber et al., 2010). The illustrative examples in Fig. 3 show fewer overflow pixels for the adaptive perfectionist example, whereas the maladaptive perfectionist example shows greater overall coverage and more correctly colored pixels alongside more overflow pixels.

Contrary to Hypothesis 3, neither High Standards nor Discrepancy was significantly associated with HRV following positive or negative feedback, and this pattern remained unchanged after controlling for age and gender. Previous findings on the relationship between perfectionism and cardiac autonomic activity have been inconsistent. Nealis et al. (2022) reported that self-critical perfectionism was negatively associated with HRV, whereas perfectionistic strivings showed a positive association based on daily HRV measurements over one week. In contrast, Harper et al. (2016) found no significant associations between perfectionism and RSA or PEP reactivity, while Azam et al. (2015) found no significant decrease in HRV under stress among individuals assessed on maladaptive perfectionism dimensions. The present null findings therefore add to the mixed evidence regarding associations between perfectionism and cardiac autonomic responses.

Exploratory analyses nevertheless revealed associations between HRV responses and coloring performance. Previous mandala-coloring studies have primarily relied on self-report measures and reported reductions in anxiety following stress induction (Curry & Kasser, 2005; Van Der Vennet & Serice, 2012). In a study combining self-report and physiological measures, Muthard and Gilbertson (2016) found effects on emotional outcomes but no between-group differences in heart rate, blood pressure, or skin conductance following a validated psychosocial stressor (Kirschbaum et al., 1993) and an intervention combining mandala coloring with a parasympathetic-activating breathing technique (Linehan, 1993). Different patterns of association between HRV and coloring performance across feedback conditions. During positive feedback, lower RMSSD was associated only with more coloring errors, an association that remained significant after controlling for age and gender. During negative feedback, lower RMSSD was consistently associated with greater coloring activity, reflected in greater coverage and more correctly colored pixels, but also with more coloring errors. A similar pattern was observed for HF, although its association with overflow pixels was no longer significant after covariate adjustment. Thus, during negative feedback, lower vagally mediated HRV was associated with greater task progress alongside reduced coloring accuracy.

4.1. Limitations

The group-based comparison of perfectionism was not part of the confirmatory analyses but was conducted as an exploratory analysis after data collection had been completed. To evaluate the sample size requirements for this comparison, an additional power analysis based on an independent-samples *t*-test was conducted, which indicated that 64 participants per group would be required. As the present sample did not meet this requirement, the findings from this exploratory group comparison should be interpreted with caution. Accordingly, the vast majority of analyses treated the SAPS scores as continuous variables, with only one exploratory analysis based on the group classification.

A further limitation concerns the absence of respiratory data during HRV measurement. As variations in respiratory patterns can influence heart rate variability, the autonomic interpretation of the observed HRV changes requires caution in the absence of respiratory control (Quigley et al., 2024). Respiratory data collection was not available within the framework of the present study. In addition, no self-report measures of state anxiety, perceived stress, or affect were collected, limiting the extent to which the physiological responses interpreted in terms of stress reactivity can be related to participants' subjective experiences.

Another limitation concerns selection bias, as our sample consisted predominantly of university students and shares several characteristics associated with WEIRD samples. Specifically, the sample can be characterized as Educated and as originating from an Industrialized and Democratic society, while the Western and Rich characteristics may be less applicable to the present sample. Prior methodological analyses have demonstrated that such samples may possess specific cognitive and motivational profiles, which may introduce population bias and reduce external validity (Henrich et al., 2010). Consequently, the generalizability of the present findings to other populations may be limited. Finally, the gender distribution of the sample was unbalanced, with a higher proportion of female participants, which may also be considered a limitation of the study.

5. Conclusion

To the best of our knowledge, this is the first study to experimentally examine perfectionism, task performance, and physiological responses within a mandala-coloring task incorporating both positive and negative performance feedback. The findings indicate that different dimensions of perfectionism are related to task performance, although these relationships were not uniformly robust after accounting for age and gender. In contrast, perfectionism was not directly associated with HRV responses to evaluative feedback. Exploratory findings nevertheless revealed relationships between HRV responses to evaluative feedback and overall coloring performance, as well as performance differences between adaptive and maladaptive perfectionist groups. Taken together, these findings suggest a complex interplay between perfectionistic tendencies, performance, and physiological responses in evaluative contexts and underscore the value of examining these processes jointly rather than treating physiological responses as direct biological indicators of perfectionism.

CRediT authorship contribution statement

Adel Bartos: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Anna Lobko:** Investigation, Data curation. **Atilla Çolak:** Software, Formal analysis. **Ricardo Marroquim:** Supervision. **János Körmendi:** Validation, Software. **Ádám Koncz:** Writing – review & editing, Formal analysis. **Kristof Schwartz:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2026.114120.

Data availability

The data will be made available upon acceptance of the manuscript.

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