

## Investigating the relationship between mood instability and ADHD traits and creativity with ECG response during a colouring activity

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### *Abstract*

*This research was conducted for the university of Lincoln's UROS scheme. Bipolar disorder (BD) is associated with creativity however the physiology and applicability of this to therapy is not fully understood. Therefore, this research asked participants, with high and low BD traits assessed by a questionnaire, to do a colouring task while undergoing an electrocardiogram (ECG). Twenty-five completed the questionnaire and 7 completed an ECG. A correlation between ADHD traits and BD traits was found. Altered ECG response indicative of lower stress was found during the colouring task however on analysis this was not significant. Lack of significance may be due to small sample size. Therefore, future research should continue to investigate this link but with a bigger sample in order to enable an investigation of group difference effects of colouring in the context of mood instability and ADHD traits.*

*Keywords: mood instability, creativity, attention deficit hyperactivity disorder, heart rate variability, echocardiogram*

### **Introduction**

This project was supported by the University of Lincoln's Undergraduate Research Opportunities Scheme (UROS). UROS is a competitive bursary scheme encouraging undergraduate students' involvement in the University of Lincoln's research projects (University of Lincoln, 2023). The philosophy of student as the producer enhances CVs by gaining valuable skills and experiences (University of Lincoln, 2023) and this was practiced by the student, with staff support, throughout the research process.

### **Project Background**

Bipolar disorder (BD) is a mood disorder classified as changing between a depressive, anxious state to an angry, manic state (Zain and Mumtaz, 2022). Bipolar 1 classifies the manic-depressive state as dominant, and bipolar 2 requires the lifetime experience of at least one depressive episode and one hypomanic episode (American Psychiatric Association's (2022) Diagnostic and Statistical Manual of Mental Disorders (5th ed. Text revision; DSM-5-TR). Pharmacology is the main treatment for BD (Hayes et al., 2016) but talking therapies and psychoeducation can be useful for those in a depressive state (Yatham et al., 2018).

The aetiology of BD is not fully understood (Young and Juruena, 2021). BD may have neuropathological (Harrison et al., 2020), genetic, or environmental causes, or a combination (Leahy, 2007; Misiak et al., 2018). The inability to anticipate one cause emphasises the importance of researching different ways to provide care, improving quality of life.

Attention deficit/hyperactivity disorder (ADHD) is characterised as developmentally inappropriate levels of inattention or hyperactivity/impulsivity (DuPaul et al., 2009). Due to the knowledge that ADHD symptoms prevail beyond childhood and requirements for precision in clinicians' assessment of the disorder, a better understanding is needed (Buitelaar et al., 2022). ADHD is associated with creativity (Boot et al., 2017; Hoogman et al., 2020) so this research included an ADHD measure to provide further insight.

Creativity is difficult to define but it generally involves four interacting areas: the person who creates, the cognitive processes involved, the environment and the product (Batey, 2007). Creativity has been associated with BD (Gostoli et al., 2017) with findings suggesting specific personality types common with BD such as affective temperament, impulsivity and risk-taking being spanned by perceptual creativity (Greenwood, 2016). Creativity and BD are associated with ambition and goal directed pursuits (Johnson et al., 2015). Suggesting that creativity can be advantageous to BD by enhancing individual characteristics.

### **Literature Review**

Despite the well-established connection between creativity and BD (Johnson et al., 2016), there are discrepancies in the research. Some studies suggest that lithium enhances creativity and others suggest the opposite (Johnson et al., 2016) which is problematic when patients refuse treatment in favour of their creativity (Johnson et al., 2016). Creativity can have clinical applications (Haugwitz, 2021; Morgan et al., 2011; Carr et al., 2013; Grocke et al., 2014) however this hasn't been thoroughly investigated in BD populations. Increased knowledge is required to disregard misinformation surrounding the best care.

Burkhardt et al (2019) connected BD and creativity in at-risk groups and this research developed their suggestions to investigate the impact of creativity on the therapeutic process, in lowering measures associated with heightened stress activation pathways. Evidence suggests that colouring tasks can reduce stress (Kaimal et al., 2017; Dresler and Perera, 2019) so this was used to engage the participants creativity. Stress is a negative bodily response to a situation (Akinola et al., 2019) measured to indicate psychological state.

Using the questionnaire data only, this research proposed a positive correlation between creativity and both ADHD and BD traits. A subset of participants was recruited for a laboratory-based echocardiogram (ECG) to measure heart rate

variability (HRV), a physiological measure of stress, in those with high and low BD traits before and during a colouring task. High and low BD traits were determined by considering the data and concluding a point which separated the two groups. Because HRV can predict mood states (Gentili et al., 2017), this methodology enabled speculation on the psychological state produced by creativity in BD populations. ECG has a 99.07% sensitivity rate (Esgalhado et al., 2022) indicating its' reliability in evaluating HRV and mood states. It was hypothesised that while conducting a creative task, stress levels would be lowered in comparison to baseline in participants scoring highly on the BD and creative questionnaires. Supporting evidence indicating creative tasks can have a positive effect on BD related symptoms.

## Methodology

All participants were female at birth with a mean age of twenty. Twenty-five participants consented to partake in the questionnaire and seven consented to undergo an ECG. Of those 7, 3 were considered high and 4 were considered low in BD traits.

The biographical inventory of creative behaviours (Batey, 2007) (Appendix A) assessed participants' levels of creativity by indicating whether they did (1) or did not (0) in response to 34 items such as decorated a room. This has a high Cronbach's alpha ( $\alpha = 0.86$ ) (Silvia et al., 2021).

The Temperament Evaluation of Memphis, Pisa, Paris and San Diego- autoquestionnaire version (TEMPS-A) (Akiskal et al., 2005) (Appendix B) established BD levels by measuring temperament variations based on diagnostic criteria with high reliability (Akiskal et al., 2005). Including 39 closed questions such as I complain a lot separated into 5 subscales.

The Conners' Adult ADHD Rating Scales--Self Report: Short Version (CAARS--S:S) (Conners et al., 2004) (Appendix C) assessed ADHD levels. Participants rated how frequently each item describes their behaviour on a Likert scale consisting of 5 subscales with 32 items such as I still throw tantrums. This scale has a high internal consistency ( $\alpha = 0.80 - 0.89$ ) (Hines et al., 2012).

Demographic questions were asked first and then 3 questionnaires assessing levels of ADHD, BD tendencies and creativity were provided. Before the ECG, the participant was asked a few questions such as their smoker status and their weight as variables such as these can influence HRV (Murgia et al., 2019; Yadav et al., 2017). Two ECG recordings were taken for each participant in a laboratory within the School of Psychology at the University of Lincoln based on the methodology by Refisch et al (2022). The first taking 10 minutes to establish a baseline heart rate and the second taking 30 minutes at a sampling rate of 1000Hz assessing how colouring affects HRV, as explained by Refisch et al. (2022). Refisch et al. (2022) also

encouraged relaxation, sitting still, and keeping the room at a comfortable temperature which this study replicated. Participants conducted the colouring task for the full 30 minutes using their chosen one of three available colouring sheets.

Ethical approval was gained from the university of Lincoln ethics department (ethics code: UoL2023\_14121). Participation was voluntary and kept anonymous excepting an email address for communication about the ECG. All identifying information was deleted after data collection was finished.

Kubios (Kubios, 2023) analysed the ECG output and assessed the root mean square of successive differences (RMSSD), the low frequency to high frequency ratio, the mean RR interval and Baevsky's stress index. A Wilcoxon signed rank test compared the baseline and task ECG output of each of these indicators for the low and high BD trait group (Tables 3 and 4). The questionnaire data was analysed using a Pearson correlation on SPSS.

## Results

BD and ADHD traits were correlated but neither correlates with creativity (Table 1). While it is understandable that ADHD and BD traits would correlate due to the similarity in symptoms, previous research suggests that they should also correlate with creative traits, which does not support the hypothesis.

	TEMPS-A	BICB	CAARS
TEMPS-A			
BICB	0.127		
CAARS	0.745	0.053	

**Table 1:** Correlations between questionnaire data measuring mood instability, attention deficit hyperactivity traits and creativity.

	1	2	3	4	5	6	7	8	9	10
1. ADHD index										
2. Problems with self-concept	.569**									
3. Impulsive/emotional ability	.741**	.302								
4. Hyperactivity/restlessness	.803**	.454*	.636**							
5. Inattention and memory problems	.729**	.267	.483*	.567**						
6. Cyclothymic	.773**	.458*	.729**	.613**	.415*					
7. Depressive	.417*	.543**	.490*	.405*	.156	.525**				
8. Irritable	.694**	.536**	.636**	.629**	.389*	.629**	.511**			
9. Hyperthymic	.449*	.155	.481*	.355	.185	.569**	.337	.433*		
10. Anxious	.336	.257	.459*	.268	-.101	.491*	.535**	.353	.156	

**Table 2:** Correlations between subscales of the questionnaires measuring mood instability (TEMPS-A) and traits for attention deficit hyperactivity disorder (CONNORs). Items 1- 5 are the subscales for the ADHD measure. Items 6-10 are the subscales for the mood instability measure. \*<0.05, \*\*<0.01

Even though no significant results were found, the raw data suggests that colouring tasks reduce stress in the high and low BD trait groups (Figures 2-5). So, the hypothesis was not supported however, the small cohort size may not be big enough to indicate significance. Future research should continue to investigate this link and its applicability clinically in larger samples since the results here suggest colouring tasks could induce relaxation. Further research could also investigate the difference between creative tasks and compare how this affects relaxation, improving the knowledge on treatment options for BD and informing on why BD is associated with creativity. These results could indicate that creativity induces relaxation which could explain the appeal as individuals may use creativity as a coping mechanism for stress. Therefore, inclusion of creativity in treatment programmes may be appropriate in the management of stress. However, clients and therapists may see creativity and pharmacology in differing importance dividing the therapeutic relationship and therefore limits creativity being used clinically (Murray & Johnson, 2010).

	RMSSD	Stress index	Mean RR interval	LF:HF ratio
Z score	-1.095	-1.890	-0.365	-1.461
P value	0.273	0.059	0.715	0.144

**Table 3:** A Wilcoxon signed rank test between the baseline output and the task output in the low BD traits group.

	RMSSD	Stress index	Mean RR interval	LF:HF ratio
Z score	-1.604	-1.604	0.000	-1.604
P value	0.109	0.109	1.000	0.109

**Table 4:** A Wilcoxon signed rank test between the baseline output and the task output in the high BD traits group.

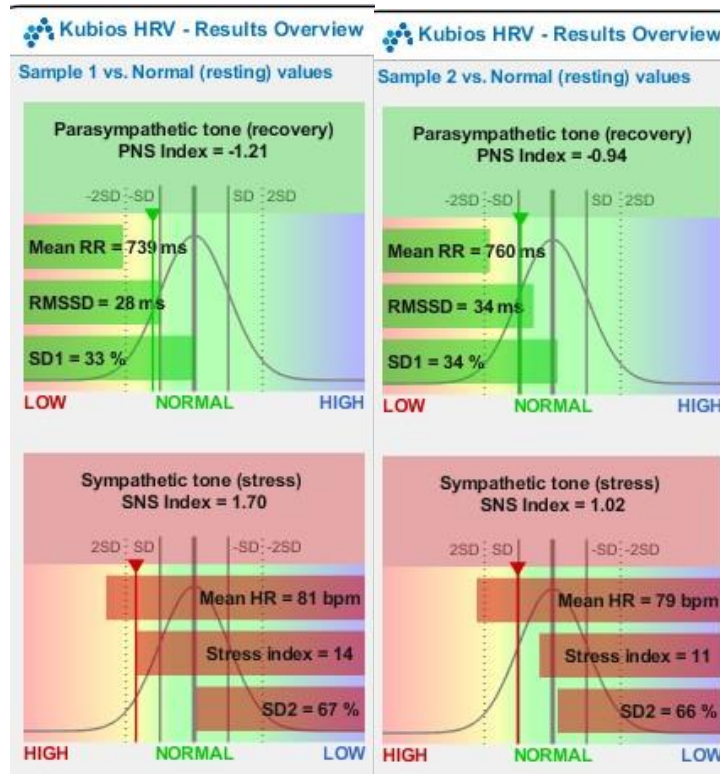


Figure 1: example of a baseline ECG output overview (left) and an example of a task ECG output overview (right)

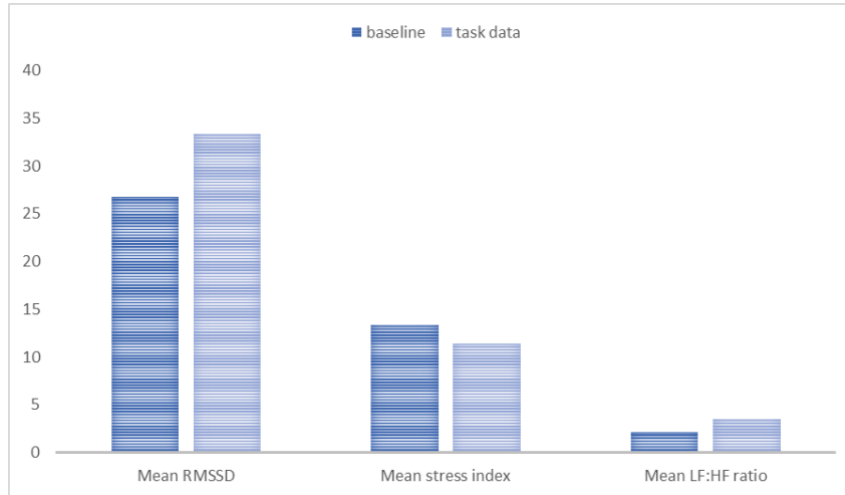


Figure 2: data from the high BD traits group

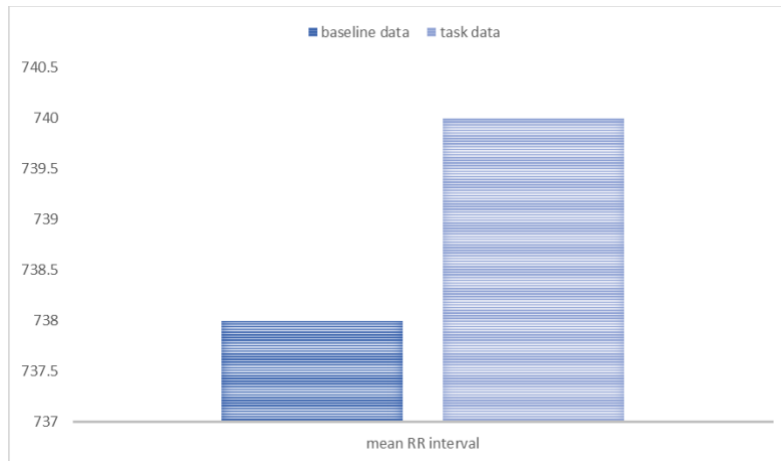


Figure 3: data from the high BD traits group

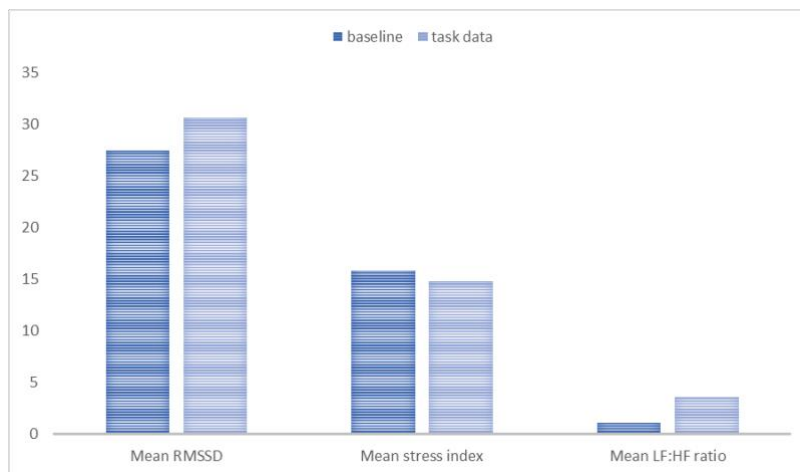


Figure 4: Data from the low BD traits group

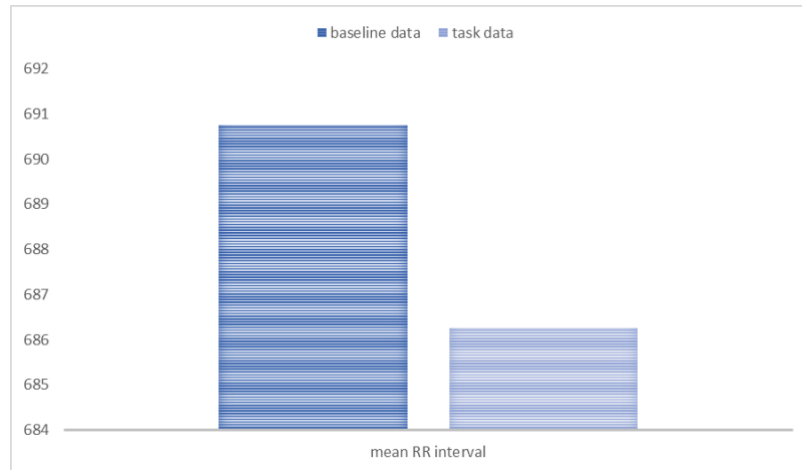


Figure 5: data from the low BD traits group

### UROS Experience

UROS provided the unique opportunity to conduct my own research, work with staff and complex technology, enhancing my university career, in deciding my dissertation topic, and my application for future careers. Ethics form submissions, journal article writing, and presentation of findings are applicable to my dissertation, and this will be reflected in my final grade.

### Conclusion

The link between BD and creativity is well established and while this study did not find similar results, it should not dissuade people from researching it. Understanding this link and its clinical applicability, even if this may be unfavorable to therapists is crucial for impacting quality of life. However, this was still a great opportunity to learn new skills and develop previous ones, and one I would recommend.

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