

**COMPUTING  
SCIENCE**

**Title: Correlation Matrices for "Evaluating Users' Affect States: Towards a Study on Privacy Concerns"**

**Names: Thomas Gross**

**TECHNICAL REPORT SERIES**

---

**No. CS-TR- 1508 -2017**

## TECHNICAL REPORT SERIES

---

**No. CS -TR - 1508**

**Date June 2017**

**Title:** Correlation Matrices for "Evaluating Users' Affect States: Towards a Study on Privacy Concerns"

**Authors:** Thomas Gross

**Abstract:** Background.

Nwadike et al. offered a comparison of affect measurements with PANAS-X, NOLDUS Face Reader and Microsoft Emotional Recognition under a neutral state and induced happiness and sadness in a within-subject pretest experiment.

**Aim.**

We investigate the correlation matrices of the measurement devices for happiness and sadness measurements.

**Method.**

A, the measurement scores are compared with Pearson correlation matrices and corresponding visualizations, once irrespective of conditions and once within conditions "neutral," "happy," and "sad."

**Results.**

We offer a more fine-grained analysis of the measurement devices beyond the effect sizes presented in Nwadike et al.

**Conclusion.**

The analysis shows that partially the NOLDUS Face Reader have been inconsistent with the PANAS-X manipulation check, especially in the sadness condition, the Face Reader sadness score was positively correlated with PANAS-X joviality.

At the same time, the pretest presented by Nwadike et al. had a low sample size and only vouches for the need of further investigation.

# **Bibliographical details**

## **Title and Authors**

NEWCASTLE UNIVERSITY

Computing Science. Technical Report Series. CS-TR- 1508

Title: Correlation Matrices for "Evaluating Users' Affect States: Towards a Study on Privacy Concerns"

Names: Thomas Gross

**Abstract:** Background. Nwadike et al. offered a comparison of affect measurements with PANAS-X, NOLDUS Face Reader and Microsoft Emotional Recognition under a neutral state and induced happiness and sadness in a within-subject pretest experiment.

**Aim.**

We investigate the correlation matrices of the measurement devices for happiness and sadness measurements.

**Method.**

A, the measurement scores are compared with Pearson correlation matrices and corresponding visualizations, once irrespective of conditions and once within conditions "neutral," "happy," and "sad."

**Results.**

We offer a more fine-grained analysis of the measurement devices beyond the effect sizes presented in Nwadike et al.

**Conclusion.**

The analysis shows that partially the NOLDUS Face Reader have been inconsistent with the PANAS-X manipulation check, especially in the sadness condition, the Face Reader sadness score was positively correlated with PANAS-X joviality.

At the same time, the pretest presented by Nwadike et al. had a low sample size and only vouches for the need of further investigation.

**About the authors:**

***Current Research: Cyber Security, Privacy and Evidence-based Methods for Security***

I'm a **Tenured Reader in System Security** (Associate Professor) at the **Newcastle University**. I'm the **Director** of the **Centre for Cybercrime and Computer Security (CCCS)**, a UK **Academic Centre of Excellence in Cyber Security Research (ACE-CSR)**. I'm a member of the Secure and Resilient Systems group and the Centre for Software Reliability (CSR).

**Suggested keywords:** Privacy concerns, affect states, Face Reader, Emotional Recognition, PANAS-X

# Correlation Matrices for “Evaluating Users’ Affect States: Towards a Study on Privacy Concerns”

Thomas Groß  
Newcastle University

## Structured Abstract

**Background.** Nwadike et al. [4] offered a comparison of affect measurements with PANAS-X, NOLDUS FaceReader and Microsoft Emotional Recognition under a neutral state and induced happiness and sadness in a within-subject pretest experiment.

**Aim.** We investigate the correlation matrices of the measurement devices for happiness and sadness measurements.

**Method.** A the measurement scores are compared with Pearson correlation matrices and corresponding visualizations, once irrespective of conditions and once within conditions “neutral,” “happy,” and “sad.”

**Results.** We offer a more fine-grained analysis of the measurement devices beyond the effect sizes presented in Nwadike et al. [4]

**Conclusion.** The analysis shows that partially the NOLDUS Face Reader have been inconsistent with the PANAS-X manipulation check, especially in the sadness condition, the FaceReader sadness score was positively correlated with PANAS-X joviality.

At the same time, the pretest presented by Nwadike et al. [4] had a low sample size and only vouches for the need of further investigation.

## 1 Variables

We analyze the correlation matrices of the experiment conducted by Nwadike et al. [4].

The experiment has been conducted as within-subjects study, in which participants have been in a neutral state as well as exposed to standardized stimulus videos [3] for the affects happiness and sadness.

The independent variable is the condition, with three levels “neutral,” “happiness,” and “sadness.”

There were six dependent variables measured drawn from three measurement devices, Positive and Negative Affect Schedule (PANAS-X) [5], NOLDUS FaceReader (FR) [2, 1], and Microsoft Emotional Recognition (ER).

**px\_sad** Sadness score of the PANAS-X self-report instrument.

**px\_jov** Joviality score of the PANAS-X self-report instrument.

**fr\_sad** Sadness score of the NOLDUS FaceReader at a defined time index.

**fr\_happy** Happiness score of the NOLDUS FaceReader at a defined time index.

**er\_sad** Sadness score of the Microsoft Emotional Recognition at a defined time index.

**er\_happy** Happiness score of the Microsoft Emotional Recognition at a defined time index.

The PANAS-X was considered as trusted instrument for a manipulation check.

## 2 Correlation Matrices

Correlation matrices are computed with Pearson's correlation coefficient at a significance level of  $\alpha = .05$ . There were no corrections made for multiple comparisons.

### 2.1 Irrespective of Conditions

We display the overall correlation matrix irrespective of conditions in Table 1. Figure 1a on p. 4 visualizes the corresponding corrgram.

We observe that the PANAS-X scores on joviality and sadness are statistically significantly negatively correlated as expected. We note further that ER shows a strong positive correlation of sadness with PANAS-X sadness, and a negative correlation with PANAS-X happiness.

We note the non-significant observation that FaceReader sadness scores seemed negatively correlated with PANAS-X sadness and positively correlated with PANAS-X joviality. This asks for further investigation on a possible contradiction between PANAS-X and FaceReader.

Table 1: Correlation matrix irrespective of conditions.

	px_sad	px_jov	fr_sad	fr_happy	er_sad
px_sad					
px_jov	-0.59**				
fr_sad	-0.18	0.40			
fr_happy	-0.27	-0.01	-0.16		
er_sad	0.72***	-0.39	-0.10	-0.29	
er_happy	-0.51*	0.33	-0.08	0.60**	-0.39

*Note:* based on 20 cases.

### 2.2 Neutral Condition

We show the correlation matrix for the neutral state in Table 2. Figure 1b on p. 4 visualizes the corresponding corrgram. None of the correlations were statistically significant.

Table 2: Correlation matrix for the neutral state.

	px_sad	px_jov	fr_sad	fr_happy	er_sad
px_sad					
px_jov	-0.64				
fr_sad	-0.17	0.33			
fr_happy	-0.31	-0.39	-0.10		
er_sad	0.29	0.19	0.74	-0.40	
er_happy	-0.65	0.31	0.43	0.54	0.25

*Note:* based on 7 cases.

### 2.3 Happiness Condition

We offer the correlation matrix for the case of induced happiness in Table 3. Figure 1c on p. 4 visualizes the corresponding corrgram.

We observe a statistically significant strong positive correlation between ER sadness and PANAS-X sadness. There is a statistically significant strong negative correlation between ER sadness and happiness.

Table 3: Correlation matrix for the happiness condition.

	px_sad	px_jov	fr_sad	fr_happy	er_sad
px_sad					
px_jov	-0.64				
fr_sad	-0.23	0.00			
fr_happy	-0.44	0.49	0.35		
er_sad	0.99***	-0.70	-0.20	-0.49	
er_happy	-0.83*	0.68	-0.23	0.34	-0.88**

*Note:* based on 6 cases.

### 2.4 Sadness Condition

We display the correlation matrix for the case of induced sadness in Table 4. Figure 1d on p. 4 visualizes the corresponding corrgram.

There is a statistically significant strong correlation between FaceReader sadness and PANAS-X joviality. We observe a statistically significant strong correlation between FaceReader and ER happiness.

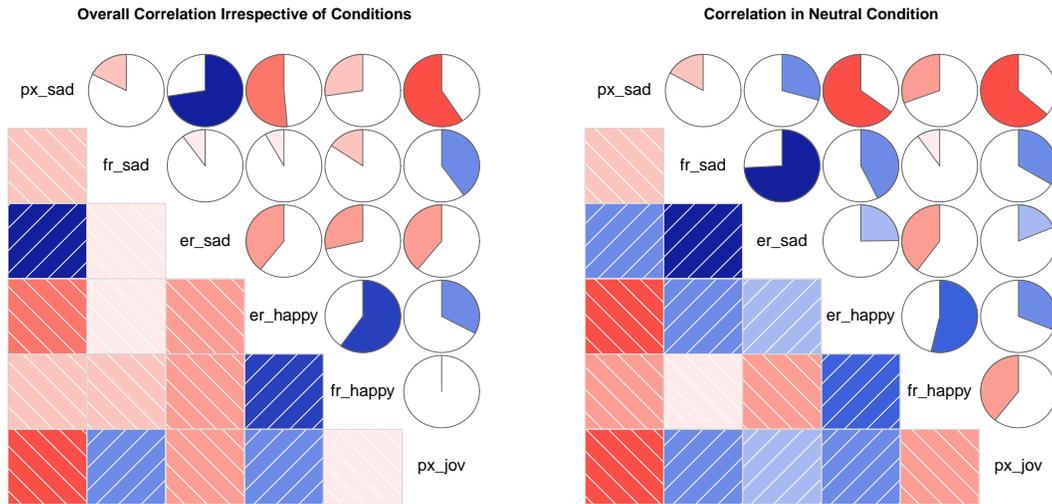
Table 4: Correlation matrix for the sadness condition.

	px_sad	px_jov	fr_sad	fr_happy	er_sad
px_sad					
px_jov	-0.35				
fr_sad	-0.46	0.96***			
fr_happy	0.05	-0.25	-0.17		
er_sad	0.82*	-0.20	-0.27	-0.29	
er_happy	0.03	-0.25	-0.18	1.00***	-0.31

Note: based on 7 cases.

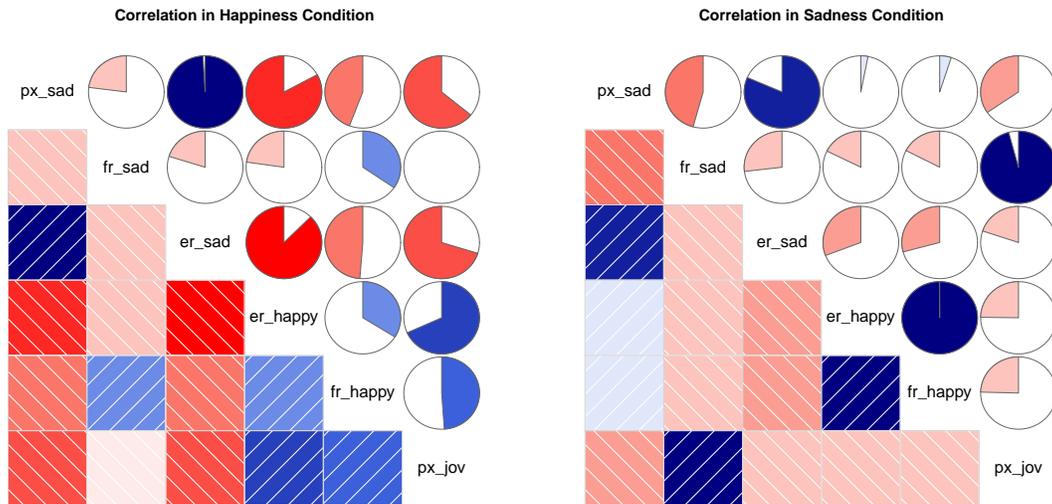
## References

- [1] BRODNY, G., KOŁAKOWSKA, A., LANDOWSKA, A., SZWOCH, M., SZWOCH, W., AND WRÓBEL, M. R. Comparison of selected off-the-shelf solutions for emotion recognition based on facial expressions. In *Human System Interactions (HSI), 2016 9th International Conference on* (2016), IEEE, pp. 397–404.
- [2] DEN UYL, M., AND VAN KUILENBURG, H. The face-reader: Online facial expression recognition. In *Proceedings of Measuring Behavior* (2005), vol. 30, pp. 589–590.
- [3] GROSS, J. J., AND LEVENSON, R. W. Emotion elicitation using films. *Cognition & emotion* 9, 1 (1995), 87–108.
- [4] NWADIKE, U., GROSS, T., AND COOPAMOOTOO, K. P. Evaluating users’ affect states: Towards a study on privacy concerns. In *Privacy and Identity Management. Facing up to Next Steps*. Springer, 2016.
- [5] WATSON, D., AND CLARK, L. A. The PANAS-X: Manual for the positive and negative affect schedule – expanded form. Tech. rep., University of Iowa, Department of Psychology, 1999.



(a) Irrespective of conditions.

(b) Neutral state.



(c) Happiness condition.

(d) Sadness condition.

Figure 1: Corrgrams for the different correlation matrices. *Note:* The variables have been ordered to group measurements of the same affects together, with the base-line manipulation check of PANAS-X on the outside. {px\_sad, fr\_sad, er\_sad} as well as {px\_jov, fr\_happy, er\_happy} are expected to be positively correlated within the respective subsets and negatively correlated between the respective subsets.