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Blue Screen – Blue Mood? Influence of Background Color and Attractiveness of Female Stimulus Persons on Current Mood in an Online Experiment (PANAS)

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Abstract

In an online experiment, more than 6,000 volunteers rated women's faces according to their attractiveness. The women were either extraordinarily attractive or of medium to low attractiveness. The background of the website was either Black, Blue, Green, Gray, Red or Yellow. Following the likeability assessments, the participants were asked to assess their own current mood using the PANAS (Positive and Negative Affect Schedule). The study was conducted in a German-language and an English-language version. A factor analysis shows perfect orthogonality for the Positive Affects and Negative Affects and a reliability analysis shows excellent reliability for both scales. In the case of Negative Affects, the scores show an extreme concentration at the lower end of the scale. The attractiveness of the stimulus persons has a significant but weak effect on Negative Affects. The background color of the website shows an effect on Positive Affects, but not on Negative Affects. The clear favorite is Green. The participants in the English-language version scored higher on Negative Affects. The older test subjects scored better on both scales than the younger ones.

Keywords: Color, Attractiveness, Female Faces, Mood, Emotional State, PANAS, Positive Affects, Negative Affects, Online-Experiment, Webdesign.

Highlights

- PANAS Positive Affects and Negative Affects are orthogonal
- PANAS scales highly reliable
- Older subjects higher Positive and lower Negative Affects
- English version somewhat higher on Positive and Negative Affects than German version
- Green website background raises Positive Affects
- No effects of background color on Negative Affects

Introduction

Colors are among the most important factors in our sensory perception and there is no doubt that they can exert an enormous influence in a wide variety of areas of life. In the present study, we look at this topic from a narrowly circumscribed perspective, namely with regard to the question of whether the color design of the background in an online experiment has an influence on the current mood state.

In a short online experiment, the participants had to rate photographs of women's faces according to their likeability. The women were either exceptionally attractive or of medium to low attractiveness. The judges were then asked to assess their own current mood. Depending on the test condition, the background of the website was Black, Blue, Green, Gray, Red or Yellow. The study was conducted in a German and an English version.

To assess the current mood state, the Positive and Negative Affect Schedule (PANAS) was used. The short questionnaire developed by Watson, Clark and Tellegen (1988) comprises 20 adjectives that address various aspects of emotional state (see Table 1). The assessment can refer to different points in time or periods of time, for example the predominant mood in general, during the last three months, during the last week or – as in our case – the current state of mood. Numerous studies have demonstrated that a factor analysis results in two independent factors, each constituted by 10 items and called Positive Affects (PA) and Negative Affects (NA). This designation is concise, but unfortunately misleading. The words 'positive' and 'negative' inevitably bring to mind a pair of opposites, but the test was explicitly designed so that the factors are orthogonal. In addition to the advantage of brevity and perfect objectivity, the instrument has both high reliability and high validity.

Along with the two core variables of color and attractiveness, the language version (German/English) and the sex and age of the test subject are also taken into account. As the study is explicitly exploratory in nature, no hypotheses are stated.

Methods

Participants were recruited via links on my home page, which was well frequented due to numerous previous online studies. Participation was voluntary, free, non-binding and anonymous. The experiment ran on a single website and only took a couple of minutes.

The key independent variable is the Color that fills the background of the website. The color values Red (RGB 990000), Yellow (FFFF99), Green (009900), Blue (000099), Grey (CCCCCC) or Black (000000) were deliberately chosen to be intense in order to maximize any effects.

Five panels, each with three portrait photos measuring 180 x 240 pixels, were presented one below the other. Within each panel, the participants were asked to mark the face they found most likeable. The stimulus persons were either exceptionally attractive, some of them world-famous supermodels, or of medium to low attractiveness. The pictures were presented in a fixed arrangement. In the second group, attractiveness decreased from panel to panel, so that the last triplet was rather unattractive. Such a gradation was neither possible nor desired for the exceptionally attractive women. The likability ratings are not taken into account; they were only used to manipulate the attractiveness variable.

Immediately after the likability ratings, the judges were asked to assess their own current mood state.

Finally, the participants were asked to state their Sex, Age and Country of Origin or, in the German version, the federal state. In this article, no distinction is made between the countries or regions of origin, but only between the German/English Language version.

This results in the 6 x 2 x 2 x 2 experimental design Color x Attractiveness x Sex x Language; and Age is considered as a covariate. The core variables Color and Attractiveness are randomized, Sex, Language version and Age inherently result from self-selection.

The current mood was assessed using the PANAS. The scale consists of the 20 items listed in Table 1 in the order used in the experiment (the order is alternating and differs slightly from the customary order).

Table 1. *PANAS Items German and English version.*

German	English	
aktiv	active	PA
bekümmert	distressed	NA
interessiert	interested	PA
verärgert	upset	NA
freudig erregt	excited	PA
schuldig	guilty	NA
stark	strong	PA
erschrocken	scared	NA
angeregt	inspired	PA
feindselig	hostile	NA
stolz	proud	PA
gereizt	irritable	NA
begeistert	enthusiastic	PA
beschämt	ashamed	NA
wach	alert	PA
nervös	nervous	NA
entschlossen	determined	PA
durcheinander	jittery	NA
aufmerksam	attentive	PA
ängstlich	afraid	NA

10 items each measure Positive Affect (PA) and Negative Affect (NA). The assessment was made on a 5-point scale, which was verbally anchored by „not at all“, „a little“, „moderately“, „quite a bit“, „extremely“ („gar nicht“, „ein bisschen“, „einigermaßen“, „erheblich“, „äußerst“). Usually, a score from 1 to 5 is used and the scale value is calculated as the sum, resulting in a range from 10 to 50. We have transformed the value to the interval [0 – 4] using the transformation x/10 - 1. We consider this to be more transparent and, as the lowest scale value was anchored with „not at all“, also more appropriate in terms of the content.

In addition, the two items „in a good mood“ and „cheerful“ were added and the mean value was calculated as a further measure of positive feelings. We refer to the

scale as GM for Good Mood.

As our data base is exceptionally large, all cases with more than one missing value were excluded. In the remaining 6,113 cases, the proportion of missing values is 0.4 percent. There is a peculiar feature in the English version of the „upset“ item. This alone accounts for 291 (52.6%) missing values, compared to only 5 for the German equivalent „verärgert“. The assumption that the respondents were non-native speakers was not confirmed. The number of subjects at the levels of the independent variables is summarized in Table 2. Of the 48 cells in the experimental design, only 10 contain fewer than 100 subjects, the minimum being 82. Thus, this study has an unusually high test power.

Table 2. *Number of subjects.*

		N				N
Color	Red	996		Attractiveness	very high	3077
	Black	1021			medium, low	3036
	Green	1007		Sex	Males	2447
	Blue	1043			Females	3666
	Yellow	1000		Language	German	2639
	Grey	1046			English	3474

Results

As is usual with online experiments, the participants were quite young and the majority came from an academic background and the English-language version was dominated by the Anglosphere (USA 64.3 percent; Canada 12.5; UK 6.0, Australia / New Zealand 1.5). The age range extends from 15 to 74 years, the mean is 26 years, the median 23 years, and only 5 percent were older than 46 years. The mean age at the different levels of the independent variables can be seen in Table 3.

Table 3. *Age of subjects.*

		M				M
Color	Red	26,2		Attractiveness	very high	26,0
	Black	25,7			medium, low	25,9
	Green	26,0		Sex	Males	28,6
	Blue	25,8			Females	24,2
	Yellow	26,2		Language	German	26,8
	Grey	25,7			English	25,4

The assignation to color and attractiveness was randomized. As expected, the age differences are statistically insignificant. For the language version and sex, however, the differences are significant at the 0.1% level. The participants in the German version are 1.43 years older and this corresponds to an effect size (Cohen’s d) of 0.15. The men are considerably older than the women; the age difference is 4.42 years, the effect size is 0.48.

Factorial structure of the PANAS

First, the suitability of the PANAS was examined. Since the factor structure is clearly predetermined, a confirmatory factor analysis was conducted first. The model with uncorrelated measurement errors shows a poor fit. A model with several correlated errors, on the other hand, results in an excellent fit (CFI and TLI >.95 and SRMR and RMSEA <.05), as can be seen in Table 4.[1]

Table 4. *Confirmatory factor analysis, correlated errors. Goodness of fit.*

				RMSEA 90% CI		Chi square		
CFI	TLI	SRMR	RMSEA	Lower	Upper	χ^2	df	p
0.968	0.955	0.0499	0.0442	0.0424	0.0461	1734	134	<.001

Subsequently, an exploratory factor analysis with Maximum Likelihood extraction and Oblimin rotation was run. This resulted in two eigenvalues greater than 1 (the third largest is 0.65). The first factor (NA) explains 22.8 percent of the variance, the second (PA) 20.8 percent. The KMO criterion for the overall scale is.91. The MSA

values of the items range from.86 to.93. KMO and MSA values above.90 are considered excellent. The loadings of the pattern matrix are shown in Table 5. Loadings of <.10 are omitted.

Table 5. *Factor loadings. Pattern matrix, Maximum Likelihood extraction, Oblimin rotation.*

		NA	PA
ängstlich	afraid	0,780	
durcheinander	jittery	0,715	
nervös	nervous	0,711	
erschrocken	scared	0,701	
beschämt	ashamed	0,687	
gereizt	irritable	0,649	
bekümmert	distressed	0,630	
schuldig	guilty	0,629	
feindselig	hostile	0,609	
verärgert	upset	0,532	0,110
begeistert	enthusiastic		0,781
entschlossen	determined		0,694
angeregt	inspired		0,682
stark	strong		0,665
aufmerksam	attentive	-0,158	0,630
stolz	proud	0,137	0,621
freudig erregt	excited	0,131	0,616
aktiv	active		0,576
interessiert	interested		0,569
wach	alert	-0,126	0,546

The pattern corresponds exactly to expectations. All items load on the appropriate factor and the secondary loadings are negligible. Although the Oblimin rotation was used, the correlation between the factors is.01. There is therefore not the slightest doubt about the orthogonality of the factors and the perfect mapping of the items.

Reliability of the PANAS scales

A reliability analysis was carried out for both scales. Table 6 shows the goodness of fit criteria Cronbach's α, McDonald's ω and the range of the corrected item total correlations.

Table 6. *Reliability. Cronbach's α, McDonald's ω, corrected item total correlation.*

	α	ω	corr. item total
PA	.87	.88	.51 –.72
NA	.88	.89	.51 –.71

Both scales have excellent internal consistency and neither could be improved by removing individual items. In view of the extraordinarily large sample, the corrected item total correlation can also be regarded as excellent.

Descriptive statistics of the dependent variables

The PANAS is a highly reliable instrument for Positive and Negative Affects. In addition, we consider the GM scale, which only consists of the two items „in a good mood" and „cheerful", which correlate with each other at.87. The correlation with PA is.61; both scales measure positive emotional states, but the common variance is only 38 percent. The correlation with NA is -.33. Table 7 shows statistical parameters of the three scales.

Table 7. *Mean, standard deviation, skewness, kurtosis.*

	M	s	Skewness	Kurtosis
PA	1,80	0,79	0,19	-0,43
NA	0,57	0,66	1,74	3,29
GL	2,30	1,13	-0,24	-0,72

The exceptional role of Negative Affects immediately catches the eye. The mean value is only 0.57. Given a range of 0 to 4, this is a strong indication that the distribution is heavily skewed. This is confirmed on the one hand by the skewness index, and on the other hand we illustrate this in Figure 1.

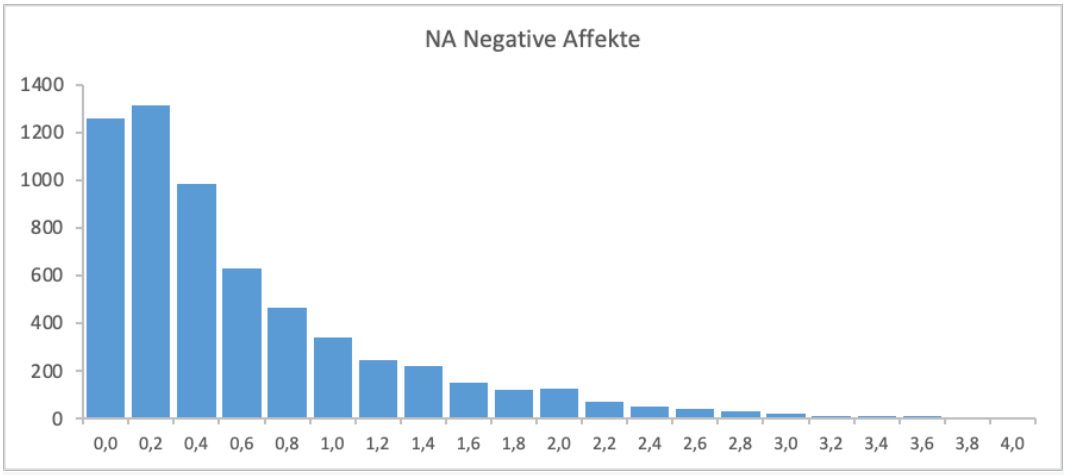

Figure 1. Frequency distribution. NA Negative Affects.

The distribution has nothing whatsoever to do with a normal distribution. Obviously, the experimental setting generated virtually no negative feelings – which of course would not have been the intention. 1,258 participants even selected the value 0 on all 10 items and thus received the NA score 0. As the response pattern on the PA and GM scales is much more balanced, it is not reasonable to assume that these judges wanted to sabotage the study. Nevertheless, the ability to differentiate is severely limited by the extreme concentration at the lower end of the scale.

Effects of the independent variables on mood

The three mood indicators PA, NA and GM were subjected to an analysis of variance in an C x A x S x L design. As there are significant age differences for sex and language version, in the first step age was taken into account as a covariate in an analysis of covariance (ANCOVA). After this, an ANOVA was carried out. Table 8 shows the p-values of all effects that are significant at the 5 percent level.

Table 8. *Significant effects, 5 per cent level.*

		PA	NA	GM
ANCOVA	Color	.018		.0345
	Attractiveness		.024	
	Language		<.001	.007
	F x A x G x S			.006
	Age	<.001	<.001	.002
ANOVA	Color	.016		.031
	Attractiveness		.034	
	Language		<.001	.010
	Sex	.009		
	F x A x G x S			.006

Table 8 shows an astonishingly simple picture. The design contains four two-way interactions, six three-way interactions and one four-way interaction. Of the 33 possible interaction effects, however, only a single one is significant, namely the four-way interaction on the GM scale. All others do not even reach the 10 percent level. As a four-way interaction cannot be meaningfully interpreted, only main effects remain.

The only difference between the ANCOVA and the ANOVA is that, without taking age into account, sex has a significant effect on the PA scale, which does not reach the 5 percent level in the covariance analysis (p =.075). Otherwise, the pattern is identical. In the following, we look at the results of the ANOVA.

For the *PA scale*, the Levene test is significant, i.e. the variance homogeneity requirement is not met (F = 2.96; df1 = 47; df2 = 6070; p <.001). However, the statistical significance is only due to the extraordinarily large sample. The Q-Q plot indicates an almost perfect normal distribution of the standardized residuals.

Positive Affects are significantly higher in men than in women. The difference is 0.06 points. This corresponds to an effect size of 0.07.

To shed light on the nature of the significant effect of color, pairwise post-hoc comparisons were carried out applying Tukey's and Holm's correction. According to both methods, only the difference between Green and Blue is significant at the 5 percent level. Positive Affects are 0.12 points higher with a green background, the effect size is 0.15. Green also tends to perform better than yellow (p_{Tukey} =.06; p_{Holm} =.08). The difference of 0.10 points corresponds to an effect size of 0.13.

For the *PN scale*, the significant Levene test (F = 4.21) is also of no importance. Here, however, the Q-Q plot indicates that the standardized residuals deviate strongly from the normal distribution. Given the extreme skewness of this scale, this is not surprising.

The Negative Affects are 0.04 points higher in the raters of the average to less attractive stimulus persons than in the raters of the extraordinarily attractive women. The effect size is 0.06.

In the English version, the Negative Affects are 0.17 points higher than in the German version. The effect size is 0.26.

For the *GM scale*, homogeneity of variance is fulfilled and the standardized residuals deviate from the normal distribution only at the extremes. Here too, the scores are higher in the English-language version. The difference of 0.08 points corresponds to an effect size of 0.07.

Just as with the Positive Affects, the post-hoc comparison Green – Blue is also significant on the GM scale. The difference is 0.15 points, the effect size is 0.13. Green – Yellow only narrowly fails the 5 percent mark and the parameters are also 0.15 points, d = 0.13. Green – Red also tends toward significance (0.14 points, d = 0.13, p_{Tukey} = 0.07; p_{Holm} = 0.09).

Overall, our two core variables have different effects. The attractiveness of the stimulus persons only had an impact on Negative Affects. However, the effect size of 0.06 is very weak. The background color of the website had an impact on both PA and GM. The differences between the color variants are illustrated in Figure 2 and Figure 3 showing the 95% confidence intervals.

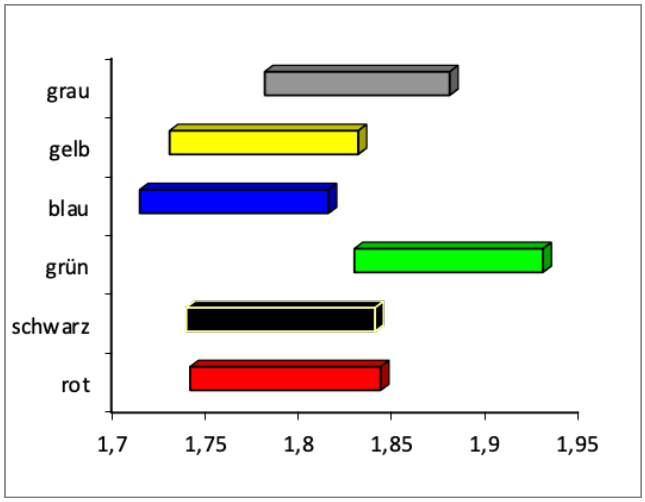

Figure 2. Background color and Positive Affects PA.

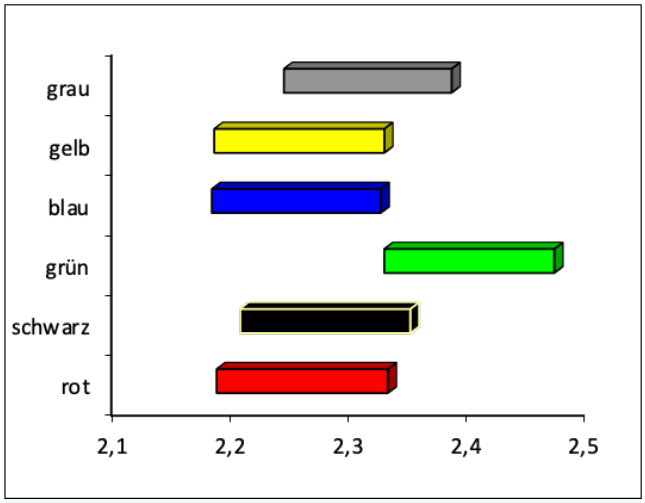

Figure 3. Background color and Good Mood GM.

Age and mood

Since, as seen in the covariance analysis (Table 8), age plays a significant role, we finally look at the effect of age on mood. Table 9 summarizes the mean values of the total sample for different age groups.

Table 9. *Age and current mood state.*

	14-19	20-24	25-29	30-34	35-39	40-44	45-74
PA	1,79	1,78	1,75	1,81	1,85	1,83	1,96
NA	0,68	0,59	0,54	0,48	0,38	0,44	0,45
GM	2,33	2,26	2,24	2,24	2,39	2,36	2,49

A one-way analysis of variance results in a p <.001 for each of the three scales. In all cases, the older participants perform „better“.

On the *PA scale*, the 45- to 74-year-olds scored significantly higher than the three youngest groups. The effect size is 0.21, 0.23 and 0.27.

On the *PN scale*, the under-20s scored significantly higher than all other groups (d = 0.14 to 0.46). The 20- to 24-year-olds reported significantly stronger Negative Affects than all groups aged 30 and over (d = 0.17 to 0.31). The 25- to 29-year-olds score significantly higher than the 35- to 39-year-olds (d = 0.24).

On the *GM scale*, the oldest group reported a more positive mood than the three groups aged 20 to 34 (d = 0.20; 0.22; 0.23).

Discussion

The most remarkable aspect of our study is the simplicity and clarity of the findings. This applies both to the measurement instruments and to the effects of the independent variables.

As there is a clearly defined factor structure for the PANAS, the first step was to carry out a confirmatory factor analysis. The model with two independent factors and uncorrelated errors shows a poor fit. By including correlated measurement errors, however, a very good fit can be achieved. This is well known in the field. An exploratory factor analysis employing the Maximum Likelihood method yields a perfectly orthogonal structure without noteworthy secondary loadings, even though an oblique rotation was applied. In addition, the reliability analysis attested excellent internal consistency to both scales.

The two factors are of different benefit for our research purposes. The NA scale is extremely skewed and thus, strictly speaking, the data are not suitable for most

parametric analyses. However, the skewness is not a methodological shortcoming; it is in the nature of things. In a relaxed situation, in which only a few women's faces are to be judged according to their likeability, negative feelings evidently do not come into play at all. The clustering at the lower end is not an oddity of our setting. For example, Watson, Clark and Tellegen (1988) report a value of 0.74 for habitual mood (here and in all subsequent cases converted to a [0 – 4] scale). Breyer and Bluemke (2016) report 0.72 for a German sample; Krohne et al. (1996), also for a German sample, 0.84 for habitual mood and 0.47 for current mood. In everyday situations, Negative Affects are usually very weak, but there are of course numerous situations in which they are of great importance. In clinical studies in particular, Negative Affects are often stronger than Positive Affects (e.g. Estévez-López et al, 2016; Hovmand et al. 2023). As an example, the study by Díaz-García et al. (2020) may be considered. In adults with depressive, anxiety, and adjustment disorders., an online version of the PANAS yielded PA scores of 1.05, 1.00 and 0.91 and NA scores of 2.12, 2.04 and 1.80 in the pre-test. In the post-test, the PA scores were 1.64, 2.20 and 1.36, and the NA scores were 1.10, 1.07 and 1.18. Thus, there were impressive improvements on both scales, but the NA scores were still considerably higher in the post-test than in our study.

Although the ability to differentiate is severely limited in our study due to the clumping at the lower end, two effects are significant. The impact of the attractiveness of the stimulus persons is hardly worth mentioning. In contrast, the difference between the German and English versions (0.48 vs. 0.64; d = 0.26) deserves attention. We have shown that the Positive and Negative Affects are perfectly orthogonal. In a separate analysis, the correlation in the German sample is -.15, whereas in the English sample it is +.12. Within both groups, the deviation from orthogonality is not dramatic, but since it points in opposite directions, the difference between the language versions is accentuated and at the same time the opposite tendency in the overall sample results in almost perfect independence.[2] Whether the skewness of the NA scale plays a role here is an open question. It is also unclear to what extent the difference is due to response tendencies, genuine differences in emotional experience, translation artifacts or other causes. Translations from one language to another are never perfect (Torres et al., 2013; Wedderhoff et al., 2021) and it is not surprising that there are differences between the culturally and ethnically very homogeneous German-speaking sample and the heterogeneous international sample.

The PA scale shows one significant effect, namely for the background color of the website. The uncontested winner is Green. The 95 percent confidence interval shows no overlap with Blue and Yellow, with Red and Black the overlap is very small and there is also an advantage over Gray. Since the GM scale shows a very similar pattern, even though it covers slightly different aspects, there is some evidence that Green may actually lift people's mood. From everyday experience with green in nature, this seems plausible. However, such far-reaching associations cannot be derived from our data.

In addition to color, the language version also has a significant effect on the GM scale. As with the NA scale, the value is higher in the English-language version, but the effect size is considerably lower. On the PA scale, on the other hand, the values are slightly higher in the German version. This speaks against a difference in response sets.

Before turning to the two core variables of color and attractiveness, the age of the participants deserves attention. It is here that the strongest effects can be seen. Both in the positive and negative realms, older people perform better than young people. In online studies, the young are typically heavily overrepresented and the older ones heavily underrepresented and typically women predominate among the young and men among the older ones. In the age group [15 – 24] there are 44.8 percent of the men and 65.9 percent of the women, in the age group [40 – 74] the figures are 15.2 vs. 7.2 percent. Due to self-selection in online studys, sex and age are usually confounded and it is necessary to take age into account, even if, as in our case, it is not the focus of the research.

Our core variables are the background color of the website and the attractiveness of the stimulus persons. Attractiveness only had an impact on Negative Affects. The judges of the average to less attractive women show slightly higher values, but the effect is quite weak. It should be emphasized that the women were not particularly unattractive let alone ugly and that only five panels with three faces each were to be judged. Maybe judging a larger number of very unattractive and ugly faces would arouse negative emotions – but who would want to conduct such a study? In retrospect, it is regrettable that only women's faces were presented. Our experience from numerous studies on face perception shows that male and female judges are not very different when evaluating women's faces. On the other hand, women tend to harshly devalue average and unattractive men, while men judge their counterparts much more mildly (Henss, 1992, 1998).

The primary interest of our study is the impact of color. The background color of the website has a significant effect on the PA and GM scales, but the effect sizes are rather weak. It should be reminded that the colors were high intensity in order to maximize possible effects. Usually, online experiments are conducted with unobtrusive colors, so that hardly any noteworthy effects on the mood of the participants may be expected. In addition, the mood of the participants is usually not the focus of attention of the researchers or the sponsors. Whether the color design has an effect on the specific questions of the respective survey cannot be answered by our study. However, we can give an answer to our question „Dark Screen – Dark Mood?". The answer is a definite No. On the NA scale, Blue performs no worse than the other colors, it does even a tiny bit better than Yellow, Grey and Black. And on the PA and GM scales, Blue is only outperformed by Green. The extent to which our finding „Green Screen – Good Mood" can be generalized is an open question.

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The data set ColoMoodDat.omv is freely available at https://www.researchgate.net/profile/Ronald-Henss

Other formats are available on request.

Footnotes

[1] This model has an excellent fit. However, it is purely data-driven and contains a dozen correlated error terms. An acceptable solution is also obtainable with fewer correlated measurement errors. However, a model should not be data-driven, but theory-driven. This task goes far beyond the scope of this paper.

[2] Our data set offers numerous possibilities for testing measurement invariance. But also in this respect, a systematic analysis goes far beyond our current issue.

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