

ORIGINAL ARTICLES

EMOTIONAL RESPONSE TO SIMPLE COLOR STIMULI

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Abstract: The emotional responses to colors were examined in two experiments in order to discover the effect of stimulus contexts. In Experiment I, the emotional responses to 36 color stimuli were profiled in terms of valence (Cronbach's $\alpha=0.793$), arousal ($\alpha=0.880$), and dominance ($\alpha=0.904$) dimensions of emotion using the Self-Assessment-Manikin (SAM) scale ($N=46$). From the 36 color stimuli, 17 were selected in Experiment II, where subjects were shown not only 17 colors, but also other types of visual stimuli, such as eight pictures, nine film-clips, and nine adjectives ($N=45$). Between the two experiments, a Preliminary Test was conveyed in order to collect film-clips. Based on the SAM ratings, the emotional profiles of visual stimuli were characterized by dimensions of emotion, and the context effect was investigated by comparison to prior results: SAM ratings of the 17 identical colors from both experiments were compared. Judgmental shifts of the 17 colors were found out to be less arousing as color stimuli were shown in a stimulus context of Experiment II than in that of Experiment I ($p<.05$, two-tailed).

Keywords: *Color, Emotion, Affective Judgment, SAM, Context Effect, Judgmental shift*

1. INTRODUCTION

Color has been considered to be the most salient, resonant, and affective feature seen in human vision. This makes color a compelling visual cue for persuasive communication purposes such as conferring identity or novelty to an object or idea [1]. Color contributes to the appreciation of and preference for products and plays an essential communication role, improving the efficacy of messages and increasing the likelihood of purchase.

Therefore, growing interest has centered on whether color may or may not communicate emotion as intended. In view of the foregoing, much attention has been focused on research on color affectivity in various disciplines. Recent studies on color affectivity have characterized the emotional profiles of color in terms of emotional dimensions, thus approaching the issue of the emotional influence of color attributes [2].

On the other hand, stimulus context has always been dedicated to color. This limitation may weaken the relevance of the results of empirical studies on the impact of color on emotional reaction.

Thus, in this study, we aimed at investigating color affectivity not only within colors, but also in relation to other types of visual stimuli.

2. GOALS AND HYPOTHESES

The purposes of this study are to describe emotional responses to colors in terms of three dimensions of emotion—valence, arousal, and dominance—and to investigate an effect of a more complex stimulus context, in

which other visual stimuli with higher semantic intensity are presented, on the emotional responses to color. Therefore, the following two hypotheses were formulated:

[H.1] Color stimuli elicit emotions that are characterized in terms of three dimensions of emotion—valence, arousal, and dominance.

[H.2] Emotional responses to color appear weaker when colors are viewed in a more complex visual stimulus context that includes stimuli with higher intensity of semantic contents than color.

3. EXPERIMENT

3.1 Plans of the Experiments

Two main Experiments and one Preliminary Test were planned. In Experiment I, the affective judgment of color was assessed in terms of valence, arousal, and dominance dimensions and the subjects were exposed to color stimuli only. Thus, the empirical results of the Experiment I could provide a baseline that would be compared with those of Experiment II. Between Experiments I and II, a Preliminary Test was carried out to select film stimuli for Experiment II.

3.2 Measuring Emotion: Self-report

In studies of emotion, there are two primary theoretical frameworks. One conceptualizes emotion discretely and the other regards emotion as a dimensional construct. Compared to the discrete approach, the dimensional approach to conceptualizing emotion has the advantage of generality and potential versatility as a descriptive system for emotion. It characterizes an emotional profile of the

stimulus and it provides a base for geometric construction, in order to explain the relationship among stimuli. However, it has been taken into consideration by only few researchers and the selection of color stimuli has not yet been systemically approached. Rather, the majority of the studies on color and emotion have focused on the synesthesia between basic categories of color and primary emotional terms. Valdez et al. [2] characterized this categorical approach as insufficient to produce reliable, valid, or comprehensive measures of emotional responses to color stimuli. In this study, the emotional responses to stimuli were conceptualized in terms of three dimensions of emotion and the Self-Assessment-Manikins (SAM) was employed to assess the affectivity in each dimension.

3.3 Self-Assessment-Manikins(SAM)

Developed by Lang [3], SAM is a nonverbal, culture-fair rating system based on a three dimensional system of emotion consisting of valence, arousal, and dominance. The SAM rating scale is comprised of three sets of graphic figures, respectively representing the three dimensions (Figure 1).

These graphic figures, which depict values along each of the three dimensions on a continuously varying scale, are used to indicate emotional reactions. As shown in Figure 1, SAM ranges from a frowning, unhappy figure to a smiling happy figure, when representing the valence dimension. For the arousal dimension, SAM ranges from a relaxed, sleepy figure to an excited, wide-eyed figure. For the dominance dimension, SAM ranges from a small figure (dominated) to a large figure (in control). The subject can select any of the five figures comprising each scale.

Fischer, Brauns, and Belschak [4] advocated the acceptance of SAM for measuring emotion, since a graphic representation of emotions requires less awareness than a verbal expression. A non-verbal scale may activate already known affective and cognitive elements of emotion to a lesser extent (p. 127).

In this study, SAM was used to assess emotional responses to the stimuli implemented by the open source

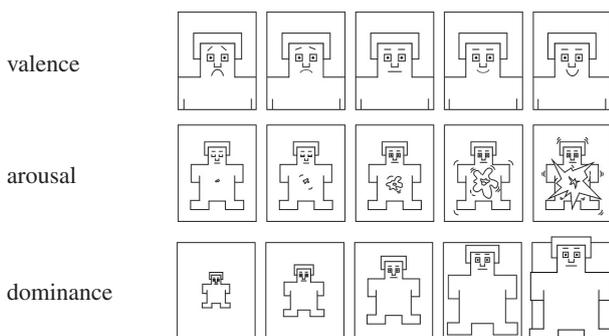


Figure 1: Self-Assessment-Manikin (SAM)

software PXLab® (www.pxlab.de) software. During the introduction of the experiments, sets of adjectives were employed (Table 1; in German) to verbally describe SAM. Thus, subjects might capture the meaning of the dimension before they facilitated the SAM scales in Experiments.

4. EXPERIMENT I

4.1 Method

4.1.1 Subjects

Forty-six people made up of 19 men and 27 women served as subjects and were recruited through advertisements in the University of Mannheim (age: M=24.43, SD= 8.99). As a reward, € 4.00 were offered for the approximately 20-minute experiment.

4.1.2 Stimuli

Five hue categories were fixed, and the hue degrees of categories in CIELab LCh* system were h=30° (red), h=80° (yellow), h=160° (green), h=260° (blue), and h=320° (violet). From each of these, representative colors of the following five tone segments were chosen: “dark”, “deep”, “vivid”, “brilliant”, and “light”.

In selecting color stimuli, it was intended to let subjects recognize the same quality of tone (combination of chroma and lightness) across the hue categories. In fact, the segmentation of tone categories varies with hue. For instance, colors of the yellow category vary their tone segmentation with smaller change of chroma and lightness than colors in red or in blue. Thus, it was necessary to consider different segments of chroma and lightness that would be representative for the specific tone category of each hue (see Table 2).

In addition, cool gray (h=260°), warm gray (h=80°),

Table 1: Emotional adjectives depicting SAM [5]

dimension	(-)	(+)
valence	unzufrieden (unsatisfied) unglücklich (unhappy) genervt (nervous) verzweifelt (desperate) schwermütig (melancholy)	zufrieden (satisfied) glücklich (happy) erfreut (pleased) hoffnungsvoll (hopeful) ausgeglichene (balanced)
arousal	träge (slow) unerregt (unexcited) schläfrig (sleepy) ruhig (quiet) entspannt (relaxed)	rasend (rushing) erregt (excited) hellwach (awake) aufgeregt (aroused) stimuliert (stimulated)
dominance	submissiv (submissive) kontrolliert (controlled) beeinflusst (influenced) geführt (guided) ehrfürchtig (reverent) versorgt sein (passive)	dominant (dominant) kontrollierend (controlling) einflussreich (influential) autonom (autonomous) wichtig (important) in der Hand haben (in control)

* CIELab LCh is a calculation derived from CIELab equations. It uses the basic CIELab information, but presents the graphical information with a focus on chroma and hue, so that it may be visually easier to understand than the opponent colors axes of CIELab.

and gray colors with lightness levels of 30, 50, and 70 were included, and black and white were added to the color stimuli. Accordingly, Table 2 and Table 3 present the CIE Lab LCh data of chromatic and achromatic color stimuli used in Experiment I.

4.1.3 Procedure

At the beginning of the experiment, a gray stimulus (L=30) was shown, in order for the subjects to get acquainted with the SAM rating scale. Color stimuli were displayed centered on CRT monitors, in a size of 25.1cm width × 15.2cm height. The two CRT monitors on which the stimuli were displayed were calibrated with a Gretag MacBeth Eye One Spectral Photometer before the experiment.

Below every stimulus, a row of SAM pictograms was presented in fixed order of valence, arousal, and dominance, and subjects could select any of the five of each row by a mouse click. Once a stimulus was assessed by all three dimensions, the next stimulus was provided. All subjects were exposed to all stimuli.

4.2 Result

The SAM ratings to 36 colors of the 46 subjects have good internal consistency, with a Cronbach’s coefficient alpha coefficient reported of .793 (valence), .880 (arousal), and .904 (dominance). The reliability assessed with Cronbach’s coefficient alpha provides an indication of the average correlation among all of the items that make up the scale, and thus, the coefficients (>.7) show a satisfactory level of internal consistency of dependent variables, SAM ratings. Therefore, the emotional profiles of colors

were describable in terms of valence ($\alpha = 0.793$), arousal ($\alpha = 0.880$), and dominance ($\alpha = 0.904$), supporting [H.1]. Moreover, the empirical results of Experiment I provided a baseline which those of Experiment II would be compared with.

4.3 Discussion

Although the hypotheses, [H.1] was statistically supported, it does not seem safe to say whether color would induce emotion in a similar way in the context of other categories of visual stimuli, in particular, when other modalities of stimuli exhibit a higher intensity of semantic content. In reality, people may perceive a colored surface as a sequence, while they are experiencing pictures or moving images (e.g. reading a magazine or watching TV).

This issue converges into stimulus context effects and their influences on target stimuli. The judgment of the target stimulus is affected by the given context. Thus, when viewing color in a more complex stimulus context, the affectivity of color as a target stimulus may be influenced by other stimulus modalities (e.g. film-clips, pictures, words).

5. PRELIMINARY TEST

The purpose of the Preliminary Test was to select film-clips to be employed later in Experiment II. The film-clips could be seen as “background stimuli” or “anchor stimuli” [5] and may modify the affective impact of focal or target stimuli, i.e. the colors.

Using film-clips as emotion elicitors, researchers have relied upon overall period of time averages to measure experiential, behavioral, and physiological reactivity. In this study, however, the main purpose was to provide the subjects with moving images as distinguished from static pictures (still images) during the experiment. Hence, the role of the film-clips was not one of storytelling. Similarly, Rottenberg, Ray, and Gross [7] edited film stimuli so that the contents of the film-clips were as homogenous as possible.

5.1 Method

5.1.1 Subjects

Twenty-four students made up of 11 men and 13 women volunteered and served as subjects for the Preliminary Test (age:M = 26.38, SD = 3.05).

5.1.2 Stimuli

19 Film-clips were collected from several commercial films and the length of the film-clips for this Preliminary Test was edited to be 13 to 14 seconds in length in order to increase the homogeneity of the semantic content of the

Table 2: Chromatic color stimuli, Experiment I

h (°)	tone categories				
	dark	deep	vivid	brilliant	light
30 (red)	L:30, C:30	L:30, C:45	L:40, C:60	L:50, C:40	L:70, C:30
80 (yellow)	L:60, C:40	L:60, C:70	L:80, C:90	L:80, C:60	L:80, C:40
160 (green)	L:30, C:30	L:40, C:45	L:50, C:60	L:40, C:40	L:70, C:20
260 (blue)	L:30, C:20	L:40, C:30	L:40, C:45	L:60, C:35	L:70, C:25
320 (violet)	L:20, C:25	L:30, C:35	L:40, C:40	L:50, C:30	L:70, C:20

Table 3: Achromatic color stimuli, Experiment I

h (°)	tone categories				
	black	dark	medium	light	white
grays	L:0, C:0	L:30, C:0	L:50, C:0	L:70, C:0	L:100, C:0
80 warm grays		L:30, C:10	L:50, C:10	L:70, C:10	
260 cool grays		L:30, C:10	L:50, C:10	L:70, C:40	

film-clips.

1) ‘Vivid red’, as emotion elicitor among moving images

Among 19 film-clips, a screen filled with vivid red, was edited from Clockwork Orange (Kubrick, 1971) and included. This clip was played until subjects proceeded to the next stimulus. Although the red screen did not contain any semantic content, it was distinguishable from a still image. It was intended to show that plain red would elicit weaker patterns of emotion than the other 18 movie clips. Therefore, it was expected that a contrast effect would be observed, since it would be judged in relation to the other film-clips, which contained a higher intensity of semantic content.

5.1.3 Procedure

The 19 film-clips were played repeatedly without break, and the sound was switched off in order to focus the viewer on the effect of the visual content. The film-clips were presented in random order and the subjects assessed their emotional responses with SAM ratings using the pencil-and-paper method.

5.2 Result

From the Preliminary Test, nine film-clips were selected (see Table 4), representing certain patterns of emotions. For instance, the film-clips of gangsters and war fighters induced similar emotional responses. Thus, the gangsters’ clip was chosen, because the semantic content related to “violence”. The selected film-clips elicited emotional responses intensively in terms of valence, arousal, or dominance and thus, it is expected that strong affectivity of those film-clips might enhance context effect on the emotional response to color stimuli.

1) ‘Vivid red’, as an emotion elicitor among moving images-result

The mean SAM ratings of ‘vivid red’ obtained in the Preliminary Test was 2.875 in valence, 2.792 in arousal, and 2.875 in dominance. As seen in Figure 2, it was found that the 18 film-clips elicited extreme emotional profiles due to their intense semantic content and pushed the ‘vivid red’ toward a neutral emotional position.

The manner in which ‘vivid red’ was assessed in the test implies that emotional responses to color stimuli are weakened by a greater intensity of semantic content.

6. EXPERIMENT II

Stimulus context provides a frame of reference, anchoring the scale of judgment [8]. The purpose of Experiment II was to observe the judgmental shift caused by a contrast in relation to other visual stimulus modalities, such as

colors, chromatic and achromatic pictures, film-clips, and adjectives.

6.1 Method

6.1.1 Subjects

The experiment was announced with flyers at the University of Mannheim and 45 subjects, made up of 24 men and 21 women, participated. They were either paid € 6.00 or given course credit for their participation (age; M=26.76, SD=10.58).

6.1.2 Stimuli

Four stimuli modalities were used in this experiment:

Table 4: The selected 9 film-clips for the Experiment II

film	t (sec)	scene description
A Clockwork Orange, S. Kubrick (1971)	14	viewing some buildings from a flying vehicle
	13	Jesus Christ walking with the cross, tortured
	14	a man surrounded by three semi-naked women
	14	four men assaulting an old homeless man
Le Papillon, P. Muyl (2003)	14	A big tree on the hill. Leaves fanning in the breeze
	14	a young girl calmly opens a door to a butterfly garden
Amélie, J.P. Jeunet (2001)	13	a little girl photographing bunny-shaped clouds
Unfaithful, A. Lyne (2002)	14	A husband and wife caressing each other
Legally blond, R. Luketic (2001)	14	many girls celebrating

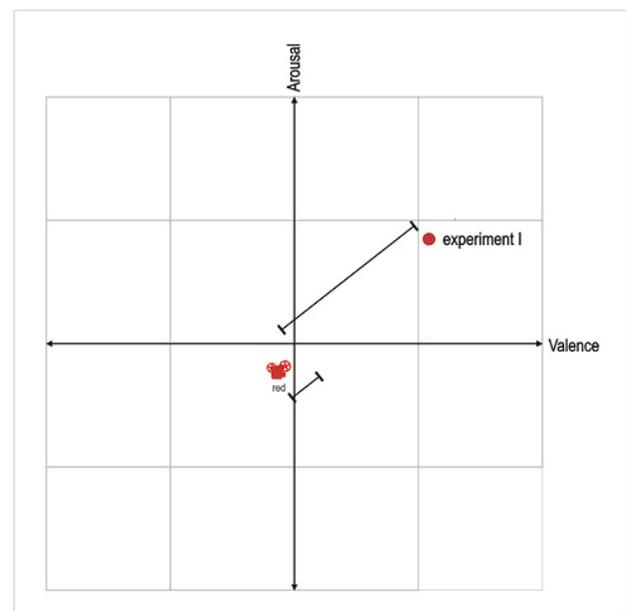


Figure 2: Plots of means of vivid red in Experiment I (N=46) and Preliminary Test (N=24), illustrated in emotion space defined by valence x arousal.

colors, pictures (chromatic as well as achromatic), film-clips, and adjectives.

1)Target Stimuli:colors

Chromatic color stimuli were collected from three tone categories: “dark”, “vivid”, and “light”. Each of the hue-categories “red”, “yellow”, “green”, and “blue” possessed three tone categories. A vivid violet was included on behalf of colors in violet hue category.

We added achromatic color stimuli, “dark” and “light gray”, “light warm gray”, and “light cool gray”. In sum, there were 17 color stimuli, which had all been rated by SAM scales in Experiment I. Color stimuli were displayed centered on the monitors, with dimensions of 22.1cm width × 14.9cm height.

2)Background Stimuli: film-clips

The nine film-clips listed in Table 4 were used. Since film-clips were in different formats, PXLab® software adjusted them either to a size of 19.0 cm width × 14.9 cm height or to that of 22.1 cm width × 14.9 cm height. Therefore, all the film-clips were presented in the same dimensions as colors and pictures.

3)Background Stimuli: pictures

Eight identically sized pictures of color stimuli —four chromatic and four achromatic—from IAPS [9] (see Figure 3), an international and standardized affective picture database, were presented. The IAPS includes contents across a wide range of semantic categories and provides a set of normative emotional stimuli for experimental investigations of emotion and attention. The eight pictures selected for this study possess stereotyped emotional profile in terms of valence, arousal, or dominance: For example, a picture with two rabbits (nr. 1750 in Figure 3) has been assessed by more than 10,000 IAPS subjects to be extremely positive. By assessing the emotional responses to the pictures, it was expected for the subjects to experience various emotional profiles.

4)Background Stimuli: words

Nine adjectives with various emotional profiles were used—“laut”(loud), “langwilig”(boring), “hektisch”(hectic), “leicht”(light), “aktiv”(active), “dynamisch”(dynamic), “gesund”(healthy), “urban”, and “modern”—and were displayed one by one among other groups of stimuli in ‘Arial’ typeface 2.5cm in height and in gray (lightness=30). The background color remained in a

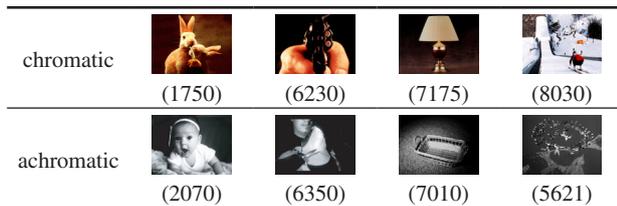


Figure 3: 8 pictures selected from IAPS (IAPS nr.)

lighter gray (lightness=70). The nine adjectives were:

The emotional profiles of the background stimuli were supposed to vary in terms of valence, arousal, and dominance, and taken together, the set of 43 stimuli and SAM figures were implemented by the PXLab® software in Experiment II.

6.1.3 Procedure

The physical environment of Experiment II was identical to that of Experiment I, so that the external variances caused by different circumstances were minimized. All the stimuli were displayed in random order and each subject was exposed to all stimuli and no missing data occurred.

6.2 Result

Cronbach’s coefficient alpha was calculated and provided a satisfactory level of reliable internal consistency for the measurements on valence ($\alpha = 0.729$), arousal ($\alpha = 0.919$), and dominance ($\alpha = 0.842$).

6.2.1 Judgmental Shift of Target Stimuli

Mean and standard deviation values of SAM ratings on valence, arousal, and dominance of the 17 colors from Experiment I and II were compared in Table 5. In Experiment II, the mean values of 13 out of 17 colors (76.5%) decreased (‘-’ valence). In the arousal dimension, the SAM ratings shifted towards less aroused, as all means of arousal decreased (‘-’arousal). In the dominance dimension, more than half of the colors (11 of 17) shifted towards greater dominance.

Table 5: Mean comparison of SAM assessments of 17 color stimuli between Experiment I (M(I)) and II (M(II)), p values yielded by t-test, two-tailed, * p<.05, df=89

color stimuli	valence			arousal			dominance		
	M(I)	M(II)	p	M(I)	M(II)	p	M(I)	M(II)	p
dark red	2.783	2.778	.980	2.826	2.467	.098	2.913	2.889	.916
vivid red	4.087	3.578	.016*	3.848	3.756	.673	3.761	3.200	.010*
light red	3.674	3.400	.195	2.696	2.467	.335	3.152	3.378	.328
dark yellow	2.739	2.756	.933	2.478	2.133	.084	2.935	3.022	.700
vivid yellow	4.239	3.844	.068	3.630	3.156	.055	3.674	3.422	.306
light yellow	3.457	3.378	.703	2.370	2.333	.875	3.261	3.467	.384
dark green	3.152	3.400	.234	2.674	2.422	.263	3.065	3.333	.183
vivid green	3.87	3.756	.540	2.826	2.489	.155	3.109	3.556	.028*
light green	3.348	3.267	.690	2.217	2.111	.637	3.044	3.311	.240
dark blue	3.174	3.133	.840	2.739	2.222	.010*	3.239	3.222	.943
vivid blue	4.109	3.978	.461	2.891	2.422	.049*	3.500	3.644	.544
light blue	4.152	4.178	.872	2.935	2.400	.035*	3.522	3.689	.456
vivid violet	3.239	3.089	.463	2.826	2.756	.755	2.783	3.067	.173
dark gray	2.065	2.089	.903	2.326	2.289	.880	2.587	2.489	.698
light gray	2.435	2.378	.749	2.087	1.844	.257	2.826	2.600	.310
light warm gray	2.544	2.533	.963	2.000	1.667	.081	2.826	3.044	.353
light cool gray	3.304	3.022	.145	2.022	1.911	.581	2.891	3.200	.187

In Figure 4, the displacements of colors are depicted with arrows (vectors). The starting point of each arrow indicates the respective mean values of valence (abscissa) and arousal (ordinate) obtained in Experiment I, while the end point indicates the mean obtained in Experiment II. Thus, the arrows characterize the direction and magnitude of judgmental shifts. Emotional responses to the 17 colors in the complex stimulus context tended to shift towards negative (‘-’ valence) and calm (‘-’ arousal). All these observations were statistically examined

Based on the SAM ratings, two-way ANOVA was run on two factors: experiment and colors (repeated measurement). As shown in Table 6, the effect of experiment between I and II is significant in the arousal dimension [$F_{(1, 89)}=5.002, p=.028^*$], whereas judgmental shifts in the other dimensions were not significant ($\alpha=.05$). The other main factor was tested to see whether different colors induced different emotional responses. The results confirmed the hypotheses of the previous experiments ([H. 1]), showing significant values ($p<.000^{***}$) for the three dimensions of emotion (valence, arousal, and dominance). No significant experiment * stimulus interaction was found.



Figure 4: The displacements of 17 colors from Experiment I to Experiment II, illustrated with vectors in emotion space defined by valence × arousal.

Table 6: Results of two-way ANOVA: factors= experiment, colors (repeated measurement) Experiments I versus II, * $p<.05$ ** $p<.01$ *** $p<.001$

factor	valence	arousal	dominance
experiment (between)	$F_{(1, 89)}= 1.814, p=.181$	$F_{(1, 89)}=5.002, p=.028^*$	$F_{(1, 89)}=.534, p=.467$
colors (within)	$F_{(9,906, 881,620)}=43.131, p=.000^{***}, \epsilon=.619$	$F_{(10,298, 916,507)}=25.876, p=.000^{***}, \epsilon=.644$	$F_{(10,253, 912,530)}=9.425, p=.000^{***}, \epsilon=.641$
exp.(between) colors (within)	$F_{(9,906, 881,620)}=.923, p=.542, \epsilon=.619$	$F_{(10,298, 916,507)}=.782, p=.650, \epsilon=.644$	$F_{(10,253, 912,530)}=1.606, p=.098, \epsilon=.641$

6.2.2 Judgmental Shift of ‘vivid red’

Figure 5 depicts averaged values of ‘vivid red’ based on Experiment I and II, and Preliminary Test. As discussed, the ‘vivid red’ film-clip was assessed with greater displacement in the Preliminary Test. However, SAM ratings of ‘vivid red’ in Experiment II lie between Experiments I and the Preliminary Test.

In fact, the stimulus quality of the color, vivid red, in Experiment II was weaker than the vivid red in the Preliminary Test. Based on affective adaptation, as proposed by Helson [10] (p. 329), it might be that the stimulus context during Experiment II did not provide sufficient affective contrast. The proportion of color stimuli in Experiment II was 39.5% (17 of 43), whereas it was 5.3% during the Preliminary Test (1 of 19).

In addition, it seems probable that subjects consciously applied adjusted reference scales for every different stimulus type and thus were able to assess the emotional responses to a color in comparison with other color stimuli during Experiment II.

7. SUMMARY AND CONCLUSION

In this study, two hypotheses were formulated and two main Experiments and one Preliminary Test were carried out.

In Experiment I, subjects assessed the emotional response to 36 colors in terms of three dimensions of emotion—valence, arousal, and dominance using the SAM. Based on the SAM ratings of 46 subjects, the reliability coefficients of internal consistency provided evidence that three dimensions of emotion may describe an emotional profile of digital colors, supporting [H.1]. From the 36 colors, 17 colors were selected as color

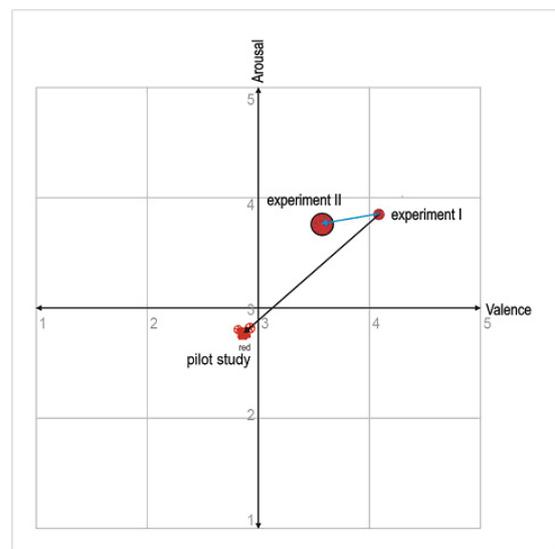


Figure 5: The averaged SAM ratings and displacements of ‘vivid red’ in valence and arousal

stimuli to be used in Experiment II and the SAM ratings of the 17 colors in Experiment I were considered as baseline, which the colors in Experiment II were compared to.

During the Preliminary Test, 19 film-clips were examined in order to pre-determine their respective emotional profile, and later nine of them were embedded in Experiment IV. During the Preliminary Test, a plain colored scene (vivid red) was assessed as close to neutral with regards to all dimensions of emotion, advocating [H. 2].

In Experiment II, we examined whether anchor effects on emotional reference occurred in a more complex stimulus context. It was hypothesized that emotional responses to color would appear in a weaker pattern due to film-clips, which contained a higher degree of semantic intensity [H. 2]. As background stimuli, other types of visual stimulus, such as pictures and words, were used as well.

The SAM ratings of colors in Experiment II were compared with those of Experiment I, in which emotional responses were tested within colors exclusively. Instead of a weaker pattern of reference field, it was observed that emotional responses to colors shifted in certain directions; toward ('-') valence, ('-') arousal, and ('+') dominance. Moreover, a two-way ANOVA with repeated measurements on one factor (colors) yielded significant results in arousal dimension ($F_{(1,89)}=5.002$, $p=.028^*$).

8. GENERAL DISCUSSION

In Experiment I, the measurement with the 5-scale SAM system provided evidence for explaining the relationship between color and emotion, confirming [H.1]. However, the measured values represent the affective relativity within colored surfaces only.

Therefore, in Experiment II, we examined whether visual stimuli with higher semantic intensity (than color) would anchor emotional reference in a more complex stimulus context. Consequently, it was hypothesized that emotional responses to color would appear in a weaker pattern due to the film-clips, which contain a higher degree of semantic intensity [H.2]. After running a statistical test, we determined that the judgmental shift of 17 colors from Experiment I to Experiment II was significant ($p=0.028$) in arousal dimension, partially confirming the [H.2].

Although such tendencies of displacement were observed and partially confirmed to be significant ($\alpha=.05$) the judgmental shifts were weaker in Experiment II than anticipated. In particular, this could be observed by the weak judgmental shift for the 'vivid red' in Experiment IV.

According to the theory on adaptation levels of Helson [10], affective judgments depend on the relative frequencies with which the stimuli are presented. Therefore, during the Preliminary Test, subjects were exposed to the 'vivid

red' film-clip, as well as 18 other film-clips. In contrast, in Experiment II, the 43 stimuli included 17 colors, representing 39.5% of the entire stimuli. Also, Garner [11] referred to the set of possible stimuli as the 'inferred set', which indicates that judgments of perceived intensity or quality depend on the set of possible stimuli. Therefore, as the proportion of colors increased (from 5.3% to 39.5%), the contrast effect was reduced respectively.

Also, it is assumed that subjects were able to apply individual reference scales for each stimulus type. Subjects were aware of different stimulus modalities and may have adjusted the frequency of range scaling according to the identified stimulus type. Thus, they may have assigned the stimuli of each category to a respective frame of reference. For future research, we suggest that the number of stimulus modalities be increased, so that category membership of stimulus may be weakened and the frame of reference can be formed with respect to all presented stimuli.

In addition, the sequential effect was not examined in Experiment IV. Instead, it was assumed that a sequential effect would occur and generate judgmental shifts overall, since the order of stimuli had been randomized every time. In future research, it is suggested to test not only contrast effects caused by semantic intensity, but also sequential dependencies to obtain more contrastive results.

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