

CHAPTER 4

RESULT AND DISCUSSION

4.1 Visual Assessment

The visual results of fourteen opponent word pairs were established. They were “Dark-Light”, “Hard-Soft”, “Cool-Warm”, “Turbid-Transparent”, “Pale-Deep”, “Vague-Distinct”, “Light-Heavy”, “Sombre-Vivid”, “Weak-Strong”, “Passive-Dynamic”, “Plain-Gaudy”, “Subdued-Striking”, “Disharmony-Harmony” and “Dislike-like”. The relationship between the derived results of the visual assessments and the colorimetric values in terms of color difference (ΔE^*), lightness difference (ΔL^*), chroma difference (ΔC^*) and hue difference (ΔH^*), respectively were given, as shown in Figure4-1 to 4-56. This include the ranking of visual scores of each opponent word pair as shown in Figure4.57 to 4-61. They were described as follows:

(a) “Dark-Light” Relationships (Figure4-1 to 4-4) were found that “Light” related to high values of color difference, lightness difference, chroma difference and hue difference, while “Dark” related to low values of color difference, lightness difference, chroma difference and hue difference. The obtained ranking of color combination were shown in Figure4-57 (a). Groups of color combination pairs that the observers judged as “Light” can be divided into three groups. The first group is a high chroma or a high lightness yellow with analogous yellow hue, such as pairs of vivid yellow with vivid green and pairs of vivid yellow with vivid red. The second

group is pair of light tone color with white, such as pair of light blue with white. The third group is pairs of light tone color, such as pair of light yellow with light green. While “Dark” can be divided into three groups. The first group is pairs composing of black with dark tone color, such as pair of dark purple with black. The second group is pairs of dark tone color, such as pair of dark red with dark purple. The third group is pairs of dull tone with dark tone color, such as pair of dull blue with dark green. The visual scores obtained was ranged from -85.29% to 83.33% .

(b)“Hard-Soft” Relationships (Figure4-5 to 4-8) were found that the distribution and visual assessments of color difference, lightness difference, chroma difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-57(b). Groups of color combination pairs that the observers judged as “Soft” can be divided into three groups. The first group is pairs composing of white with light tone color, such as pair of light blue with white. The second group is pairs of light tone color, such as pair of light green with light purple. The third group is pairs of light tone with dull tone color, such as pair of light red with dull yellow. While “Hard” can be divided into two groups. The first group is pairs composing of color patches that have low lightness with vivid red, such as pair of vivid red with black. The second group is pairs of dark tone color, such as pair of dark red with dark purple. The visual scores obtained was ranged from -61.76% to 79.41% .

(c)“Cool-Warm” Relationships (Figure4-9 to 4-12) were found that the distribution and visual assessments of color difference, lightness difference, chroma

difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-57(c). Groups of color combination pairs that the observers judged as “Warm” can be divided into three groups. The first group is pairs composing of vivid red with analogous red hue, such as pair of vivid red with vivid yellow and pair of vivid red with vivid purple. The second group is pairs composing of vivid red with complementary red hue, such as pair of vivid red with vivid green. The third group is pairs of red color patches that have different lightness and chroma value, such as pair of vivid red with dark red. While “Cool” can be divided into three groups. The first group is pairs of green color patches that have different lightness and chroma value, such as pair of light green with dull green. The second group is pairs of blue color patches that have different lightness and chroma value, such as pair of vivid blue with light blue. The third group is pairs composing of light tone color that have hue range between 150-320 with white, such as pair of light blue with white. The visual scores obtained was ranged from -69.61% to 79.41%.

(d)“Turbid-Transparent” Relationship (Figure4-13 to 4-16) were found that the distribution and visual assessments of color difference, lightness difference, chroma difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-58(d). Groups of color combination pairs that the observers judged as “Transparent” can be divided in to three groups. The first group is pairs composing of white with light tone color, such as pair of light green with white. The second group is pairs composing of a high chroma or a high lightness yellow with light tone color, such as pair of light yellow with light blue. The third group is pairs of light tone, such as pair of light green with light blue. While “Turbid”

can be divided into three groups. The first group is pairs composing of black with dark tone or dull tone color, such as pair of dark purple with black and pair of dull purple with black. The second group is pairs of dark tone color, such as pair of dark green with dark purple. The third group is pairs composing of dull tone with dark tone color, such as pair of dull blue with dark green. The visual scores obtained was ranged from -83.33% to 72.55%.

(e) “Pale-Deep” Relationship (Figure4.17 to 4.20) were found that the distribution and visual assessments of color difference, lightness difference, chroma difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-58(e). Groups of color combination pairs that the observers judged as “Deep” can be divided into three groups. The first group is pairs composing of black with dark tone color, such as pair of dark blue with black. The second group is pairs composing of vivid red with color patches that darker than vivid red, such as pair of vivid red with dark blue. The third group is pairs of dark tone color, such as pair of dark red with dark blue. While “Pale” can be divided into three groups. The first group is pairs composing of white with light tone color, such as pair of light purple with white. The second group is pairs of light tone color, such as pair of light green with light purple. The third group is pairs composing of light tone color with dull tone color, such as pair of light blue with dull yellow. The visual scores obtained was ranged from -69.61% to 82.35%.

(f) “Vague-Distinct” Relationship (Figure4-21 to 4-24). were found that “Distinct” related to high values of color difference, lightness difference, chroma

difference and hue difference, while “Vague” related to low values of color difference, lightness difference, chroma difference and hue difference. The obtained ranking of color combination are shown in Figure4-58(f). Groups of color combination pairs that the observers judged as “Distinct” can be divided into two groups. The first group is pairs composing of white with light tone color, such as pair of light purple with white. The second group is pairs of light tone color, such as pair of light yellow with light green. While “Vague” can be divided into three groups. The first group is pairs composing of gray with dull tone color, such as pair of dull green with gray. The second group is pairs composing of dull tone with dark tone color, such as pair of dull blue with dark green. The third group is pairs of dull tone color, such as pair of dull red with dull green. The visual scores obtained was ranged from – 66.67% to 82.35%.

(g) “Light-Heavy” Relationships (Figure4-25 to 4-28) were found that the distribution and visual assessments of color difference, lightness difference, chroma difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-59(g). Groups of color combination pairs that the observers judged as “Heavy” can be divided into two groups. The first group is pairs composing of black with dark tone color, such as pair of dark blue with black. The second group is pairs of dark tone color, such as pair of dark red with dark blue. While “Light” can be divided into two groups. The first group is pairs composing of white with light tone color, such as pair of light purple with white. The second group is pairs of light tone color, such as pair of light yellow with light green. The visual scores obtained was ranged from –73.53% to 75.49%.

(h) “Sombre-Vivid” Relationships (Figure4-29 to 4-32) were found that “Vivid” related to high values of color difference, chroma difference and hue difference, while “Sombre” related to low values of color difference, chroma difference and hue difference. The distribution and visual assessments of lightness difference was randomly scattered. The obtained ranking of color combination are shown in Figure4-59(h). Groups of color combination pairs that the observers judged as “Vivid” can be divided into two groups. The first group is pairs composing of a high chroma or a high lightness yellow with analogous yellow hue, such as pair of vivid red with vivid yellow. The second group is pairs composing of a high chroma yellow with split-complementary yellow hue, such as pair of vivid yellow with vivid blue and pair of vivid yellow with vivid purple. The third group is pairs composing of a high chroma red with complementary red hue, such as pair of vivid red with vivid green. While “Sombre” can be divided into four groups. The first group is pairs composing of gray with dull tone color, such as pair of dull purple with gray. The second group is pairs composing of dull tone color with dark tone color, such as pair of dull purple with dark green. The third group is pairs composing of black with dark tone color, such as pair of dark purple with black. The fourth group is pairs of dull tone color, such as pair of dull yellow with dull green. The visual scores obtained was ranged from -73.53% to 84.31%.

(i) “Weak-Strong” Relationships (Figure4-33 to 4-36) were found that the distribution and visual assessments of color difference, lightness difference, chroma difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-59(i). Groups of color combination pairs that the

observers judged as “Strong” can be divided into three groups. The first group is pairs composing of black with dark tone color, such as pair of dark red with black. The second is pairs composing of vivid red with color patches that have low lightness, such as pair of vivid red with dark blue. The third is pairs of dark tone color, such as pair of dark red with dark blue. While “Weak” can be divided into four groups. The first group is pairs composing of white with light tone color, such as pair of light purple with white. The second group is pairs composing of gray with light tone color, such as pair of light green with gray. The third group is pairs of light tone color, such as pair of light yellow with light purple. The fourth group is pairs of light tone color with dull tone color, such as pair of light red with dull purple. The visual scores obtained was ranged from -64.71% to 73.53% .

(j) “Passive-Dynamic” Relationships (Figure4-37 to 4-40) were found that “Dynamic” related to high values of color difference, chroma difference and hue difference, while “Passive” related to low values of color difference, chroma difference and hue difference. The distribution and visual assessments of lightness difference was randomly scattered. The obtained ranking of color combination are shown in Figure4-60(j). Groups of color combination pairs that the observers judged as “Dynamic” can be divided into three groups. The first group is pairs composing of vivid red with vivid tone color, such as pairs of vivid red with vivid purple. The second group is pairs composing of a high chroma or a high lightness yellow with analogous yellow hue, such as pairs of vivid yellow with vivid green and pairs of vivid yellow with vivid red. The third group is pairs of vivid tone color with light tone color, such as pair of vivid red with light blue. While “Passive” can be divided into

three groups. The first group is pairs composing of black with dark tone color, such as pair of dark blue with black. The second group is pairs composing of gray with dull tone color, such as pair of dull green with gray. The third group is pairs of dull tone with dark tone color, such as pair of dull blue with dark blue. The visual scores obtained was ranged from -69.61% to 80.39%.

(k) “Plain-Gaudy” Relationships (Figure4-41 to 4-44) were found that “Gaudy” related to high values of color difference, chroma difference and hue difference, while “Plain” related to low values of color difference, chroma difference and hue difference. The distribution and visual assessments of lightness difference was randomly scattered. The obtained ranking of color combination are shown in Figure4-60(k). Groups of color combination pairs that the observers judged as “Gaudy” can be divided into three groups. The first group is pairs composing of vivid red with vivid tone color, such as pair of vivid red with vivid green. The second group is pairs composing of vivid yellow with vivid tone color, such as pair of vivid yellow with vivid purple. The third group is pairs of vivid tone color with light tone color, such as pair of vivid purple with light red. While “Plain” can be divided into three groups. The first group is pairs composing of gray with dark or dull tone color, such as pair of dull blue with gray and pair of dark blue with gray. The second group is pairs of achromatic color, such as pair of gray with black. The third group is pairs of dull tone color with dark tone color, such as pair of dull green with dark green. The visual scores obtained was ranged from -67.65% to 88.24%.

(l) “Subdued-Striking” Relationships (Figure4-45 to 4-48) were found that “Striking” related to high values of color difference, chroma difference and hue difference, while “Subdued” related to low values of color difference, chroma difference and hue difference. The distribution and visual assessments of lightness difference was randomly scattered. The obtained ranking of color combination are shown in Figure4-60(l). Groups of color combination pairs that the observers judged as “Striking” can be divided into three groups. The first group is pairs composing of vivid red with vivid tone color, such as pair of vivid red with vivid blue. The second group is pairs composing of vivid yellow with vivid tone color, such as pair of vivid yellow with vivid green. The third group is pairs of vivid tone color with light tone color, such as pair of vivid purple with light red. While “Subdued” can be divided in to three groups. The first group is pairs composing of gray with light tone or dull tone color, such as pair of light green with gray and pair of dull red with gray. The second group is pairs of dull tone color, such as pair of dull yellow with dull green. The third group is pairs of light tone with dull tone color, such as pair of light blue with dull green. The visual scores obtained was ranged from -57.84% to 85.29%.

(m) “Disharmony-Harmony” Relationships(Figure4-49 to 4-52) were found that “Disharmony” related to high values of color difference, chroma difference and hue difference, while “Harmony” related to low values of color difference, chroma difference and hue difference. The distribution and visual assessments of lightness difference was randomly scattered. The obtained ranking of color combination are shown in Figure4-61(m). Groups of color combination pairs that the observers judged as “Harmony” can be divided into one group. It is pairs composing

of same hue color that have different lightness and chroma value, such as pairs of dull purple with dark purple. While “Disharmony” can be divided into two groups. The first group is pairs composing of vivid tone color with dull tone or dark tone color, such as pair of vivid red with dull green and pair of vivid purple with dark yellow. The second group is pairs of light tone color with dark tone color, such as pair of light purple with dark yellow. The visual scores obtained was ranged from -68.63% to 82.35% .

(n) “Dislike-like” Relationships (Figure4-53 to 4-56) were found that the distribution and visual assessments of color difference, lightness difference, chroma difference and hue difference were randomly scattered. The obtained ranking of color combination are shown in Figure4-61(n). Groups of color combination pairs that the observers judged as “Like” can be divided into three groups. The first group is pairs of light tone color, such as pairs of light green with light blue, The second group is pairs of blue hue color patches that have different lightness and chroma value, such as pairs of light blue with dull blue. The third group is pairs composing of white with light tone color, such as pairs of light blue with white. While “Dislike” can be divided into two groups. The first group is pairs composing of vivid tone color with dull tone or dark tone color, such as pair of vivid green with dull purple or pair of vivid red with dark yellow. The second group is pairs of light tone with dark tone color, such as pair of light green with dark yellow. The visual scores obtained was ranged from -67.65% to 77.45% .

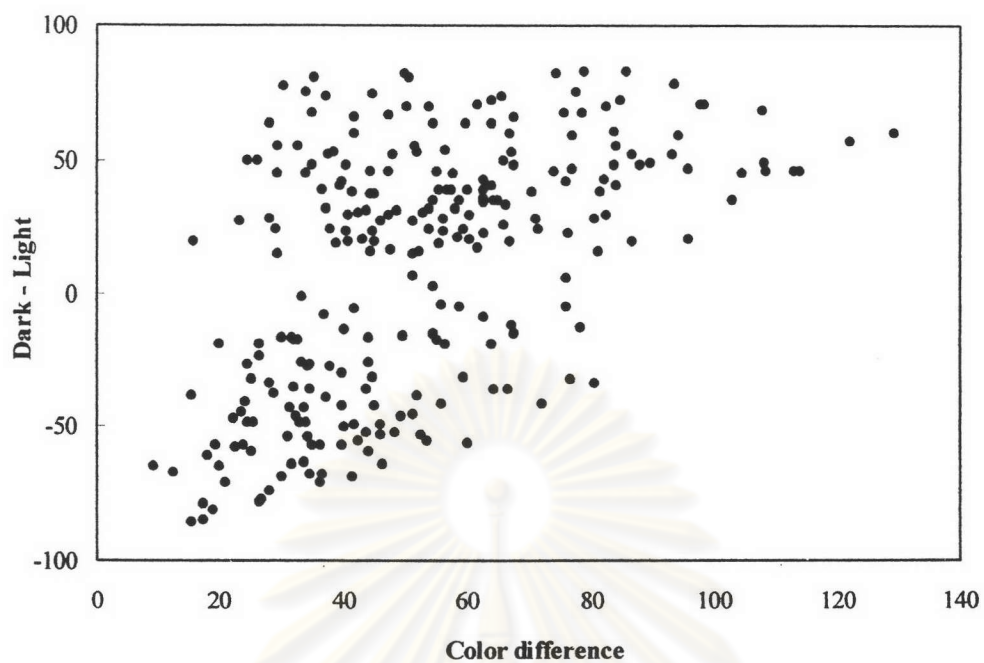


Figure 4-1 Visual results of “Dark-Light” relationship on color difference(ΔE^*)

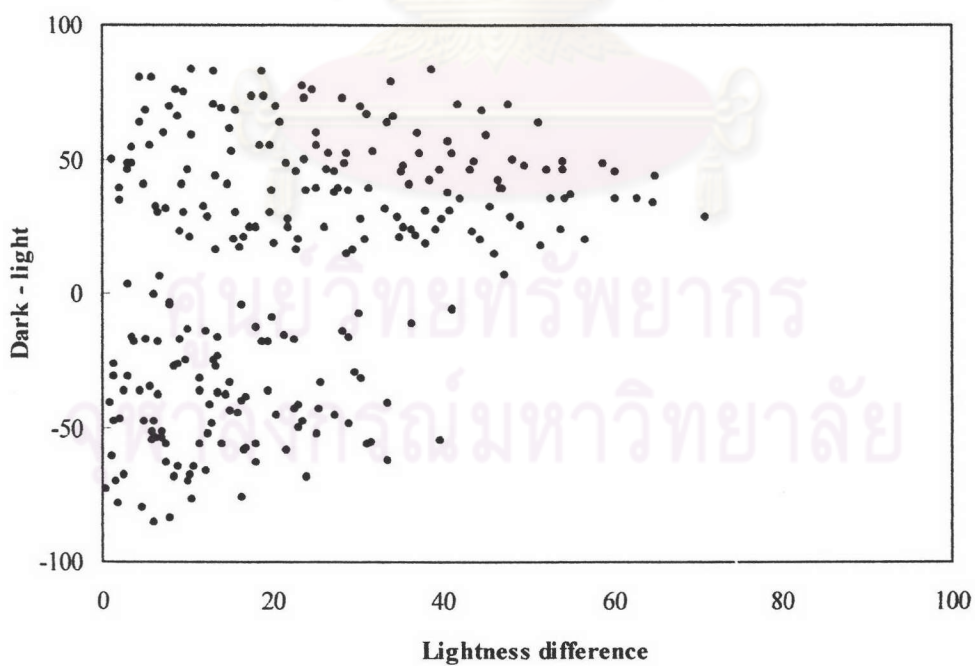


Figure 4-2 Visual results of “Dark-Light” relationship on lightness difference (ΔL^*)

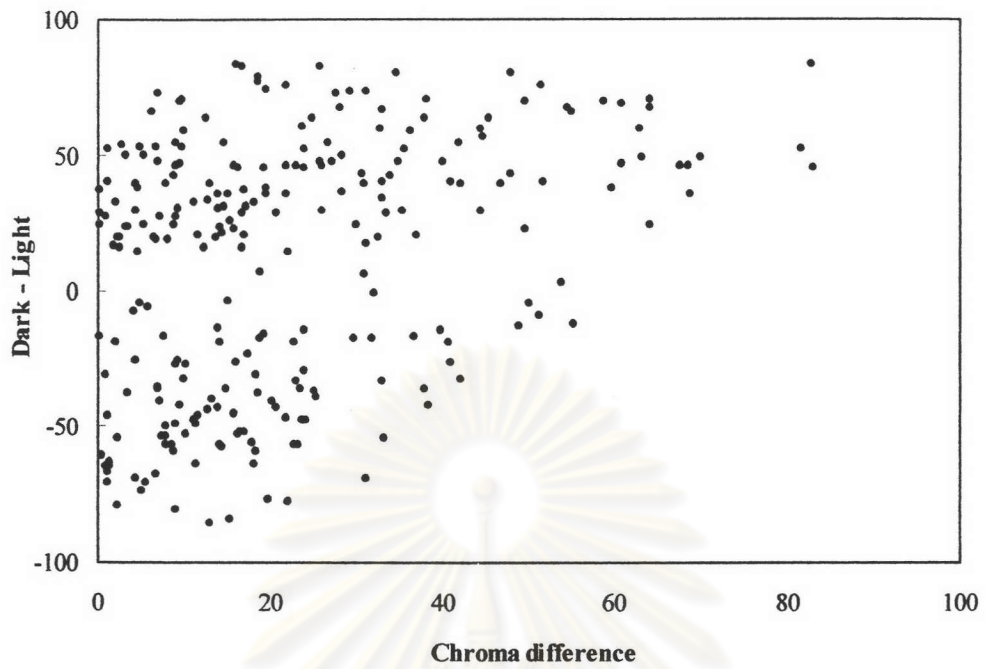


Figure 4-3 Visual results of “Dark-Light” relationship on chroma difference (ΔC^*)

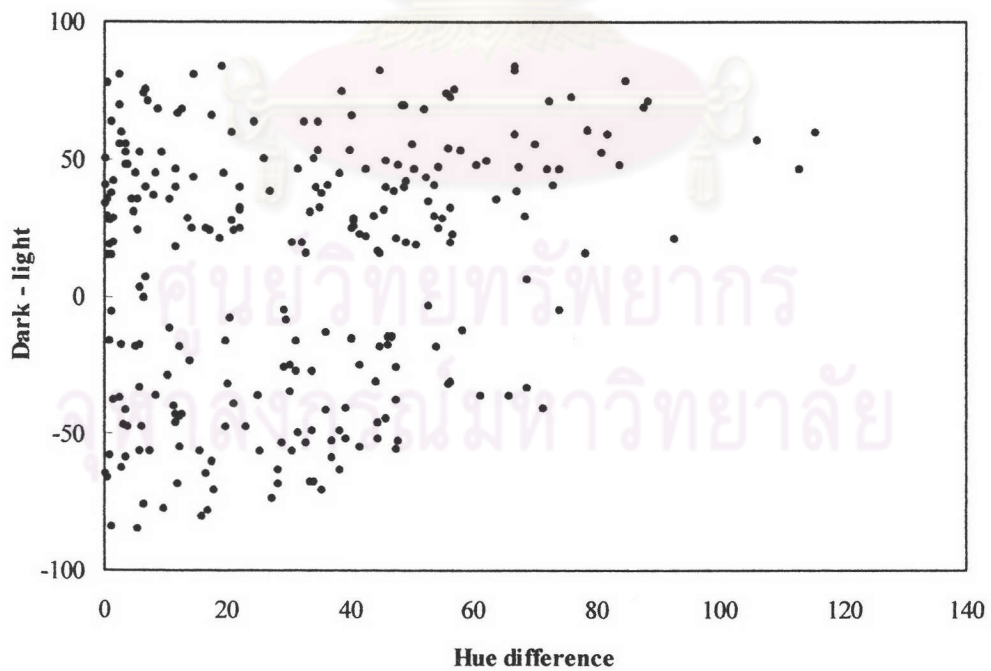


Figure 4-4 Visual results of “Dark-Light” relationship on hue difference (ΔH^*)

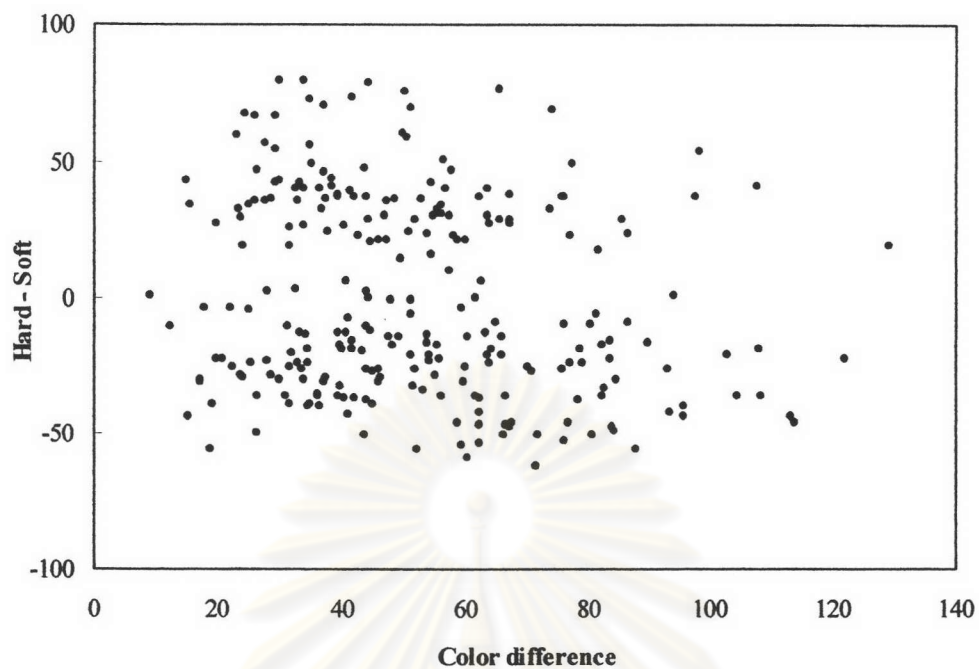


Figure 4-5 Visual results of “Hard-Soft” relationship on color difference (ΔE^*)

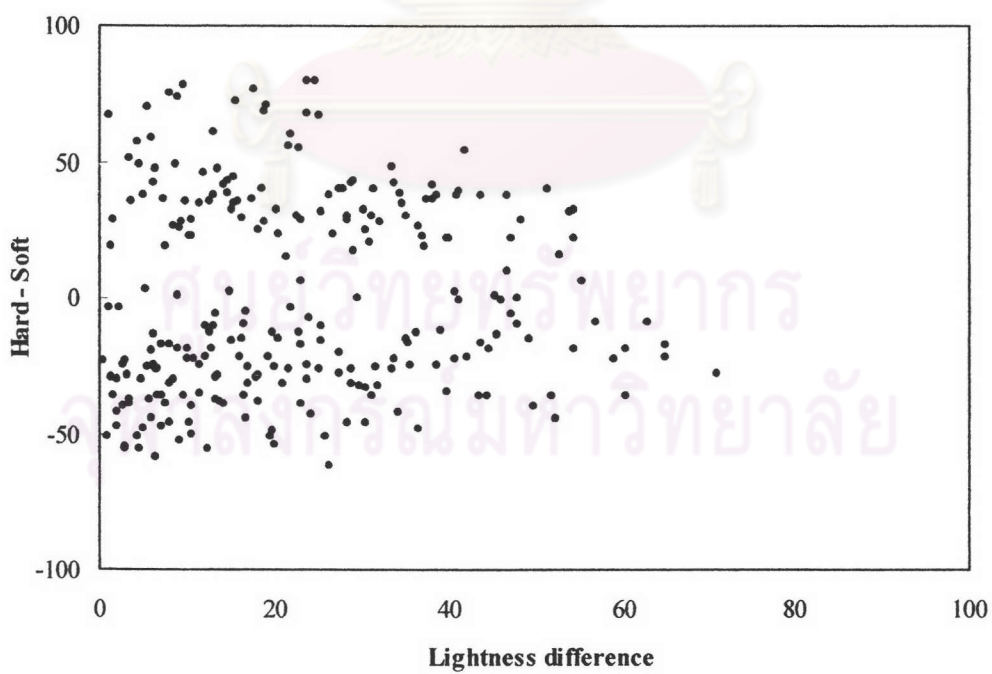


Figure 4-6 Visual results of “Hard-Soft” relationship on lightness difference (ΔL^*)

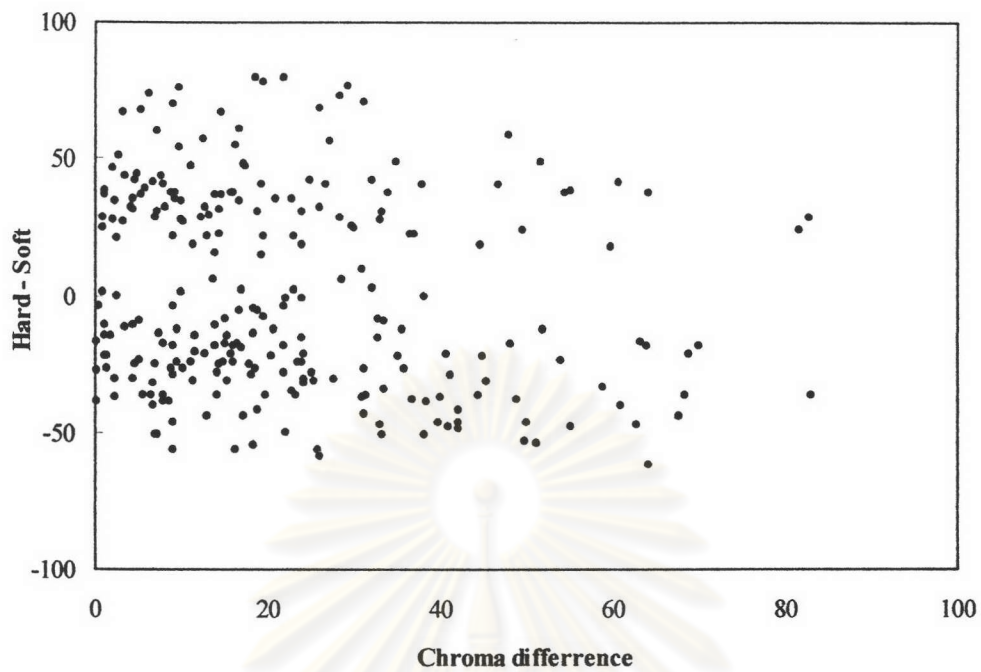


Figure 4-7 Visual results of “Hard-Soft” relationship on chroma difference (ΔC^*)

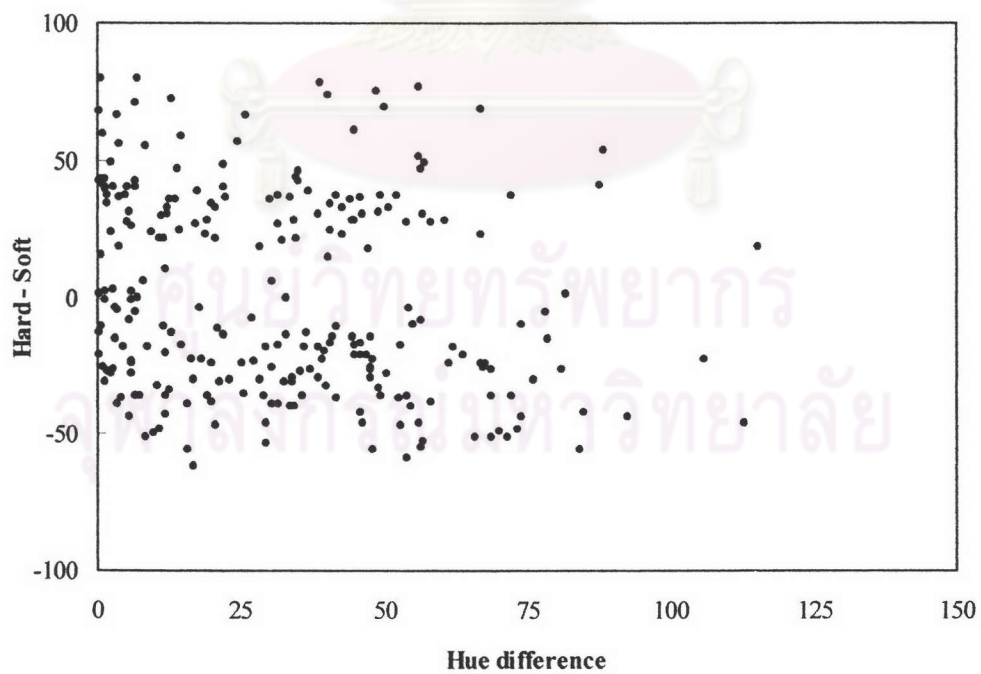


Figure 4-8 Visual results of “Hard-Soft” relationship on hue difference (ΔH^*)

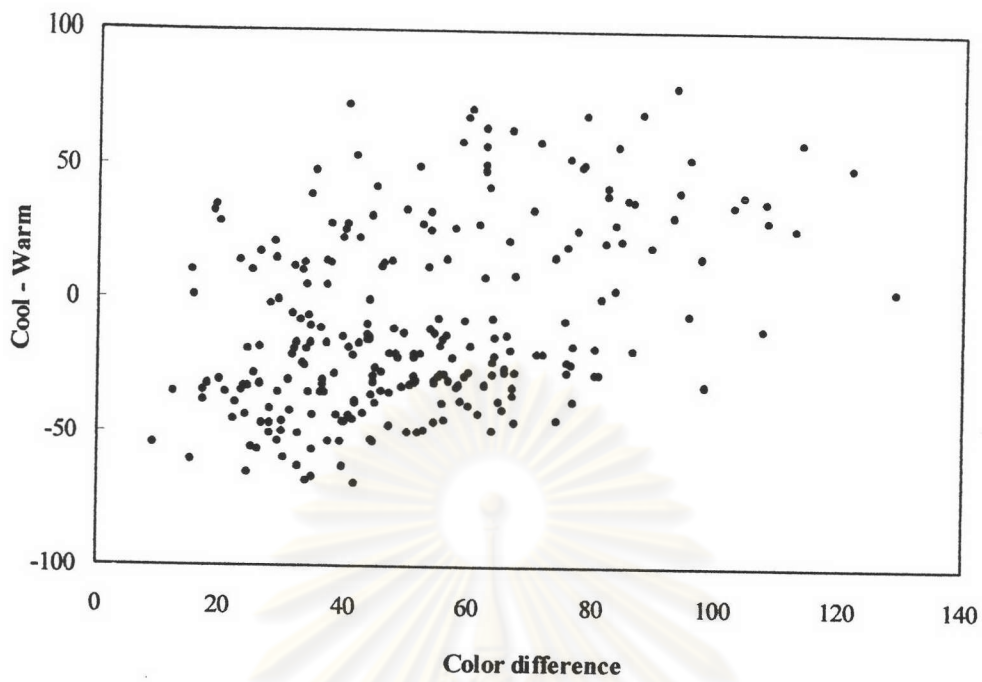


Figure 4-9 Visual results of “Cool-Warm” relationship on color difference (ΔE^*).

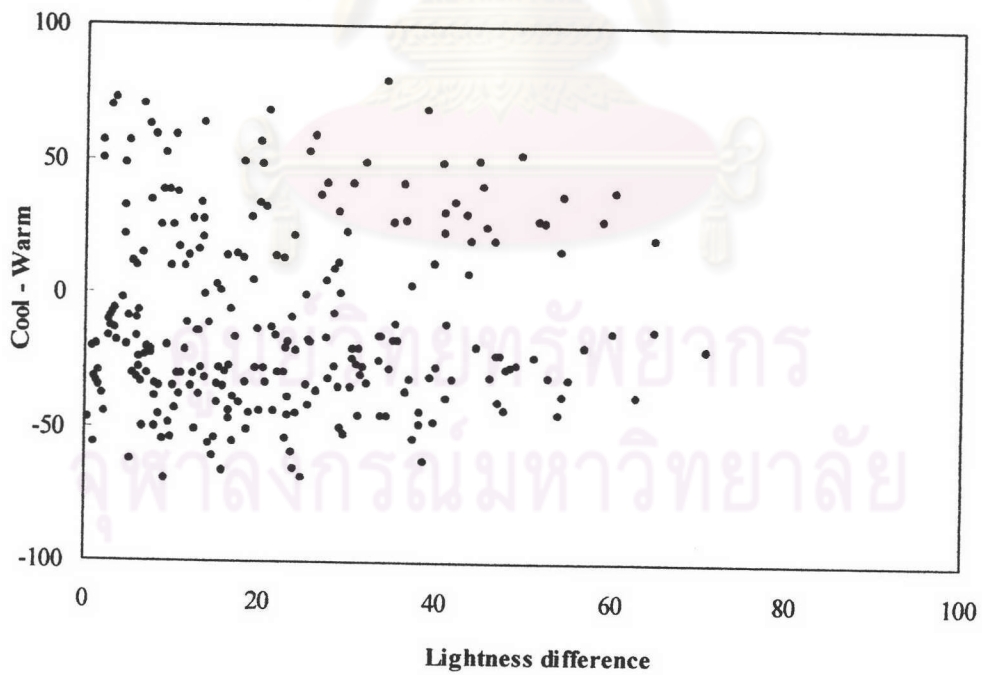


Figure 4-10 Visual results of “Cool-Warm” relationship on lightness difference (ΔL^*)

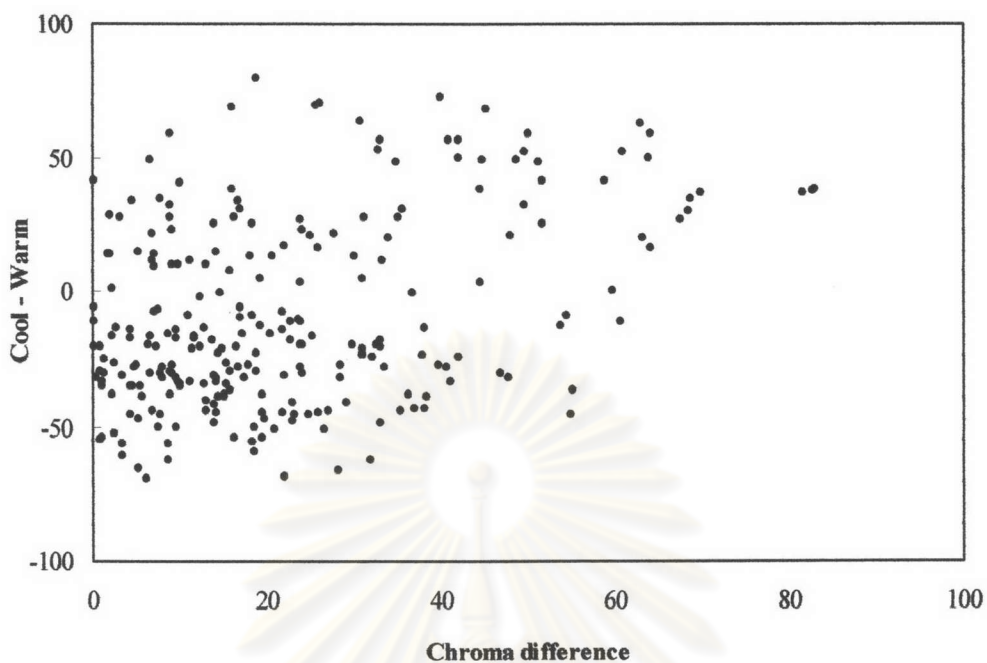


Figure 4-11 Visual results of “Cool-Warm” relationship on chroma difference (ΔC)

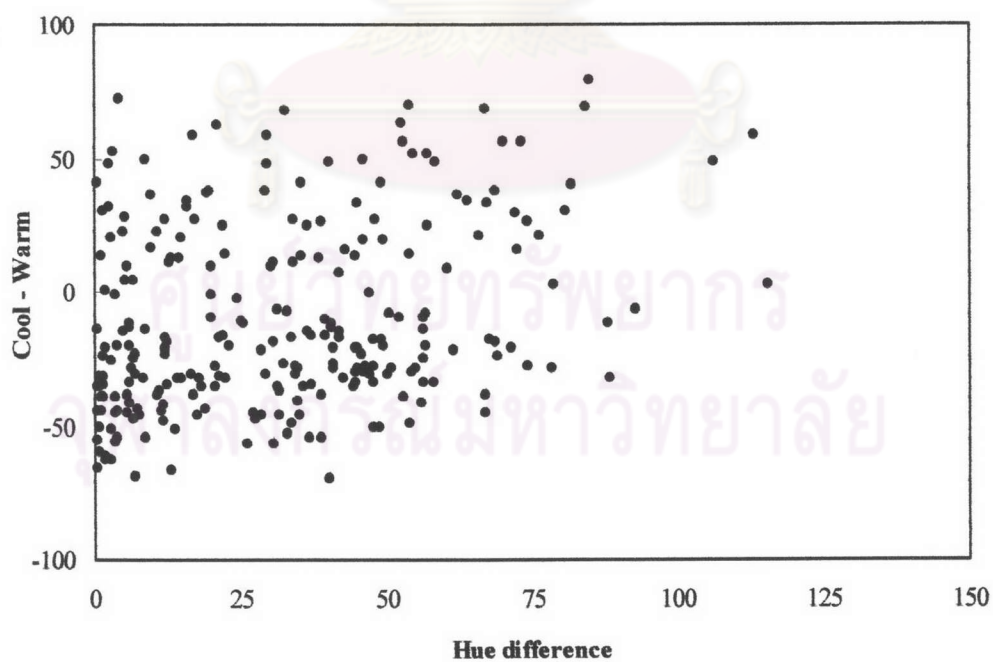


Figure 4-12 Visual results of “Cool-Warm” relationship on hue difference (ΔH^*)

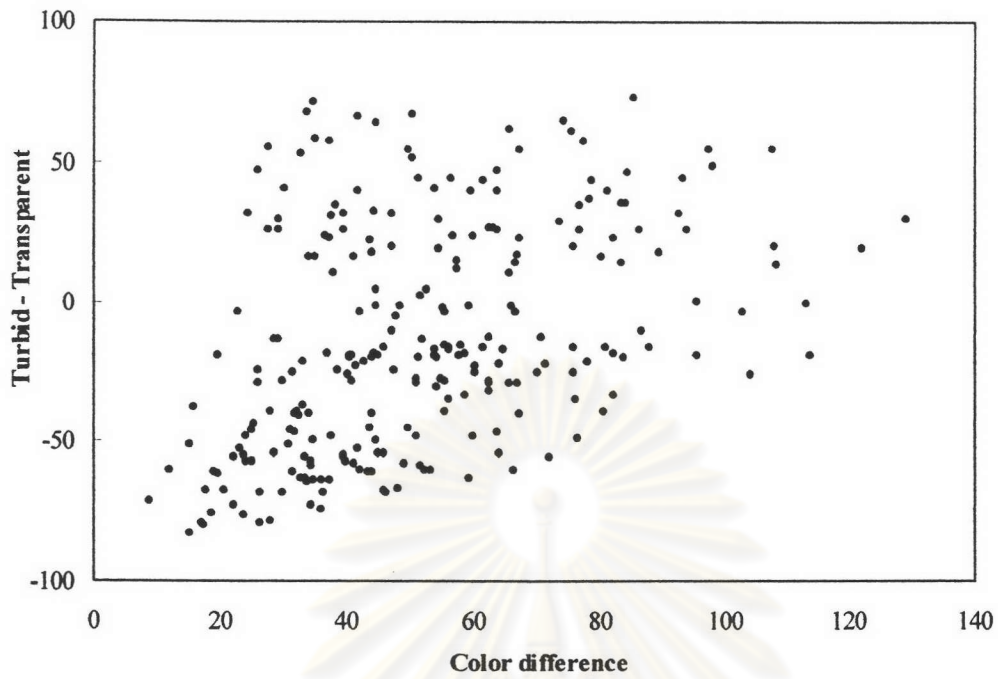


Figure 4-13 Visual results of “Turbid-Transparent” relationship on color difference (ΔE^*)

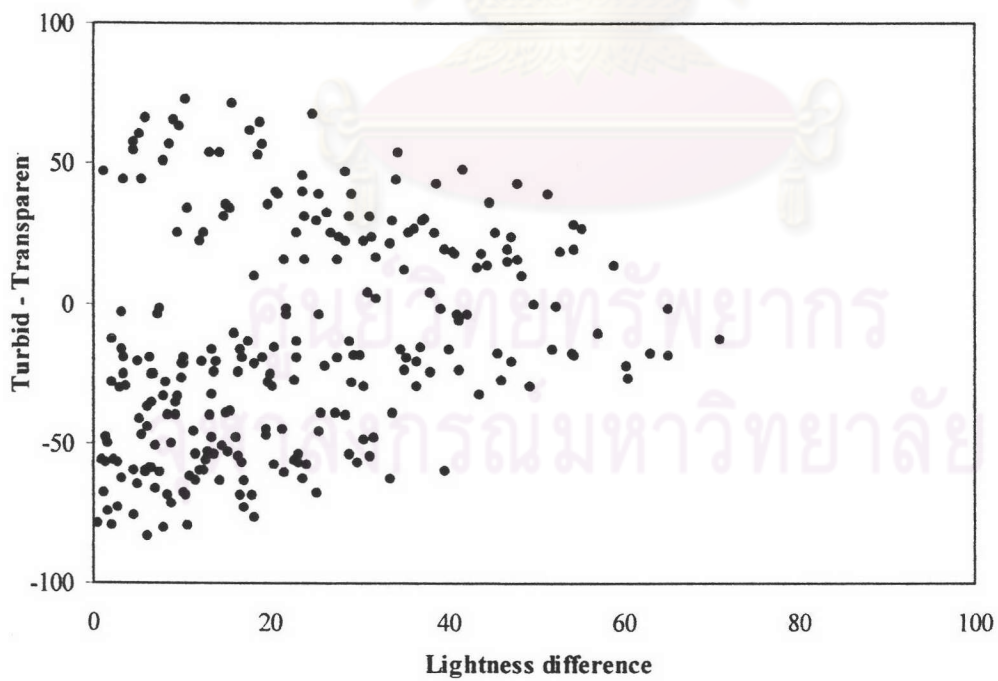


Figure 4-14 Visual results of “Turbid-Transparent” relationship on lightness difference (ΔL^*)

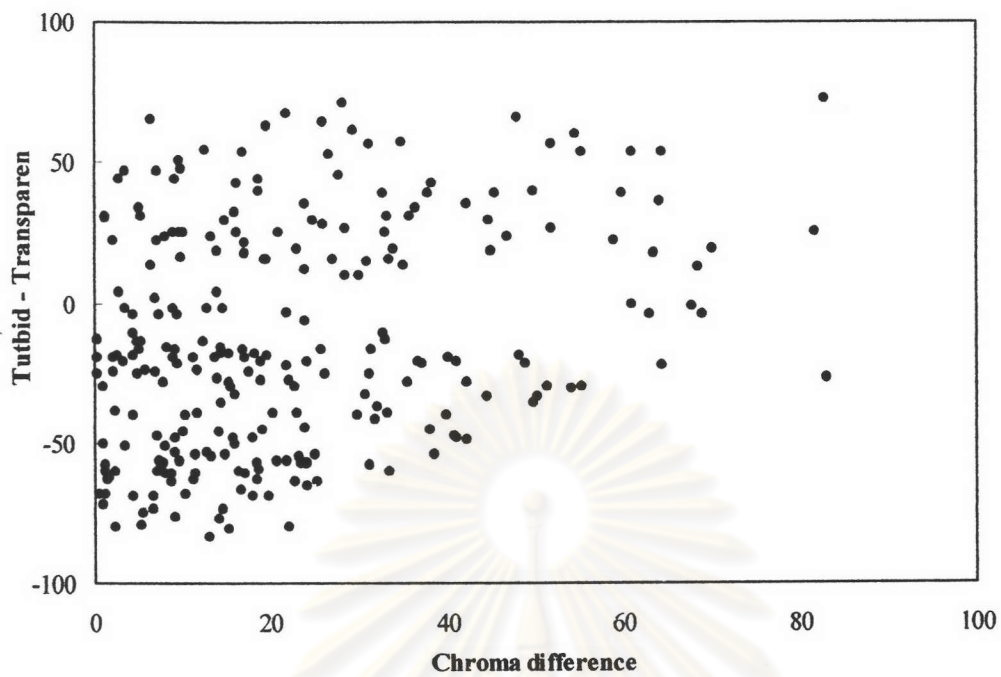


Figure 4-15 Visual results of “Turbid-Transparent” relationship on chroma difference (ΔC^*).

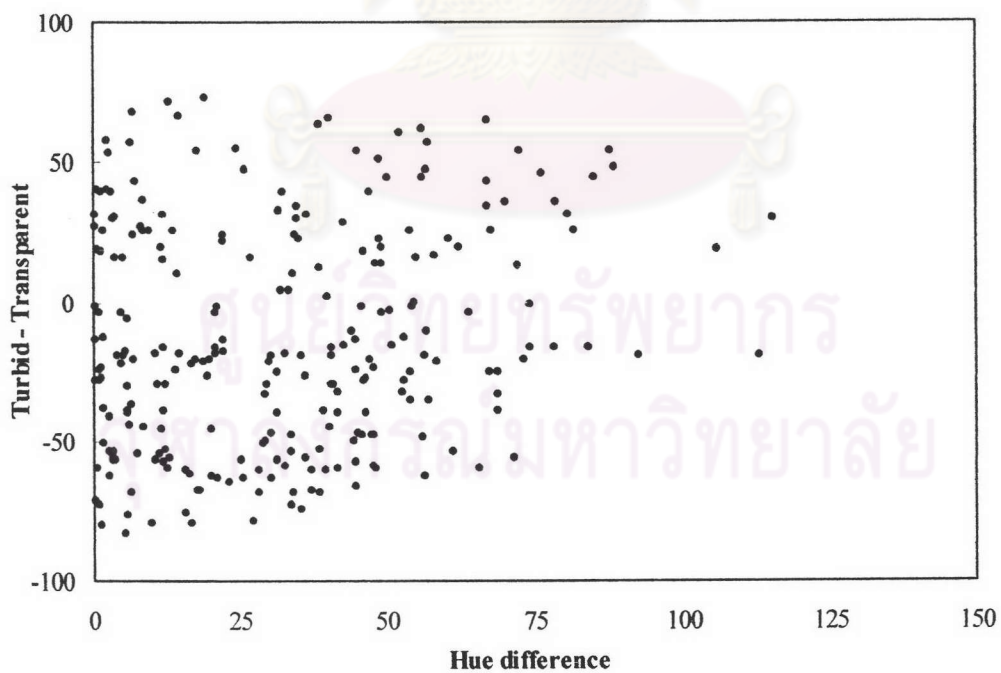


Figure 4-16 Visual results of “Turbid-Transparent” relationship on hue difference (ΔH^*).

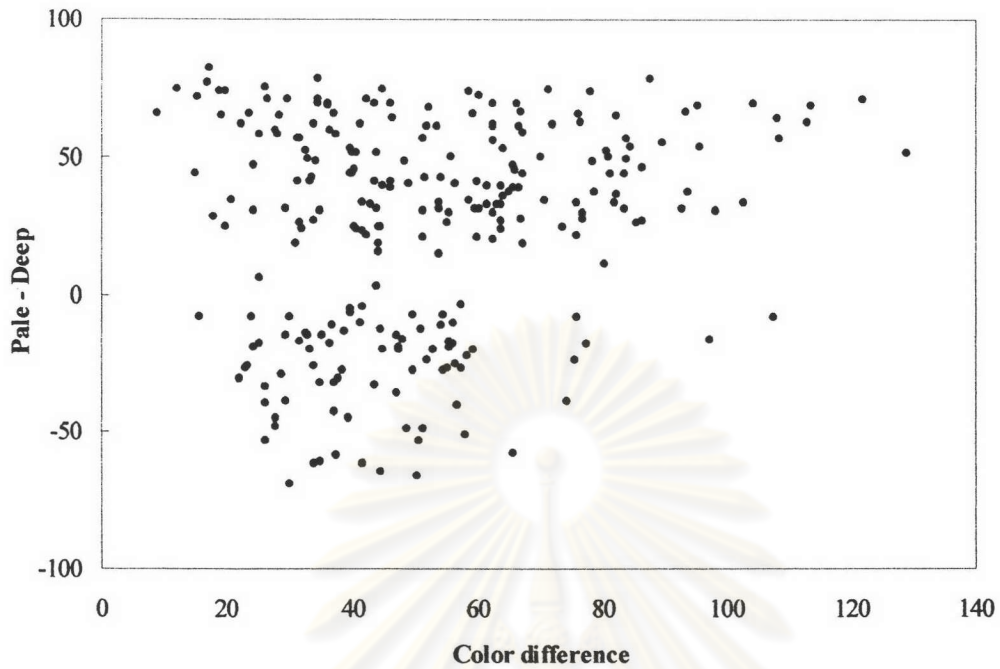


Figure 4-17 Visual results of “Pale-Deep” relationship on color difference (ΔE^*)

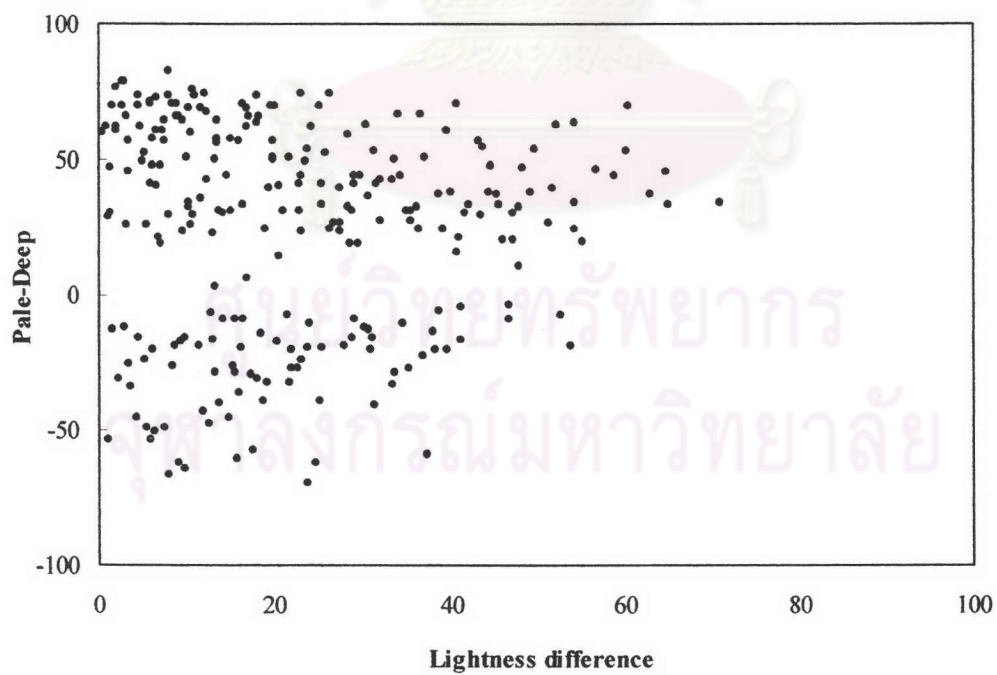


Figure 4-18. Visual results of “Pale-Deep” relationship on lightness difference (ΔL^*)

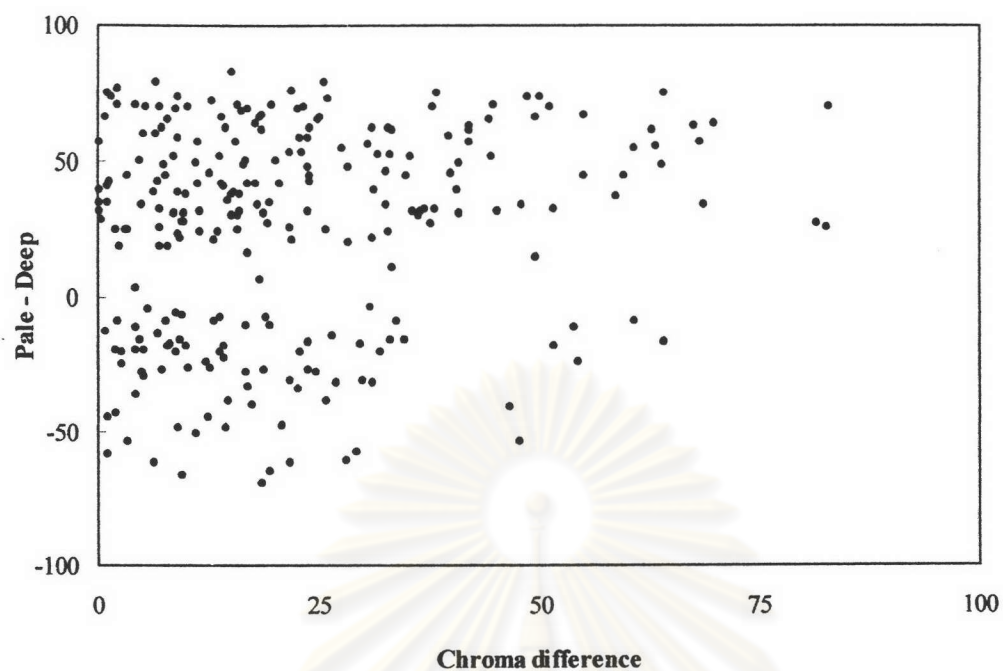


Figure 4-19 Visual results of “Pale-Deep” relationship on chroma difference (ΔC^*)

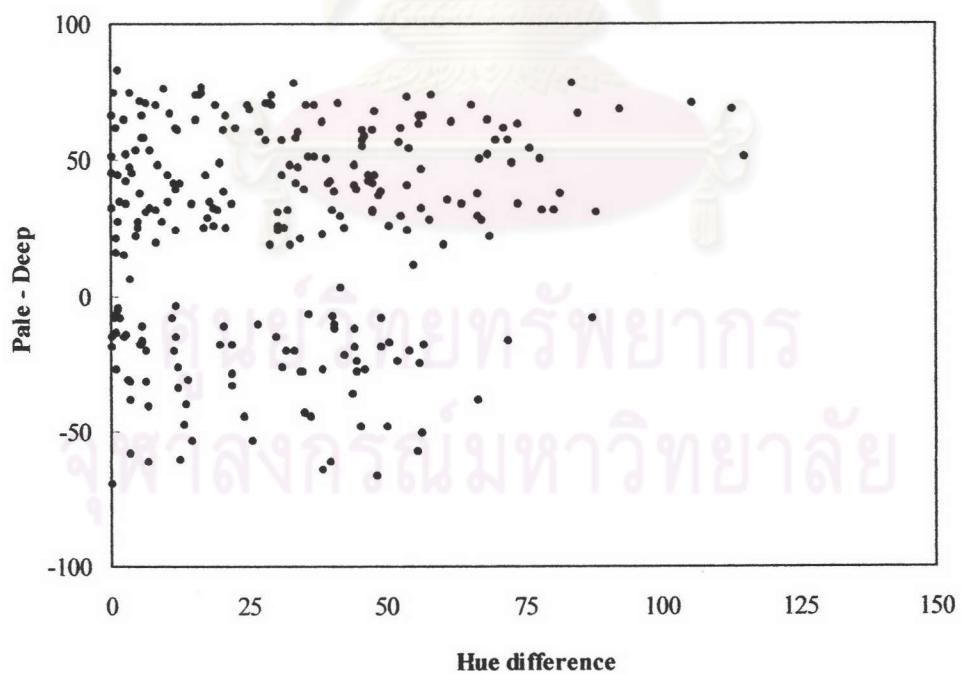


Figure 4-20 Visual results of “Pale-Deep” relationship on hue difference (ΔH^*)

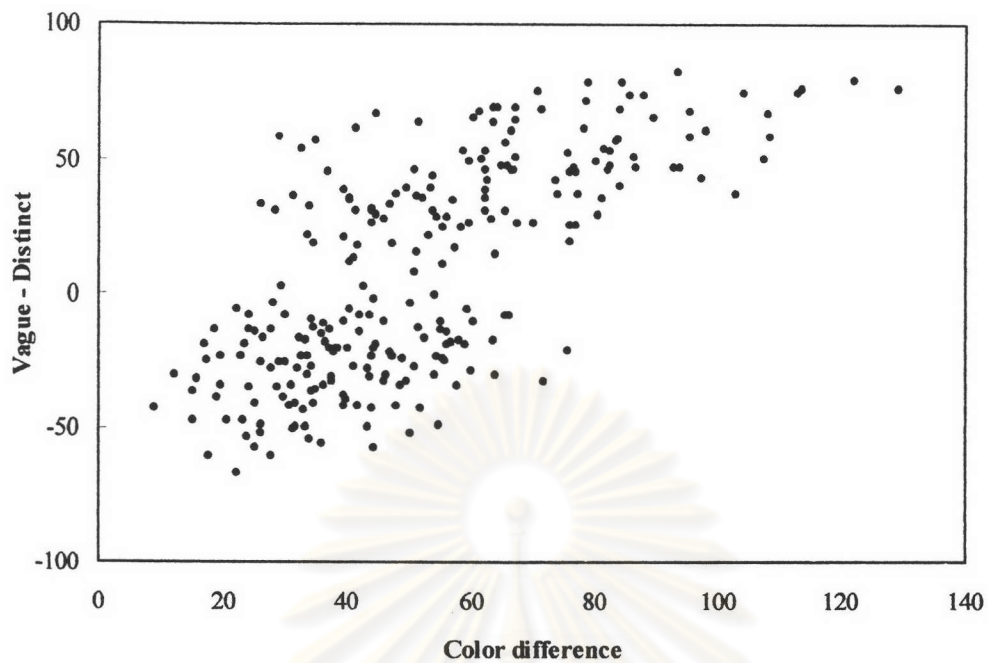


Figure 4-21 Visual results of “Vague-Distinct” on color difference (ΔE^*)

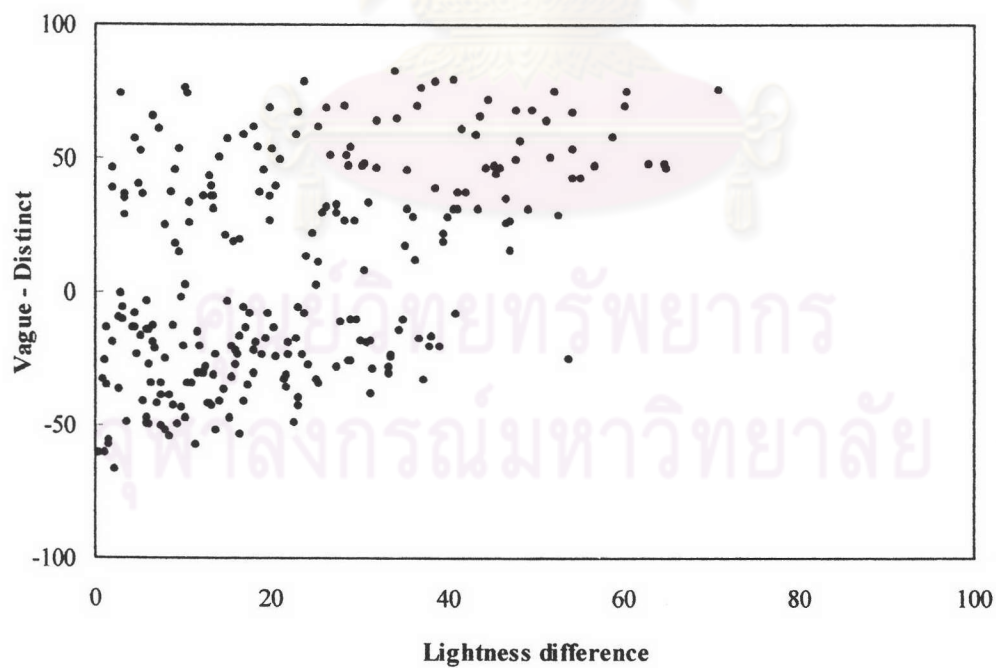


Figure 4-22. Visual results of “Vague-Distinct” relationship on lightness difference (ΔL^*)

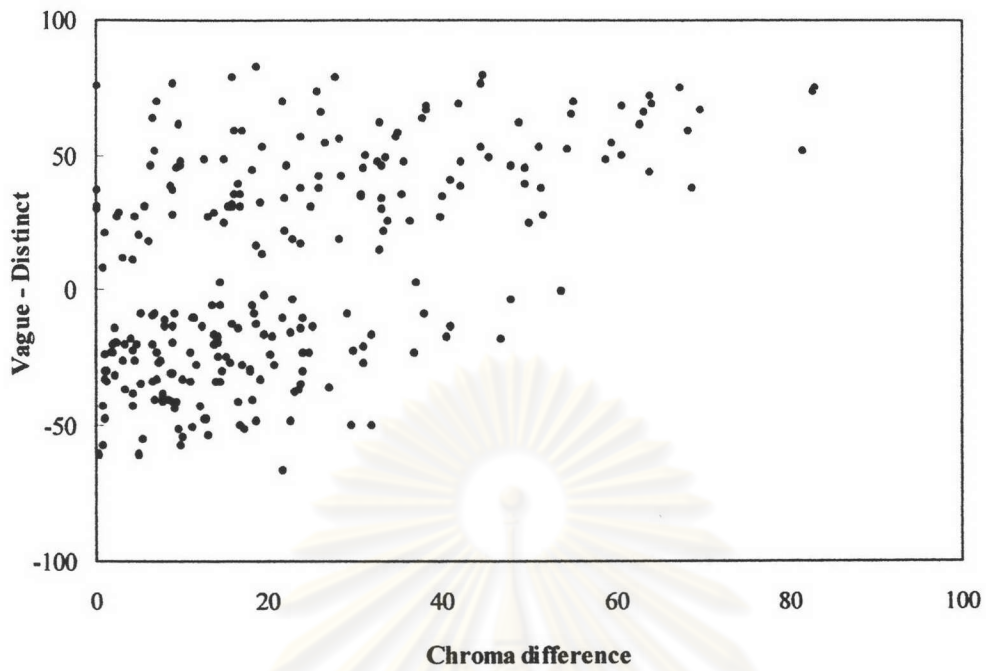


Figure 4-23 Visual results of “Vague-Distinct” relationship on chroma difference (ΔC^*)

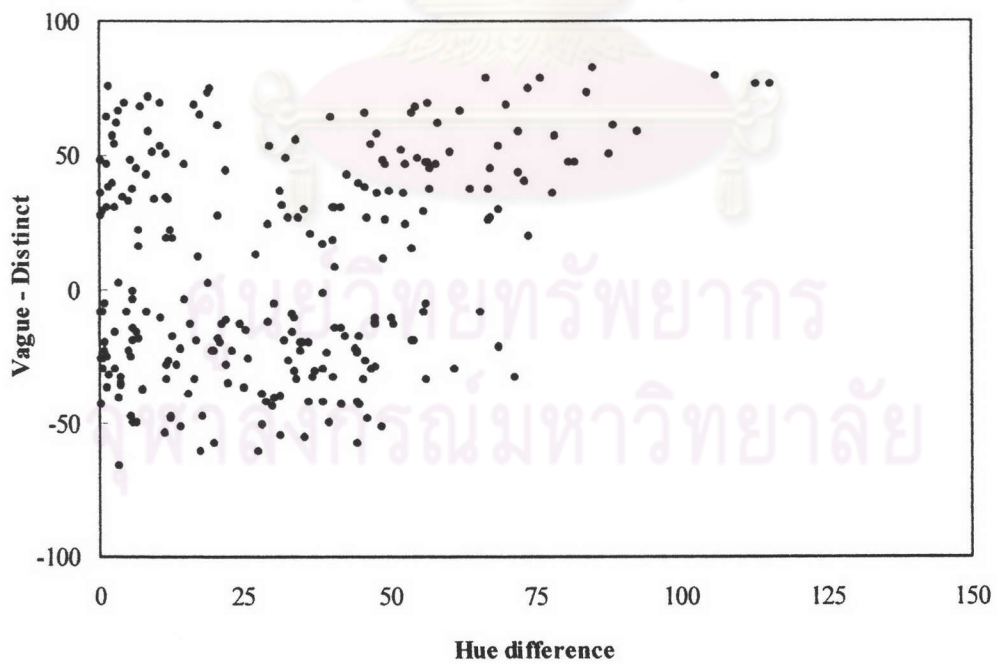


Figure 4-24 Visual results of “Vague-Distinct” relationship on hue difference (ΔH^*)

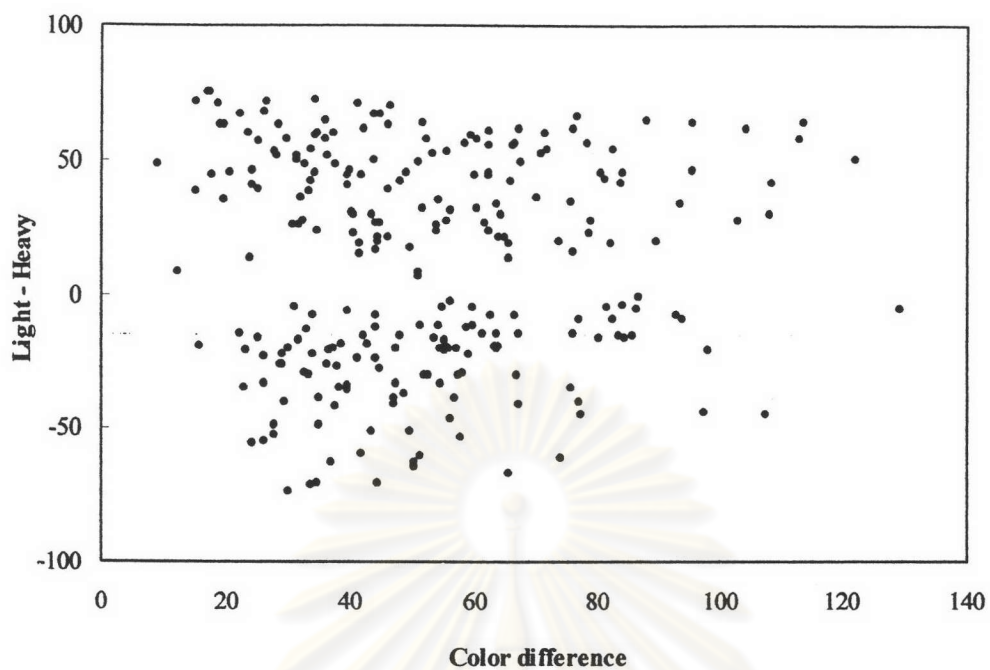


Figure 4-25 Visual results of “Light-Heavy” on color difference (ΔE^*)

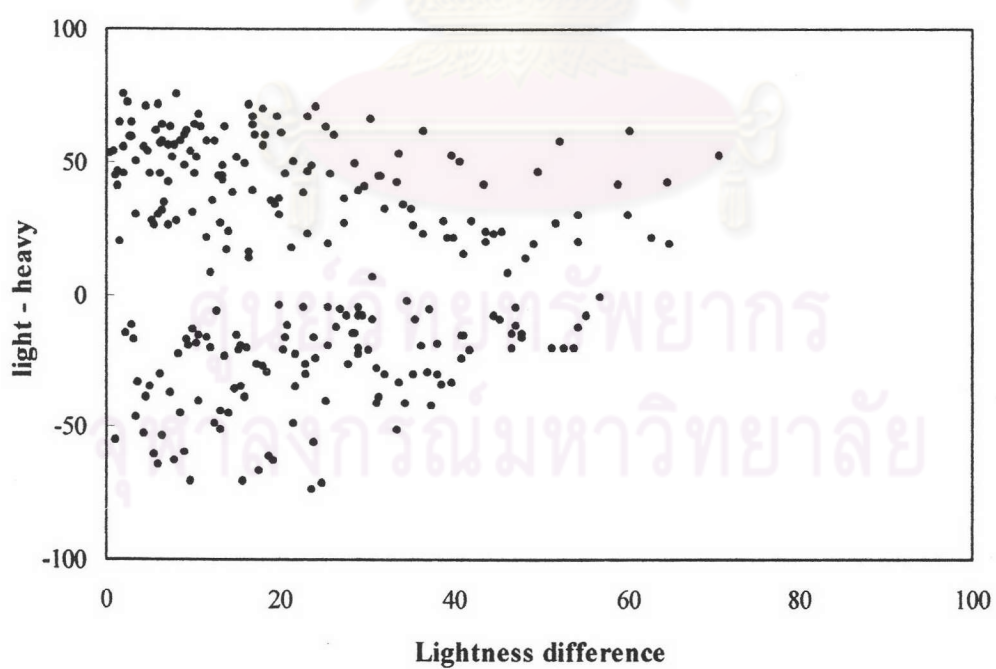


Figure 4-26 Visual results of “Light-Heavy” relationship on lightness difference (ΔL^*)

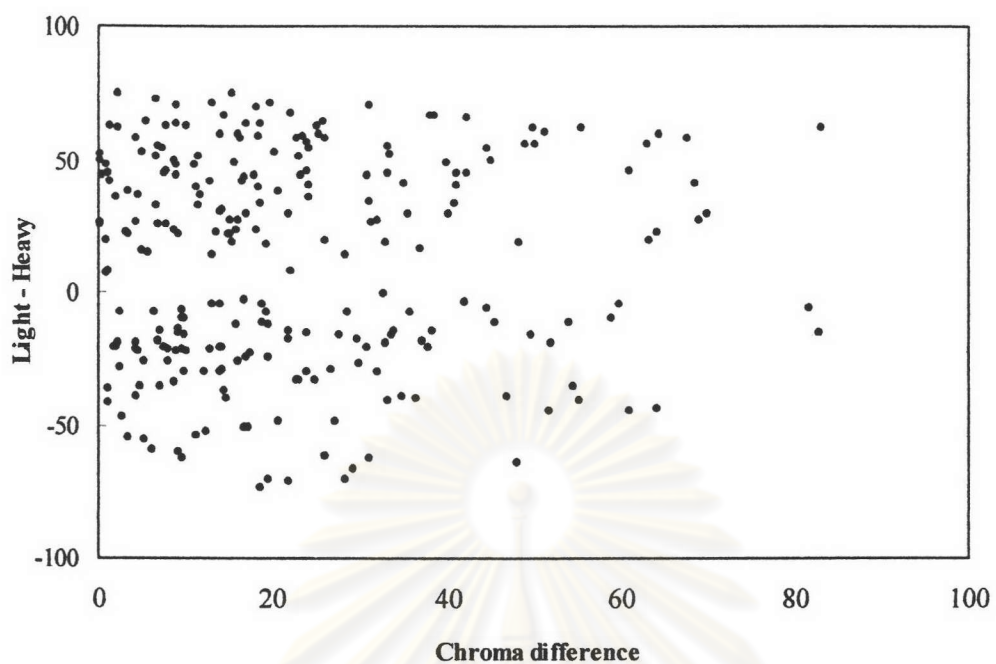


Figure 4-27 Visual results of “Light-Heavy” relationship on chroma difference (ΔC^*)

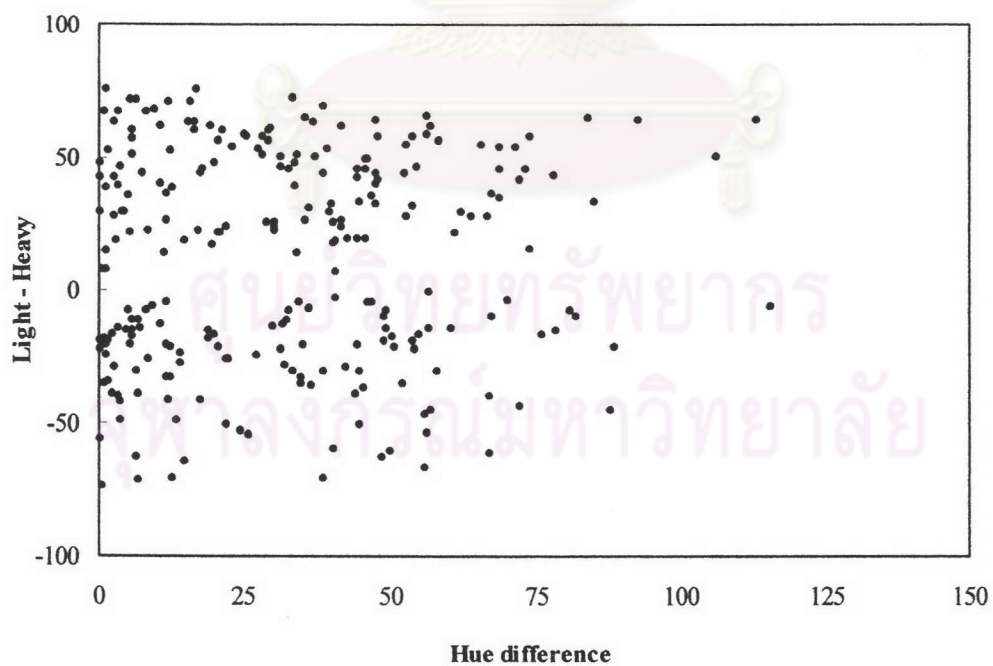


Figure 4-28 Visual results of “Light-Heavy” relationship on hue difference (ΔH^*)

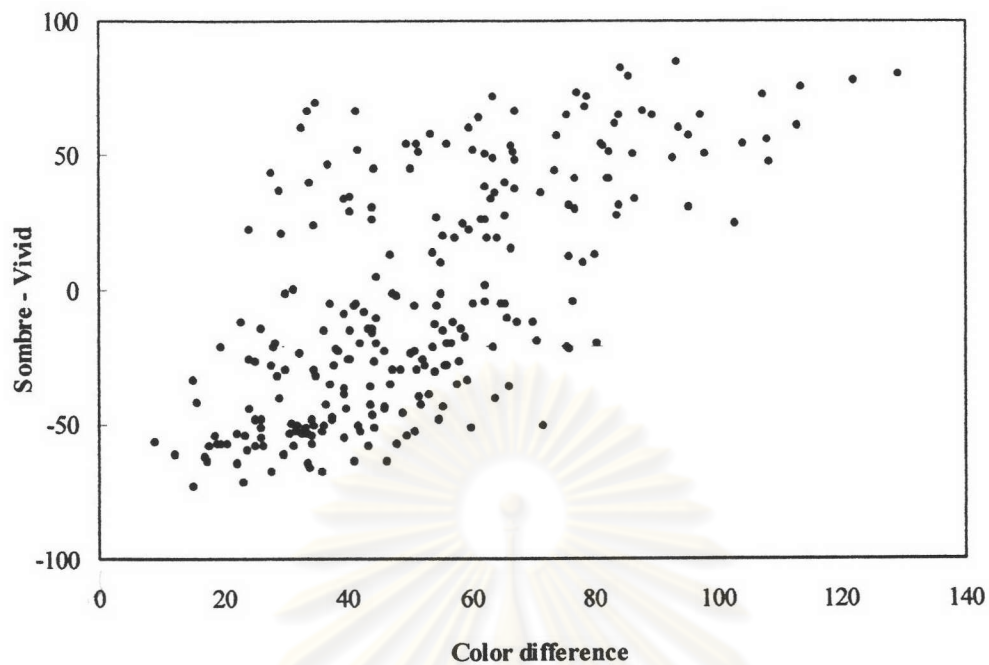


Figure 4-29 Visual results of “Sombre-Vivid” relationship on color difference (ΔE^*)

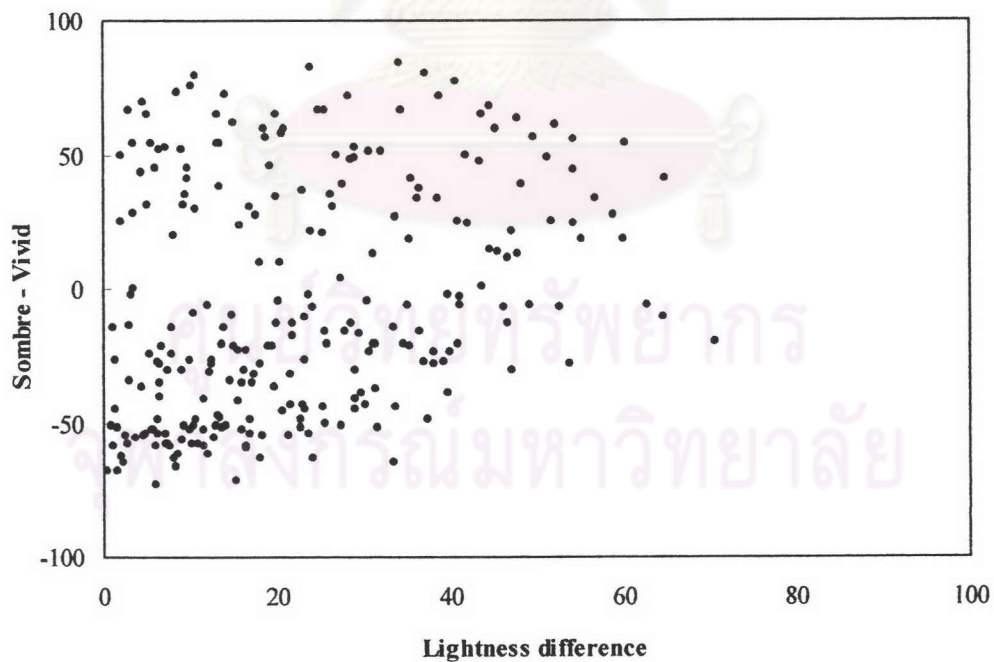


Figure 4-30 Visual results of “Sombre-Vivid” relationship on lightness difference (ΔL^*).

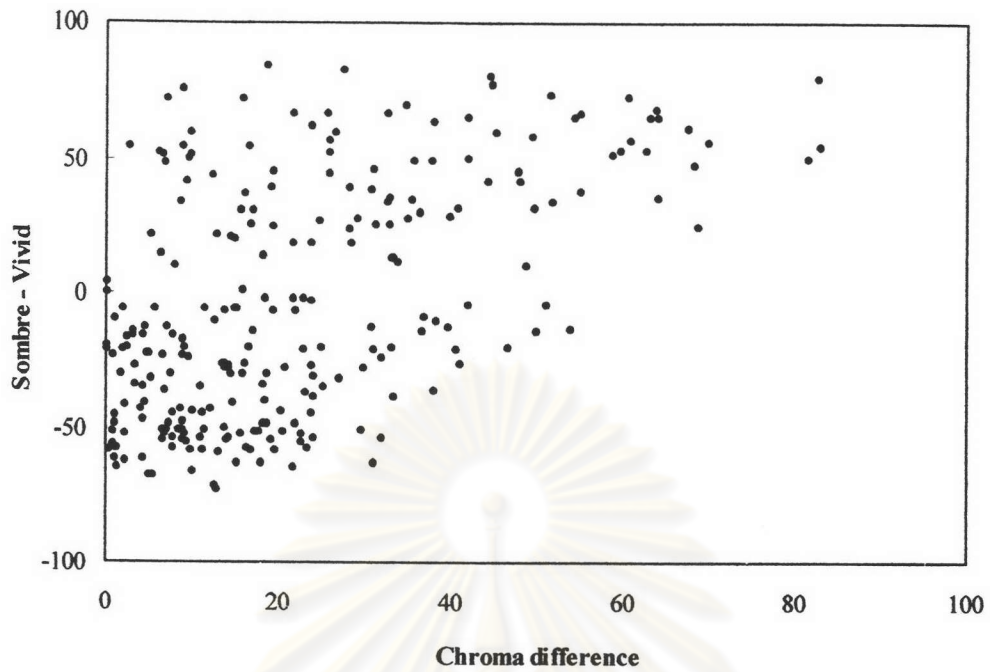


Figure 4-31 Visual results of “Sombre-Vivid” relationship on chroma difference (ΔC^*)

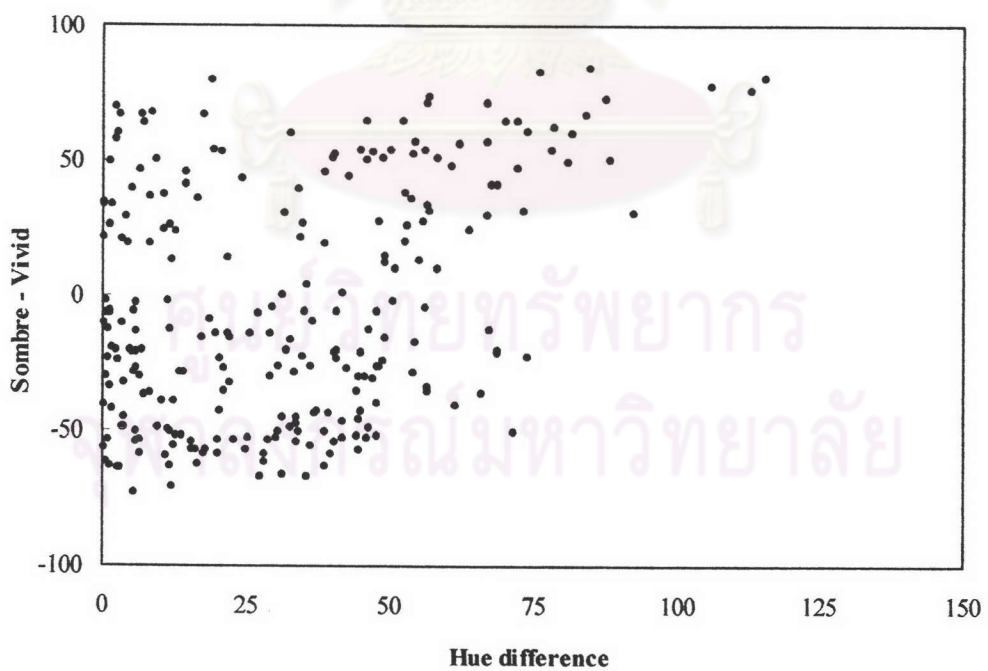


Figure 4-32 Visual results of “Sombre-Vivid” relationship on hue difference (ΔH^*)

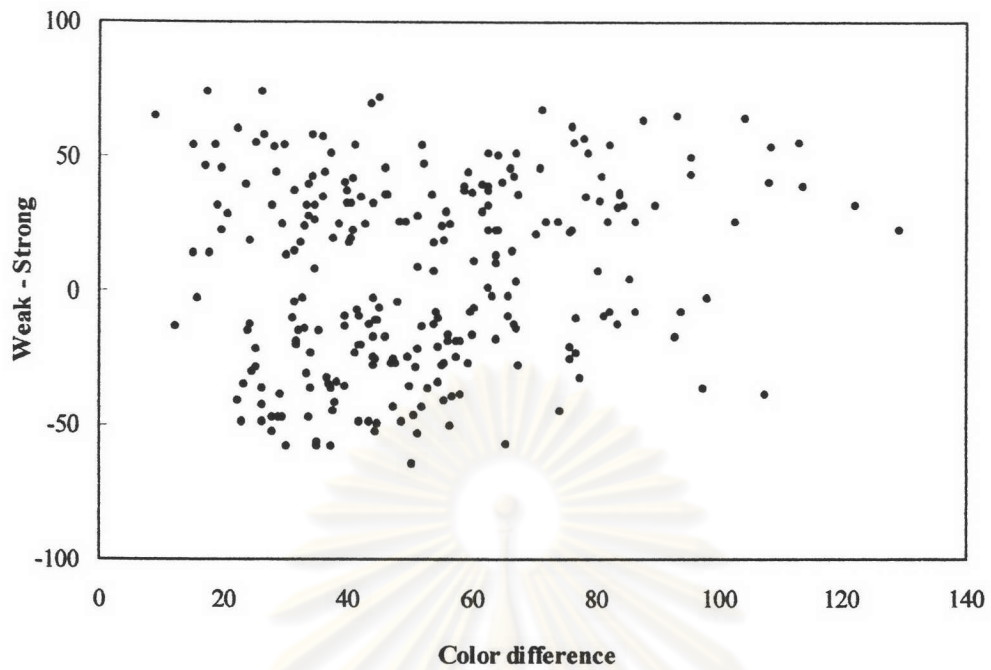


Figure 4-33 Visual results of “Weak-Strong” relationship on color difference (ΔE^*)

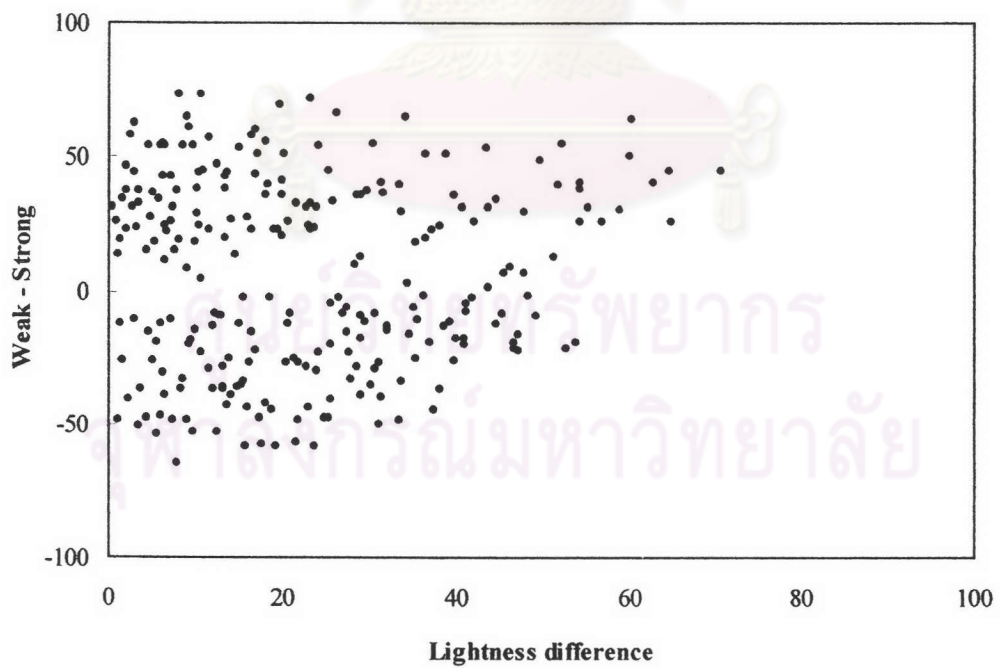


Figure 4-34 Visual results of “Weak-Strong” relationship on lightness difference (ΔL^*)

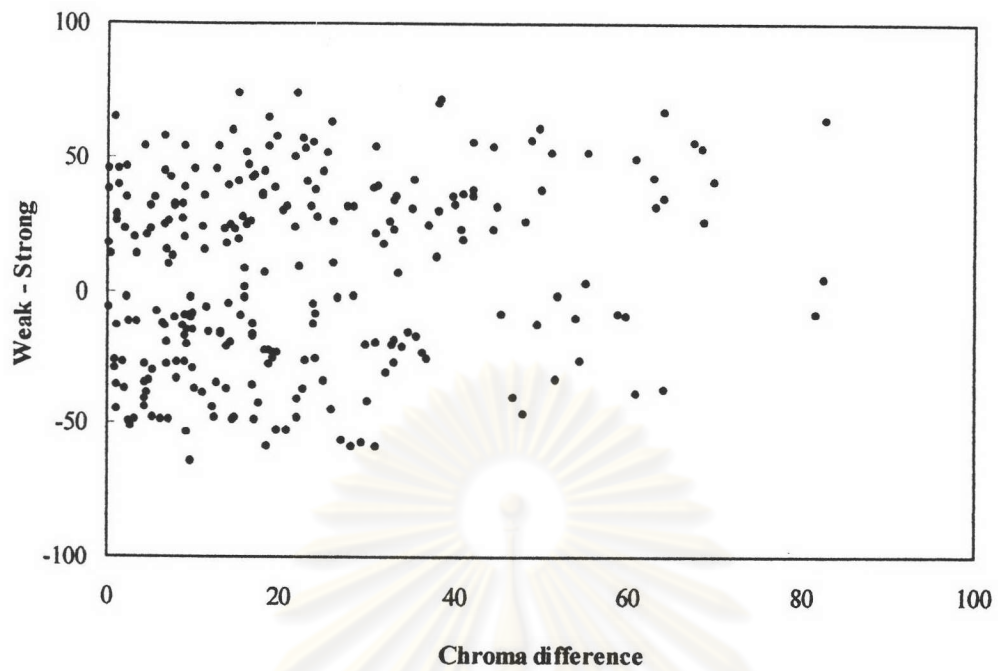


Figure 4-35 Visual results of “Weak-Strong” relationship on chroma difference (ΔC^*)

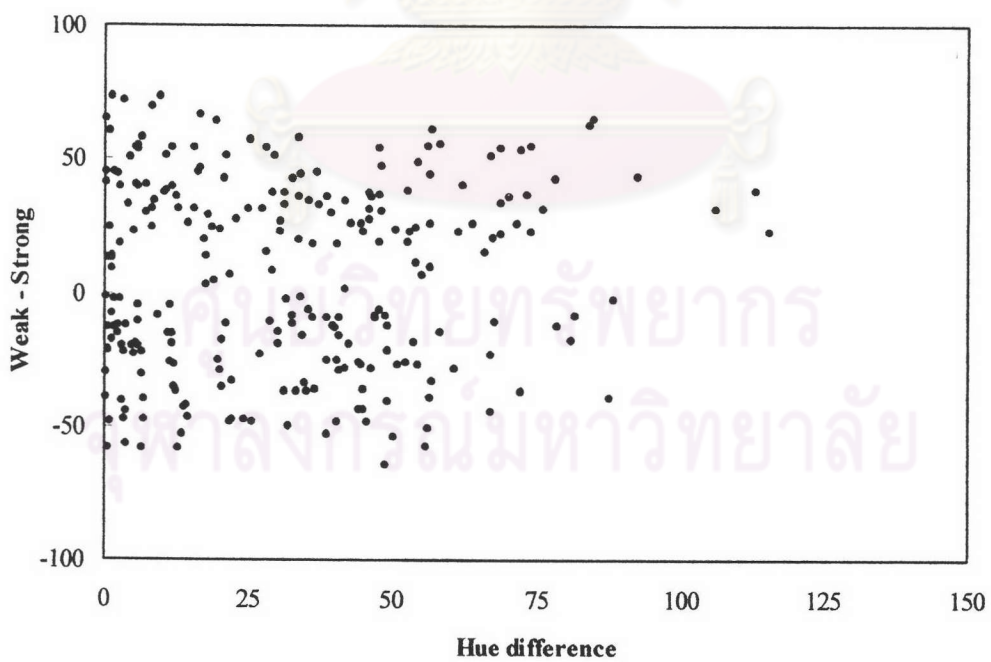


Figure 4-36 Visual results of “Weak-Strong” relationship on hue difference (ΔH^*)

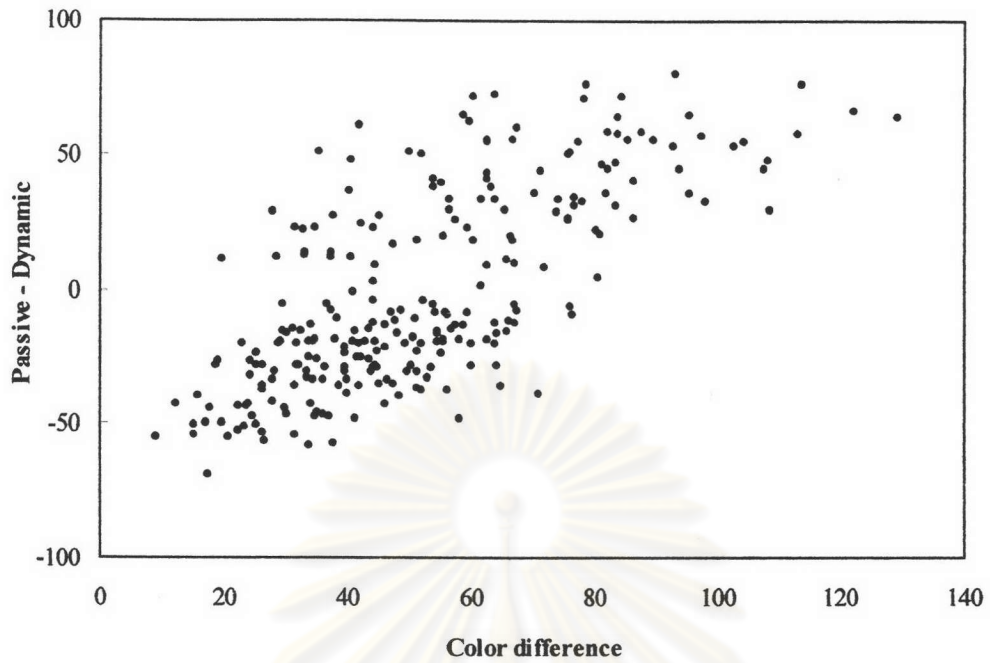


Figure 4-37 Visual results of “Passive-Dynamic” relationship on color difference (ΔE^*)

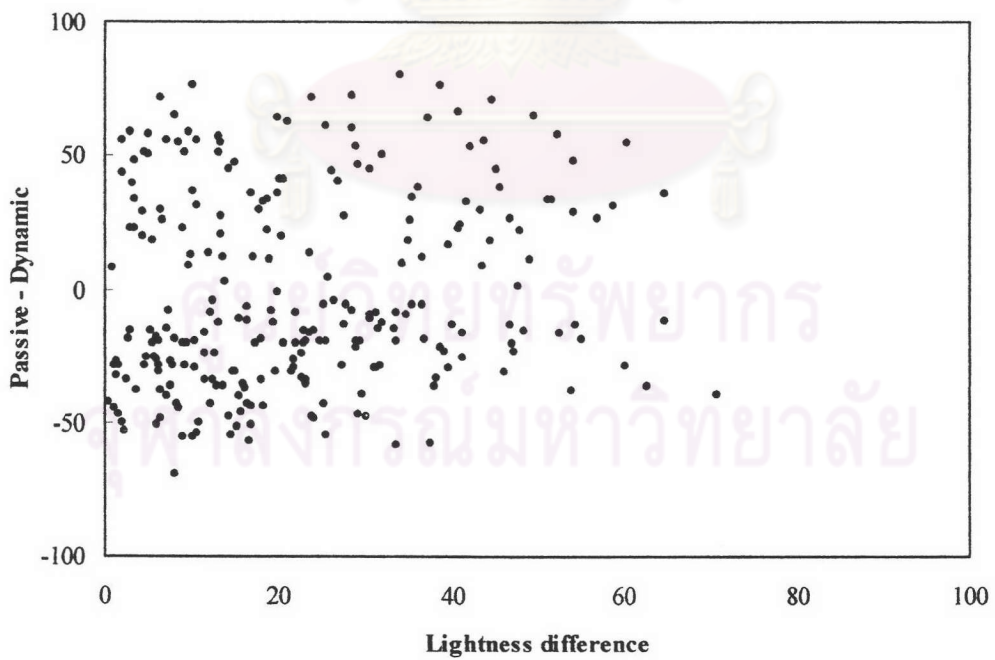


Figure 4-38 Visual results of “Passive-Dynamic” relationship on lightness difference (ΔL^*)

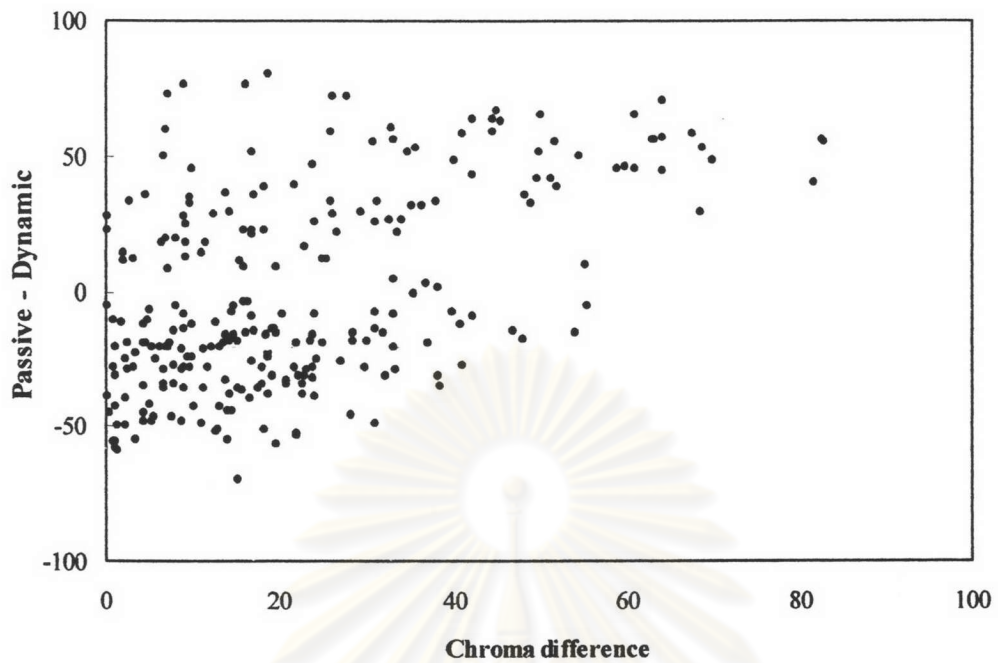


Figure 4-39 Visual results of “Passive-Dynamic” relationship on chroma difference (ΔC^*)

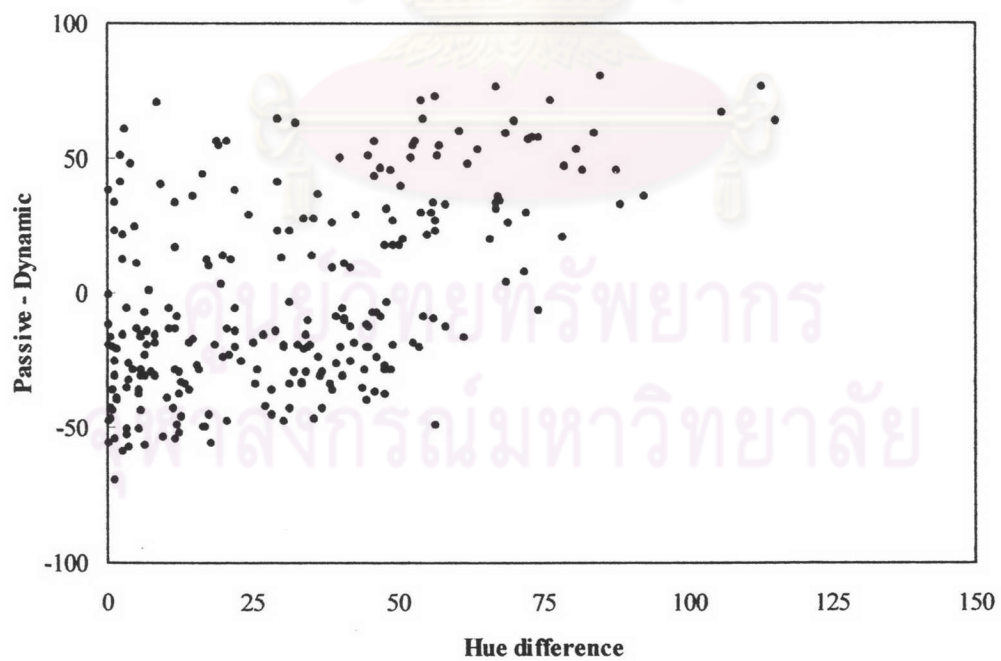


Figure 4-40 Visual results of “Passive-Dynamic” relationship on hue difference (ΔH^*)

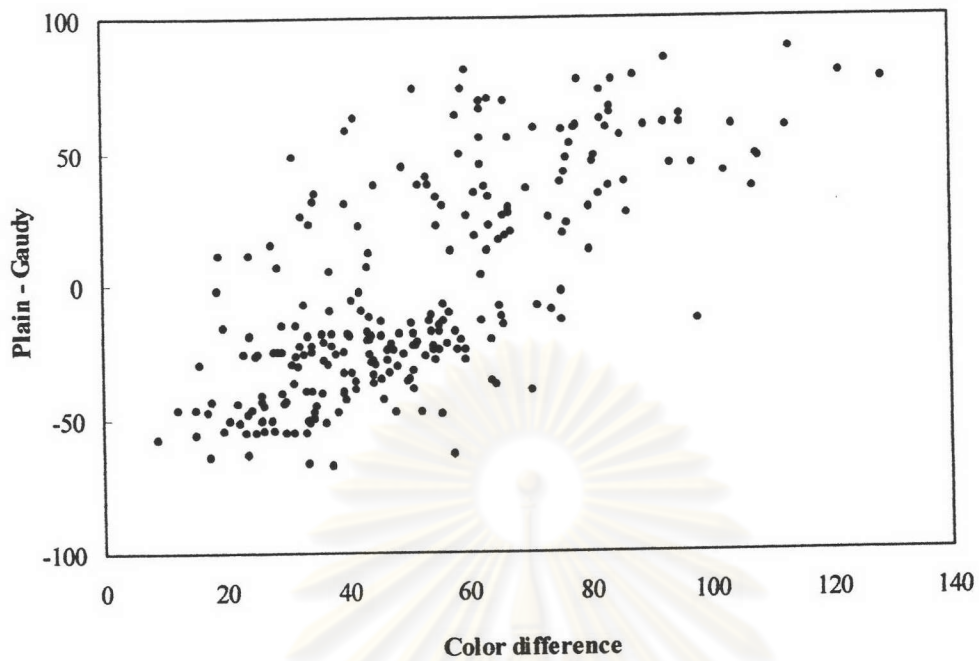


Figure 4-41. Visual results of “Plain-Gaudy” relationship on color difference (ΔE^*)

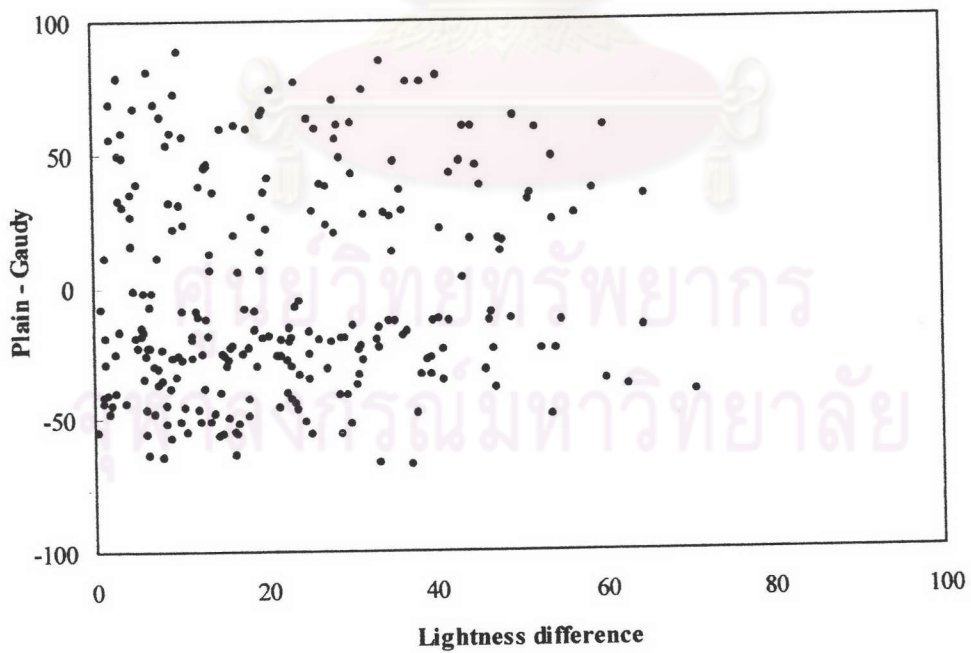


Figure 4-42. Visual results of “Plain-Gaudy” relationship on lightness difference (ΔL^*)

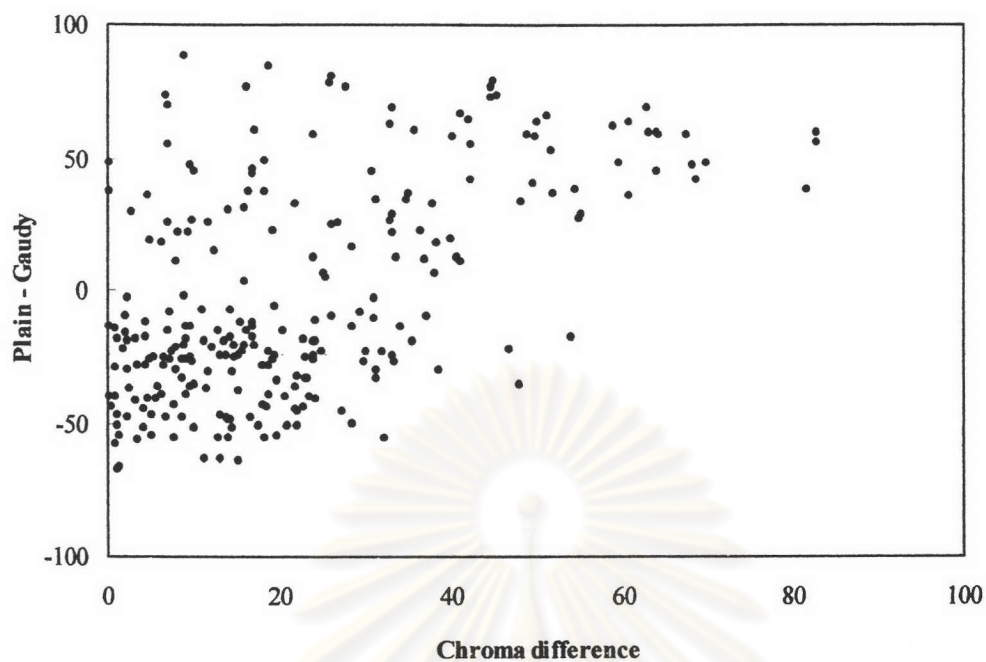


Figure 4-43 Visual results of “Plain-Gaudy” relationship on chroma difference (ΔC^*)

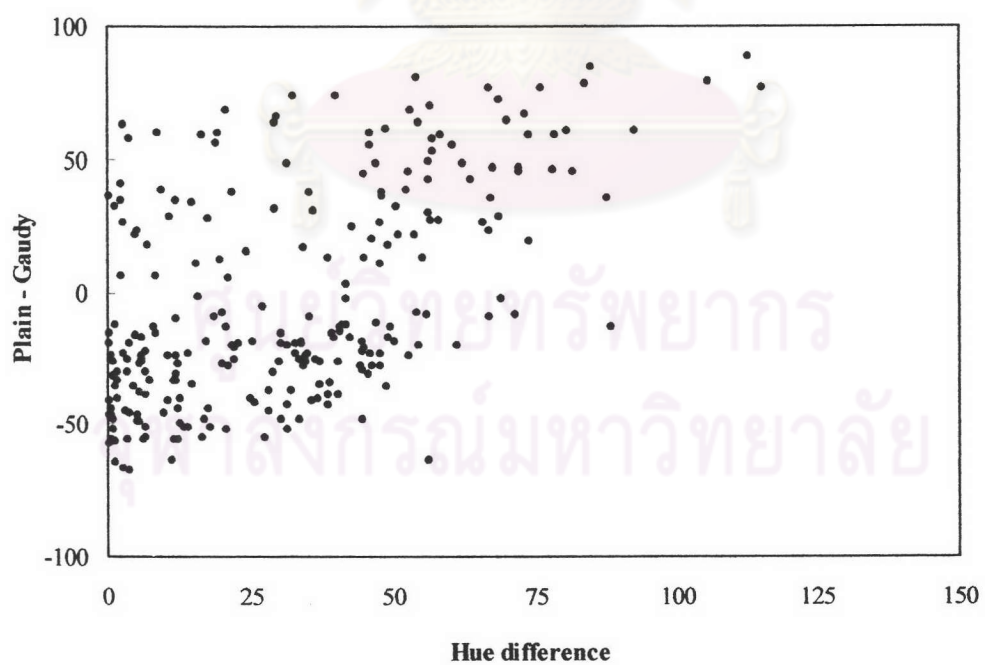


Figure 4-44 Visual results of “Plain-Gaudy” relationship on hue difference (ΔH^*)

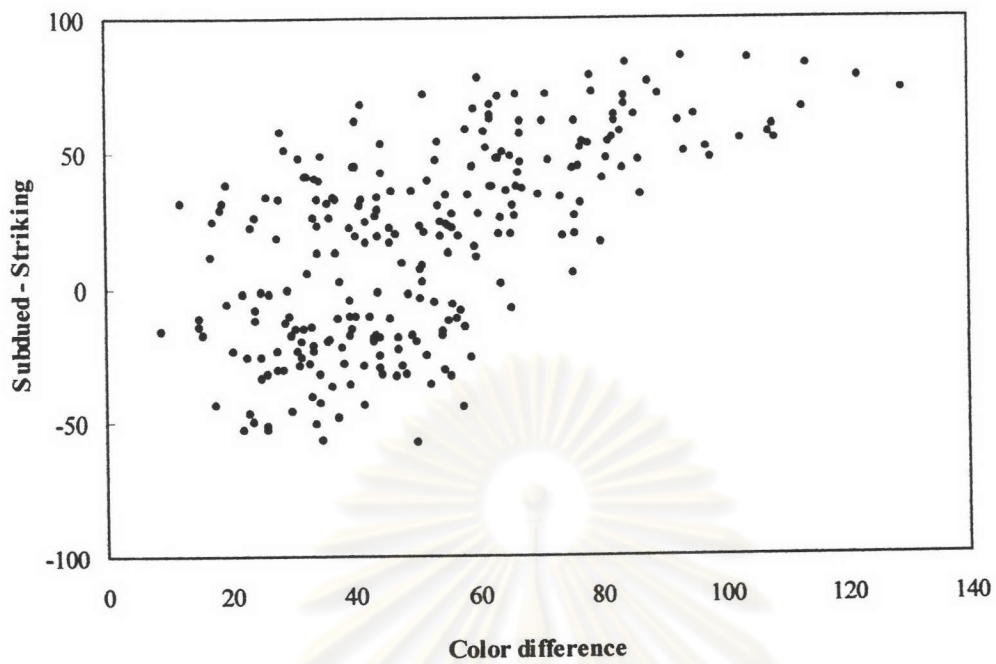


Figure 4-45 Visual results of “Subdued-Striking” relationship on color difference (ΔE^*)

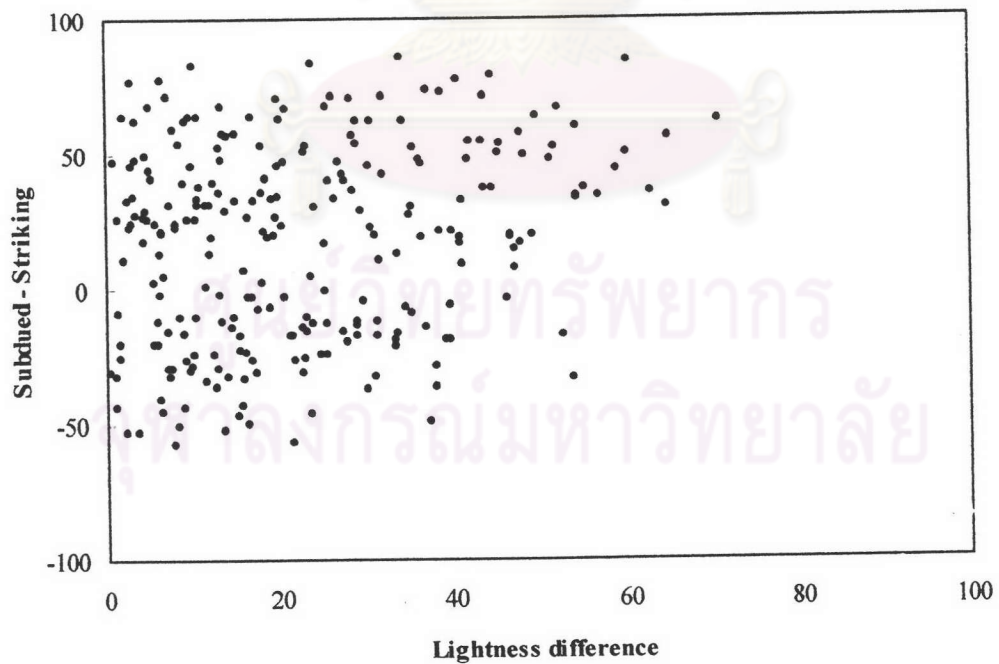


Figure 4-46 Visual results of “Subdued-Striking” relationship on lightness difference (ΔL^*)

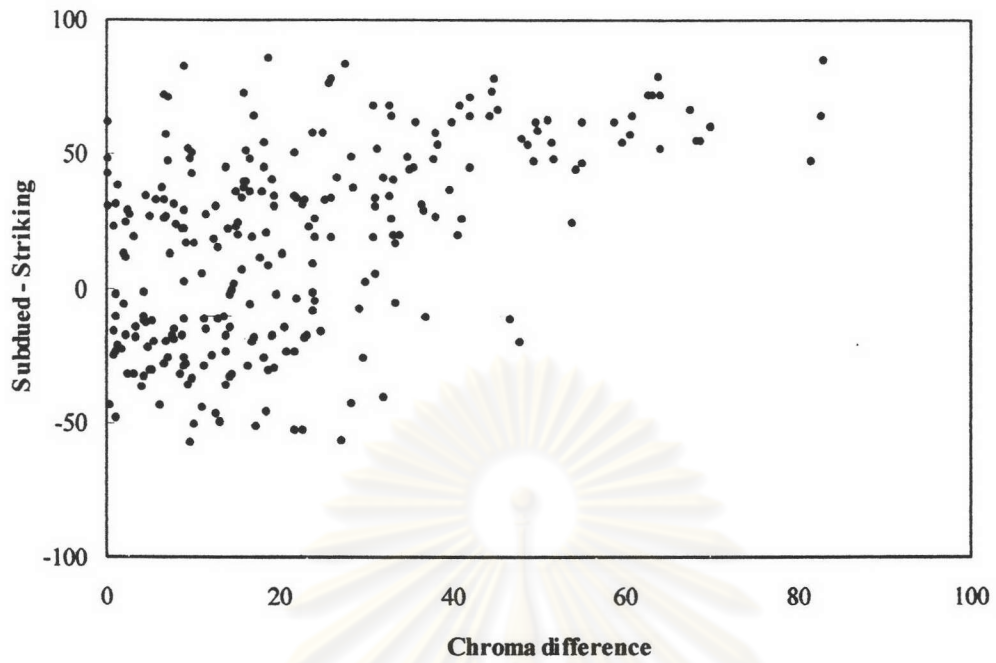


Figure 4-47 Visual results of “Subdued-Striking” relationship on chroma difference (ΔC^*)

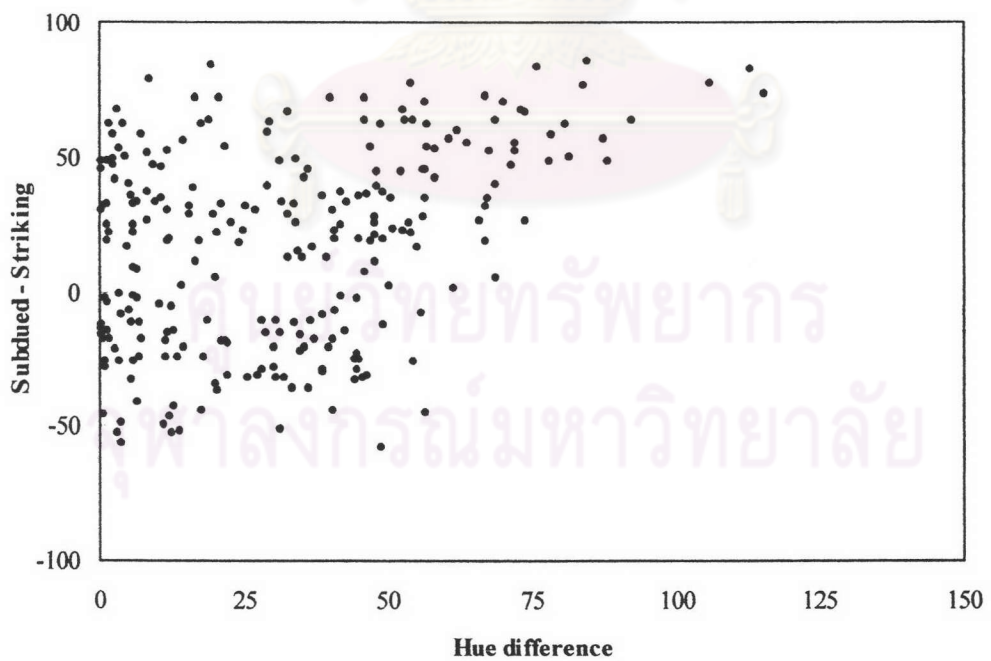


Figure 4-48 Visual results of “Subdued-Striking” relationship on hue difference (ΔH^*)

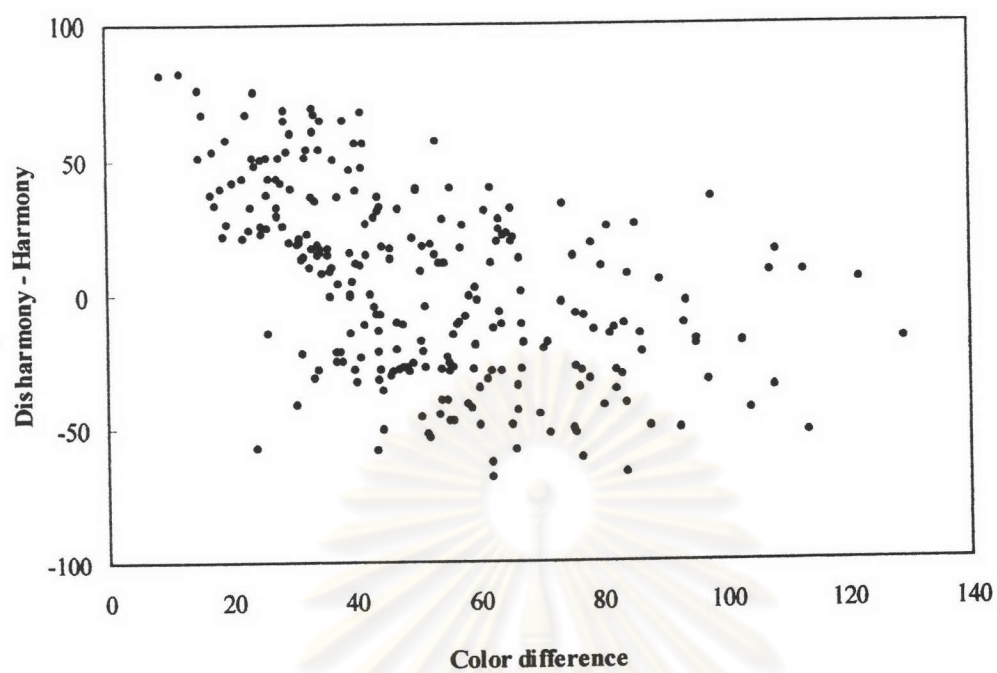


Figure 4-49 Visual results of “Disharmony-Harmony” relationship on color difference (ΔE^*)

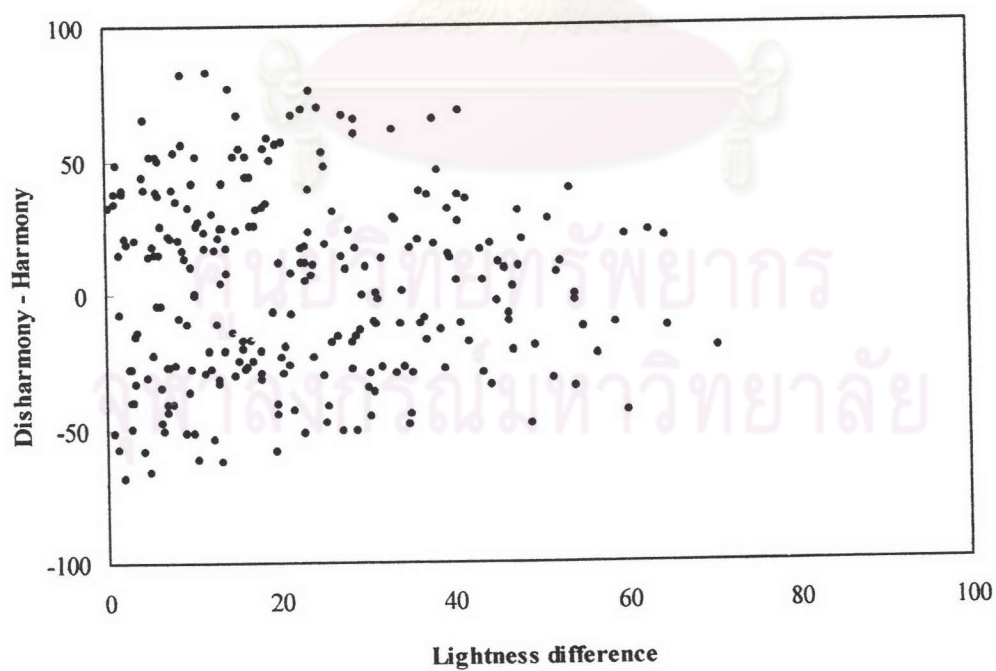


Figure 4-50 Visual results of “Disharmony-Harmony” relationship on lightness difference (ΔL^*)

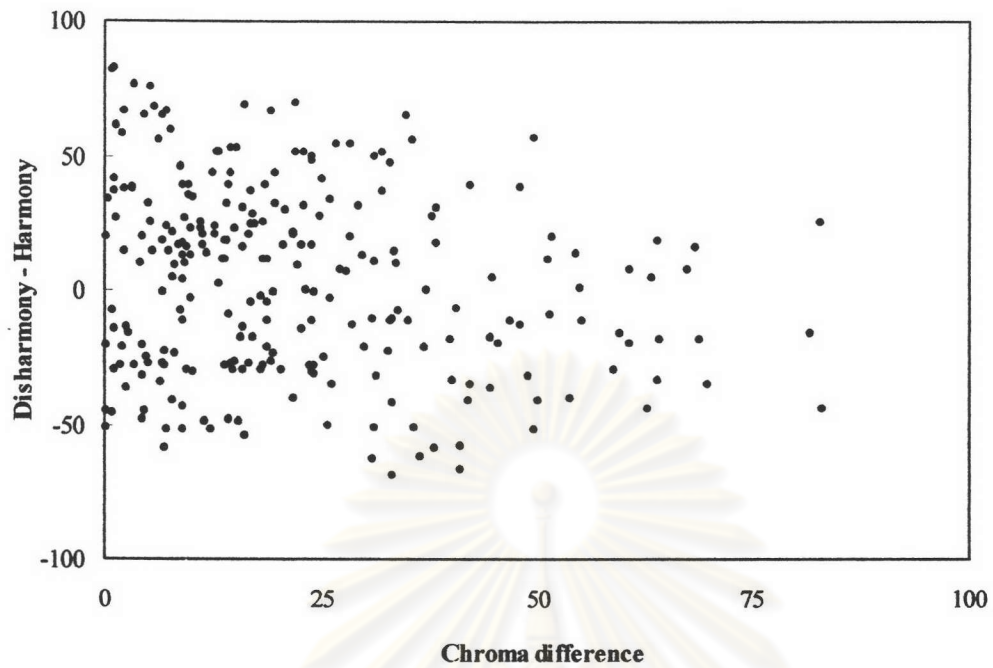


Figure 4-51. Visual results of “Disharmony-Harmony” relationship on chroma difference (ΔC^*)

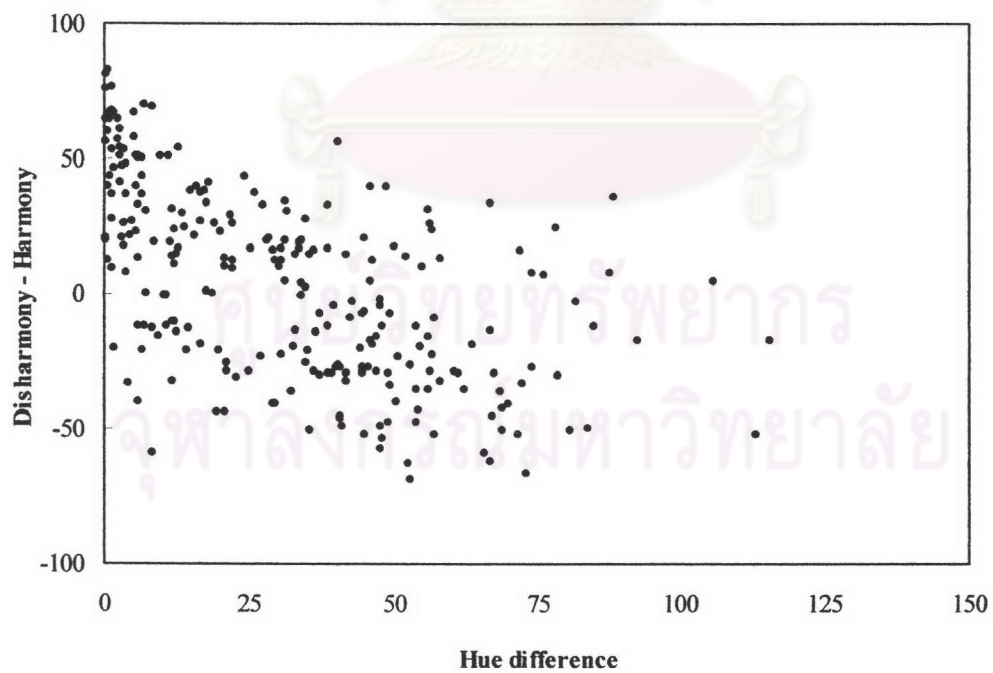


Figure 4-52 Visual results of “Disharmony-Harmony” relationship on hue difference (ΔH^*)

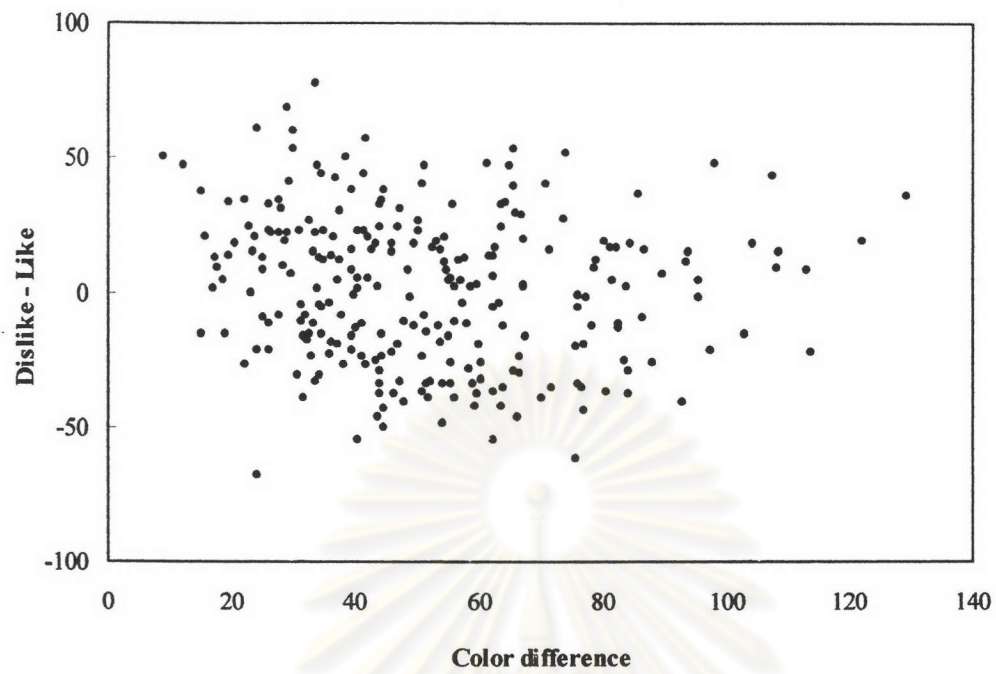


Figure 4-53 Visual results of “Dislike-Like” relationship on color difference (ΔE^*).

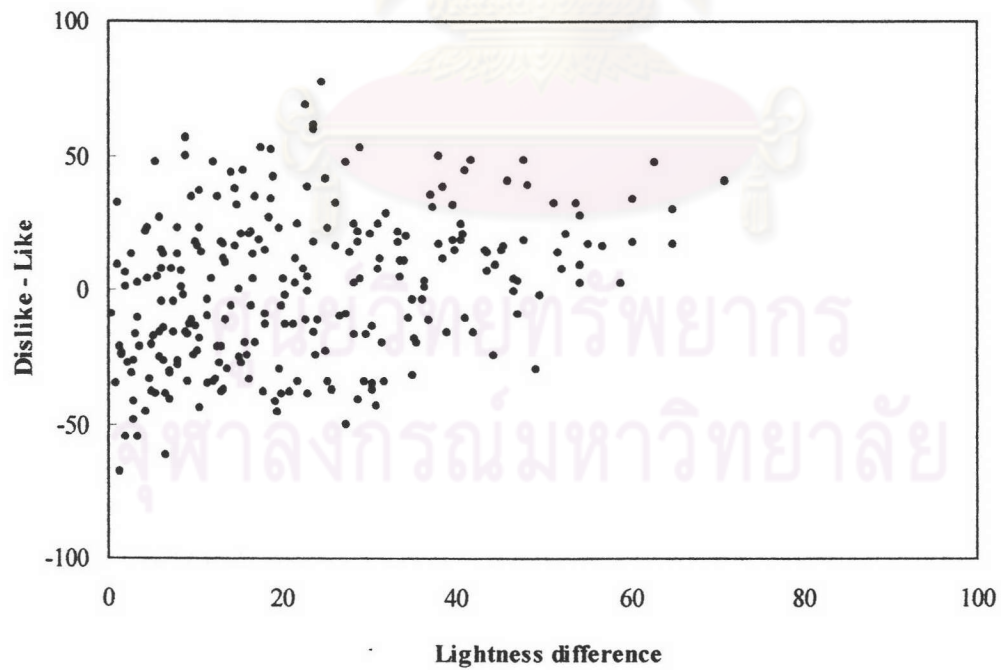


Figure 4-54. Visual results of “Dislike-Like” relationship on lightness difference (ΔL^*)

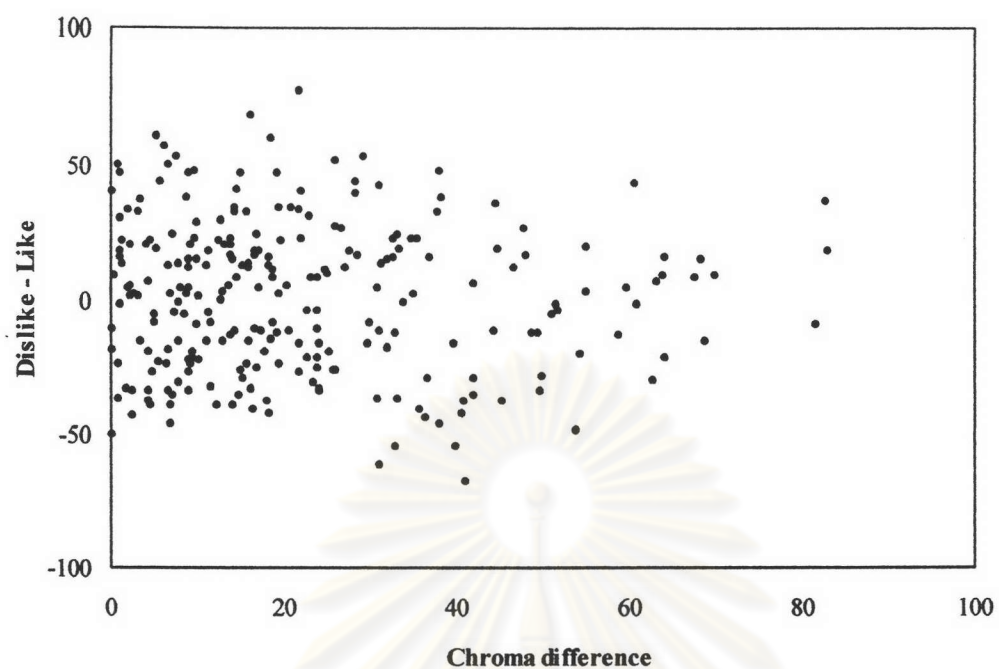


Figure 4-55 Visual results of “Dislike-Like” relationship on chroma difference (ΔC^*)

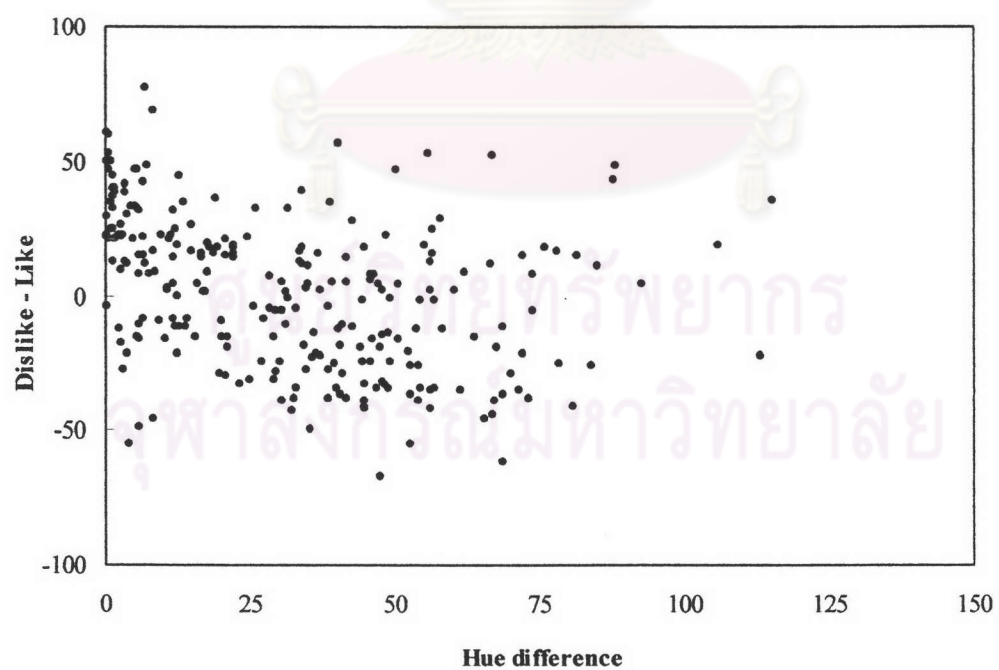


Figure 4-56. Visual results of “Dislike-Like” relationship on hue difference (ΔH^*)

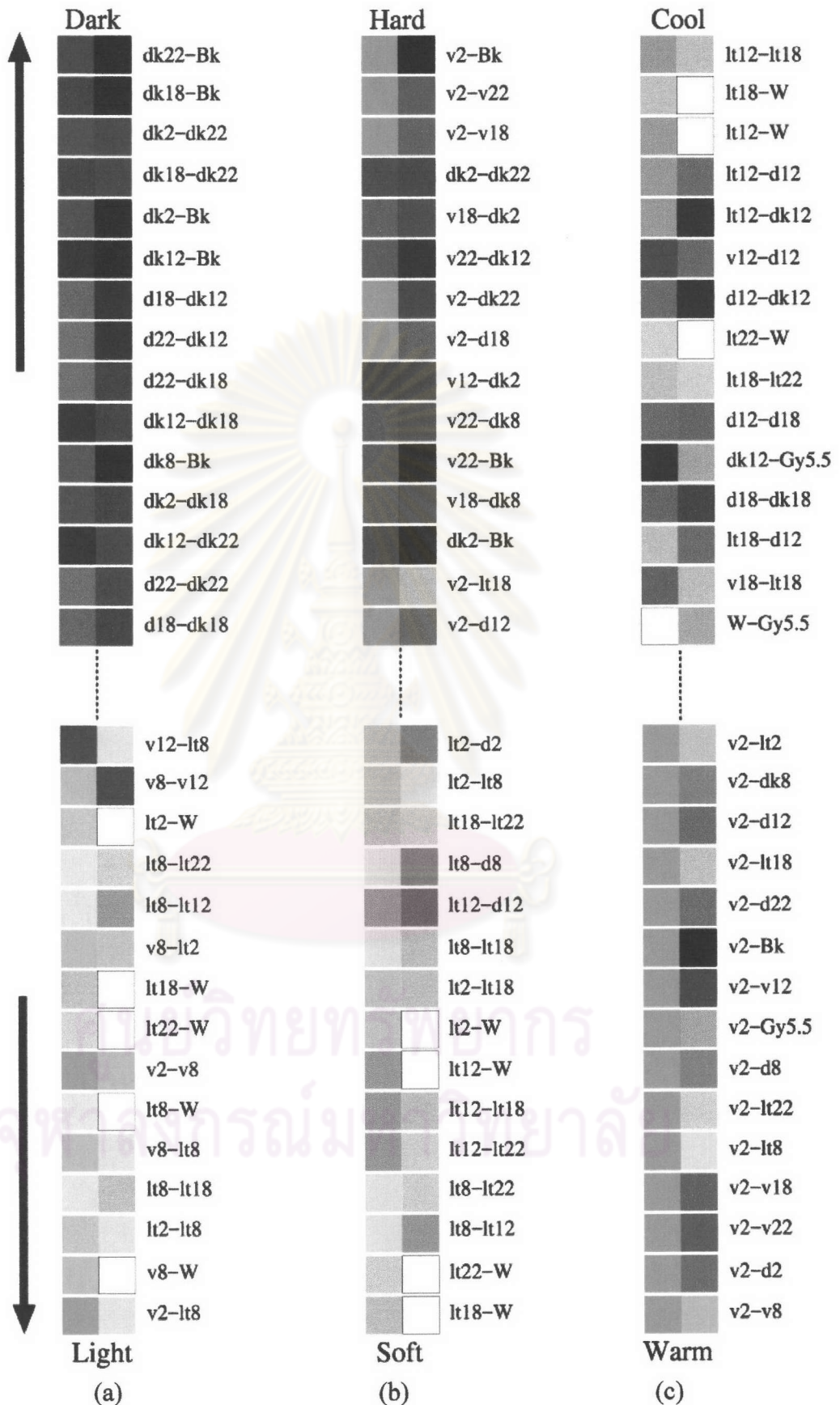


Figure 4-57 Ranking of color combination pairs relevant to (a)Light-Dark, (b)Hard-Soft and (c)Cool-Warm

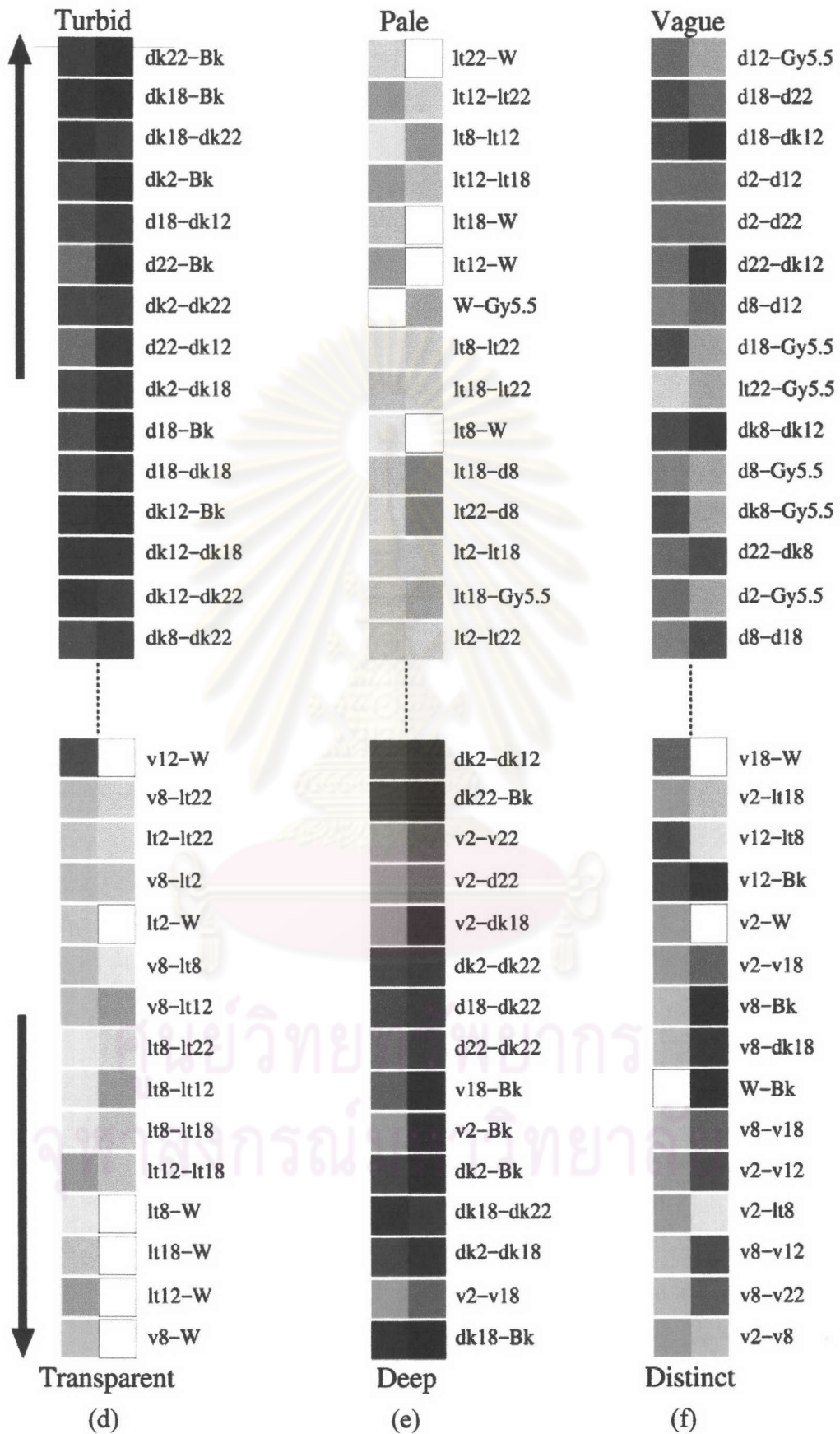


Figure 4-58 Ranking of color combination pairs relevant to (d)Turbid-Transparent, (e)Pale-Deep and (f)Vague-Distinct

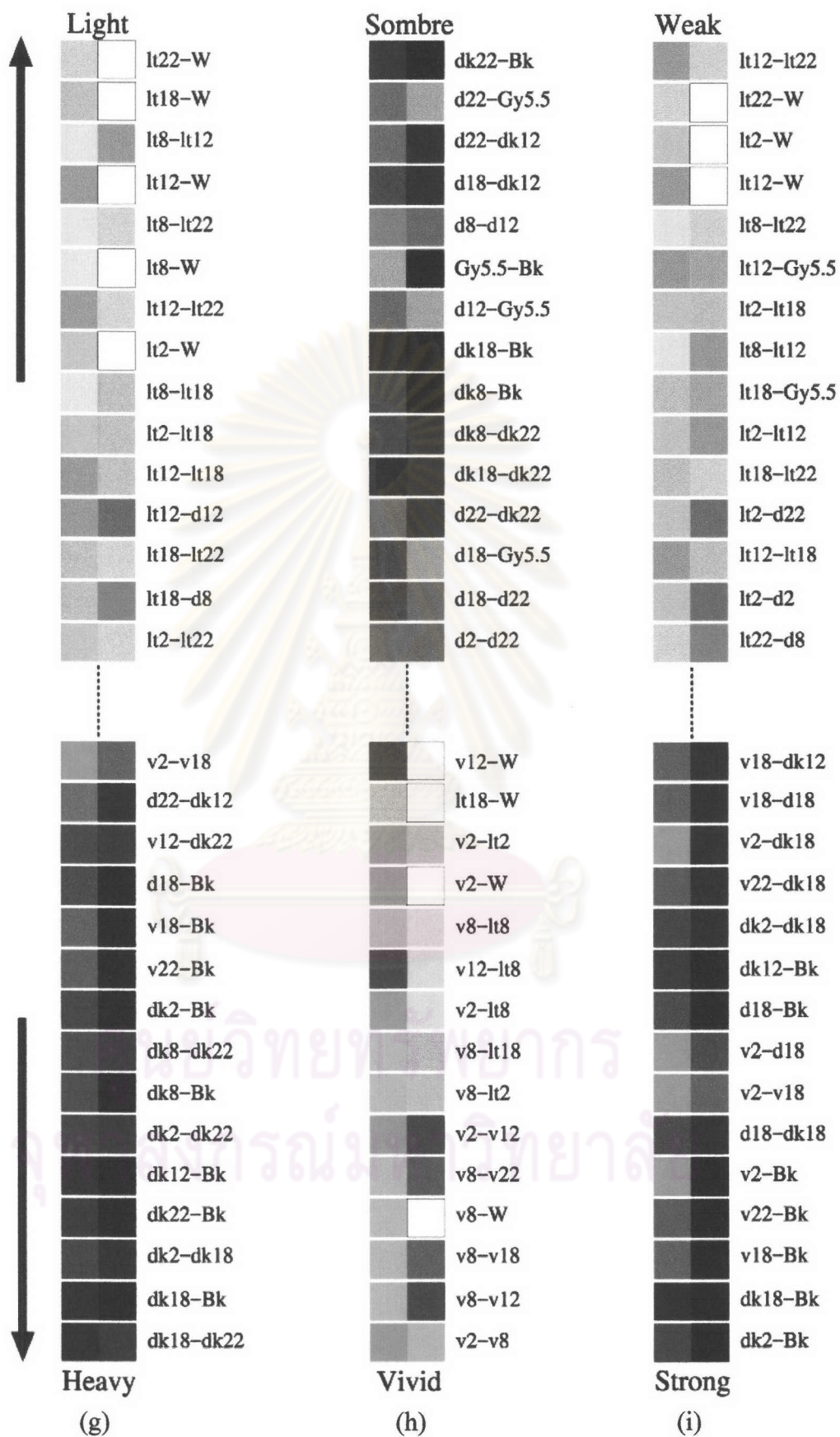


Figure 4-59 Ranking of color combination pairs relevant to (g) Light-Heavy, (h) Sombre-Vivid and (i) Weak-Strong

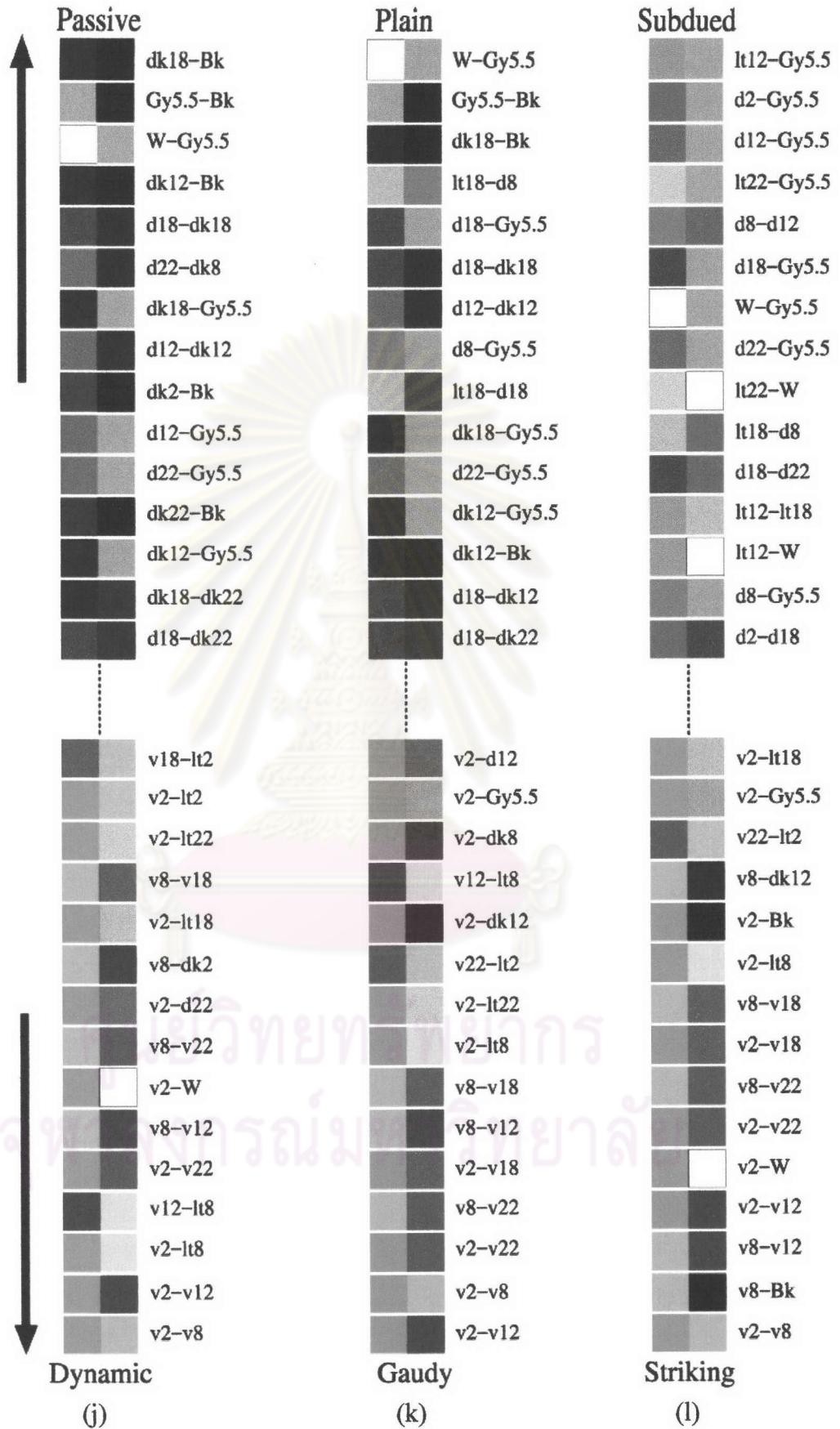


Figure 4-60 Ranking of color combination pairs relevant to (j)Passive-Dynamic, (k) Plain-Gaudy and (l)Subdued-Striking

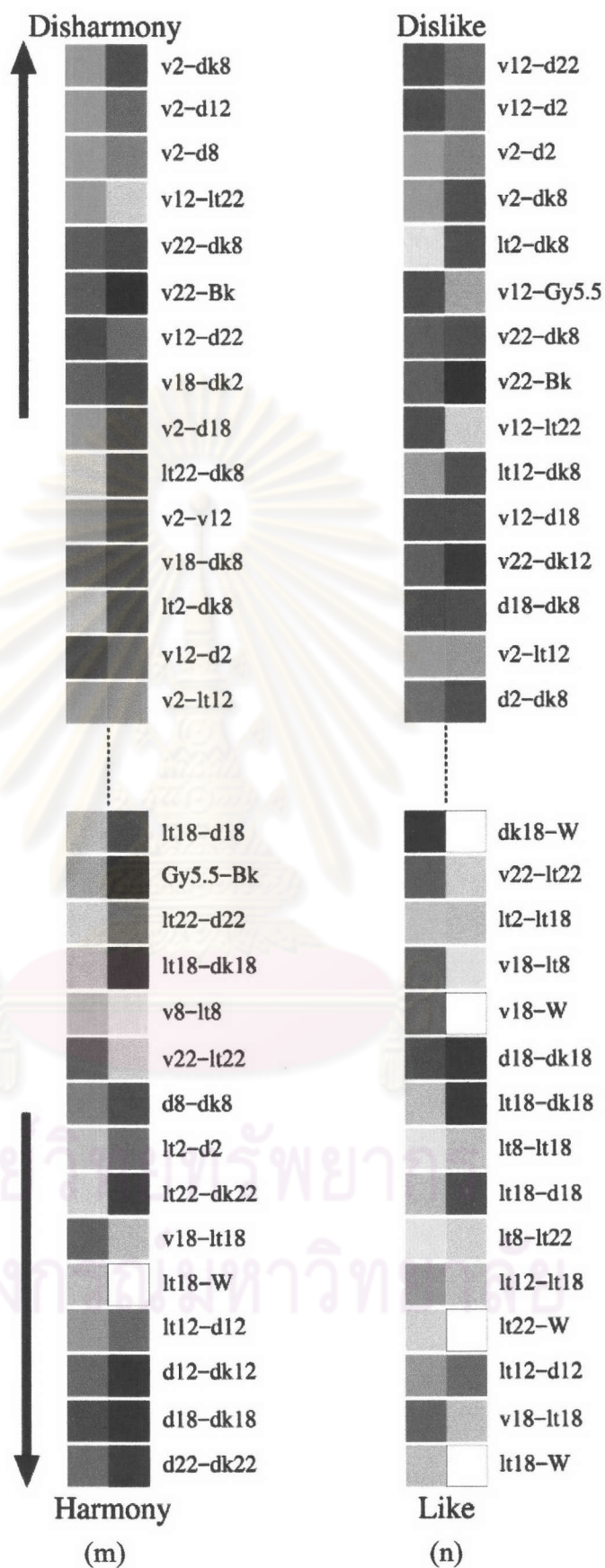


Figure 4-61 Ranking of color combination pairs relevant to (m)Disharmony-Harmony and (n)Dislike-Like

4.2 Extraction of Fourteen Opponent Word Pairs

4.2.1 Extraction of Fourteen Opponent Word Pairs by Factor Analysis

By reducing a data set from a group of interrelated variables into a smaller set of not correlated factors, factor analysis reveals underlying dimensions of all variables involved. In this study, factor analysis was carried out to find such dimensions from the fourteen opponent word pairs for Thai observers. The extraction method of principle component analysis and an orthogonal rotation were used.

Factors accounting for 88.57% of total variance were extracted. 3 components were obtained as showed in Table4-1. Component 1 has highest loading (rotated factor matrix) on opponent word pairs “Plain-Gaudy” , “Subdued-Striking” , “Passive-Dynamic” , “Vague-Distinct” , “Sombre-Vivid” and “Cool-Warm”. Component 2 has highest loading on “Light-Heavy” , “Turbid-Transparent” , “Dark-Light” , “Hard-Soft” , “Pale-Deep” and “Weak-Strong” and component 3 has highest loading on “Dislike-Like” and “Disharmony-Harmony”.

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Table4-1 Rotated factor matrix of two color combination visual scores for Thai observers

Opponent word pairs	Component 1	Component2	Component3
Plain-Gaudy	0.95	0.07	-0.11
Subdued-Striking	0.92	-0.10	0.20
Passive-Dynamic	0.90	0.26	-0.14
Vague-Distinct	0.84	0.29	0.29
Sombre-Vivid	0.79	0.59	0.16
Cool-Warm	0.63	0.27	-0.39
Light-Heavy	0.25	-0.92	0.18
Turbid-Transparent	0.32	0.91	0.00
Dark-Light	0.47	0.84	-0.05
Hard-Soft	-0.44	0.84	0.04
Pale-Deep	0.47	-0.79	0.29
Weak-Strong	0.40	-0.79	0.42
Dislike-Like	-0.22	0.49	0.79
Disharmony-Harmony	-0.47	0.26	0.73

4.2.2 Establishment of Three-dimensional Color Sensation Space for Two Color Combinations

The three-dimensional color sensation space for combination was established by using factor analysis with the extraction method of the principal component analysis and an orthogonal rotation. The visual scores of color sensation for all observers were involved. All the eleven opponent word pairs were applied in the extraction, except “Cool-Warm”, “Disharmony-Harmony” and “Dislike-Like”. Note that “Cool-Warm” has no correlation with others, it then was used as the third dimension in color sensation space.

The obtained three-dimensional color sensation space represents 3 dimensions. The first dimension composed of “Plain-Gaudy”, “Subdued-Striking”, “Passive-Dynamic”, “Vague-Distinct”, “Sombre-Vivid”. This dimension relates to chroma. The second dimension composed of “Light-Heavy”, “Turbid-Transparent”, “Dark-Light”, “Hard-Soft”, “Pale-Deep” and “Weak-Strong”. This dimension relates to lightness. The third dimension composed of “Cool-Warm” This dimension relates to hue.

The two color combination samples were finally mapped on space according to visual scores of group of opponent word pair in each dimension. as shown in Figure4-62 – Figure4-64.

Following is the analysis of color pairs between the first dimension and the second dimension.

The first quadrant, represents positive color sensation values of “Gaudy”, “Striking”, “Dynamic”, “Distinct”, “Vivid” (1stdimension) and “Light”, “Transparent”, “Soft” (2nddimension). The color pairs in this quadrant have high lightness and high chroma, dividing into three groups. The first group is pairs of light tone color, such as pair of light yellow with light green. The second is pairs composing of a high chroma or a high lightness yellow with color patches which darker than yellow, such as pair of vivid yellow with dark yellow. The third is pairs composing of red with complementary red hue, such as pair of vivid red with light green.

The second quadrant, represents positive color sensation values of “Light”, “Transparent”, “Soft” (2nddimension) and negative color sensation values of “Plain”, “Subdued”, “Passive”, “Vague”, “Sombre” (1stdimension). The color pairs in this quadrant have high lightness and low chroma, dividing into three group. The first group is pairs of composing of gray with light tone or dull tone color, such as pair of light blue with gray and pair of dull yellow with gray. The second group is pairs of light tone, such as pairs of light green with light purple. The third group is pairs of composing of light tone color with dull tone or dark tone color, such as pairs of light blue with dull yellow or pairs of light purple with dark blue.

The third quadrant, represents negative color sensation values of “Plain”, “Subdued”, “Passive”, “Vague”, “Sombre” (1stdimension) and “Turbid”, “Dark”, “Hard” (2nddimension). The pairs in this quadrant have low lightness and low chroma, dividing into three groups. The first group is pairs of composing of black with dull

tone or dark tone color, such as pair of dark purple with black and pair of dull blue with black. The second group is pairs of composing of gray with dark tone color, such as pair of dark red with gray. The third group is pairs of dull tone color with dark tone color, such as pair of dull blue with dark green.

The fourth quadrant, represents positive color sensation value of “Gaudy”, “Striking”, “Dynamic”, “Distinct”, “Vivid” (1stdimension) and negative color sensation values of “Turbid”, “Dark”, “Hard” (2nddimension). The color pairs in this quadrant have low lightness and high chroma, dividing into three groups. The first group is pairs of vivid tone color, such as pair of vivid red with vivid green. The second group is pairs composing of vivid tone color with color patches which more dark color, such as pair of vivid red with black. The third group is pairs of vivid tone color with light tone color, such as pair of vivid purple with light red.

Following is the analysis of color pairs between the first dimension and the third dimension.

The first quadrant, represents positive color sensation value of “Gaudy”, “Striking”, “Dynamic”, “Distinct”, “Vivid” (1stdimension) and “Warm” (3rddimension). The color pairs in this quadrant have high chroma and their hue angles are between 5° - 90°, dividing into three groups. The first group is pairs of vivid tone color, such as pair of vivid red with vivid purple. The second group is pairs of vivid tone color with light tone color, such as pair of vivid red with light purple. The third group is pairs composing of more dark color with vivid tone or light tone color, such as pair of vivid red with black or pair of light red with dark yellow.

The second quadrant, represents negative color sensation values of “Plain”, “Subdued”, “Passive”, “Vague”, “Sombre” (1stdimension) and positive color sensation values of “Warm” (3rddimension). The color pairs in this quadrant have low chroma and their hue angles are between 5° - 90°, dividing into three groups. The first group is pairs of dark tone color, such as pair of dark red with dark yellow. The second group is pairs composing of black with dull tone or dark tone color, such as pair of dull red with black or pair of dark red with black. The third group is pairs composing of dull tone color with dark tone color, such as pair of dull purple with dark red color.

The third quadrant, represents negative color sensation values of “Plain”, “Subdued”, “Passive”, “Vague”, “Sombre” (1stdimension) and “Cool” (3rddimension).. The color pairs in this quadrant have low chroma and their hue angles are between 150° - 270°, dividing into three groups. The first group is pairs of dark tone color, such as pair of dark blue with dark green. The second group is pairs composing of black with dark tone color, such as pair of dark blue with black. The third group is pairs composing of dull tone color with dark tone color, such as pair of dull green with dark green color.

The fourth quadrant, represents positive color sensation values of “Gaudy”, “Striking”, “Dynamic”, “Distinct”, “Vivid” (1stdimension) and negative color sensation values of “Cool” (3rddimension). The color pairs in this quadrant have high chroma and their hue angles are between 150° - 270°, dividing into three groups. The first group is pairs composing of yellow with light tone color, such as pair of vivid yellow with light green. The second group is pairs composing of white with vivid tone or light tone color, such as pair of light blue with white or pair of vivid

green with white. The third group is pairs of vivid tone color with light tone color, such as pair of vivid blue with light blue

Following is the analysis of color pairs between the second dimension and the third dimension.

The first quadrant, representing positive color sensation values of “Light”, “Transparent”, “Soft” (2nd dimension) and “Warm” (3rd dimension). The color pairs in this quadrant have high lightness and their hue angles are between 5° - 90°, dividing into three groups. The first group is pairs composing of high lightness or high chroma yellow with vivid tone or light tone color, such as pair of vivid yellow with vivid purple and pair of light red with light yellow. The second group is pairs of vivid tone color with light tone color, such as pair of vivid red with light purple. The third group is pairs of light tone color with dull tone color, such as pair of light red with dull yellow.

The second quadrant, represents negative color sensation values of “Turbid”, “Dark”, “Hard” (2nd dimension) and positive color sensation values of “Warm” (3rd dimension). The color pairs in this quadrant have low lightness and their hue angles are between 5° - 90°, dividing into four groups. The first group is pairs composing of vivid red and color with lower lightness than vivid red, such as pair of vivid red with dark blue. The second group is pairs of dark tone color, such as pair of dark green with dark purple. The third group is pairs of dull tone color with dull tone or dark tone color, such as pair of dull green with dull purple. The fourth group is pairs of dark tone color with dark tone color or black, such as pair of dark yellow with dark purple or pair of dark red with black.

The third quadrant, represents negative color sensation values of “Turbid”, “Dark”, “Hard” (2nd dimension) and “Cool” (3rd dimension). The color pairs in this quadrant have low lightness and their hue angles are between 150° - 270°, dividing into four groups. The first group is pairs composing of gray with dull tone or dark tone color, such as pair of dull green with gray and pair of dark blue with gray. The second group is pairs composing of black with dull tone or dark tone color, such as pair of dull blue with black or pair of dark blue with black. The third group is pairs of dull tone color with dull tone or dark tone color, such as pair of dull green with dull blue and pair of dull blue with dark green. The fourth group is pairs of dark tone color, such as pair of dark green with dark blue.

The fourth quadrant, represents positive color sensation values “Light”, “Transparent”, “Soft” (2nd dimension) and negative color sensation values of “Cool” (3rd dimension). The color pairs in this quadrant have high lightness and their hue angles are between 150° - 270°, dividing into four groups. The first group is pairs composing of light green with analogous green hue, such as pair of light green with light blue. The second group is pairs composing of yellow with light tone color, such as vivid yellow with light green. The third group is pairs of light tone color, such as pair of light blue with light purple. The fourth group is pairs composing of white with vivid tone or light tone color, such as pair of vivid blue with white or pair of light green with white.

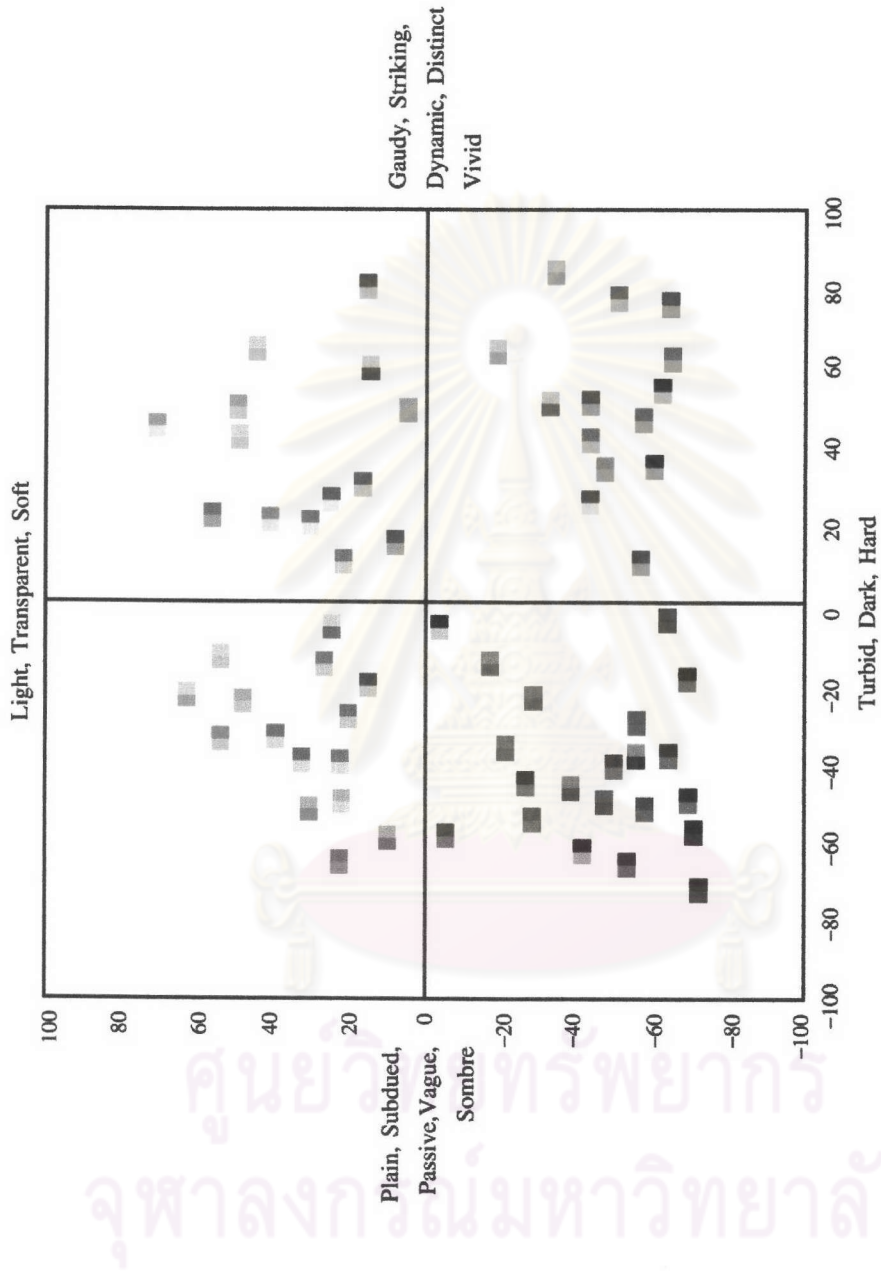


Figure4-62 Color sensation space of color sample pairs, according to the first and second dimensions

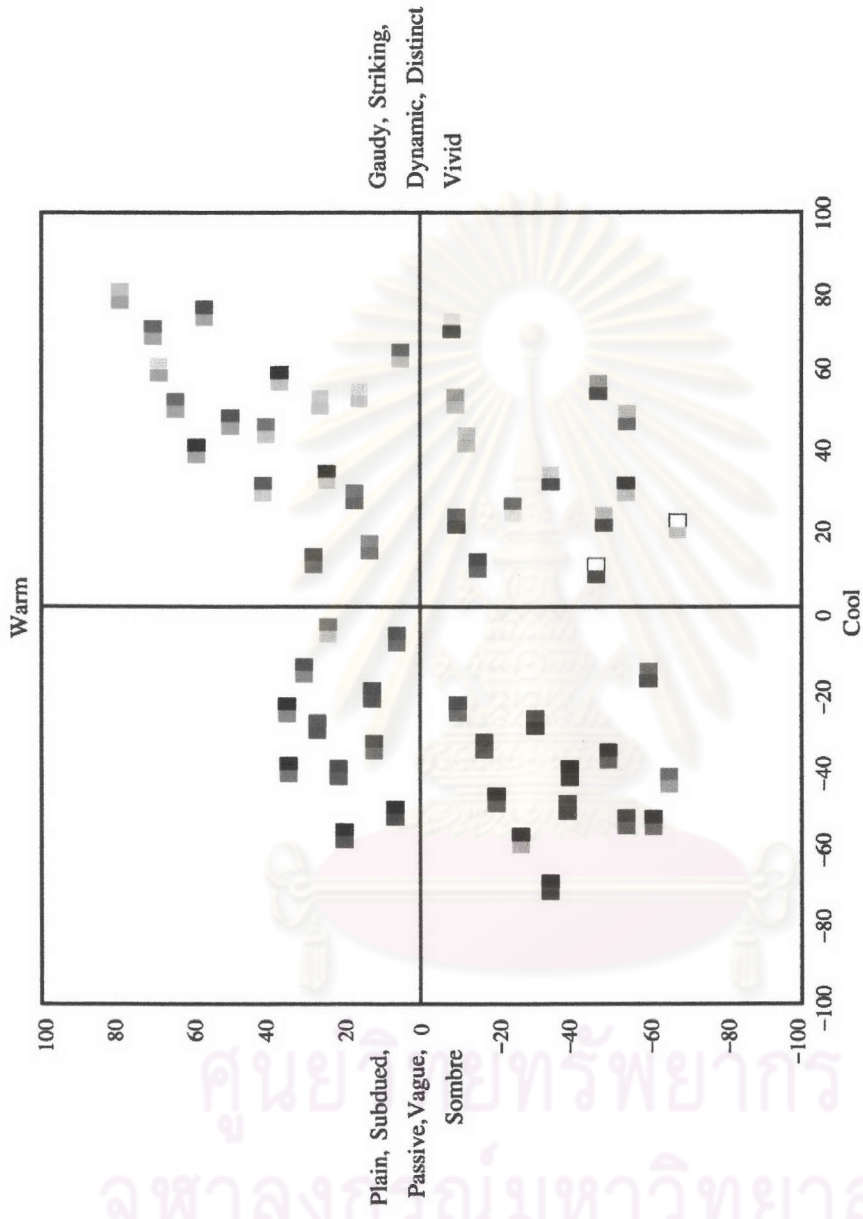


Figure4-63 Color sensation space of color sample pairs, according to the first and third dimensions

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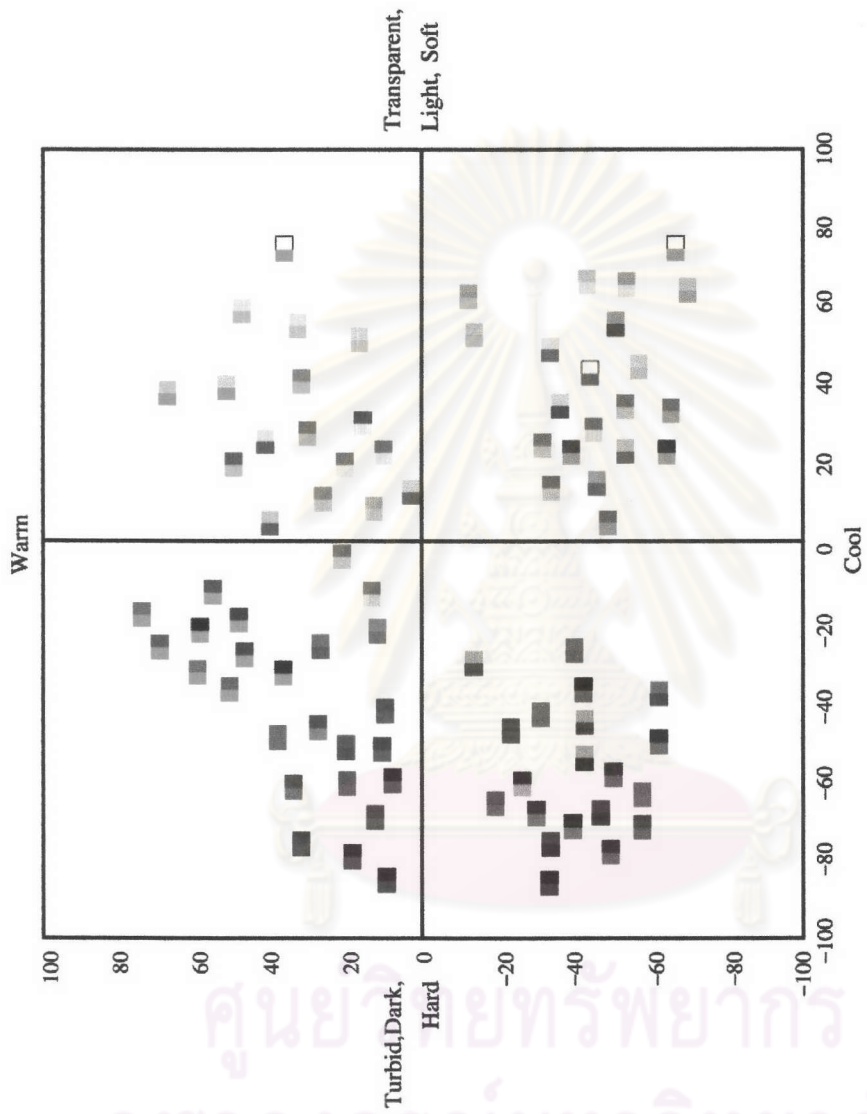


Figure4-64 Color sensation space of color sample pairs, according to the second and third dimensions

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4.3 Relationship between Two Color Combination and Relevant Single Color

Comparing the visual scores of two color combination and relevant single color, an additivity relationship of color sensation was found between them by using multi linear regression. The two color combination sensation values can be predicted by two single color sensation values, derived from precious works done by Bangchokdee, Y. The results obtained are as follows:

“Dark-Light” Equation

$$DL_{\text{Combine}} = -23.652 + 0.716DL_1 + 0.446DL_2 \quad (4.1)$$

where, DL_{Combine} : Dark-Light sensation of a color pair generated by color1 and color2

DL_1 : Dark-Light sensation of a color1

DL_2 : Dark-Light sensation of a color2

The Dark-Light sensation value of each single color can predicted by colorimetric value on CIEL* C^* h color system, as follow.

$$DL_{\text{Single}} = [\{3.4(L^*-10)\}^2 + \{4.5(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 184 \quad (4.1.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Hard-Soft” Equation

$$HS_{\text{Combine}} = -13.872 + 0.694HS_1 + 0.46HS_2 \quad (4.2)$$

where, HS_{Combine} : Hard-Soft sensation of a color pair generated by color1 and color2

HS_1 : Hard-Soft sensation of a color1

HS_2 : Hard-Soft sensation of a color2

The Hard-Soft sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$HS_{\text{Single}} = - [\{2.2(L^*-90)\}^2 + \{0.9(1-\Delta h_{290}/360)C^*\}^2]^{1/2} + 79 \quad (4.2.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Cool-Warm” Equation

$$CW_{\text{Combine}} = 7.249 + 0.664CW_1 + 0.506CW_2 \quad (4.3)$$

where, CW_{Combine} : Cool-Warm sensation of a color pair generated by color1 and color2

CW_1 : Cool-Warm sensation of a color1

CW_2 : Cool-Warm sensation of a color2

The Cool-Warm sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$CW_{\text{Single}} = [\{0.27(L^*-100)\}^2 + \{1.48\{1+\cos(\Delta h_{40})\}(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 58 \quad (4.3.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Turbid-Transparent” Equation

$$TT_{\text{Combine}} = -16.767 + 0.645TT_1 + 0.502TT_2 \quad (4.4)$$

where, TT_{Combine} : Turbid-Transparent sensation of a color pair generated by color1
and color2

TT_1 : Turbid-Transparent sensation of a color1

TT_2 : Turbid-Transparent sensation of a color2

The Turbid-Transparent sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$TT_{\text{Single}} = \left[\{3.1(L^*-30)\}^2 + \{2.7(1-\Delta h_{290}/360)C^*\}^2 \right]^{1/2} - 122 \quad (4.4.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Pale-Deep” Equation

$$PD_{\text{Combine}} = -0.274 + 0.542PD_1 + 0.43PD_2 \quad (4.5)$$

where, PD_{Combine} : Pale-Deep sensation of a color pair generated by color1 and color2

PD_1 : Pale-Deep sensation of a color1

PD_2 : Pale-Deep sensation of a color2

The Cool-Warm sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$PD_{\text{Single}} = [\{2.6(L^*-100)\}^2 + \{1.8(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 90 \quad (4.5.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Vague-Distinct” Equation

$$VD_{\text{Combine}} = -23.841 + 0.65VD_1 + 0.634VD_2 \quad (4.6)$$

where, VD_{Combine} : Pale-Deep sensation of a color pair generated by color1 and color2

VD_1 : Pale-Deep sensation of a color1

VD_2 : Pale-Deep sensation of a color2

The vague-distinct sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$VD_{\text{Single}} = [\{1.9(L^*-60)\}^2 + \{3.3(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 62 \quad (4.6.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Light-Heavy” Equation

$$LH_{\text{Combine}} = 0.41 + 0.578LH_1 + 0.491LH_2 \quad (4.7)$$

where, LH_{Combine} : Light-Heavy sensation of a color pair generated by color1 and color2

LH_1 : Light-Heavy sensation of a color1

LH₂ : Light-Heavy sensation of a color2

The light-heavy sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$LH_{\text{Single}} = [\{2.6(L^*-100)\}^2 + \{0.6(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 96 \quad (4.7.1)$$

where, L* : CIELAB metric lightness

C* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Sombre-Vivid” Equation

$$SV_{\text{Combine}} = -15.762 + 0.569SV_1 + 0.508SV_2 \quad (4.8)$$

where, SV_{Combine} : Sombre-Vivid sensation of a color pair generated by color1 and color2

SV_1 : Sombre-Vivid sensation of a color1

SV_2 : Sombre-Vivid sensation of a color2

The sombre-vivid sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$SV_{\text{Single}} = [\{2.2(L^*-10)\}^2 + \{5(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 157 \quad (4.8.1)$$

where, L* : CIELAB metric lightness

C* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Weak-Strong” Equation

$$WS_{\text{Combine}} = -13.225 + 0.642WS_1 + 0.491WS_2 \quad (4.9)$$

where, WS_{Combine} : Weak-Strong sensation of a color pair generated by color1 and color2

WS_1 : Weak-Strong sensation of a color1

WS_2 : Weak-Strong sensation of a color2

The weak-strong sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$WS_{\text{Single}} = [\{2.1(L^*-90)\}^2 + \{0.6(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 52 \quad (4.9.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Passive-Dynamic” Equation

$$PDY_{\text{Combine}} = -7.865 + 0.606PD_1 + 0.281PD_2 \quad (4.10)$$

where, PDY_{Combine} : Passive-Dynamic sensation of a color pair generated by color1 and color2

PDY_1 : Passive-Dynamic sensation of a color1

PDY_2 : Passive-Dynamic sensation of a color2

The passive-dynamic sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$PDY_{\text{Single}} = [\{1.1(L^*-20)\}^2 + \{3.8(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 100 \quad (4.10.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Plain-Gaudy” Equation

$$PG_{\text{Combine}} = -1.283 + 0.561PG_1 + 0.308PG_2 \quad (4.11)$$

where, PG_{Combine} : Plain-Gaudy sensation of a color pair generated by color1
and color2

PG_1 : Plain-Gaudy sensation of a color1

PG_2 : Plain-Gaudy sensation of a color2

The plain-gaudy sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$PG_{\text{Single}} = [\{0.4(L^*-10)\}^2 + \{3.8(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 95 \quad (4.11.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

“Subdued-Striking” Equation

$$SS_{\text{Combine}} = -8.676 + 0.606 SS_1 + 0.303SS_2 \quad (4.12)$$

where, SS_{Combine} : Subdued-Striking sensation of a color pair generated by color1
and color2

SS_1 : Subdued-Striking sensation of a color1

SS_2 : Subdued-Striking sensation of a color2

The subdued-striking sensation value of single color can predicted by colorimetric value on CIEL*C*h color system, as follow.

$$SS_{\text{Single}} = [\{1.6(L^*-90)\}^2 + \{3.1(1-\Delta h_{290}/360)C^*\}^2]^{1/2} - 65 \quad (4.12.1)$$

where, L^* : CIELAB metric lightness

C^* : CIELAB metric chroma

H : CIELAB metric hue angle

Δh : CIELAB metric hue angle difference from $h=x$, $0 \leq \Delta h_x \leq 180$

The empirical two color combination equation corresponding to the seven-point assessments were derived. To determine if the derived empirical two color combination equations are suitable for the color sensation, the results from visual assessment experiment through the seven-point method were plotted against those calculated from equation based on linear regression. Figure 4-65 to 4-76. illustrate the relationship between the two color combination values from direct visual assessments and those calculated from the equations. Then, the correlation coefficient was determined. The higher the correlation coefficient is, the more relationship becomes an important determining factor. All of the equations had been confirmed to have correlation coefficient value between 0.74 – 0.86. It is found that the “Turbid-Transparent” combination equation can be predicted the turbid-transparent sensation values most nearly the visual results.

The obtained regression coefficients (β_1, β_2) in the color combination equations indicate that which color patch influences to color sensation value. For example, from equation 4.12, β_1 value is higher than β_2 value. This mean that the left – side color patch determining color sensation much more than the effect of right – side color patch.

Table4-2 Correlation coefficients between the visual results from observers and the predicted values by color combination equation

Color sensation	DL	HS	CW	TT	PD	VD	LH	SV	WS	PDY	PG	SS
r	0.84	0.76	0.84	0.86	0.77	0.75	0.83	0.83	0.79	0.74	0.79	0.74

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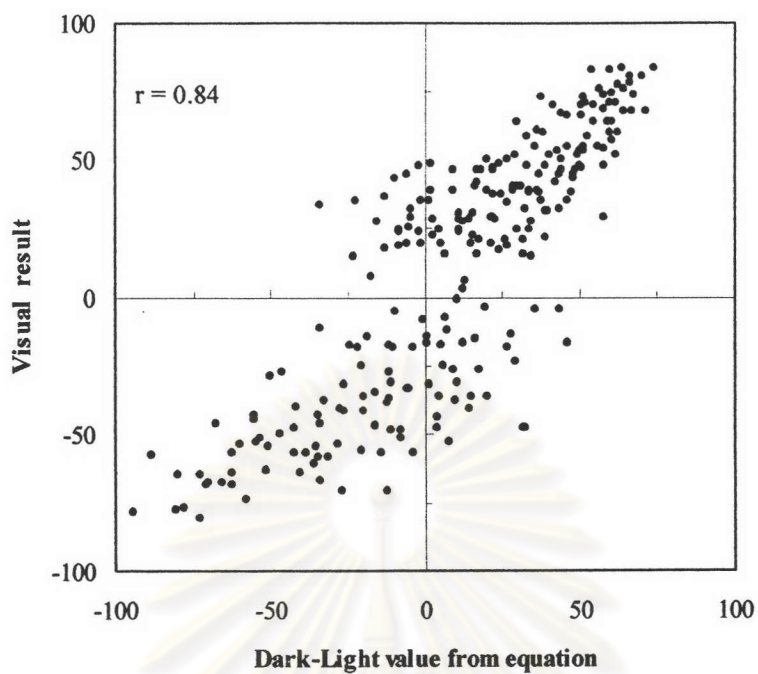


Figure 4-65 Relationship between the predicted values from Dark-Light equation and visual results

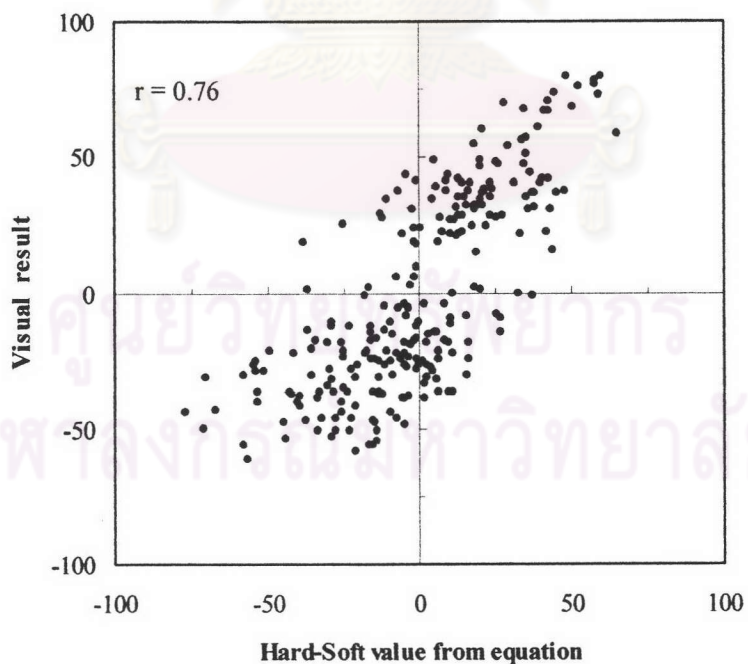


Figure 4-66 Relationship between the predicted values from Hard-Soft equation and visual results

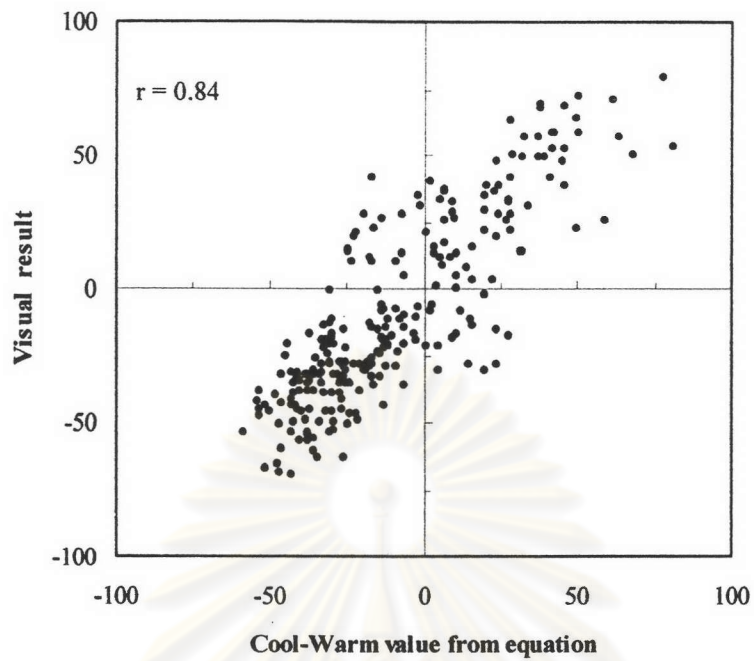


Figure 4-67. Relationship between the predicted values from Cool-Warm equation and visual results

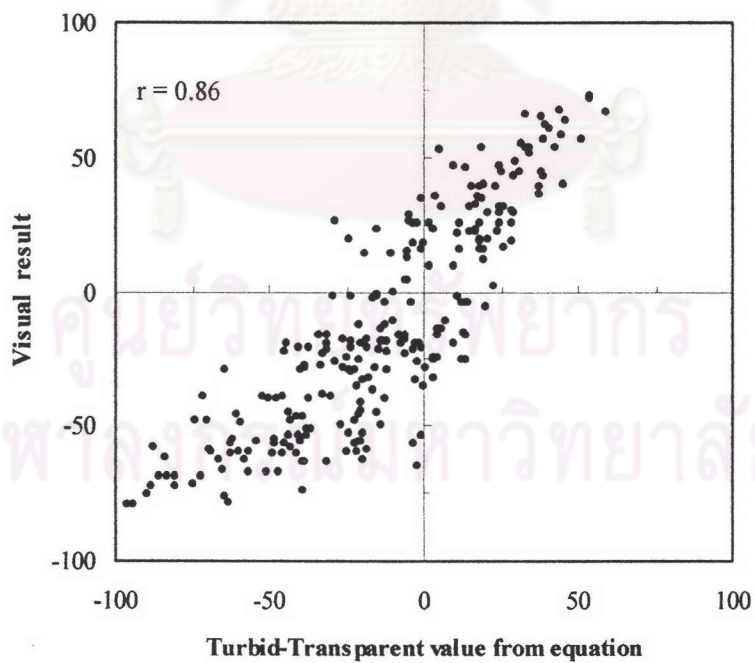


Figure 4-68. Relationship between the predicted values from Turbid-Transparent equation and visual results

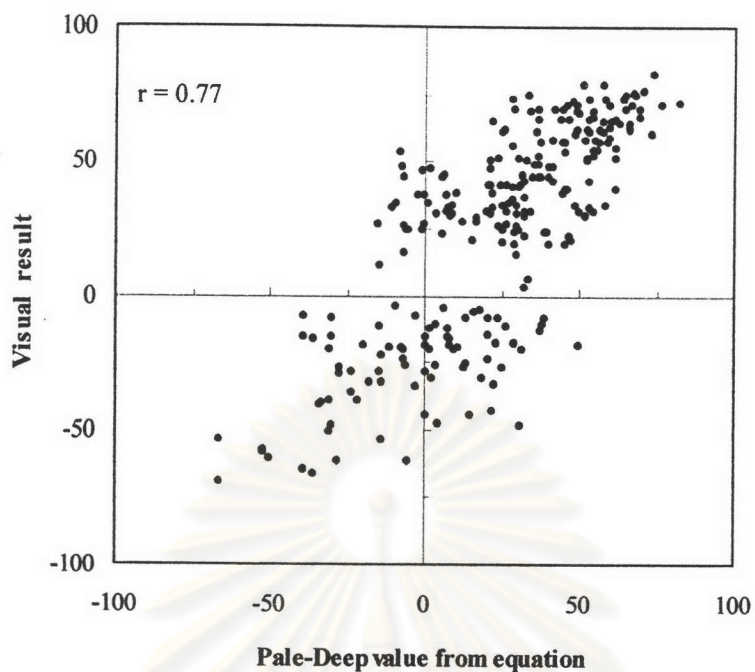


Figure 4-69. Relationship between the predicted values from Pale-Deep equation and visual results

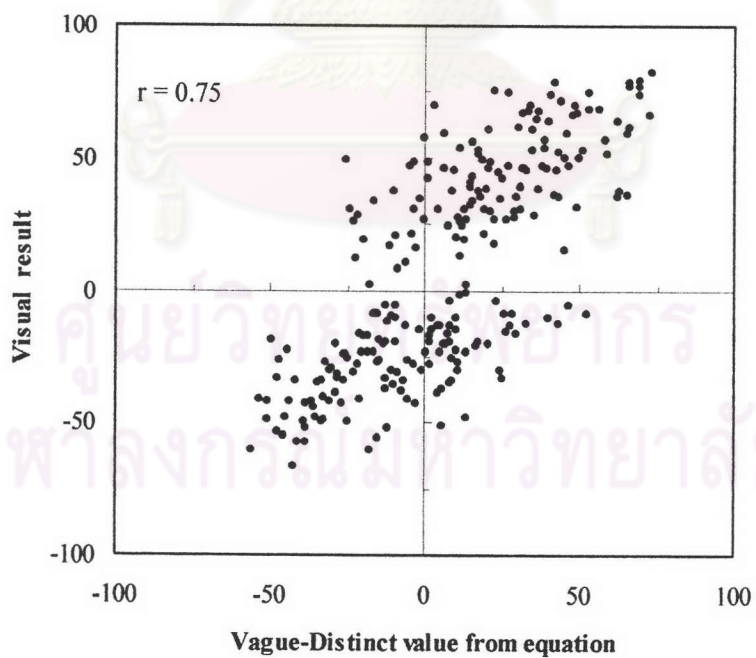


Figure 4-70. Relationship between the predicted values from Vague-Distinct equation and visual results

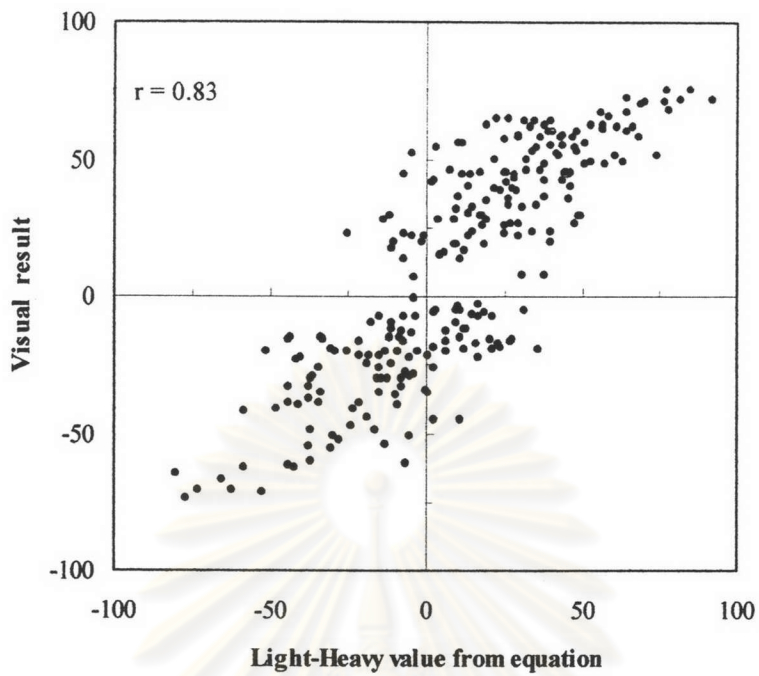


Figure 4-71 Relationship between the predicted values from Light-Heavy equation and visual results

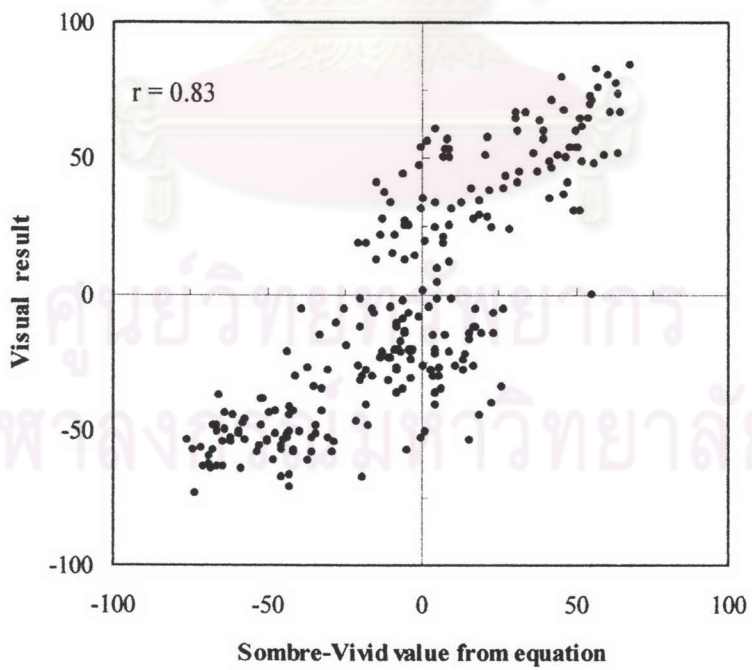


Figure 4-72. Relationship between the predicted values from Sombre-Vivid equation and visual results

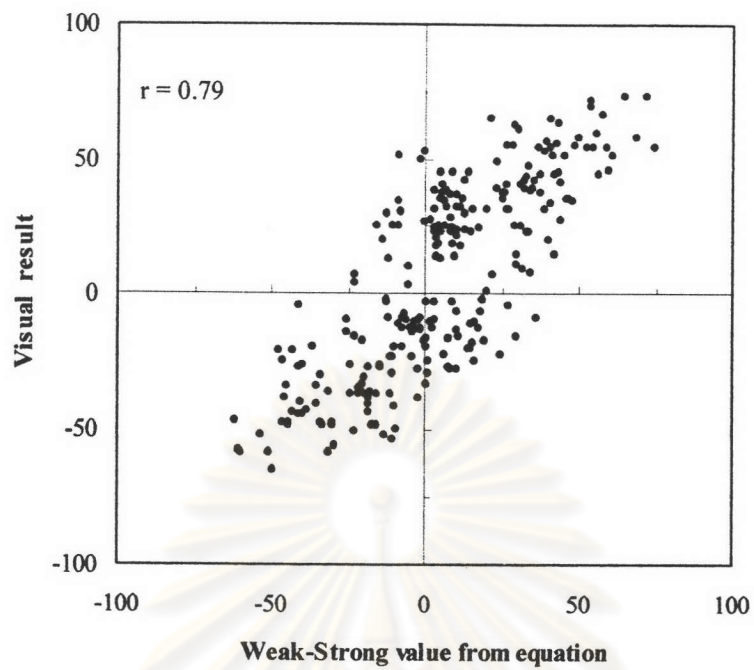


Figure 4-73 Relationship between the predicted values from Weak-Strong equation and visual results

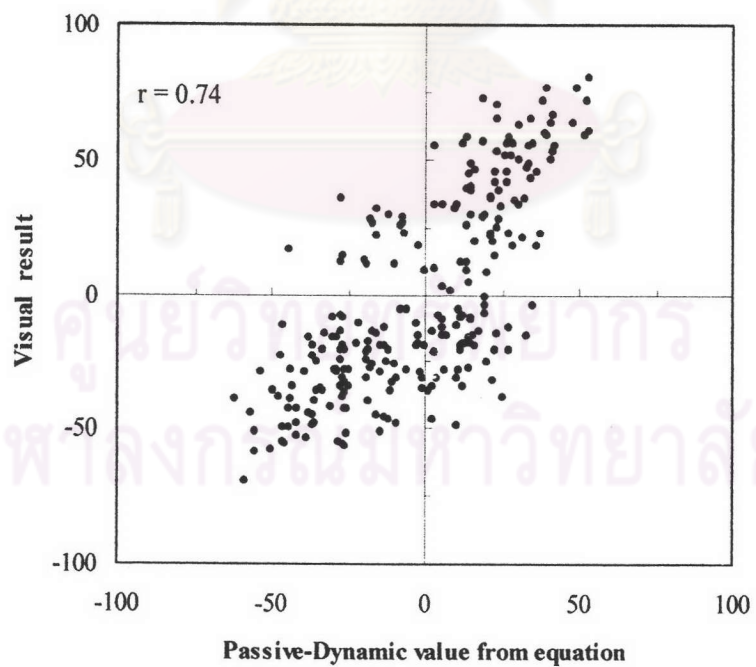


Figure 4-74 Relationship between the predicted values from Passive-Dynamic equation and visual results

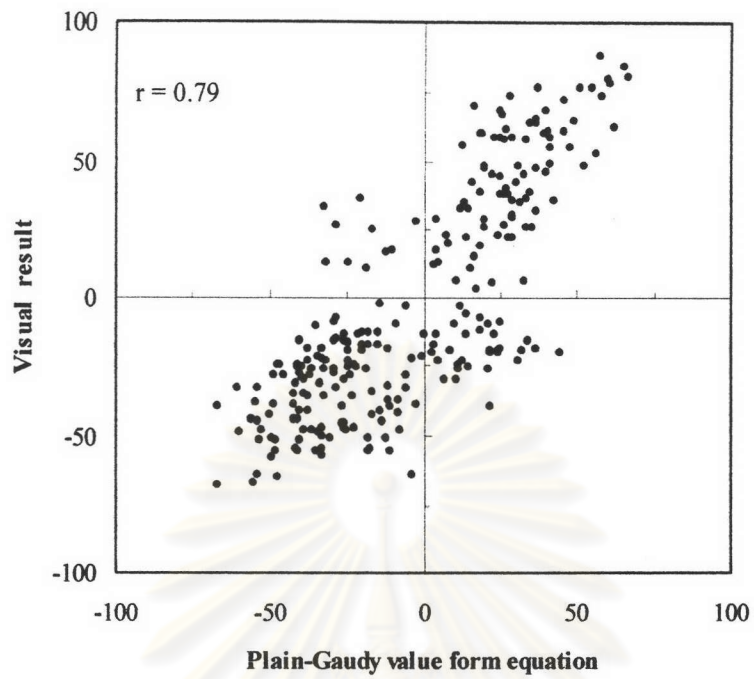


Figure 4-75 Relationship between the predicted values from Plain-Gaudy equation and visual results

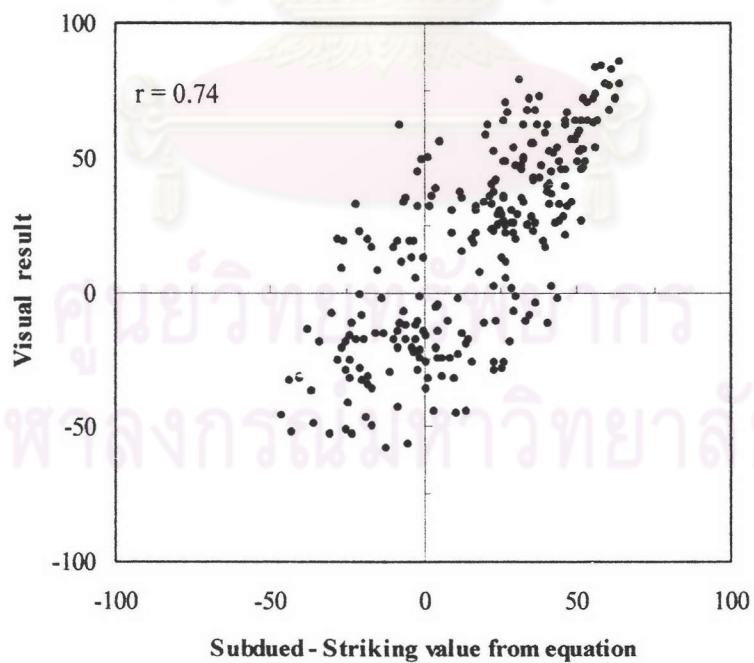


Figure 4-76 Relationship between the predicted values from Subdued-Striking equation and visual results

4.4 Relationship between Color Harmony and Colorimetric Values

The relationship between color harmony and colorimetric values was found. The higher the values of chroma difference and hue difference, the more the colors tend to be Disharmony. The relationship equation was derived by using polynomial and multi linear regression as given in equation 4-13. Comparing the color harmony visual results from observers with those obtained from equation, the correlation coefficient was 0.65 as shown in Figure4-77, Note that, there are 60 color pairs give close relationship as shown in Figure4-80.

“Disharmony – Harmony” Equation

$$\begin{aligned} \text{DHH} = & 46.82 - 2.29(\Delta H^*) + 0.027(\Delta H^*)^2 - 9.89 \times 10^{-5}(\Delta H^*)^3 + 0.15(\Delta C^*) \\ & - 0.015(\Delta C^*)^2 + 1.19 \times 10^{-5}(\Delta C^*)^3 \end{aligned} \quad (4.13)$$

where DHH : Disharmoy-Harmony” value

ΔH^* : hue difference on CIEL*C*h color space

ΔC^* : chroma difference on CIEL*C*h color space

4.5 Relationship between visual scores of “Disharmony-Harmony” and “Dislike-Like”

The relationship between visual score of “Disharmony-Harmony” and visual score of “Dislike-Like” was established as shown in Figure4-78. From this relationship, it can be created “Dislike-Like” equation by using color harmony values as shown equation 4-14. Comparing the color preference visual results from observers with those obtained from equation the correlation coefficient is 0.76 as shown in Figure4-79. Figure4-81 show the examples of color combination representing “Dislike-Like” closely predicted to the visual results from observer.

“Dislike – Like” Equation

$$DLL = 1.597 + 0.519(DHH) - 2.4 \times 10^{-3} (DHH)^2 + 4 \times 10^{-5} (DHH)^3 \quad (4.14)$$

where DLL : “Dislike-Like” values

DHH : Disharmoy-Harmony” value

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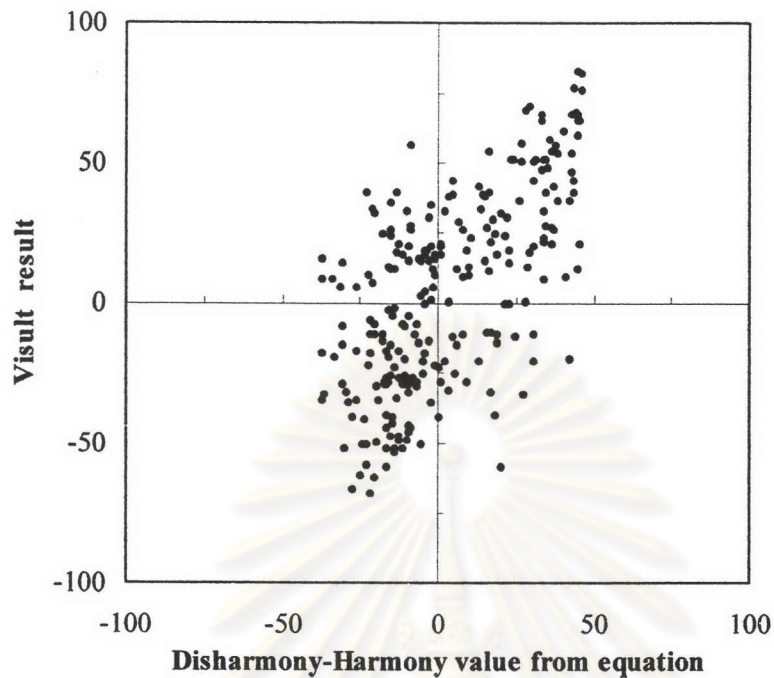


Figure4-77 Relationship between the predicted values from Disharmony-Harmony equation and the visual results

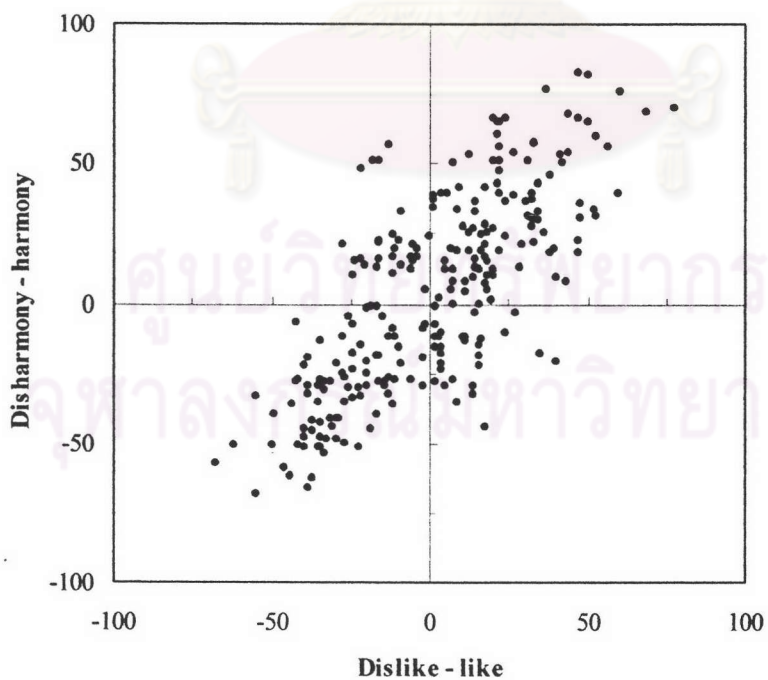


Figure4-78 Relationship between Dislike-Like equation and Disharmony-Harmony equation

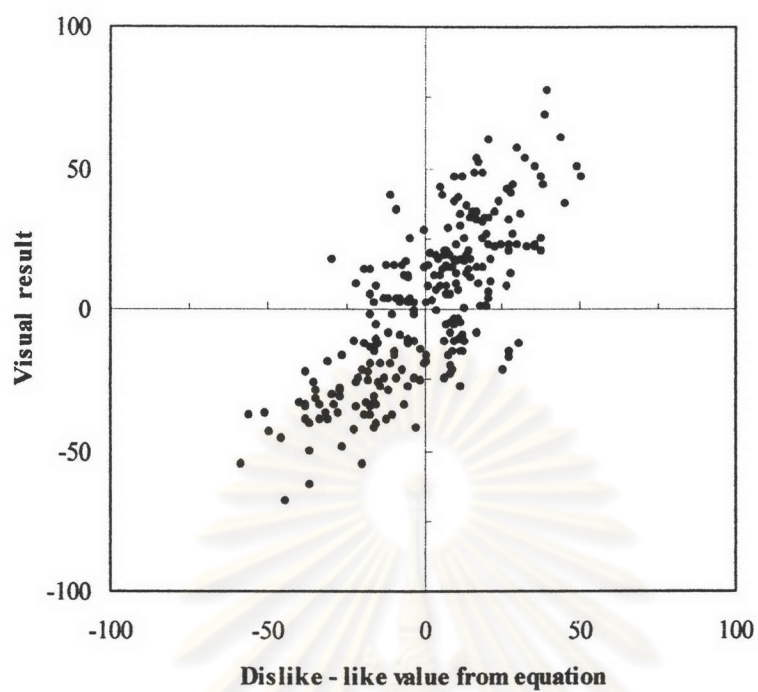


Figure4-79 Relationship between the predicted values from Dislike-Like equation and the visual results

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Figure 4-80 Ranking of color sample pairs which have Disharmony-Harmony values closely to visual results

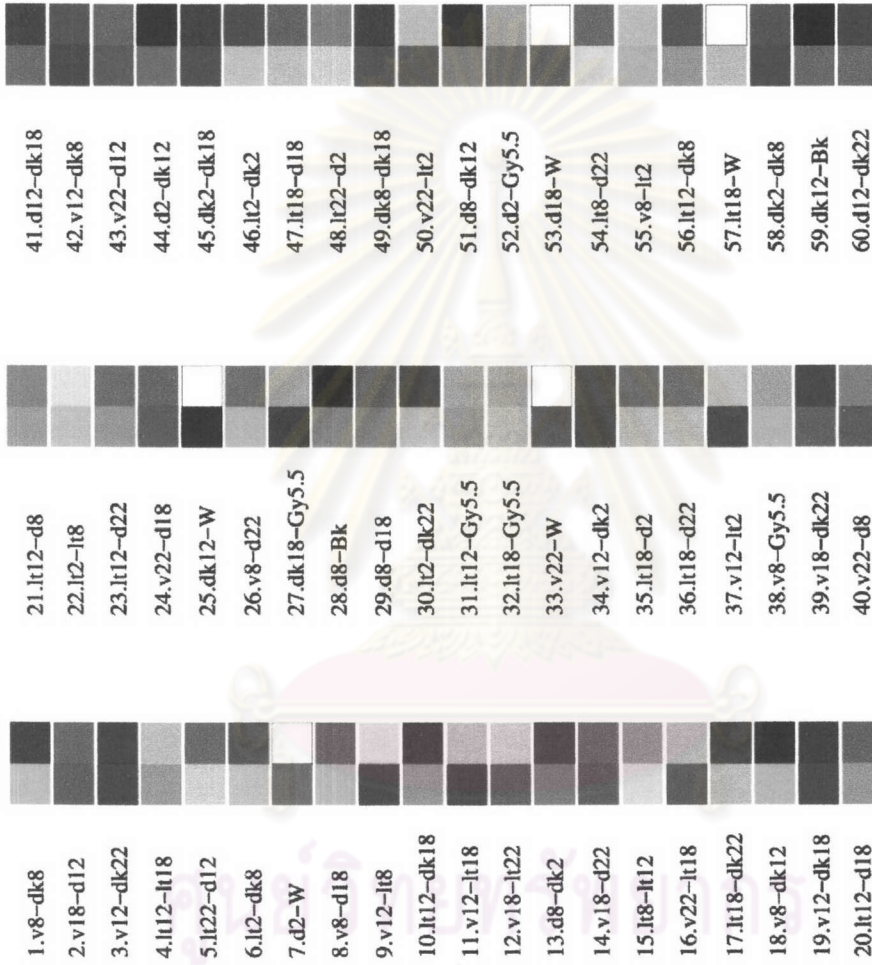


Figure 4-81 Ranking of color sample pairs which have Dislike-Like values closely to visual results

4.6 Comparison of the visual assessment of fourteen opponent word pairs

The relationship between two opponent word pairs are shown in Figure4-80 to Figure4-172. The correlation coefficients is the simplest way to describe the relationship between the opponent word pairs. as shown in Table 4-3.

Note that there are some cases that express the correlation coefficients of greater than 0.8, are as follow:

“Dark – Light” and “Turbid – Transparent”	=	0.92
“Passive – Dynamic” and “Plain – Gaudy”	=	0.91
“Pale – Deep” and “Light – Heavy”	=	0.88
“Pale – Deep” and “Weak – Strong”	=	0.88
“Vague – Distinct” and “Sombre – Vivid”	=	0.86
“Light – Heavy” and “Weak – Strong”	=	0.86
“Hard – Soft” and “Light – Heavy”	=	- 0.85
“Hard – Soft” and “Pale - Deep”	=	- 0.84
“Dark – Light” and “Sombre - Vivid”	=	0.84
“Plain – Gaudy” and “Subdued – Striking”	=	0.83
“Vague – Distinct” and “Subdued – Striking”	=	0.82

Table 4-3 The correlation coefficient between two opponent word pairs

Symbol	DL	HS	CW	TT	PD	VD	LH	SV	WS	PDY	PG	SS	DHH	DLL
DL	1.00													
HS	0.48	1.00												
CW	0.23	-0.42	1.00											
TT	0.92	0.60	0.08	1.00										
PD	-0.45	-0.84	0.37	-0.54	1.00									
VD	0.65	-0.14	0.46	0.54	0.25	1.00								
LH	-0.66	-0.85	0.29	-0.76	0.88	-0.02	1.00							
SV	0.84	0.16	0.40	0.78	-0.05	0.86	-0.32	1.00						
WS	-0.44	-0.79	0.29	-0.54	0.88	0.24	0.86	-0.07	1.00					
PDY	0.62	-0.15	0.73	0.51	0.17	0.72	-0.03	0.79	0.09	1.00				
PG	0.48	-0.34	0.74	0.36	0.36	0.74	0.15	0.74	0.25	0.91	1.00			
SS	0.33	-0.45	0.61	0.21	0.59	0.82	0.34	0.66	0.50	0.74	0.83	1.00		
DHH	-0.07	0.45	-0.35	0.07	-0.23	-0.19	-0.23	-0.09	-0.13	-0.39	-0.45	-0.32	1.00	
DLL	0.27	0.53	-0.31	0.37	-0.27	0.18	-0.36	0.23	-0.14	-0.15	-0.25	-0.11	0.75	1.00

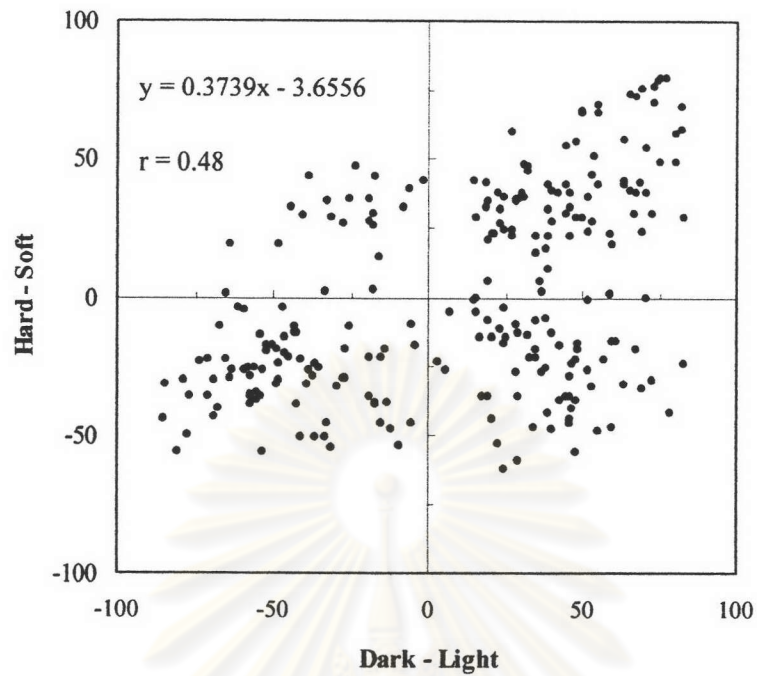


Figure 4-82 Relationship between the visual scores of Dark-Light and the visual scores of Hard - Soft

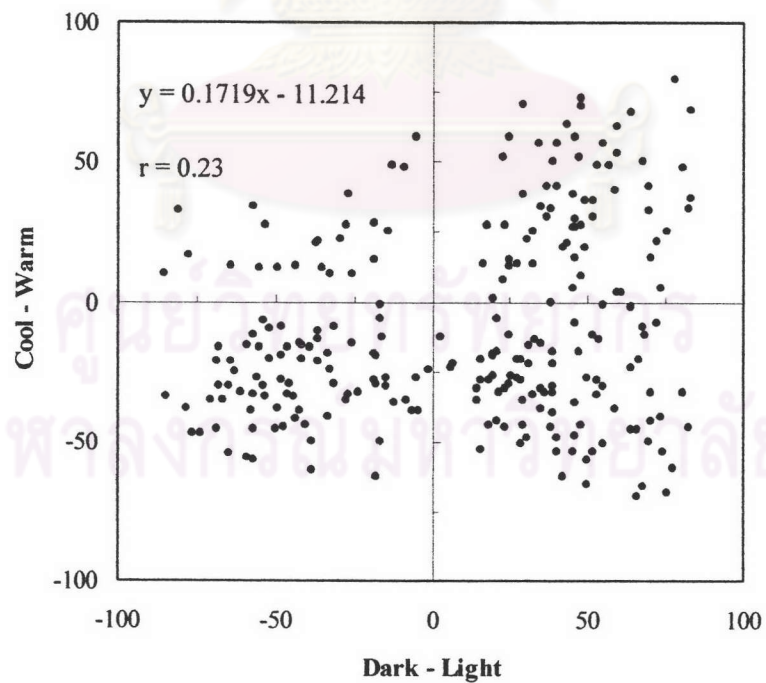


Figure 4-83 Relationship between the visual scores of Dark-Light and the visual scores of Cool-Warm

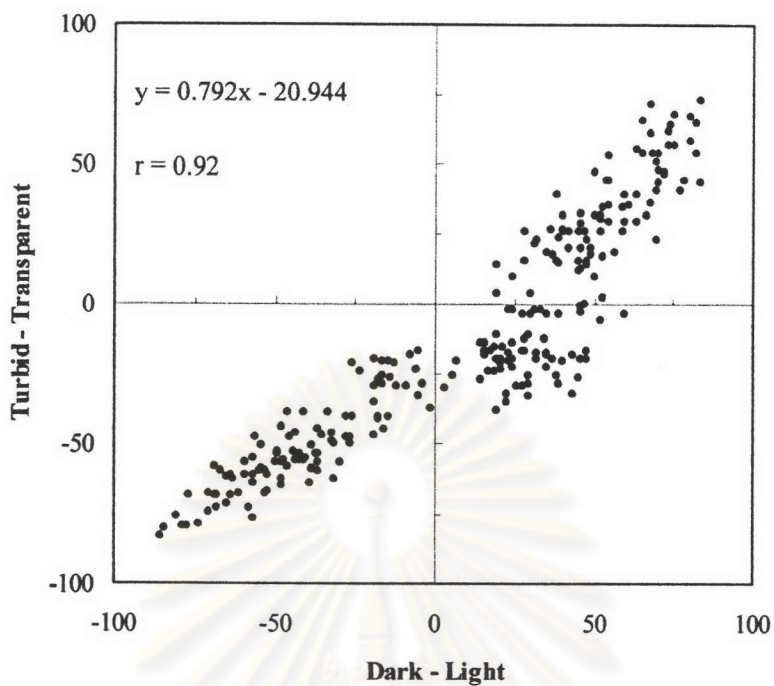


Figure 4-84 Relationship between the visual scores of Dark-Light and the visual scores of Turbid-Transparent

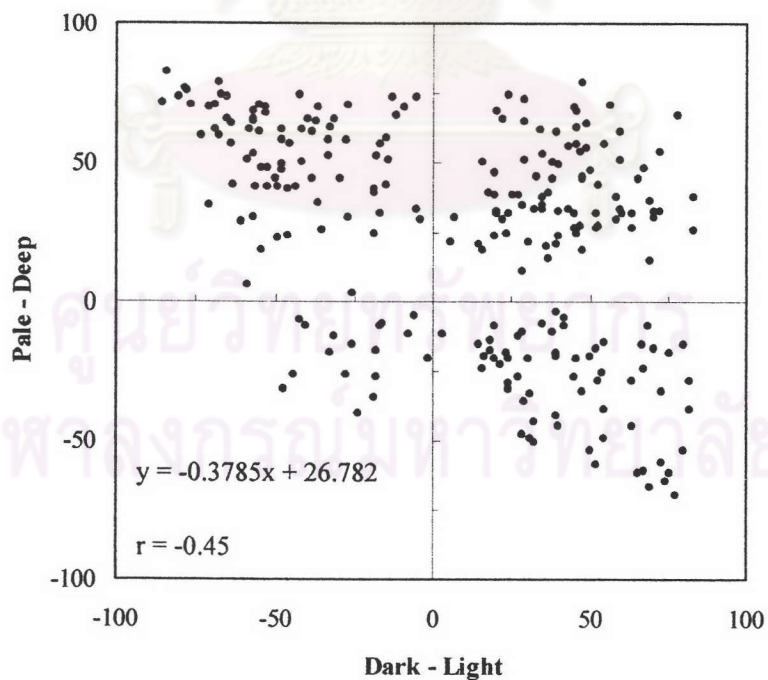


Figure 4-85 Relationship between the visual scores of Dark-Light and the visual scores of Pale-Deep

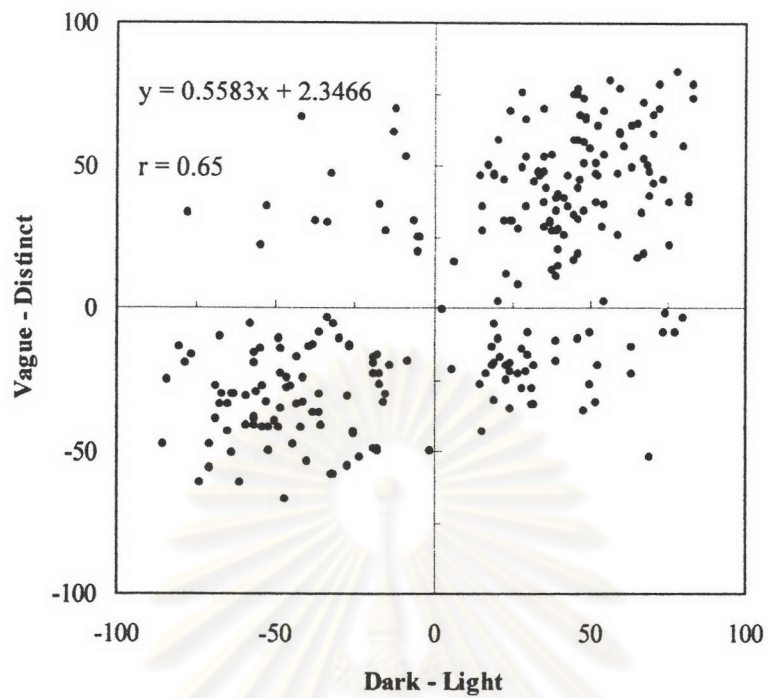


Figure 4-86 Relationship between the visual scores of Dark-Light and the visual scores of Vague-Distinct

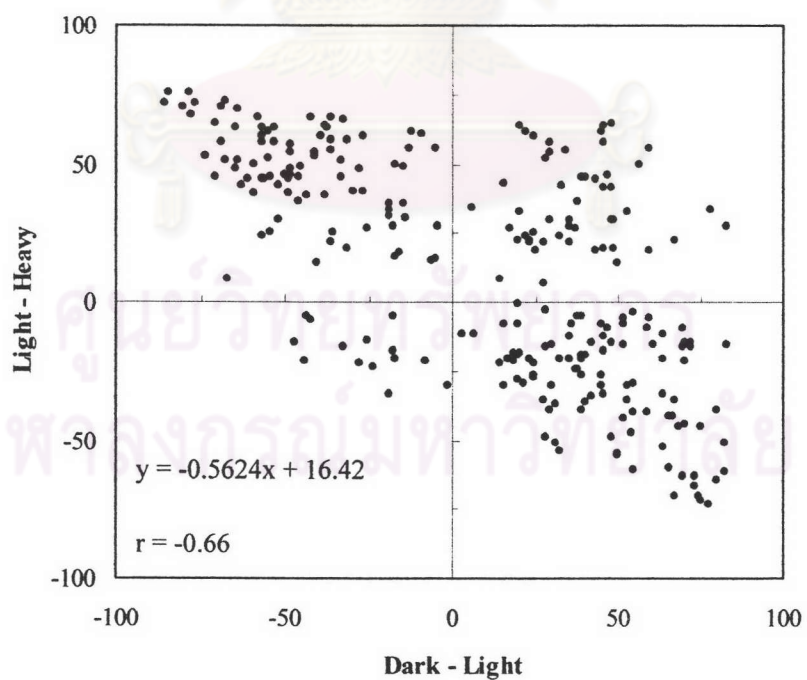


Figure 4-87 Relationship between the visual scores of Dark-Light and the visual scores of Light-Heavy

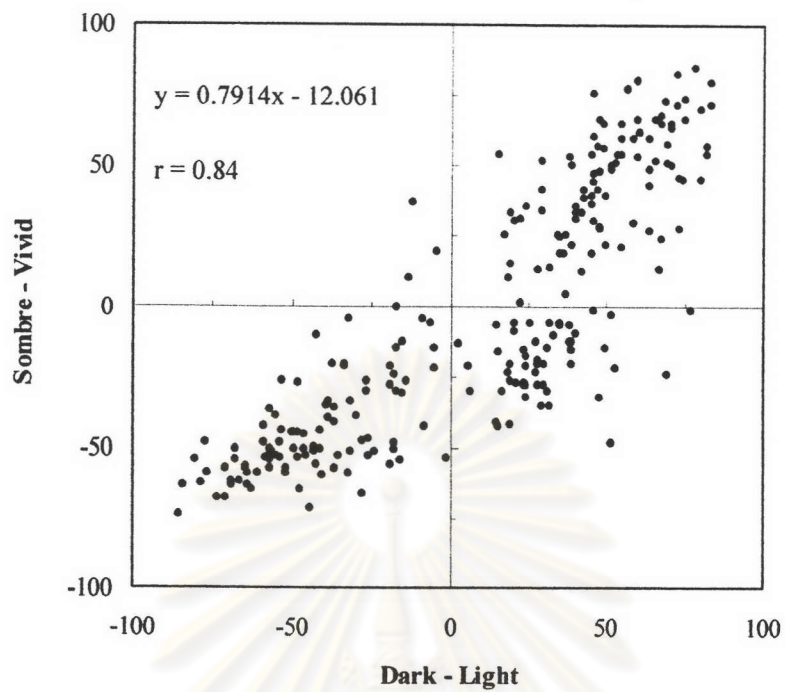


Figure 4-88 Relationship between the visual scores of Dark-Light and the visual scores of Sombre-Vivid

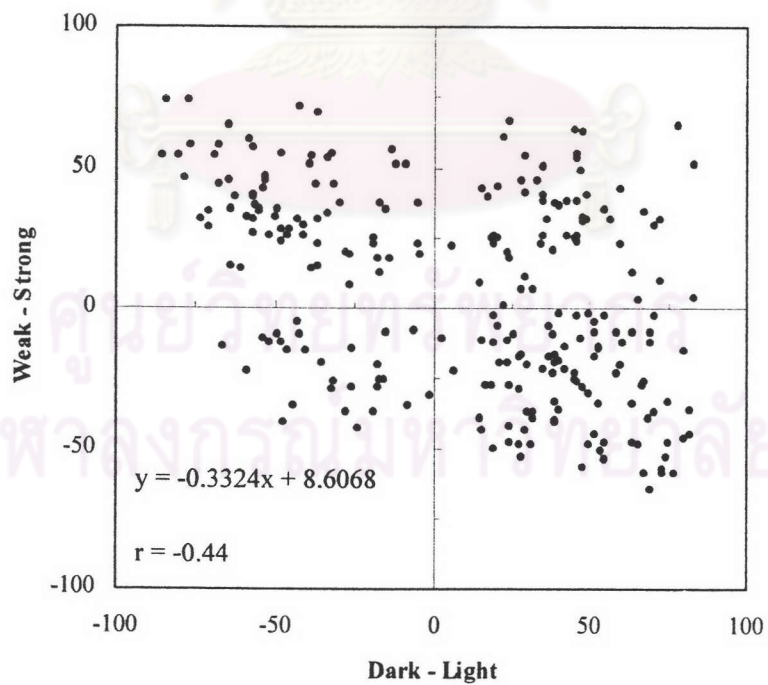


Figure 4-89 Relationship between the visual scores of Dark-Light and the visual scores of Weak-Strong

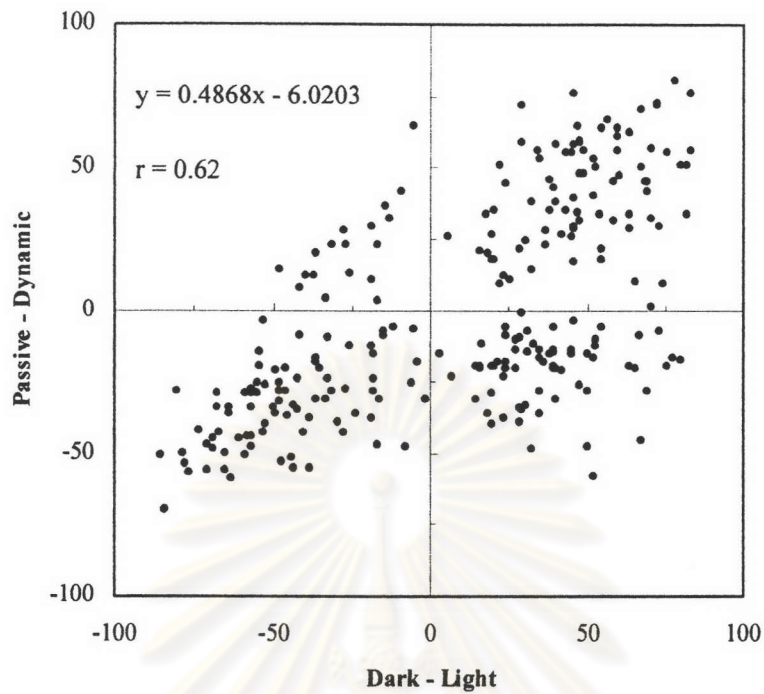


Figure 4-90 Relationship between the visual scores of Dark - Light and the visual scores of Passive - Dynamic

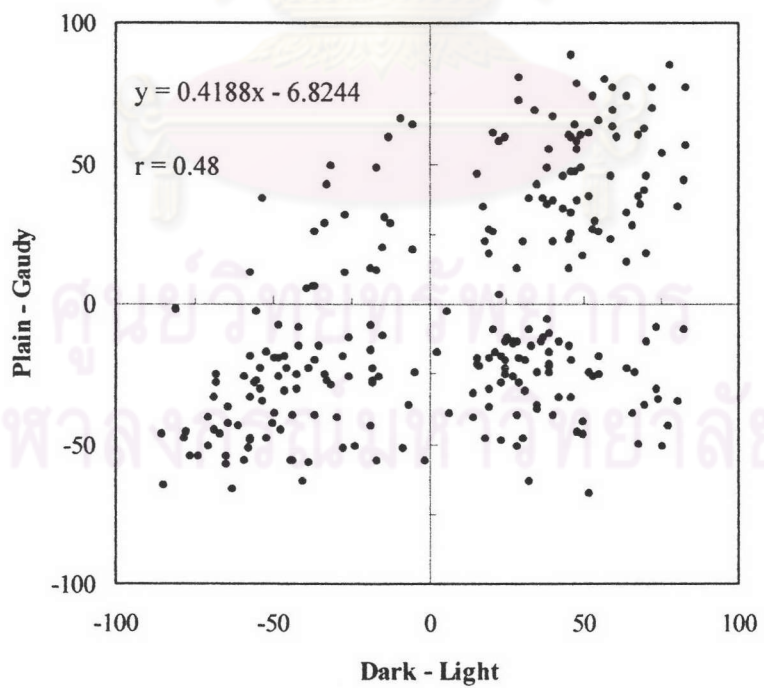


Figure 4-91. Relationship between the visual scores of Dark - Light and the visual scores of Plain - Gaudy

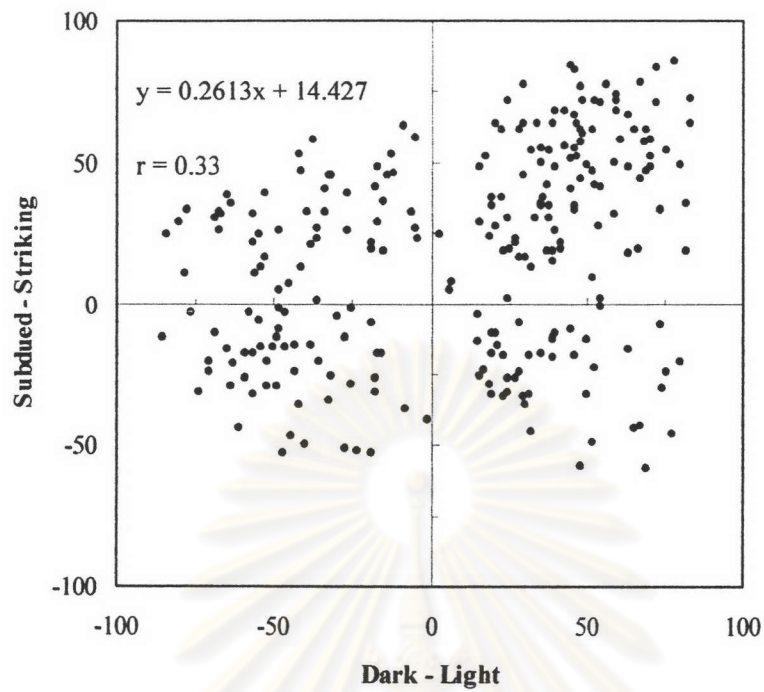


Figure 4-92 Relationship between the visual scores of Dark - Light and the visual scores of Subdued - Striking

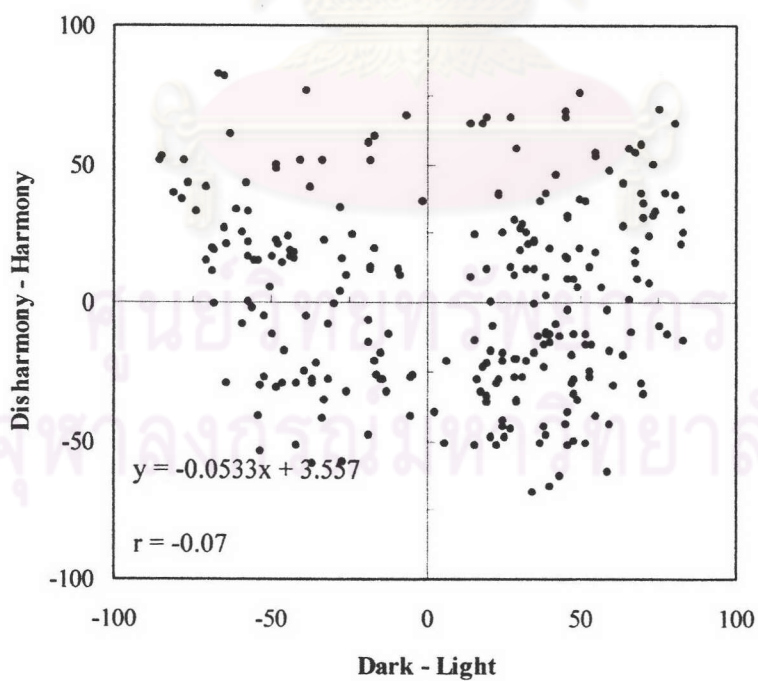


Figure 4-93 Relationship between the visual scores of Dark - Light and the visual scores of Disharmony - Harmony

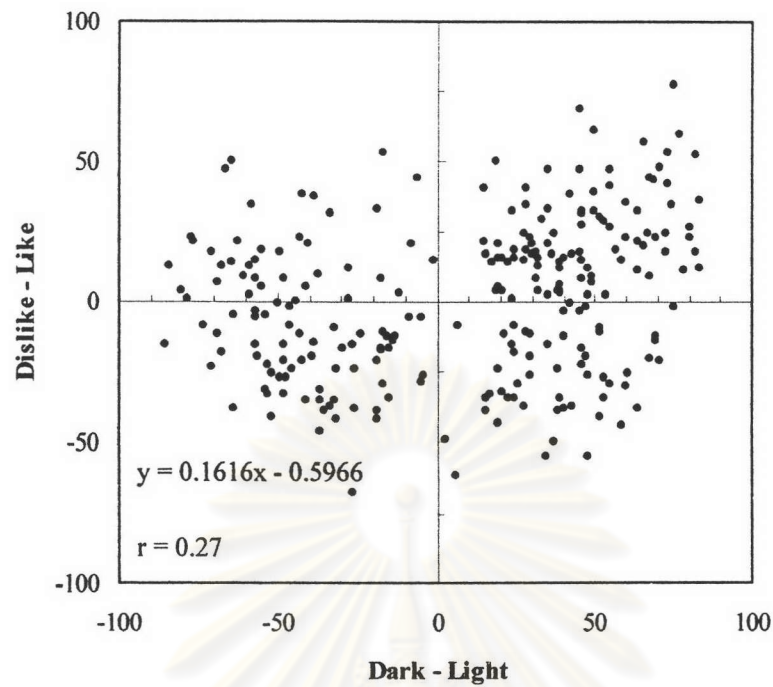


Figure 4-94 Relationship between the visual scores of Dark - Light and the visual scores of Dislike - Like

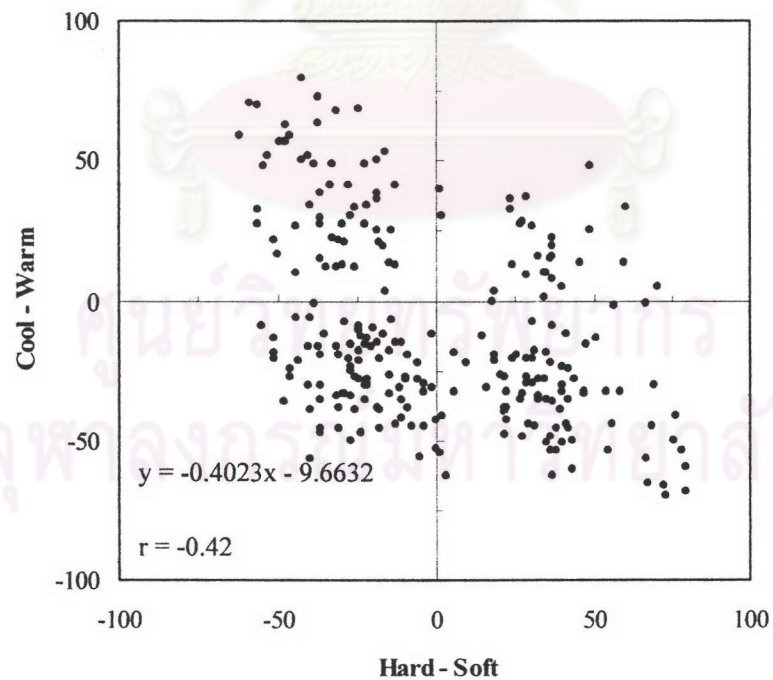


Figure 4-95 Relationship between the visual scores of Hard - Soft and the visual scores of Cool - Warm

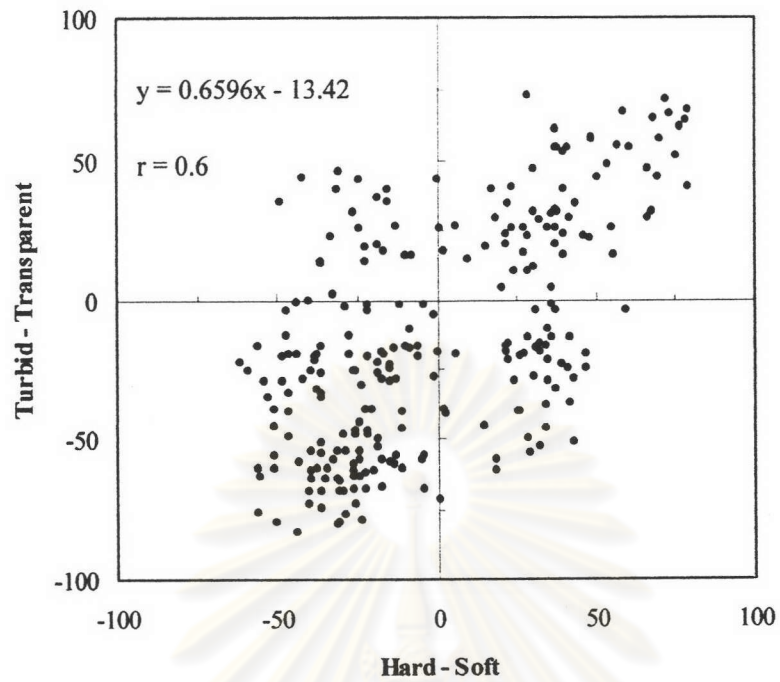


Figure 4-96 Relationship between the visual scores of Hard - Soft and the visual scores of Turbid - Transparent

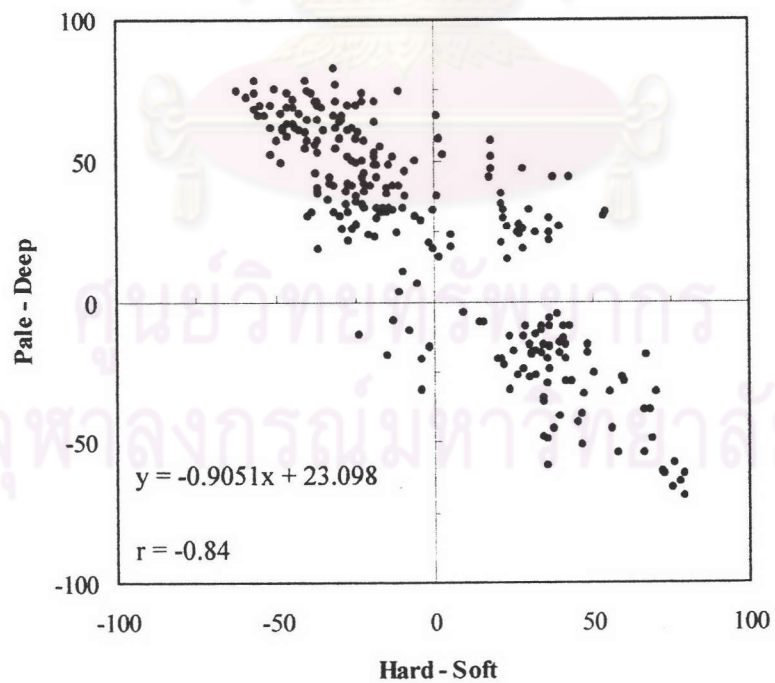


Figure 4-97 Relationship between the visual scores of Hard - Soft and the visual scores of Pale - Deep

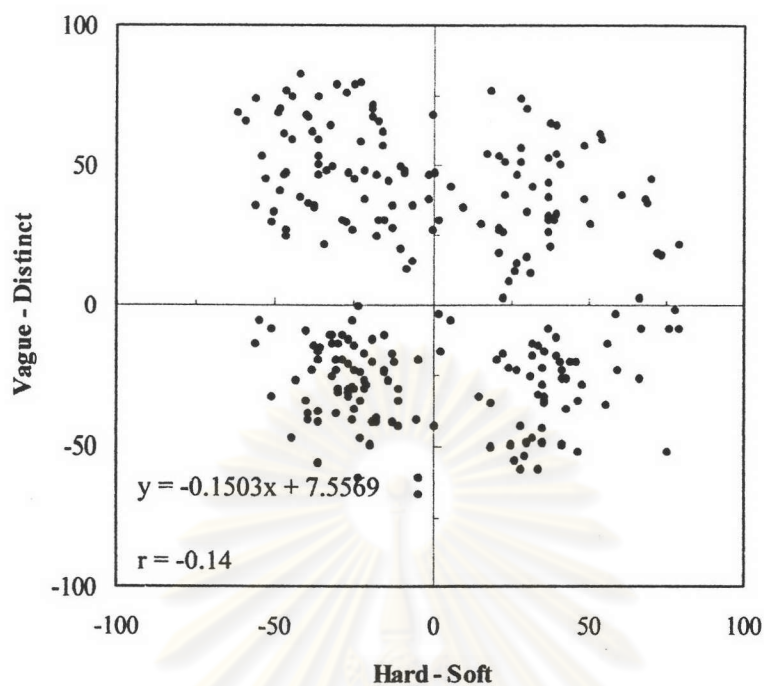


Figure 4-98 Relationship between the visual scores of Hard - Soft and the visual scores of Vague - Distinct

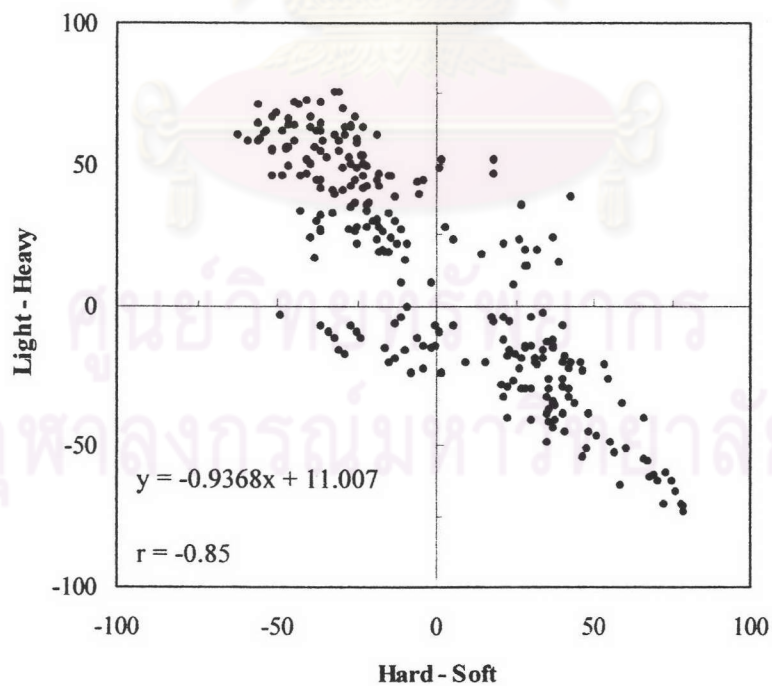


Figure 4-99 Relationship between the visual scores of Hard - Soft and the visual scores of Light - Heavy

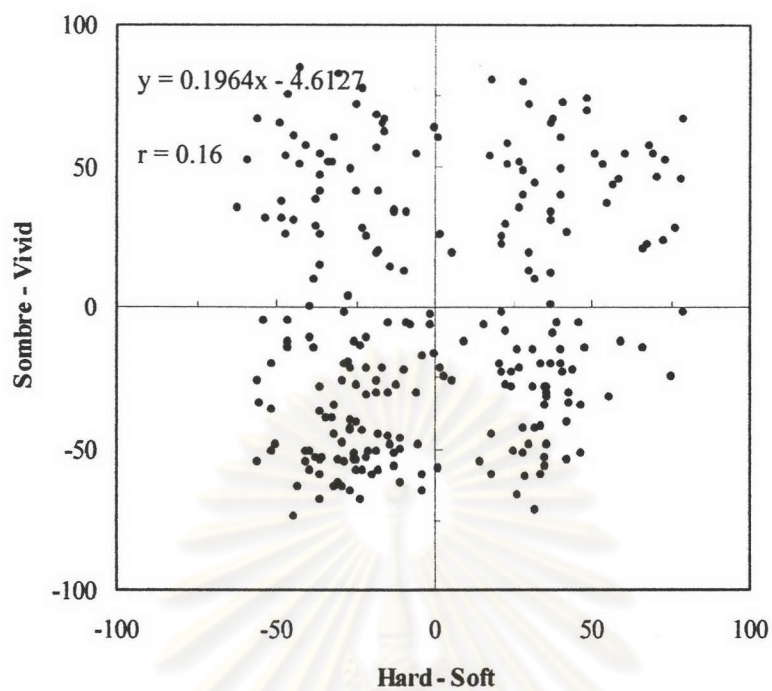


Figure 4-100. Relationship between the visual scores of Hard - Soft and the visual scores of Sombre - Vivid

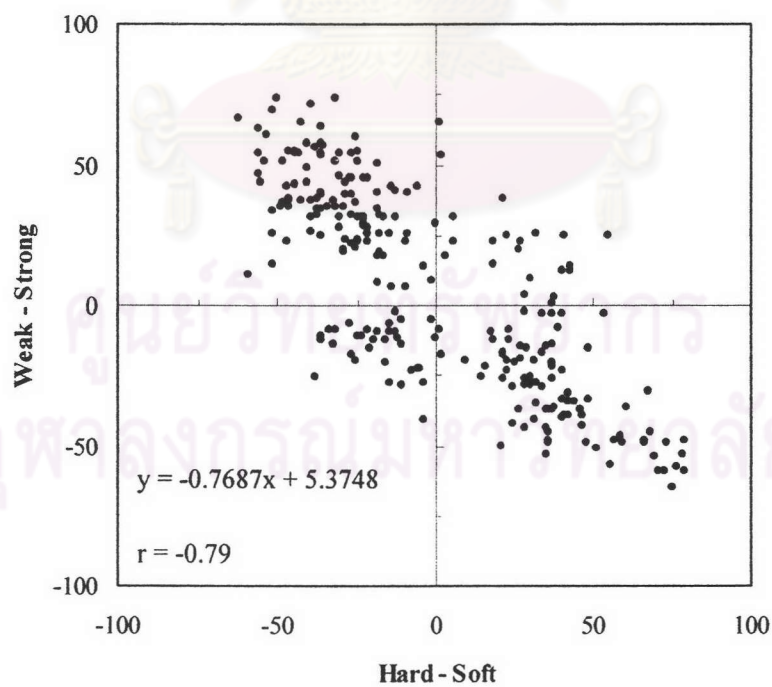


Figure 4-101 Relationship between the visual scores of Hard - Soft and the visual scores of Weak - Strong

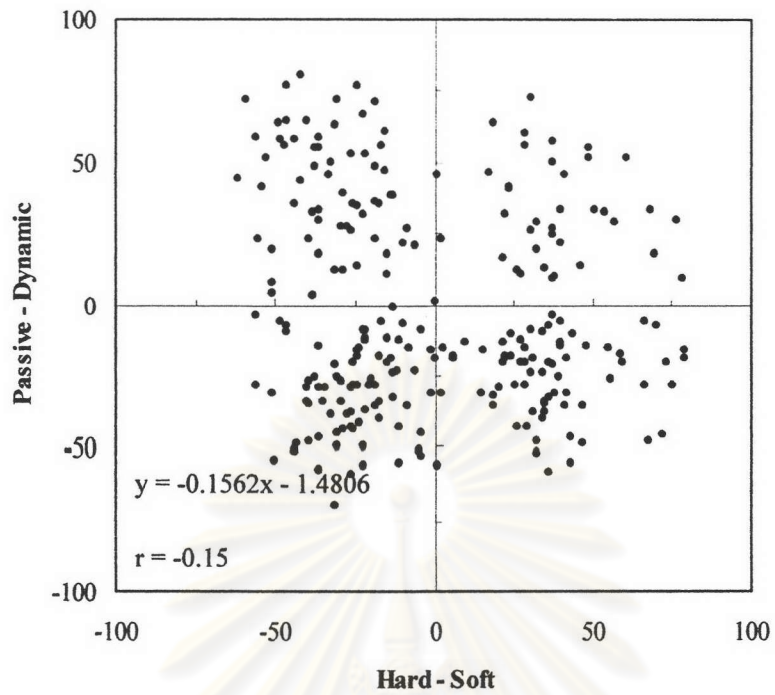


Figure 4-102 Relationship between the visual scores of Hard - Soft and the visual scores of Passive - Dynamic

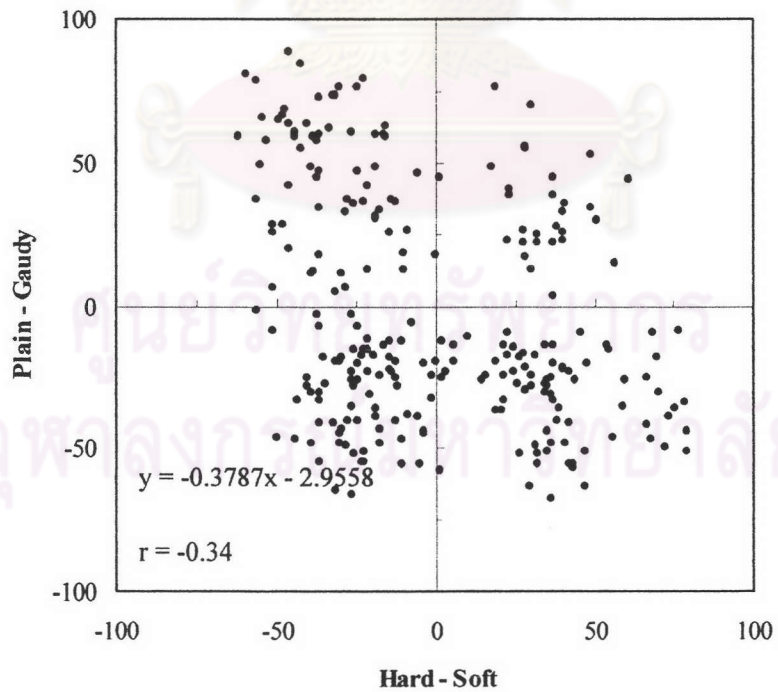


Figure 4-103 Relationship between the visual scores of Hard - Soft and the visual scores of Plain - Gaudy

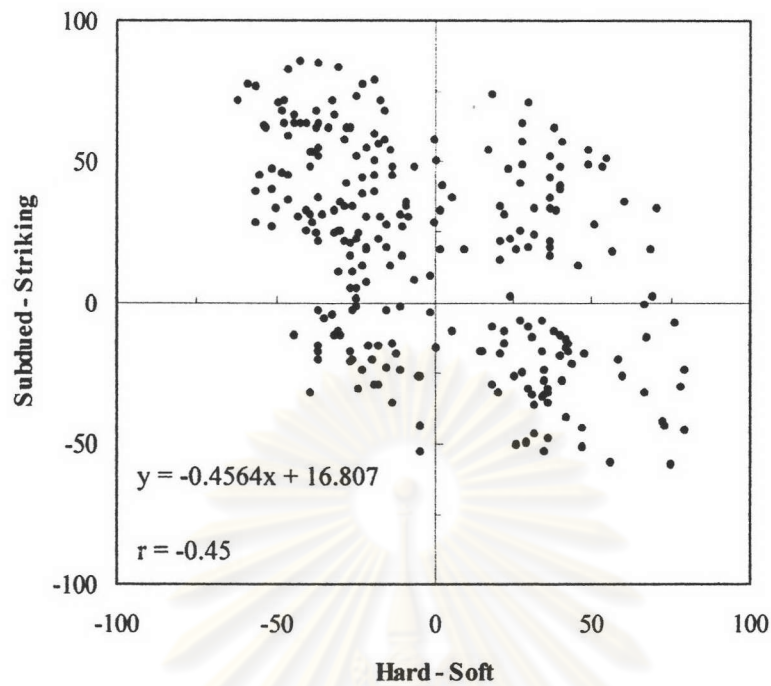


Figure 4-104 Relationship between the visual scores of Hard - Soft and the visual scores of Subdued - Striking

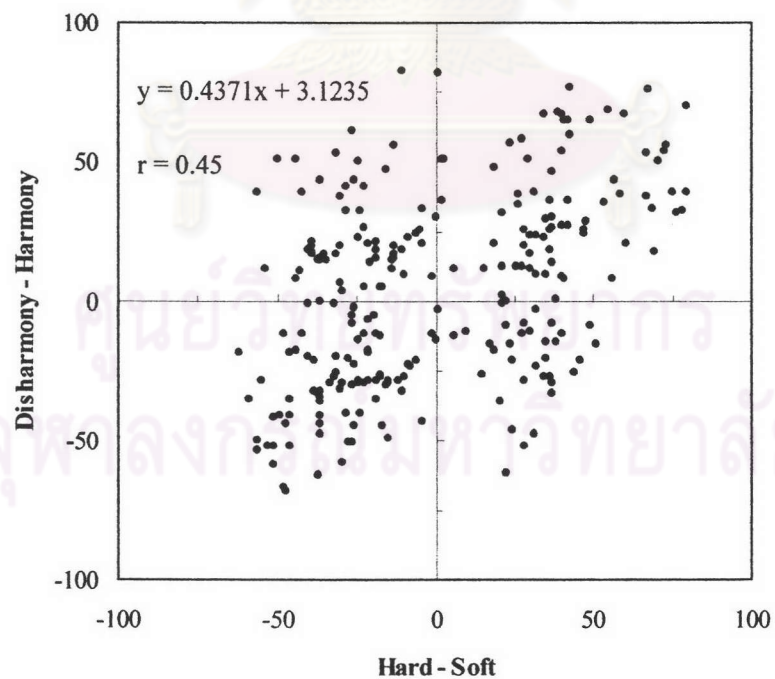


Figure 4-105 Relationship between the visual scores of Hard - Soft and the visual scores of Disharmony - Harmony

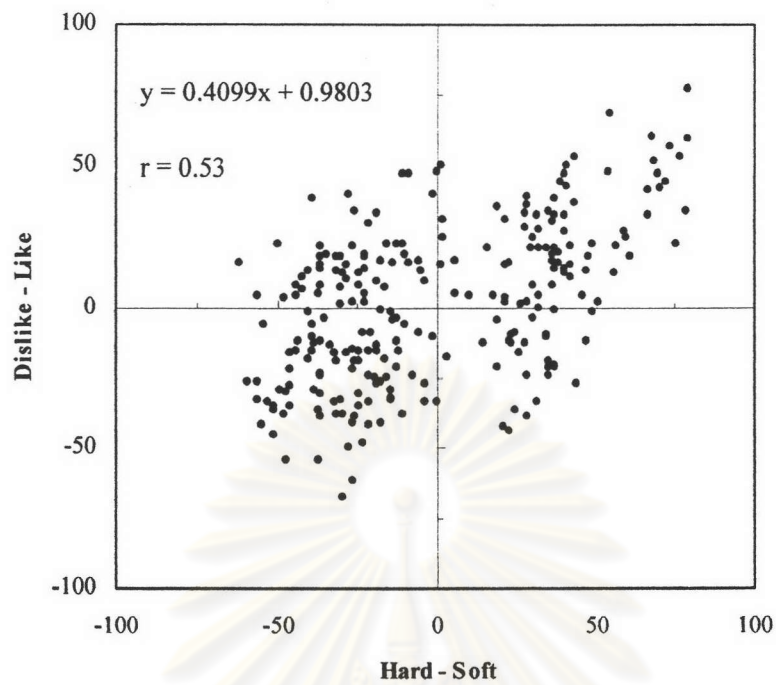


Figure 4-106 Relationship between the visual scores of Hard - Soft and the visual scores of Dislike - Like

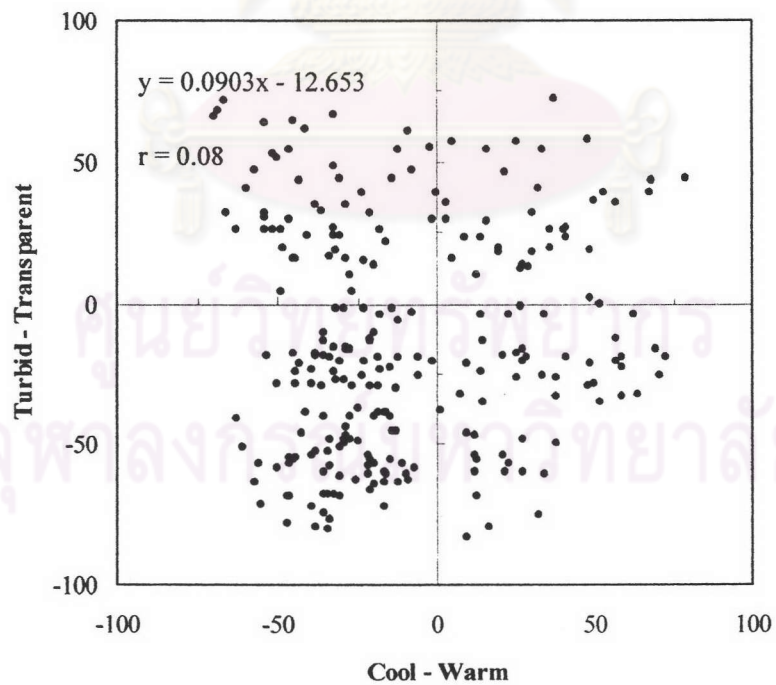


Figure 4-107 Relationship between the visual scores of Cool - Warm and the visual scores of Turbid - Transparent

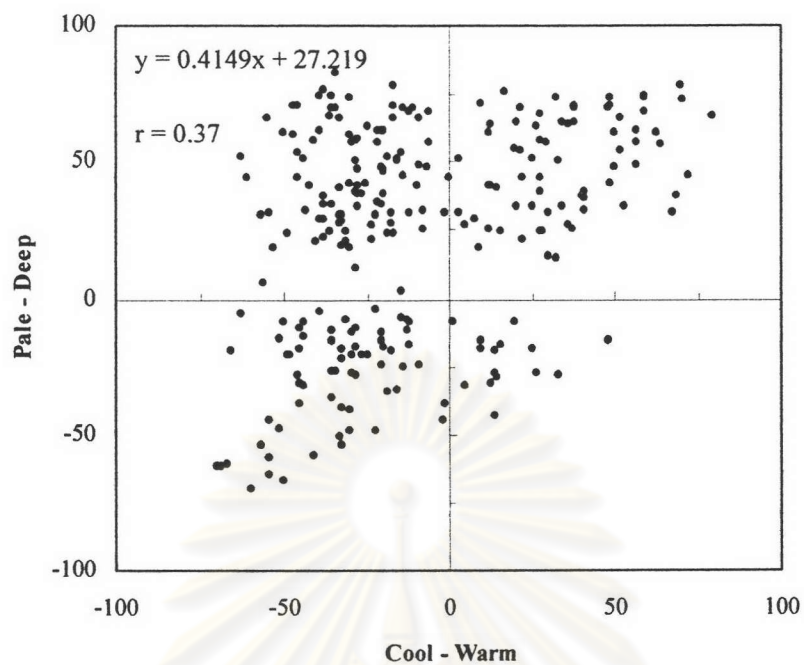


Figure 4-108 Relationship between the visual scores of Cool - Warm and the visual scores of Pale - Deep

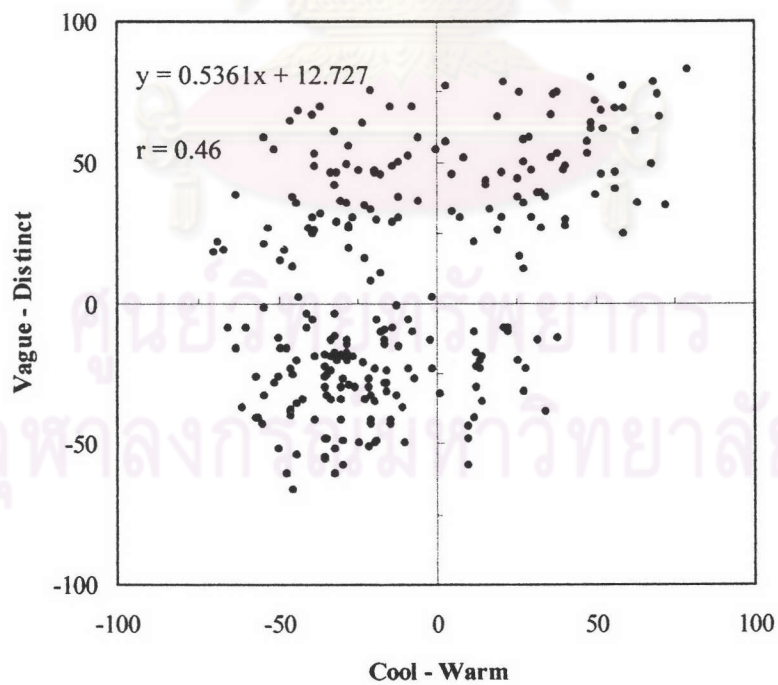


Figure 4-109 Relationship between the visual scores of Cool - Warm and the visual scores of Vague - Distinct

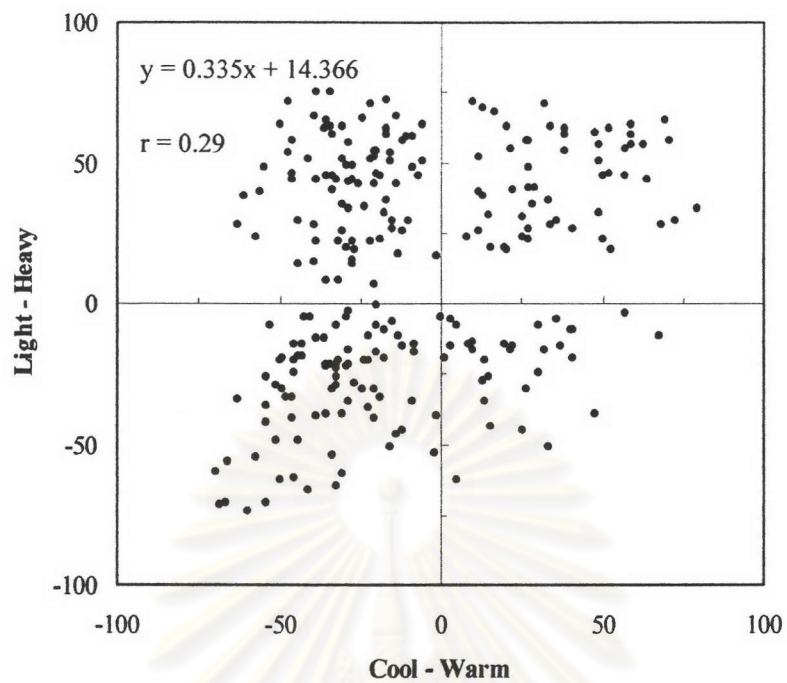


Figure 4-110 Relationship between the visual scores of Cool - Warm and the visual scores of Light - Heavy

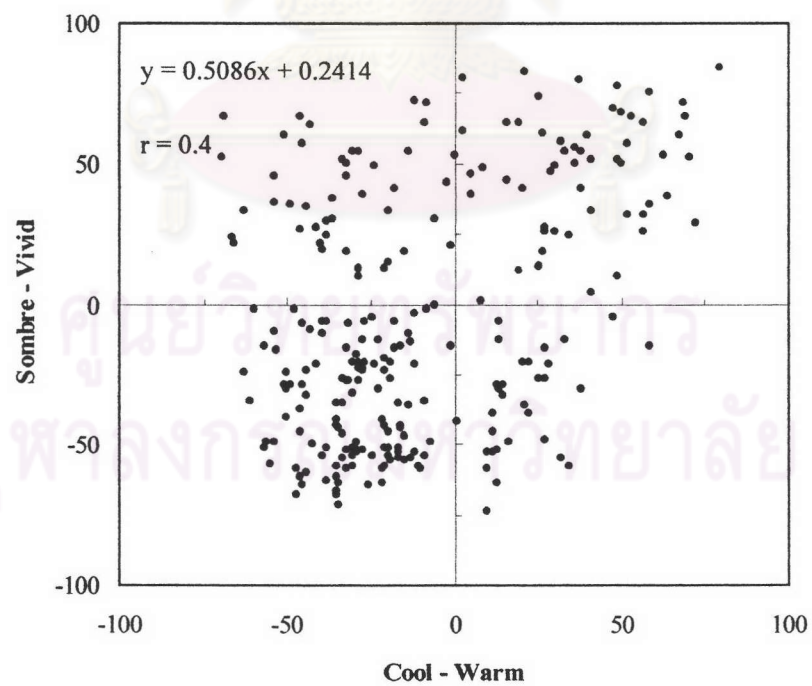


Figure 4-111 Relationship between the visual scores of Cool - Warm and the visual scores of Sombre - Vivid

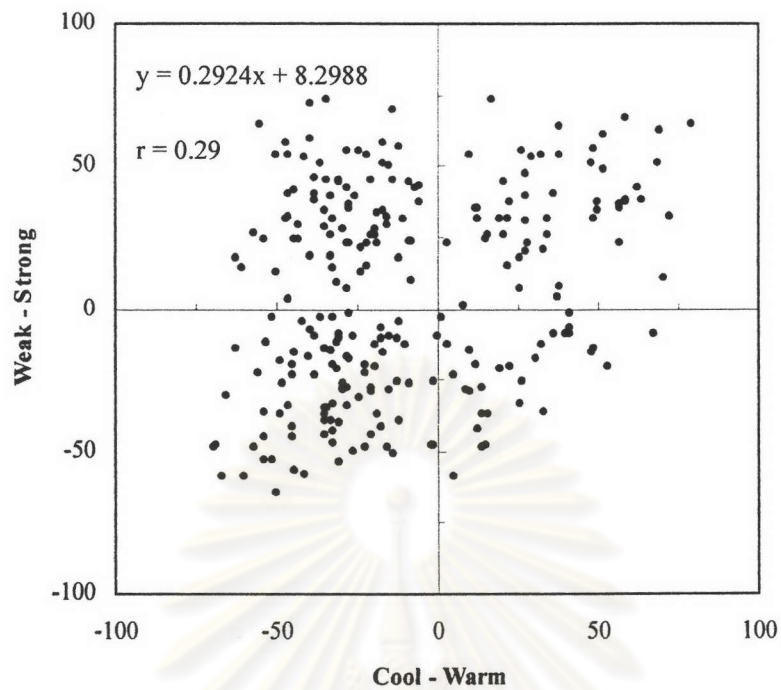


Figure 4-112 Relationship between the visual scores of Cool - Warm and the visual scores of Weak - Strong

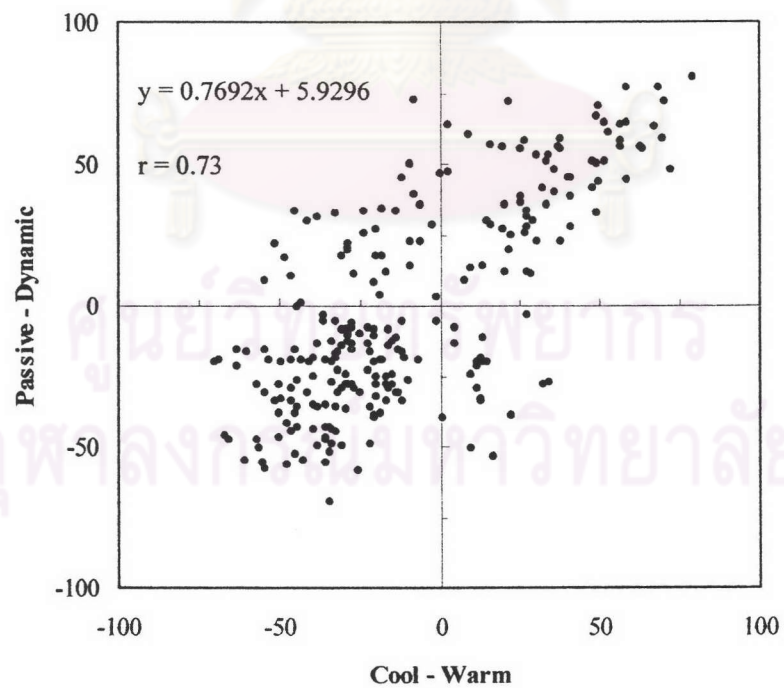


Figure 4-113. Relationship between the visual scores of Cool - Warm and the visual scores of Passive - Dynamic

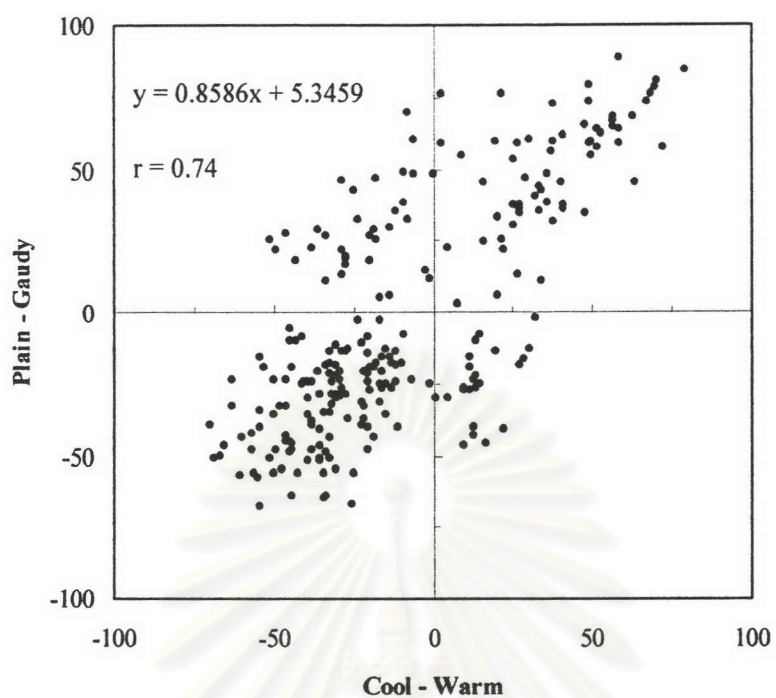


Figure 4-114 Relationship between the visual scores of Cool - Warm and the visual scores of Plain - Gaudy

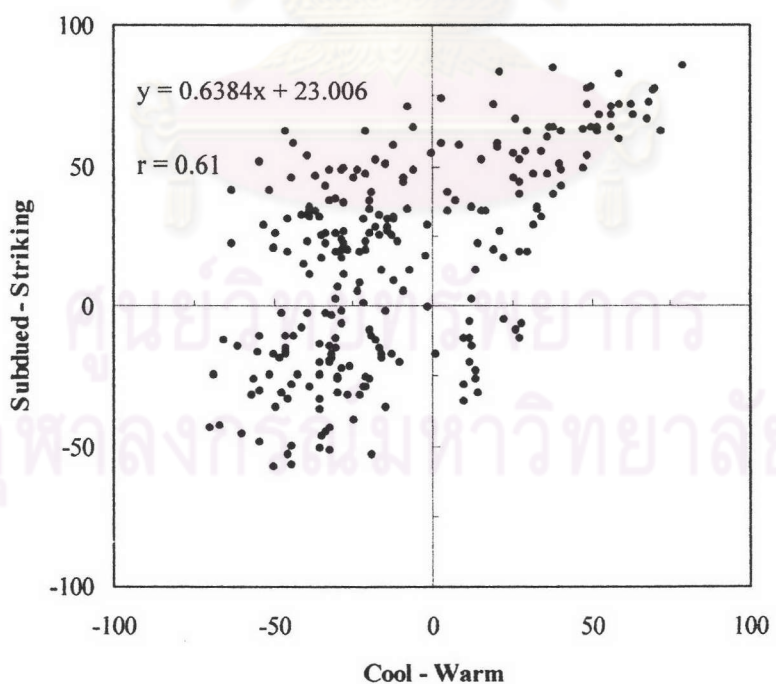


Figure 4-115 Relationship between the visual scores of Cool - Warm and the visual scores of Subdued - Striking

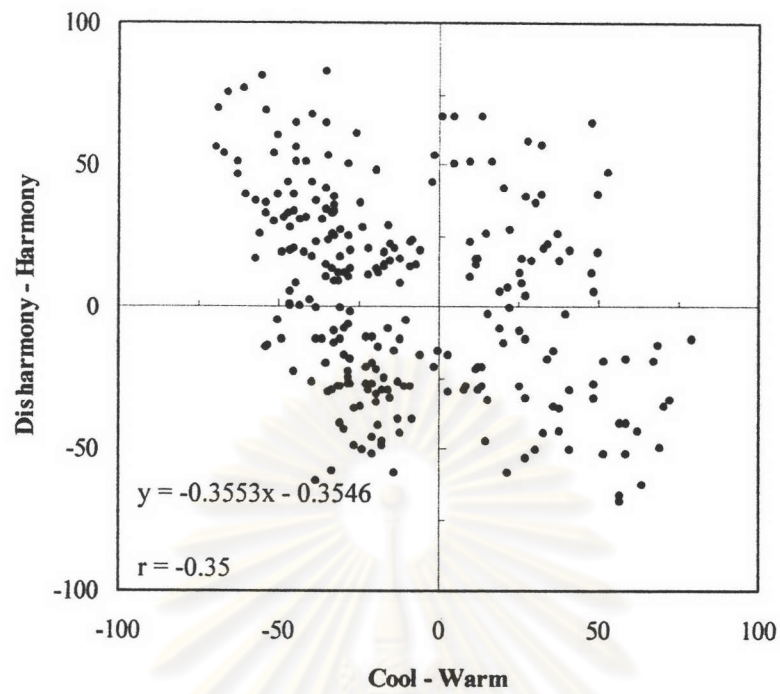


Figure 4-116. Relationship between the visual scores of Cool - Warm and the visual scores of Disharmony - Harmony

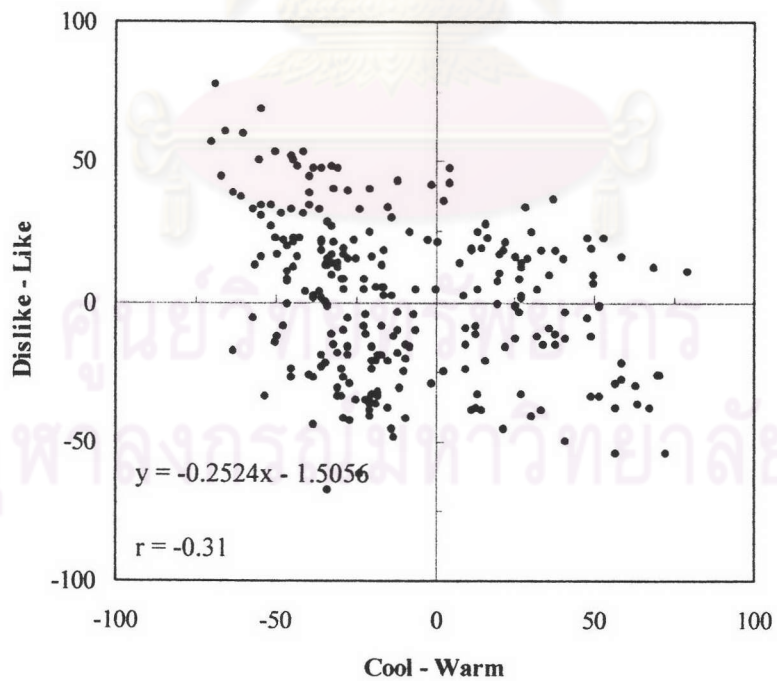


Figure 4-117 Relationship between the visual scores of Cool - Warm and the visual scores of Dislike - Like

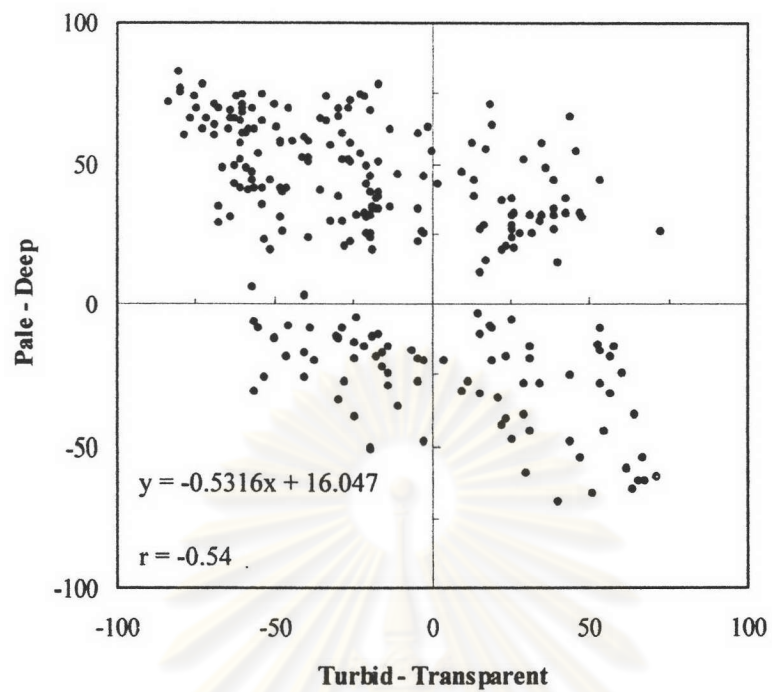


Figure 4-118 Relationship between the visual scores of Turbid - Transparent and the visual scores of Pale - Deep

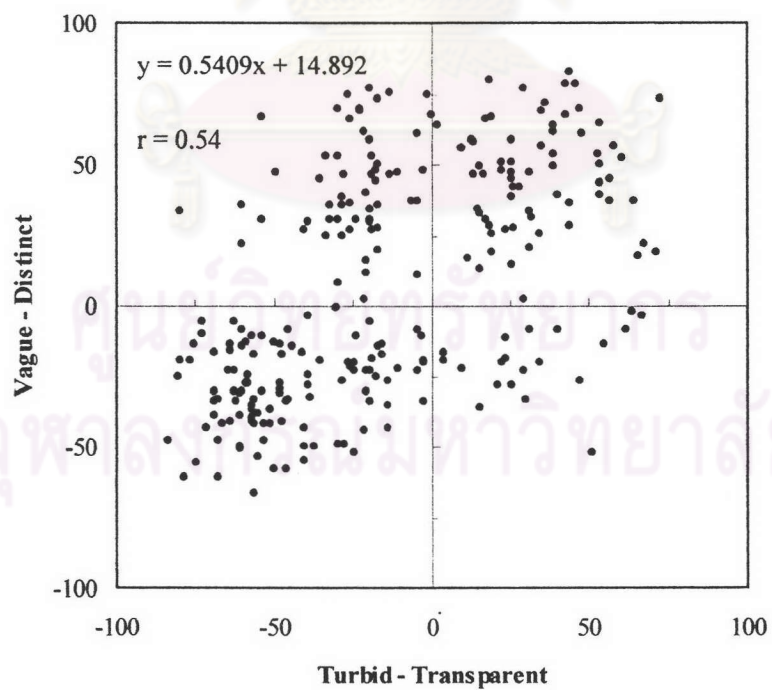


Figure 4-119 Relationship between the visual scores of Turbid - Transparent and the visual scores of Vague - Distinct

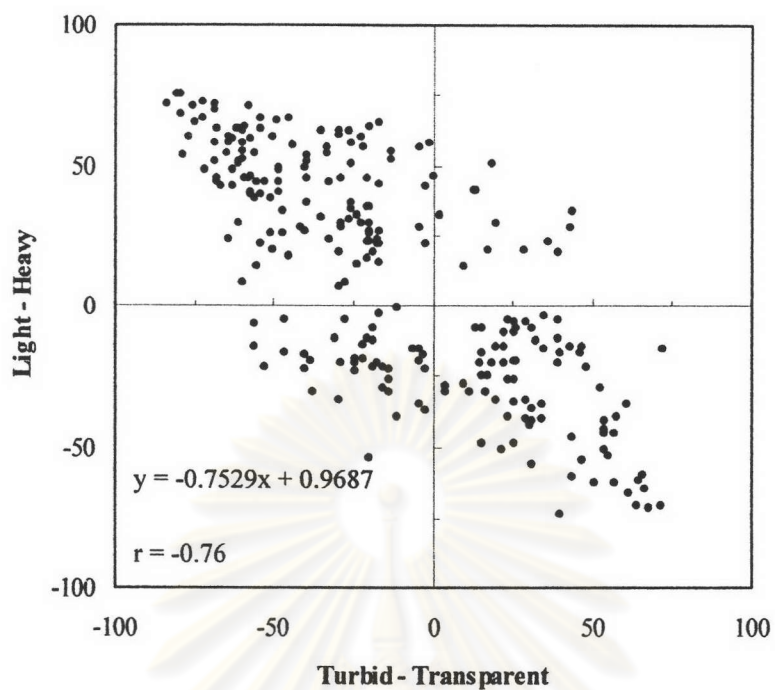


Figure 4-120 Relationship between the visual scores of Turbid - Transparent and the visual scores of Light - Heavy

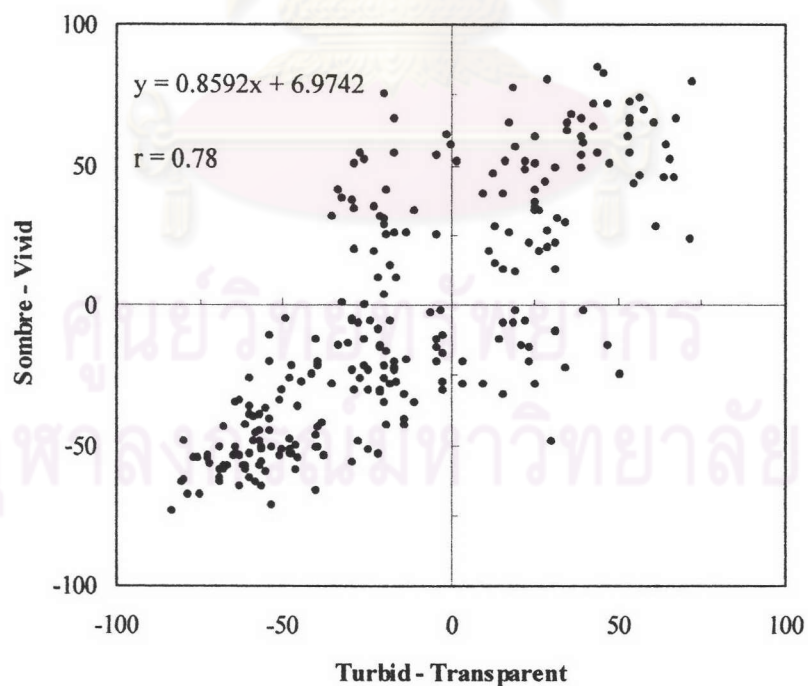


Figure 4-121 Relationship between the visual scores of Turbid - Transparent and the visual scores of Sombre - Vivid

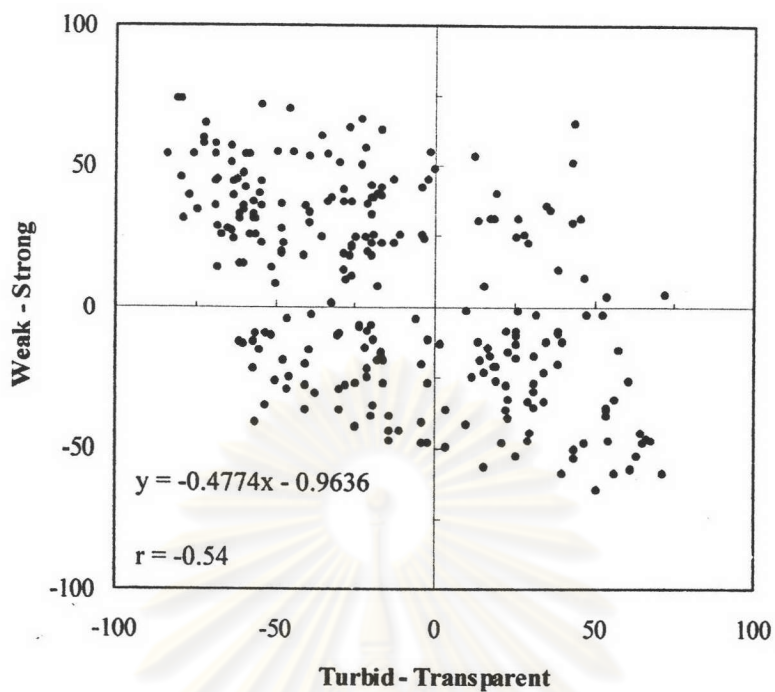


Figure 4-122 Relationship between the visual scores of Turbid - Transparent and the visual scores of Weak - Strong

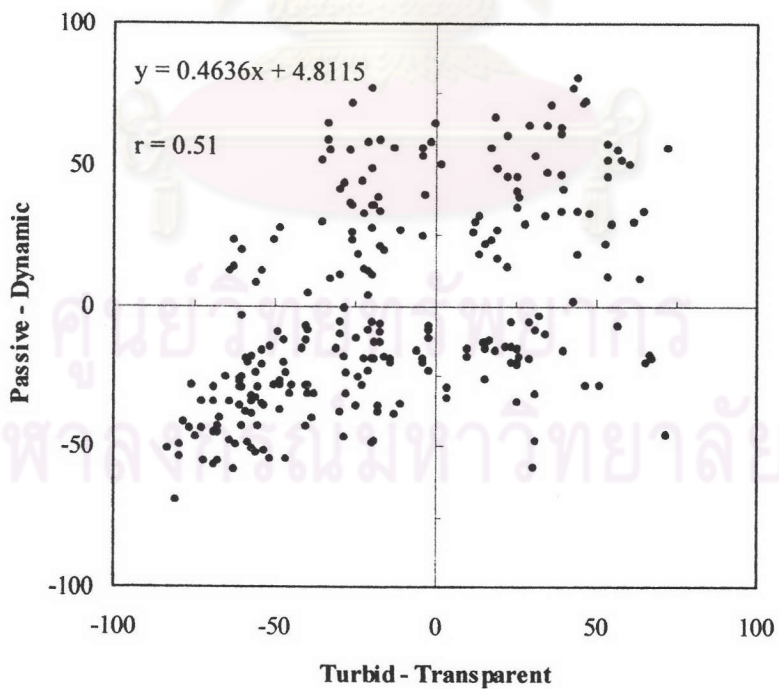


Figure 4-123 Relationship between the visual scores of Turbid - Transparent and the visual scores of Passive - Dynamic

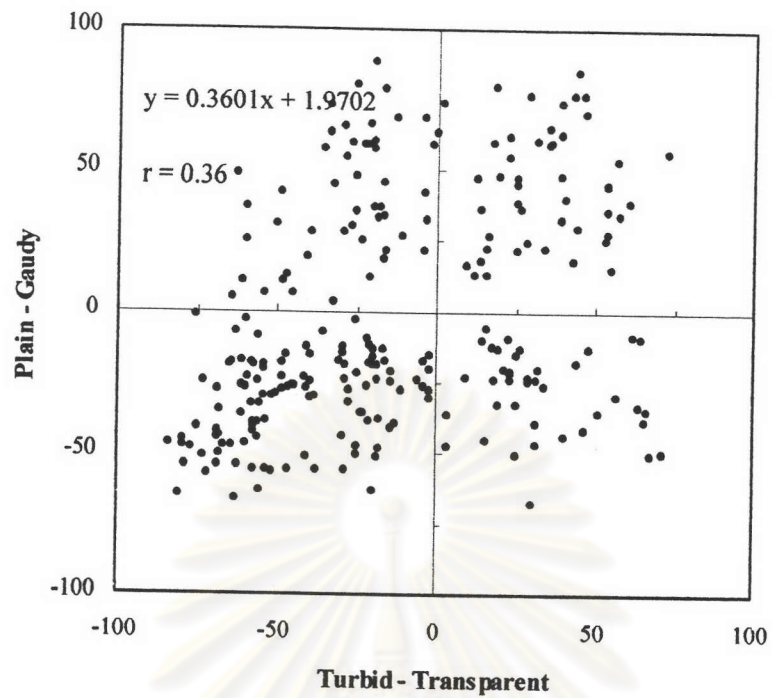


Figure 4-124 Relationship between the visual scores of Turbid - Transparent and the visual scores of Plain - Gaudy

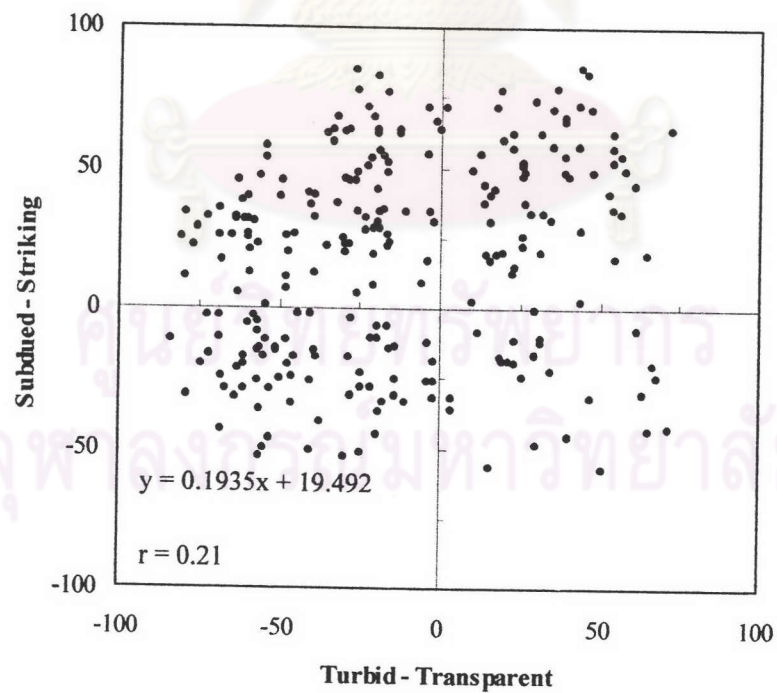


Figure 4-125 Relationship between the visual scores of Turbid - Transparent and the visual scores of Subdued - Striking

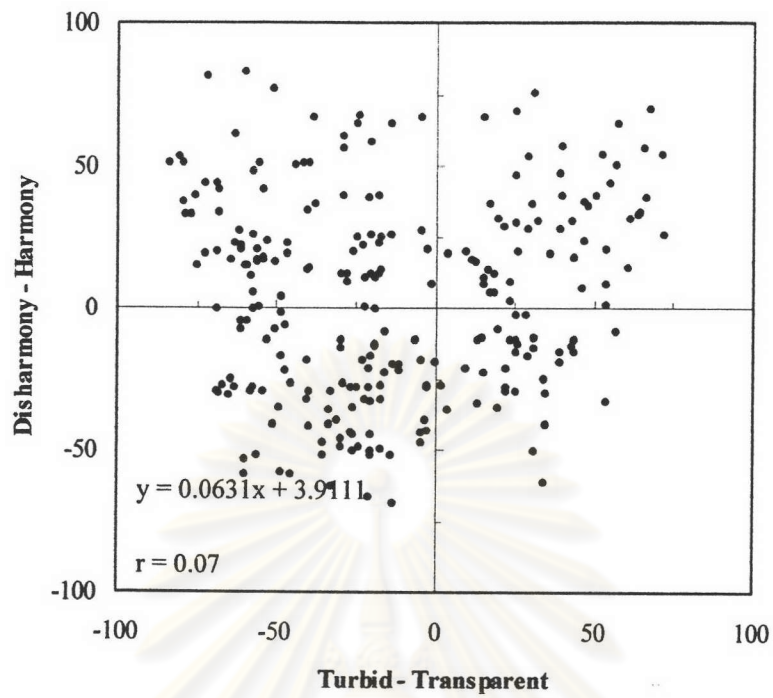


Figure 4-126. Relationship between the visual scores of Turbid - Transparent and the visual scores of Disharmony - Harmony

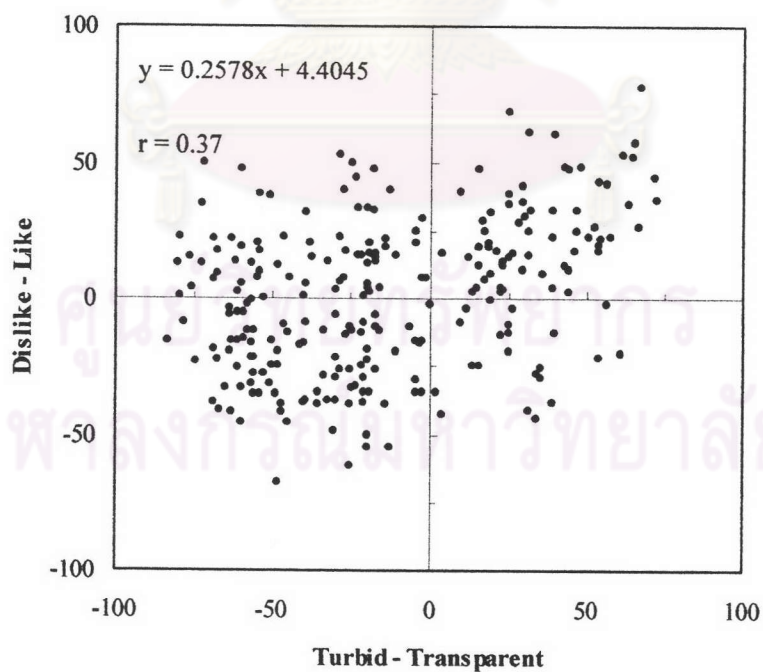


Figure 4-127 Relationship between the visual scores of Turbid - Transparent and the visual scores of Dislike - Like

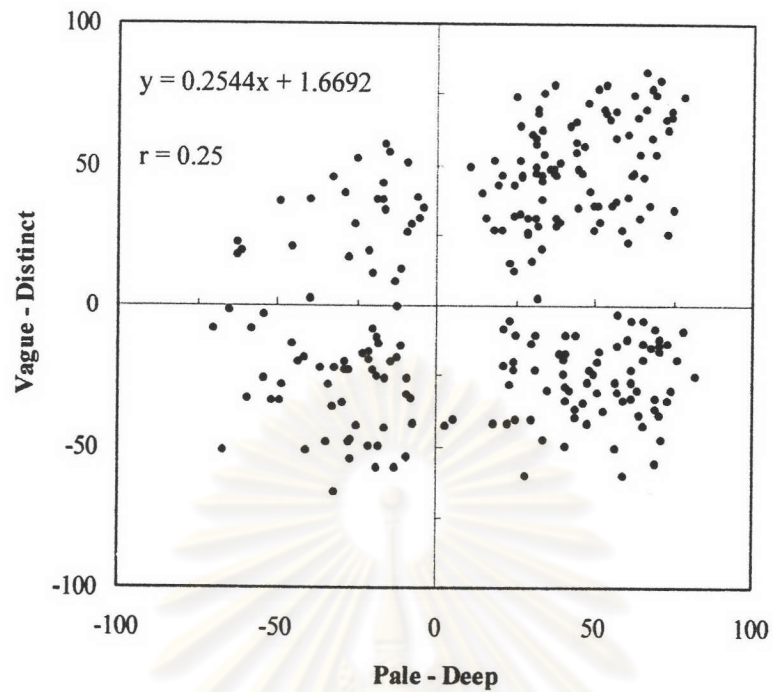


Figure 4-128 Relationship between the visual scores of Pale - Deep and the visual scores of Vague - Distinct

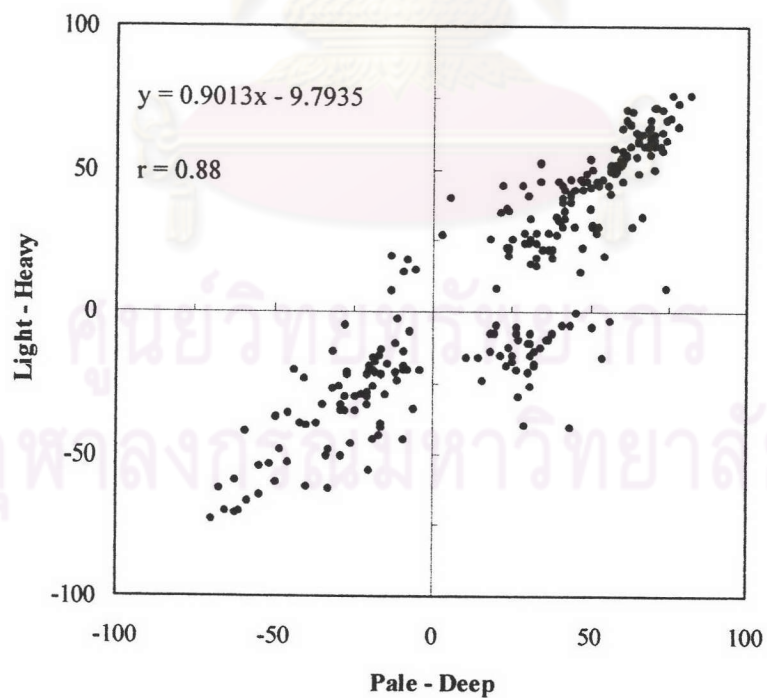


Figure 4-129 Relationship between the visual scores of Pale - Deep and the visual scores of Light - Heavy

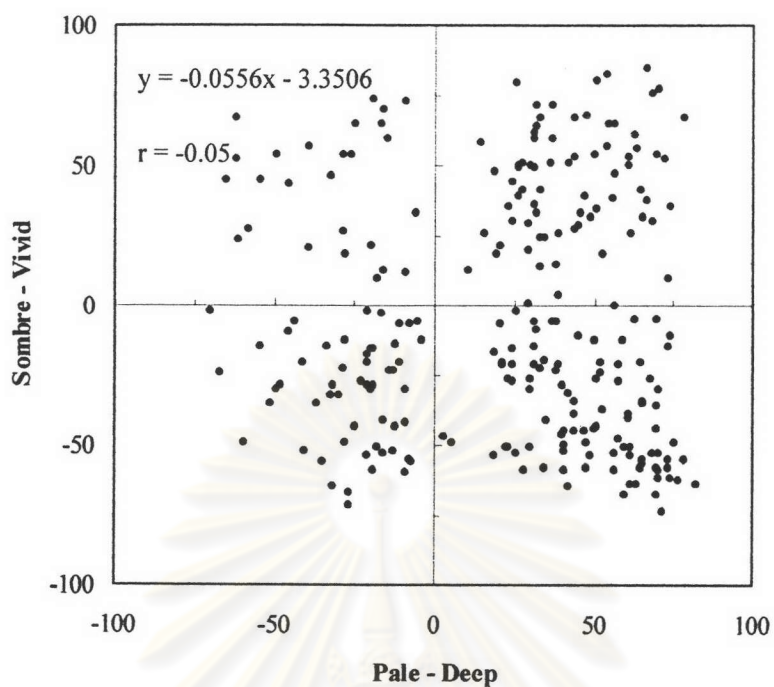


Figure 4-130. Relationship between the visual scores of Pale - Deep and the visual scores of Sombre - Vivid

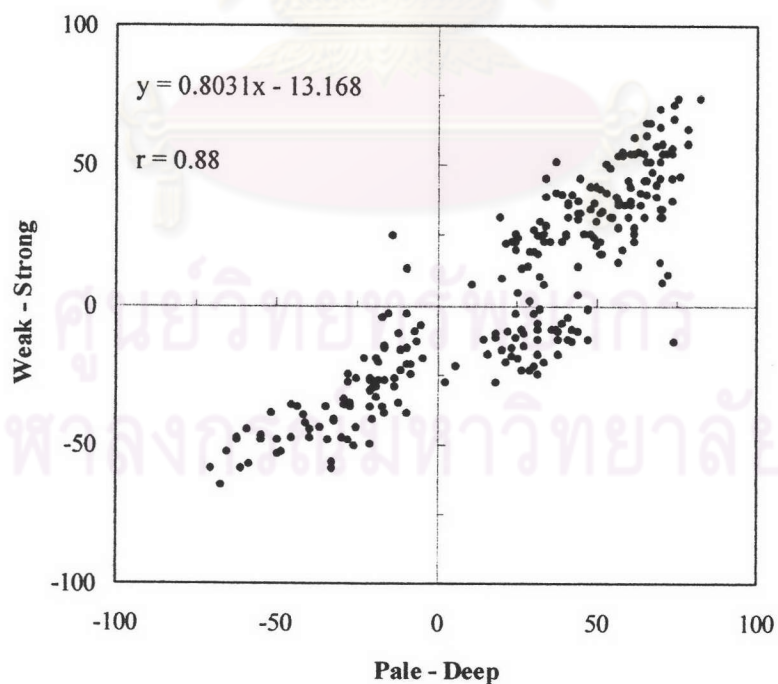


Figure 4-131 Relationship between the visual scores of Pale - Deep and the visual scores of Weak - Strong

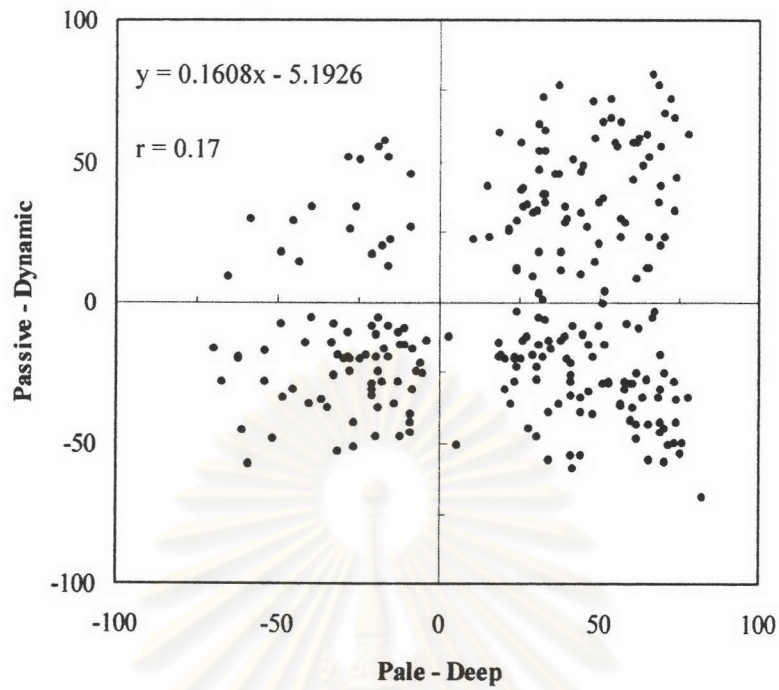


Figure 4-132 Relationship between the visual scores of Pale - Deep and the visual scores of Passive - Dynamic

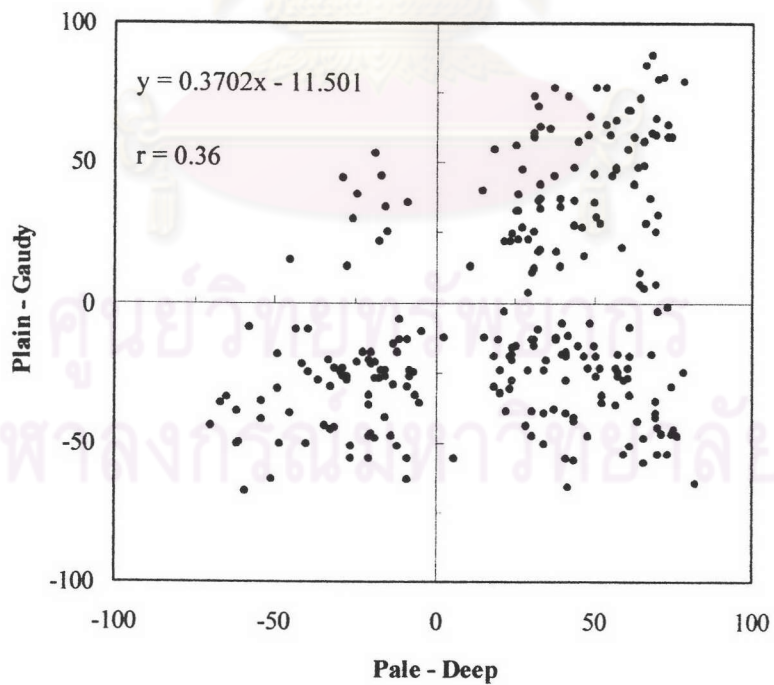


Figure 4-133 Relationship between the visual scores of Pale - Deep and the visual scores of Plain - Gaudy

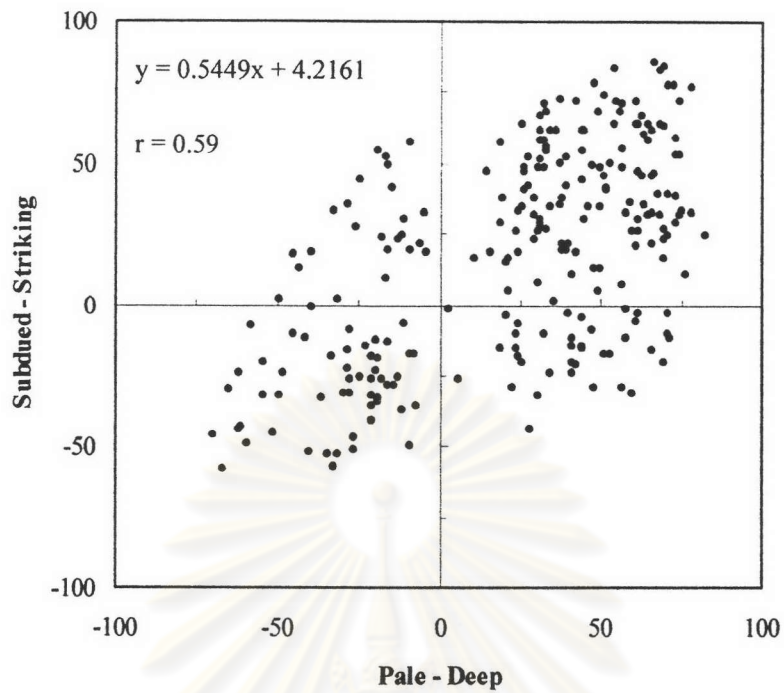


Figure 4-134. Relationship between the visual scores of Pale - Deep and the visual scores of Subdued - Striking

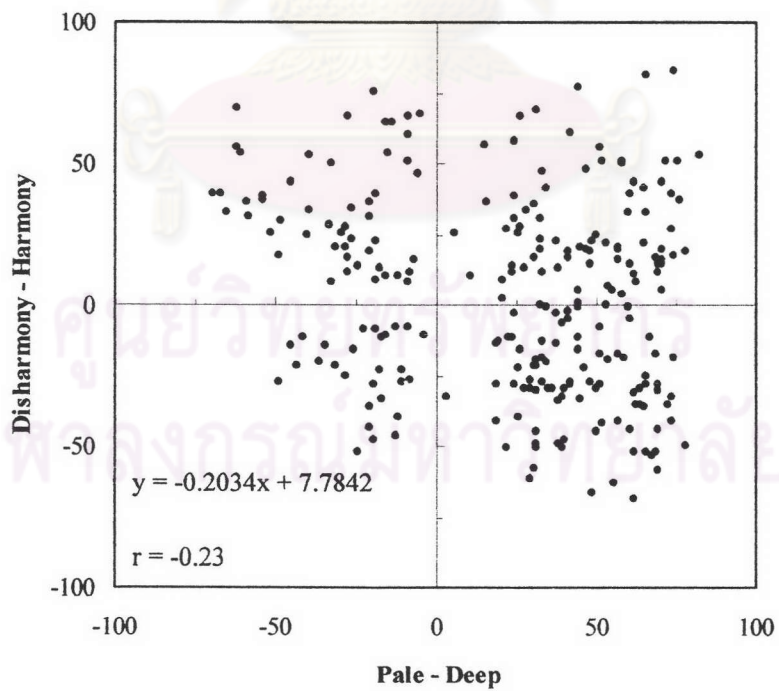


Figure 4-135 Relationship between the visual scores of Pale - Deep and the visual scores of Disharmony - Harmony

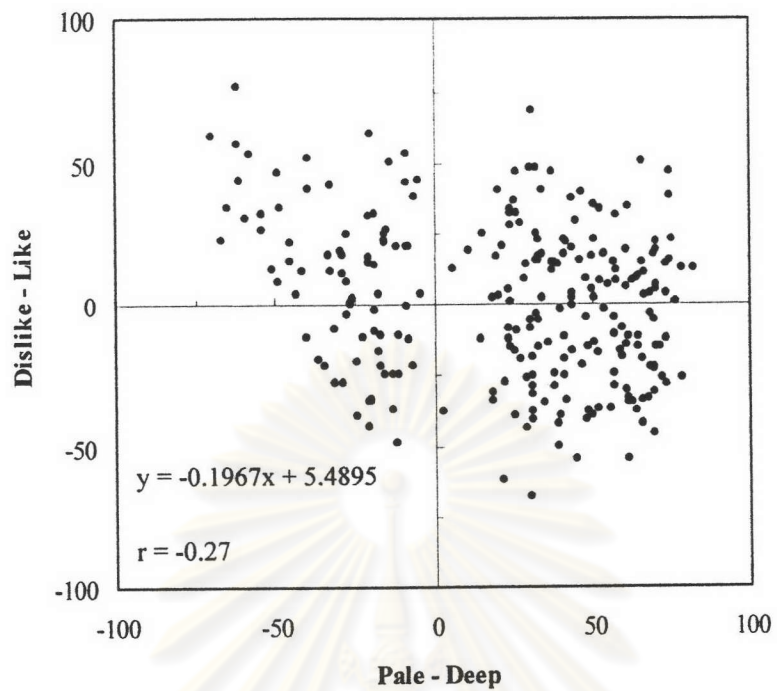


Figure 4-136 Relationship between the visual scores of Pale - Deep and the visual scores of Dislike - Like

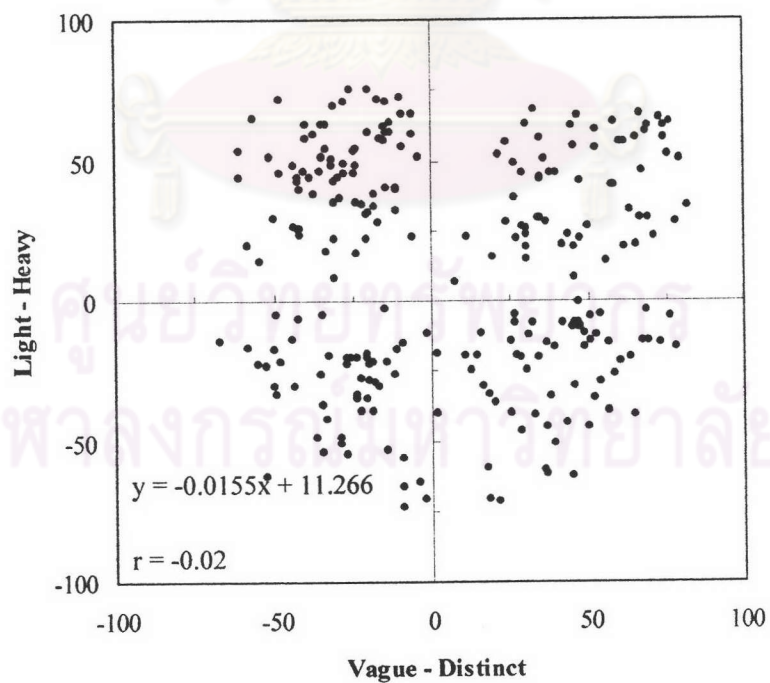


Figure 4-137 Relationship between the visual scores of Vague - Distinct and the visual scores of Light - Heavy

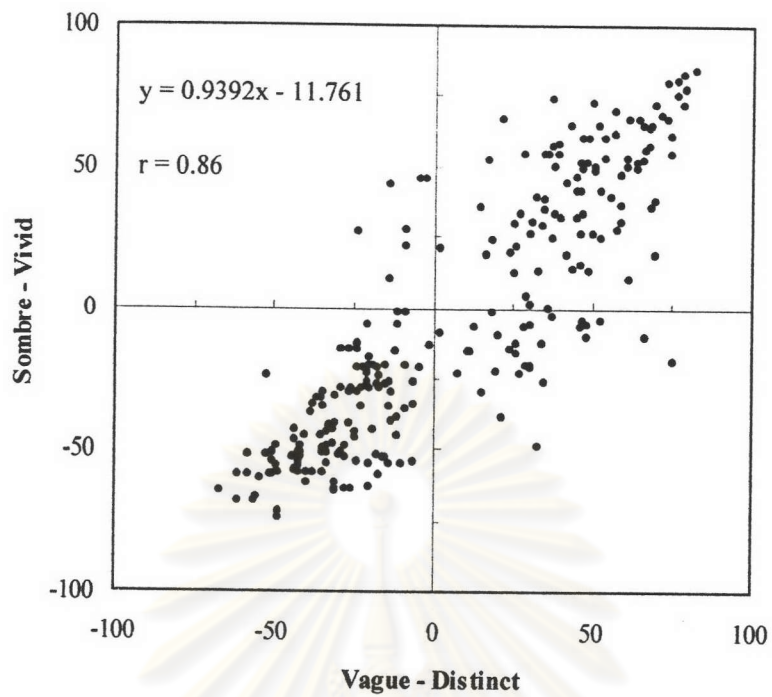


Figure 4-138 Relationship between the visual scores of Vague - Distinct and the visual scores of Sombre - Vivid

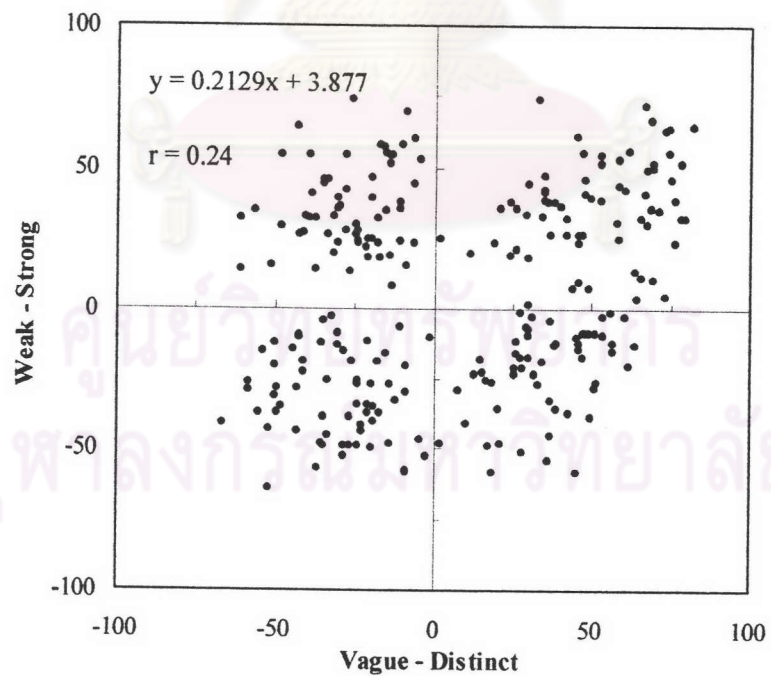


Figure 4-139 Relationship between the visual scores of Vague - Distinct and the visual scores of Weak - Strong

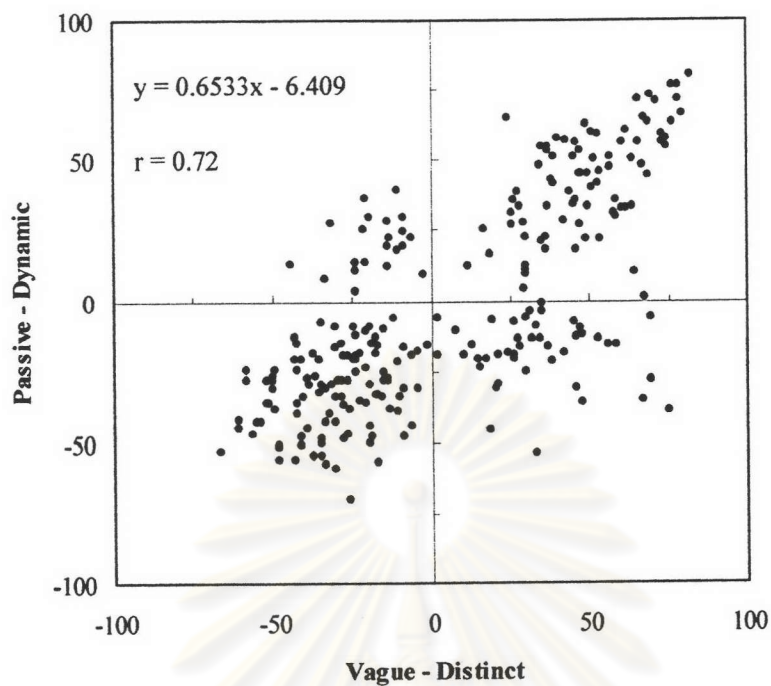


Figure 4-140 Relationship between the visual scores of Vague - Distinct and the visual scores of Passive - Dynamic

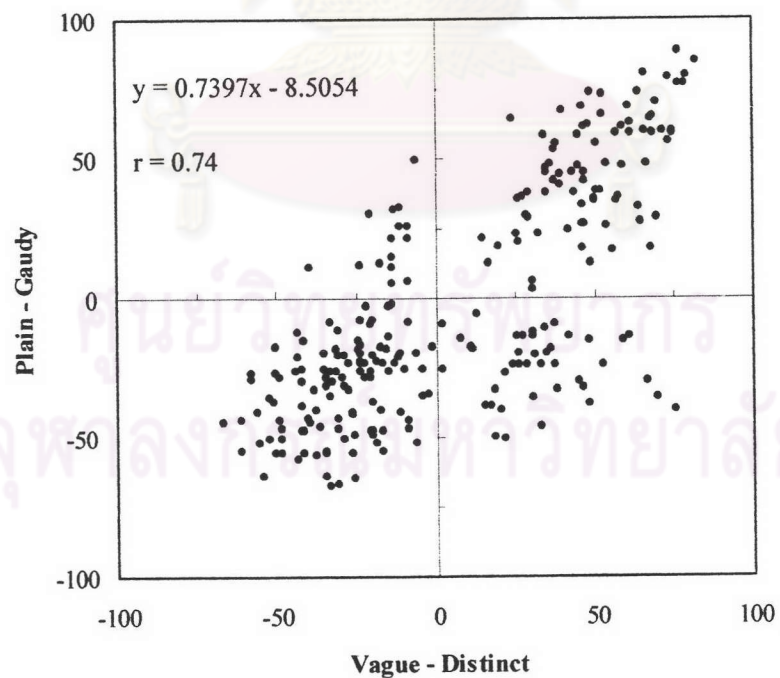


Figure 4-141 Relationship between the visual scores of Vague - Distinct and the visual scores of Plain - Gaudy

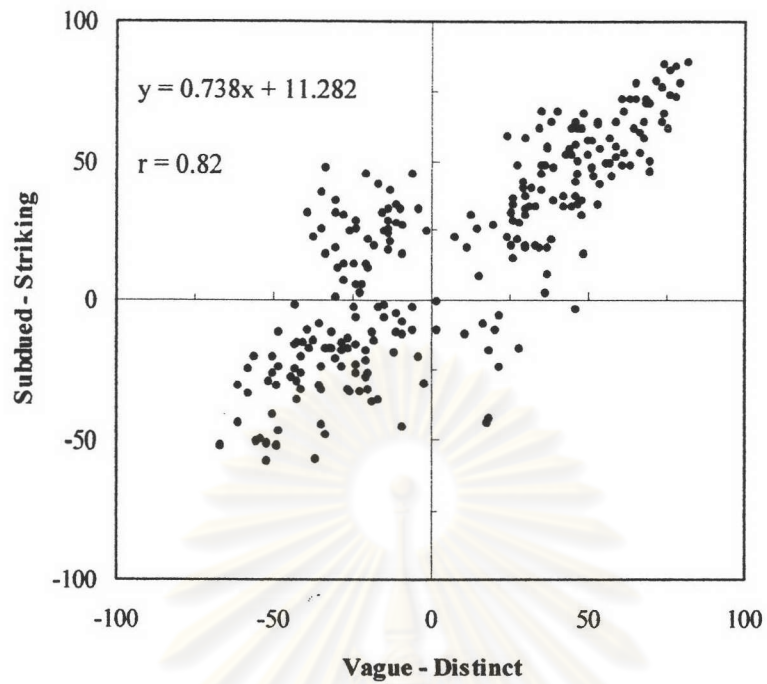


Figure 4-142. Relationship between the visual scores of Vague - Distinct and the visual scores of Subdued - Striking

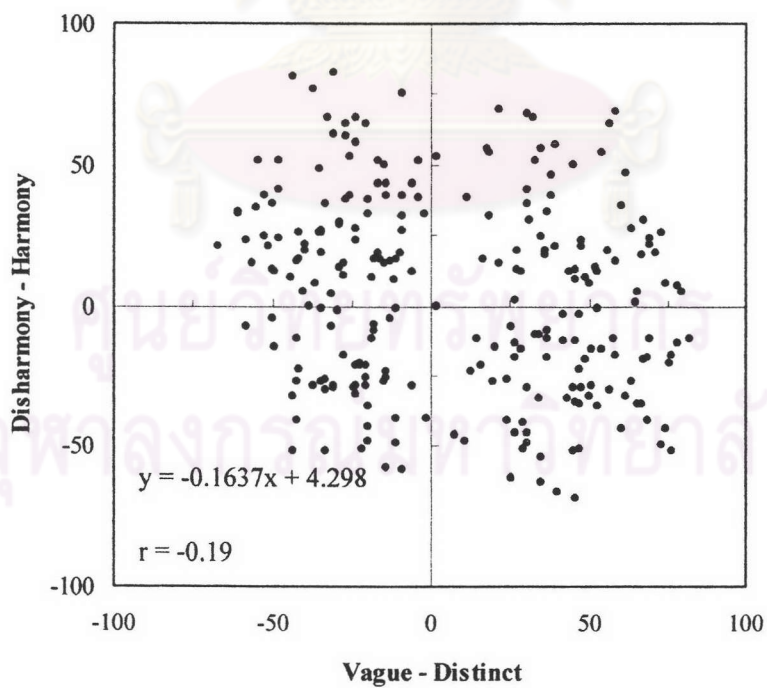


Figure 4-143. Relationship between the visual scores of Vague - Distinct and the visual scores of Disharmony - Harmony

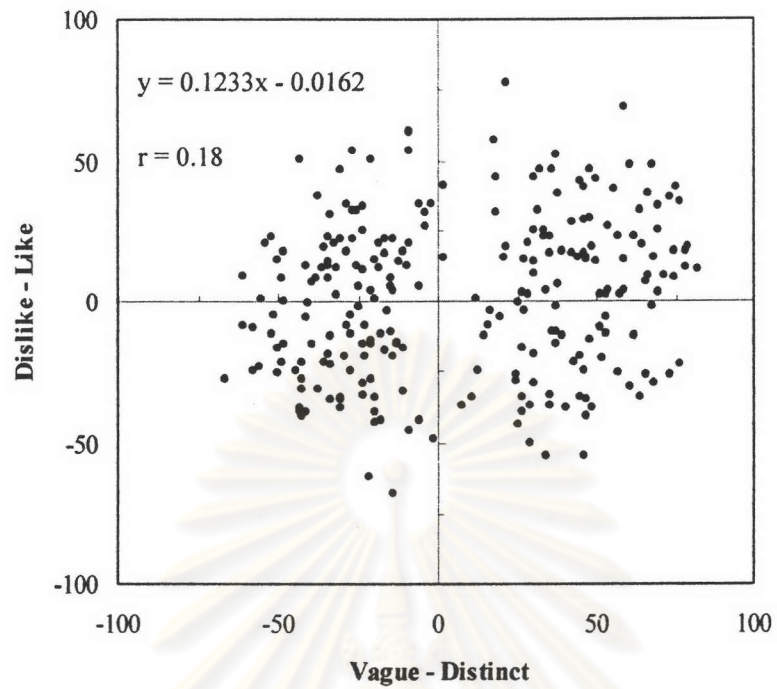


Figure 4-144 Relationship between the visual scores of Vague - Distinct and the visual scores of Dislike - Like

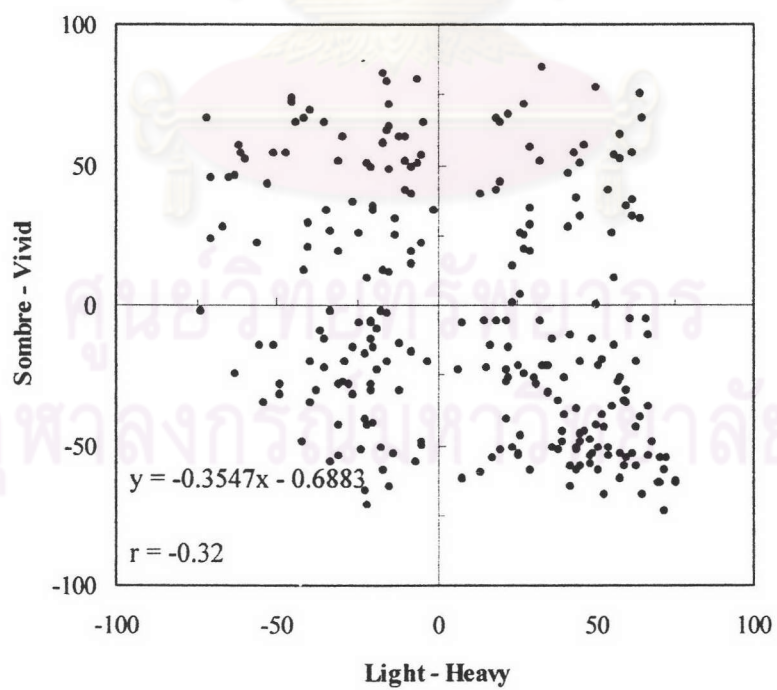


Figure 4-145 Relationship between the visual scores of Light - Heavy and the visual scores of Sombre - Vivid

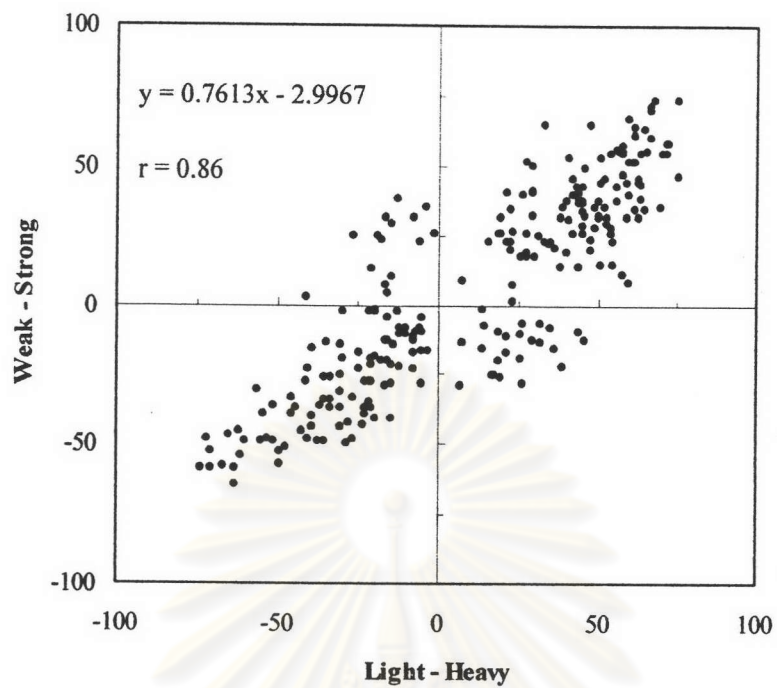


Figure 4-146 Relationship between the visual scores of Light - Heavy and the visual scores of Weak - Strong

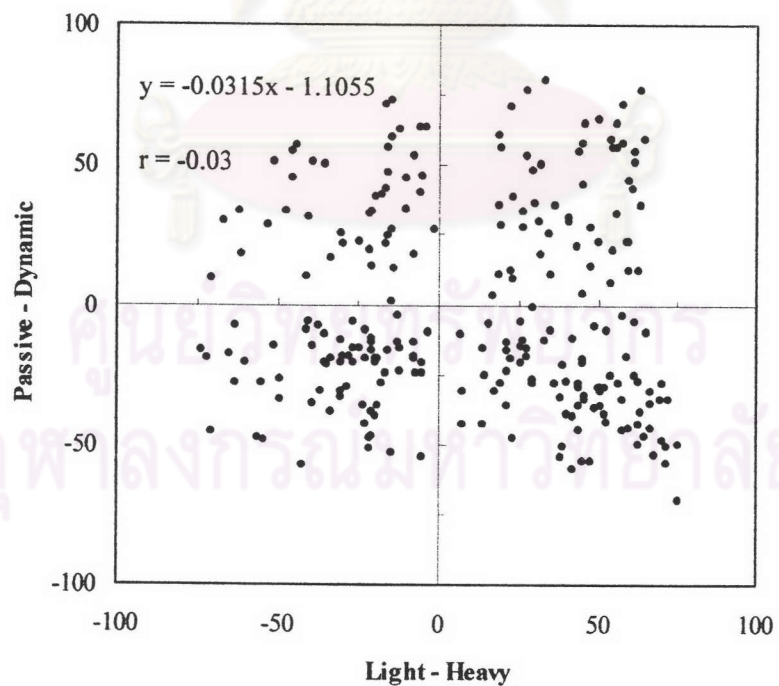


Figure 4-147 Relationship between the visual scores of Light - Heavy and the visual scores of Weak - Strong

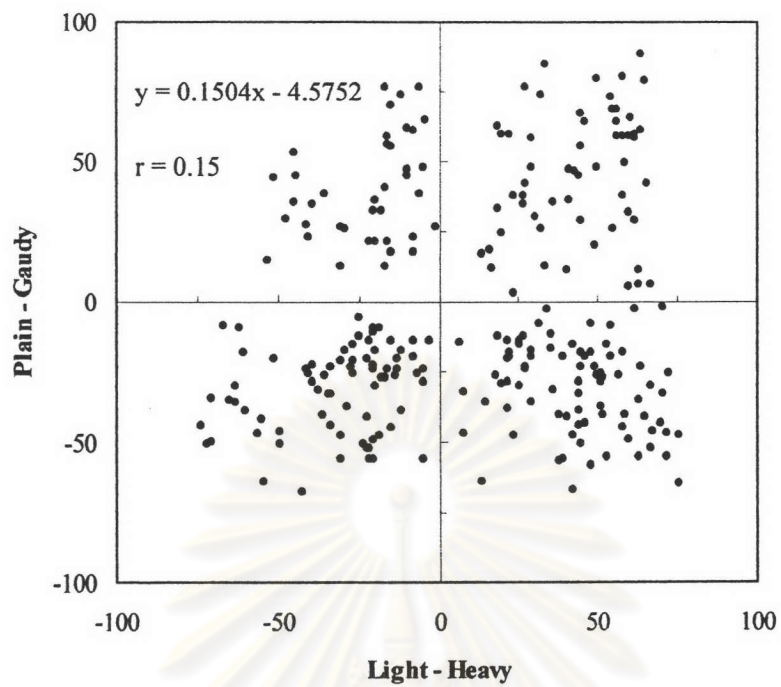


Figure 4-148 Relationship between the visual scores of Light – Heavy and the visual scores of Plain - Gaudy

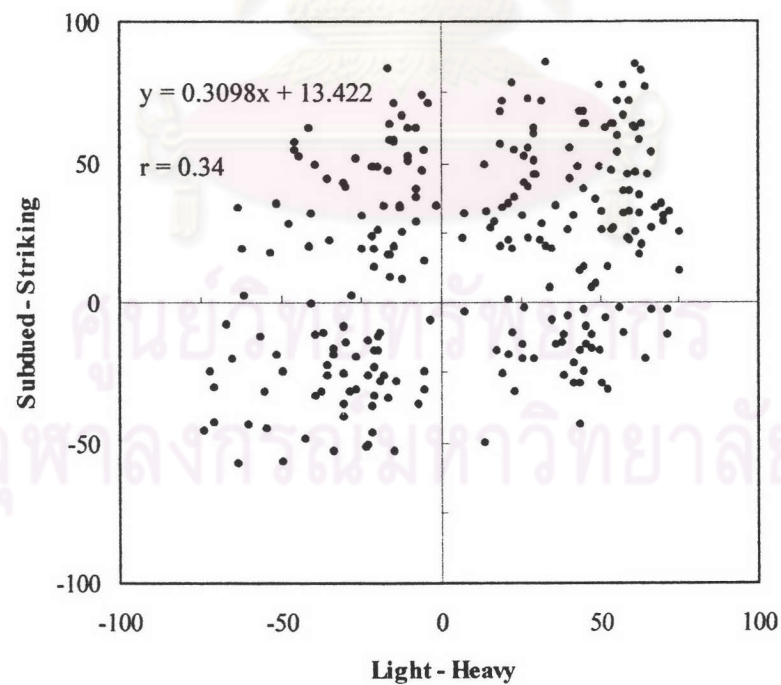


Figure 4-149 Relationship between the visual scores of Light – Heavy and the visual scores of Subdued - Striking

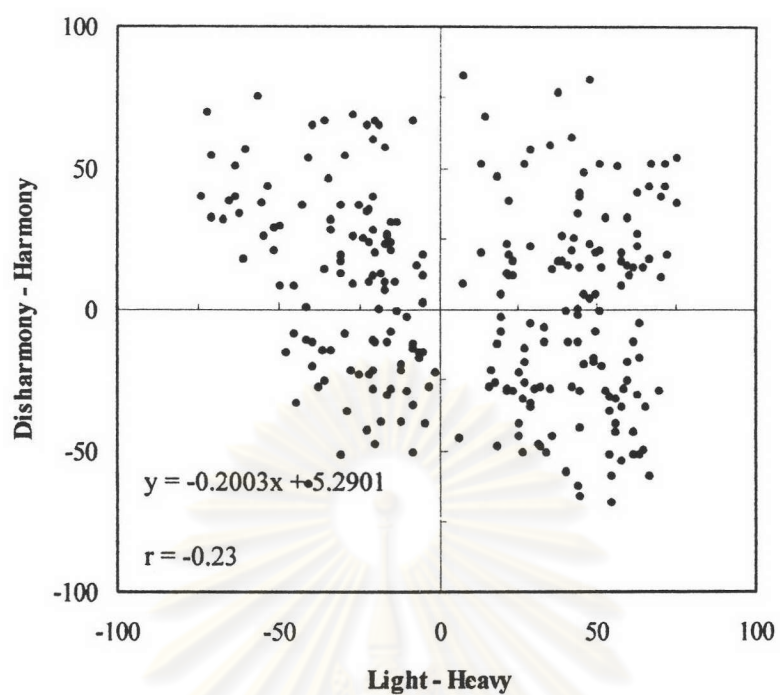


Figure 4-150 Relationship between the visual scores of Light – Heavy and the visual scores of Disharmony - Harmony

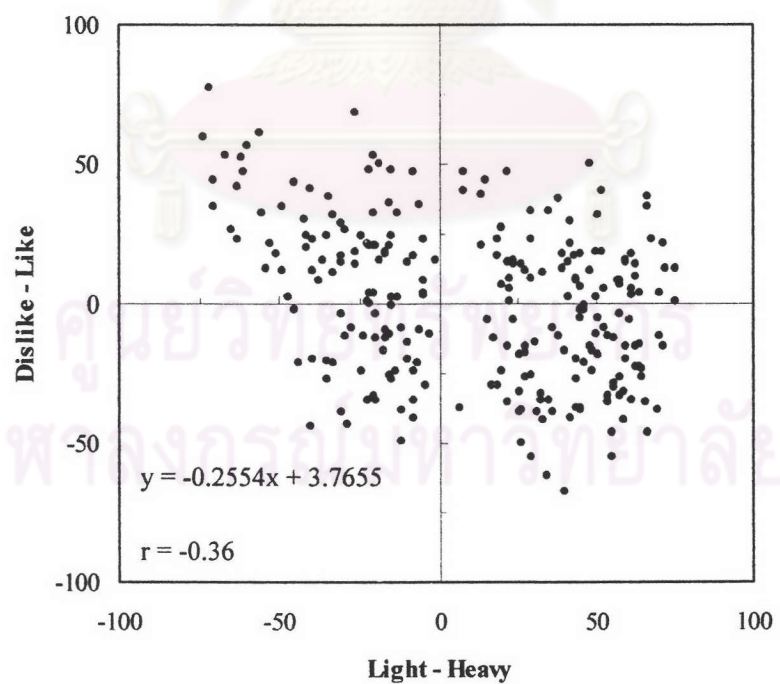


Figure 4-151 Relationship between the visual scores of Light – Heavy and the visual scores of Dislike - Like

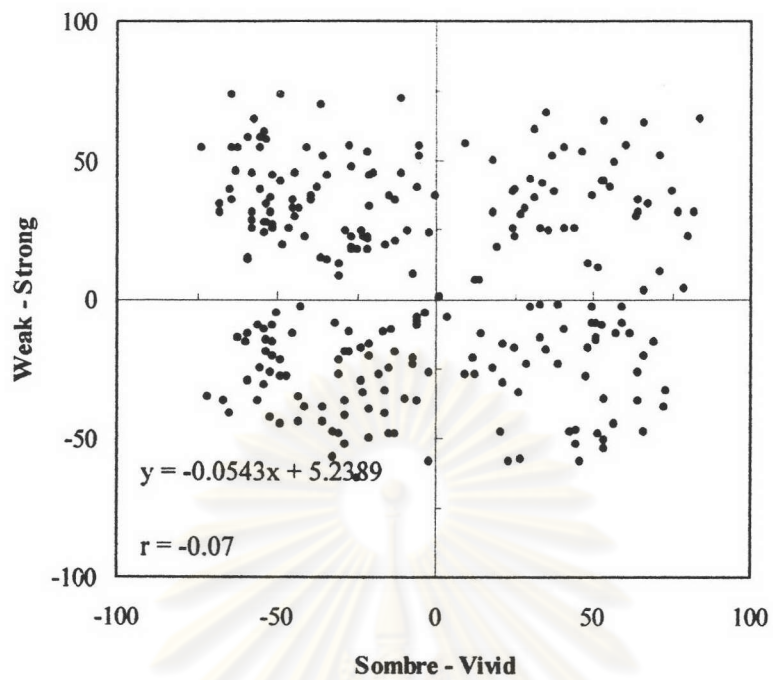


Figure 4-152 Relationship between the visual scores of Sombre - Vivid and the visual scores of Weak - Strong

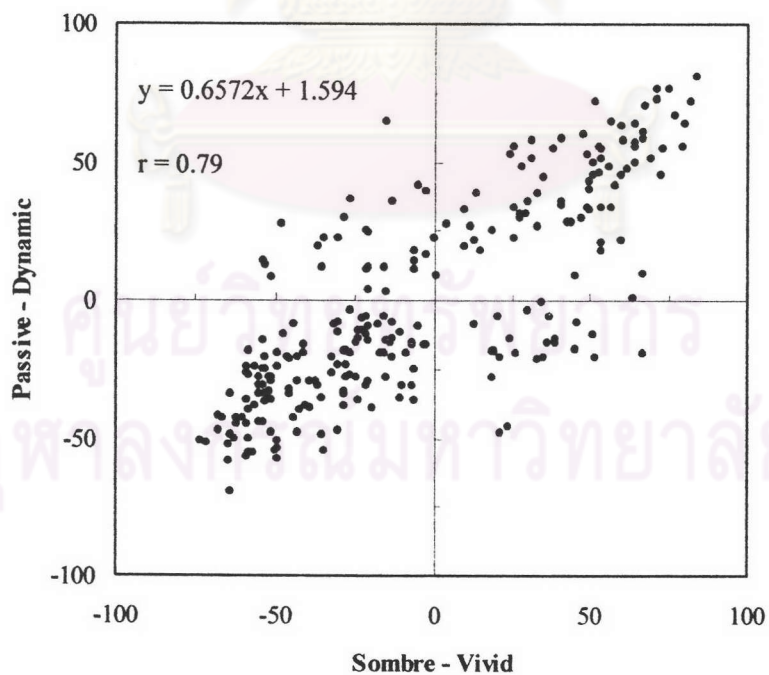


Figure 4-153 Relationship between the visual scores of Sombre - Vivid and the visual scores of Passive - Dynamic

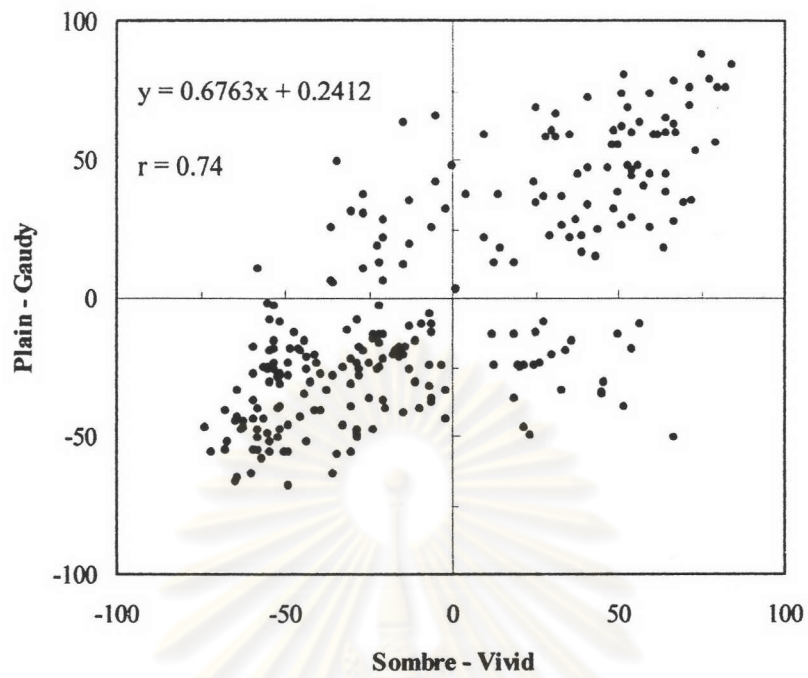


Figure 4-154 Relationship between the visual scores of Sombre - Vivid and the visual scores of Plain - Gaudy

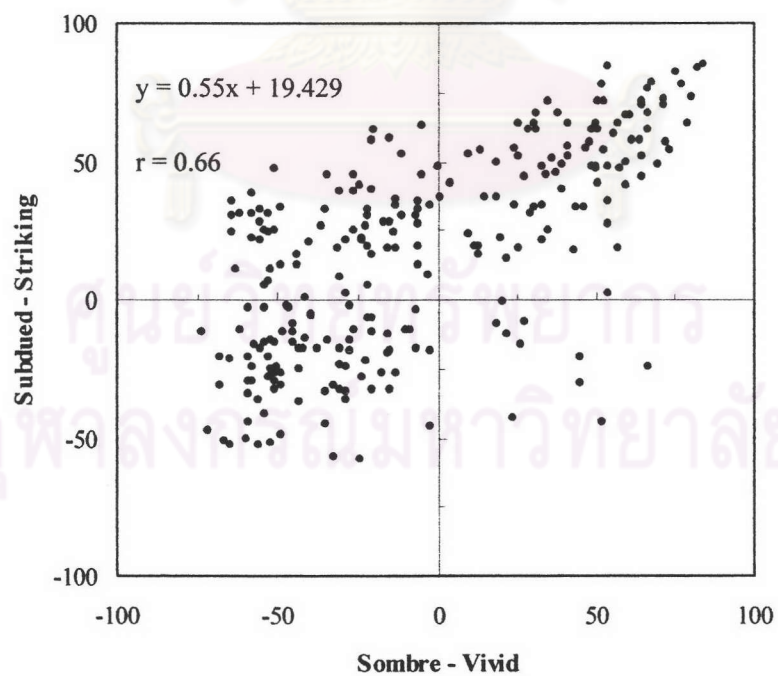


Figure 4-155 Relationship between the visual scores of Sombre - Vivid and the visual scores of Subdued - Striking

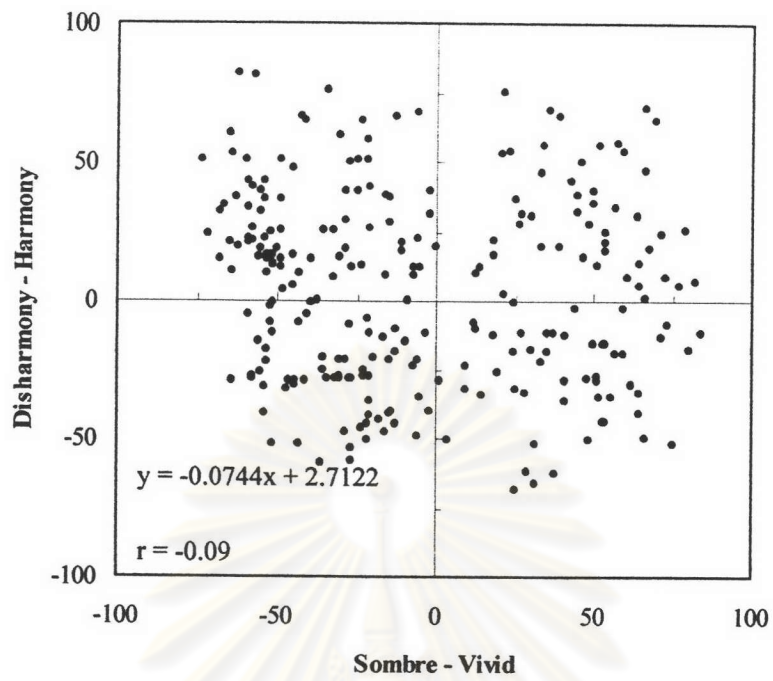


Figure 4-156 Relationship between the visual scores of Sombre - Vivid and the visual scores of Disharmony - Harmony

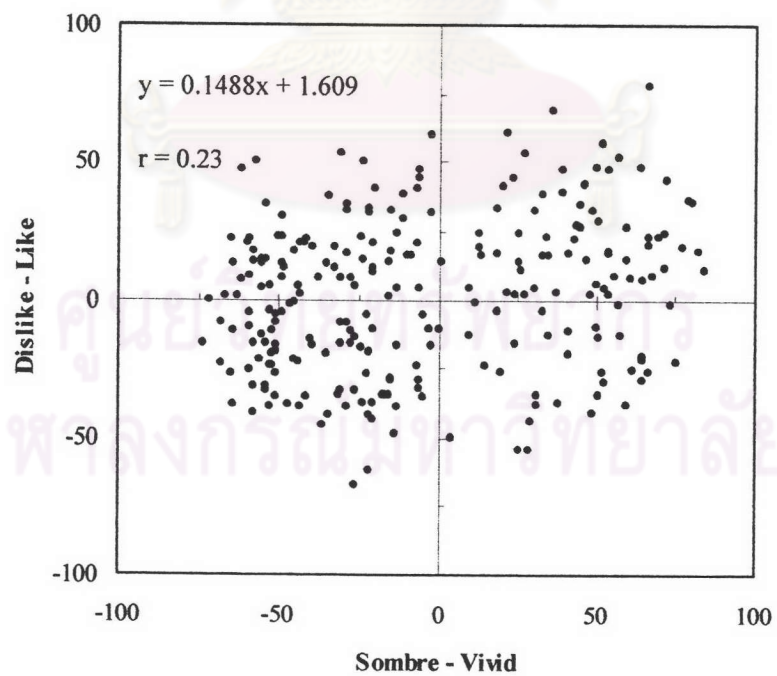


Figure 4-157 Relationship between the visual scores of Sombre - Vivid and the visual scores of Dislike - Like

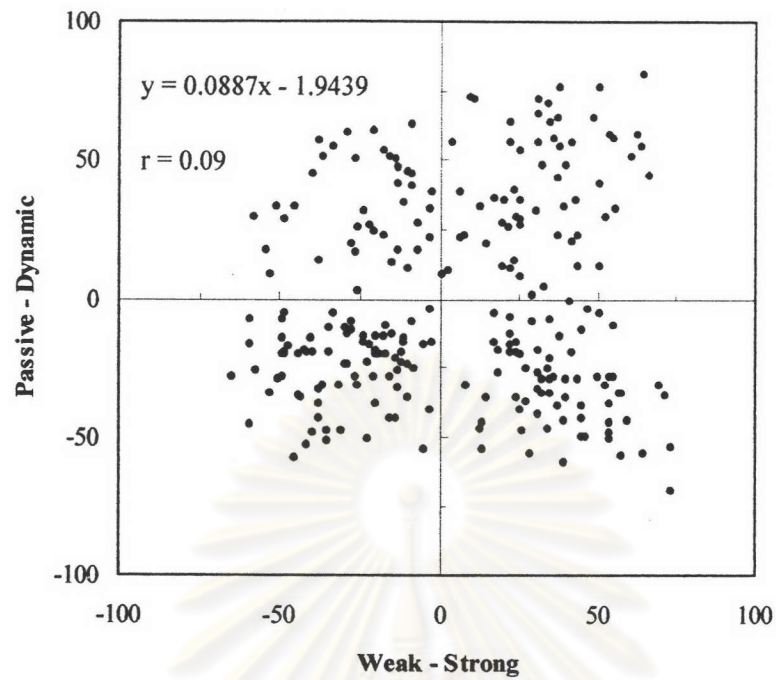


Figure 4-158 Relationship between the visual scores of Weak - Strong and the visual scores of Passive - Dynamic

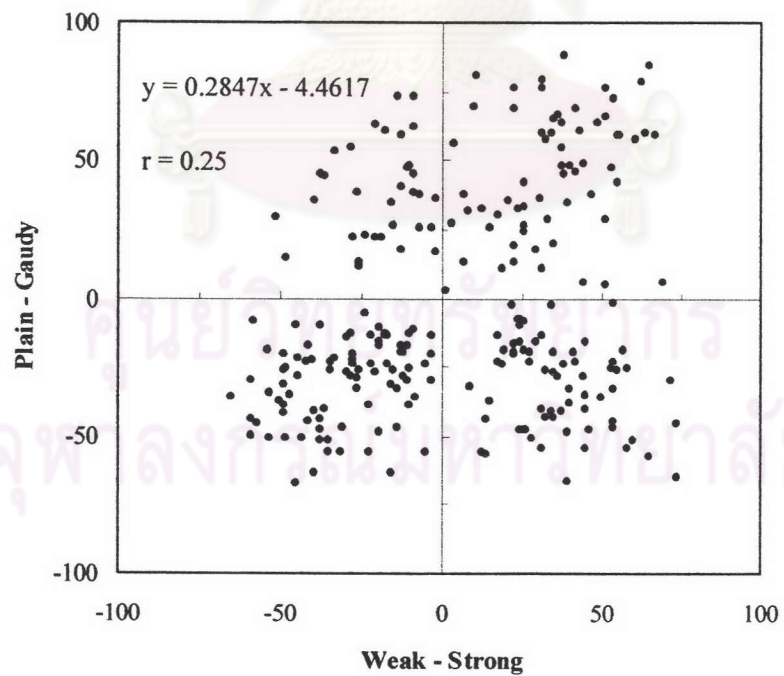


Figure 4-159 Relationship between the visual scores of Weak - Strong and the visual scores of Plain - Gaudy

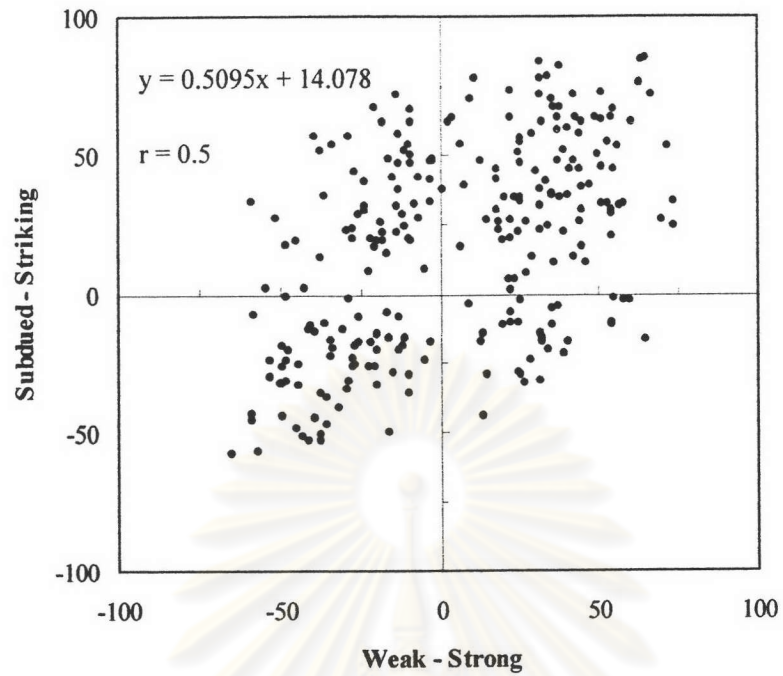


Figure 4-160 Relationship between the visual scores of Weak - Strong and the visual scores of Subdued - Striking

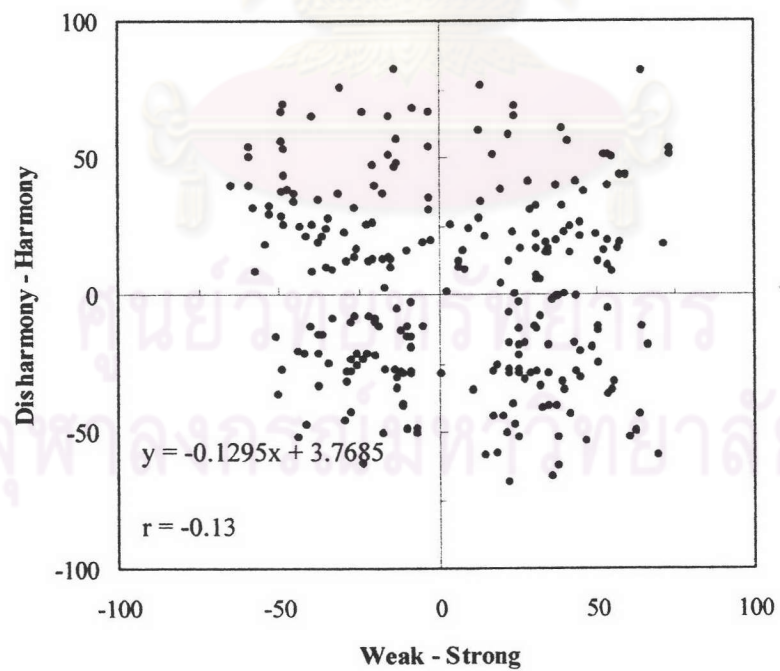


Figure 4-161 Relationship between the visual scores of Weak - Strong and the visual scores of Disharmony - Harmony

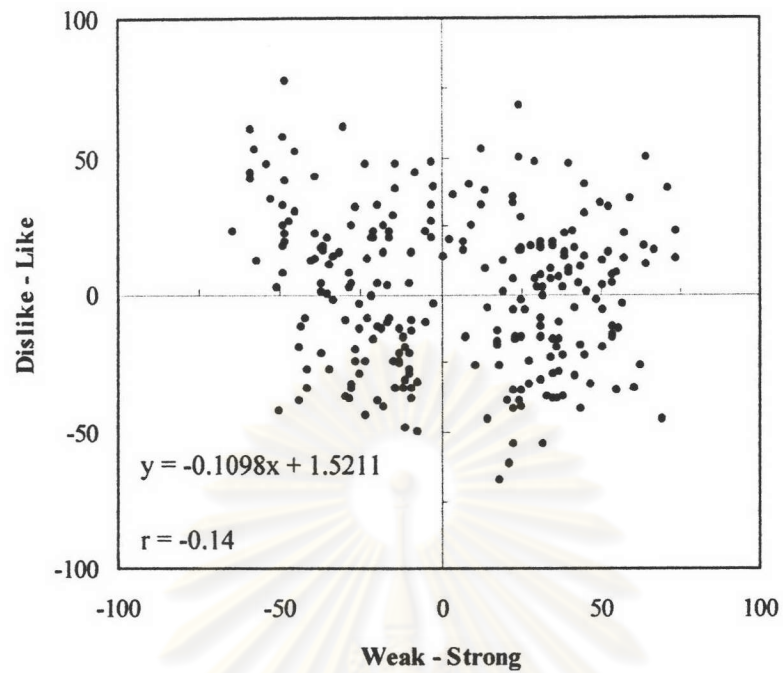


Figure 4-162 Relationship between the visual scores of Weak - Strong and the visual scores of Dislike - Like

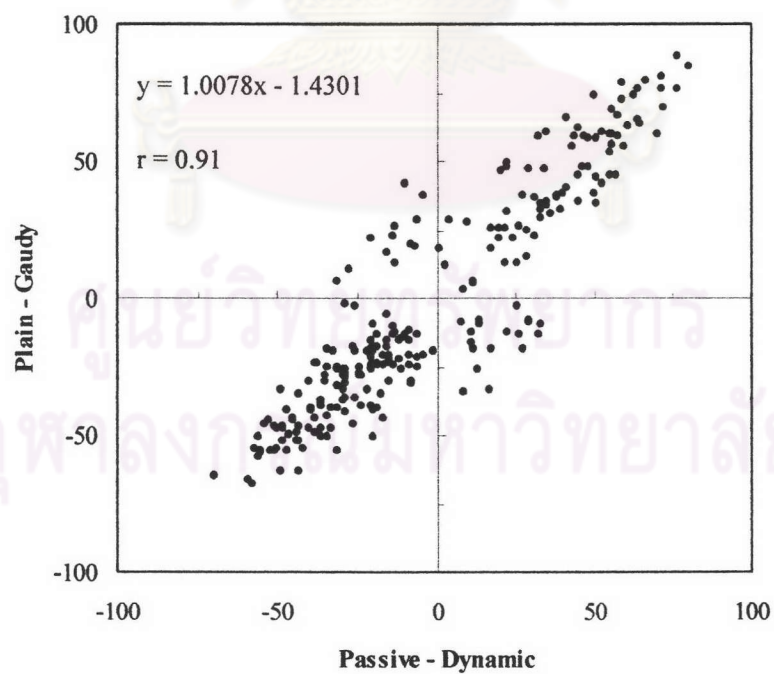


Figure 4-163 Relationship between the visual scores of Passive - Dynamic and the visual scores of Plain - Gaudy

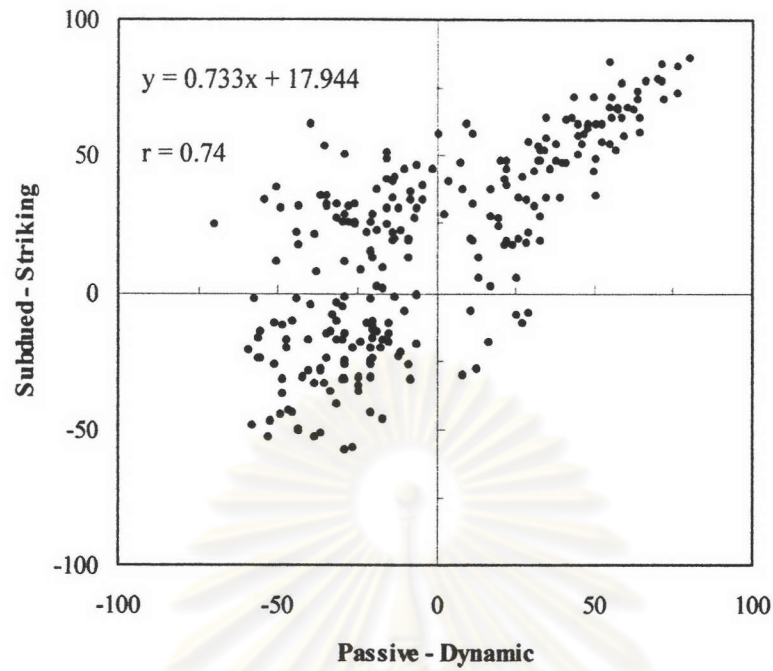


Figure 4-164 Relationship between the visual scores of Passive - Dynamic and the visual scores of Subdued - Striking

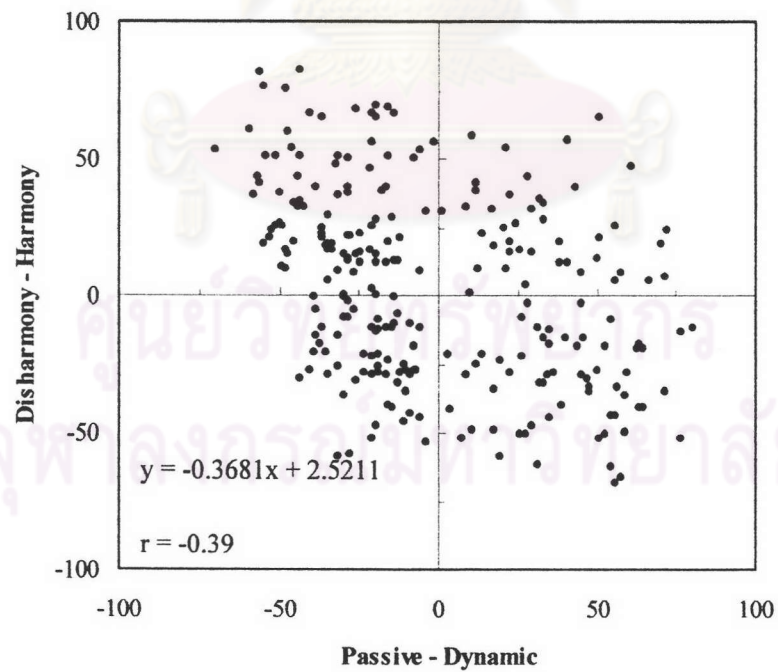


Figure 4-165 Relationship between the visual scores of Passive - Dynamic and the visual scores of Disharmony - Harmony

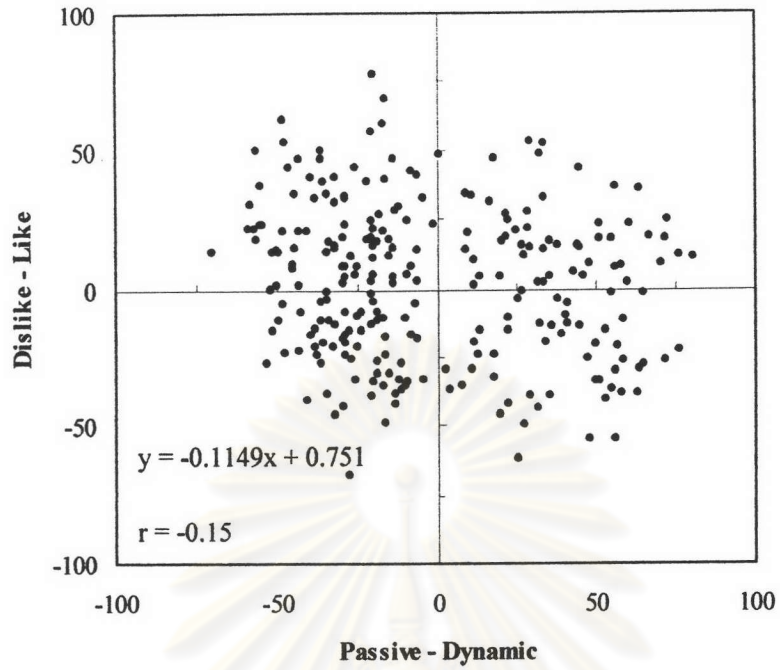


Figure 4-166 Relationship between the visual scores of Passive - Dynamic and the visual scores of Dislike - Like

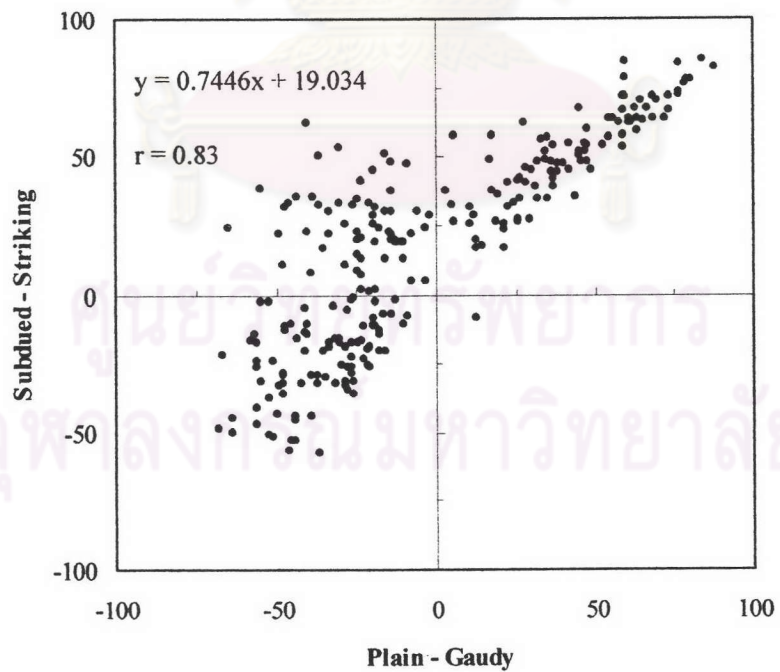


Figure 4-167 Relationship between the visual scores of Plain - Gaudy and the visual scores of Subdued - Striking

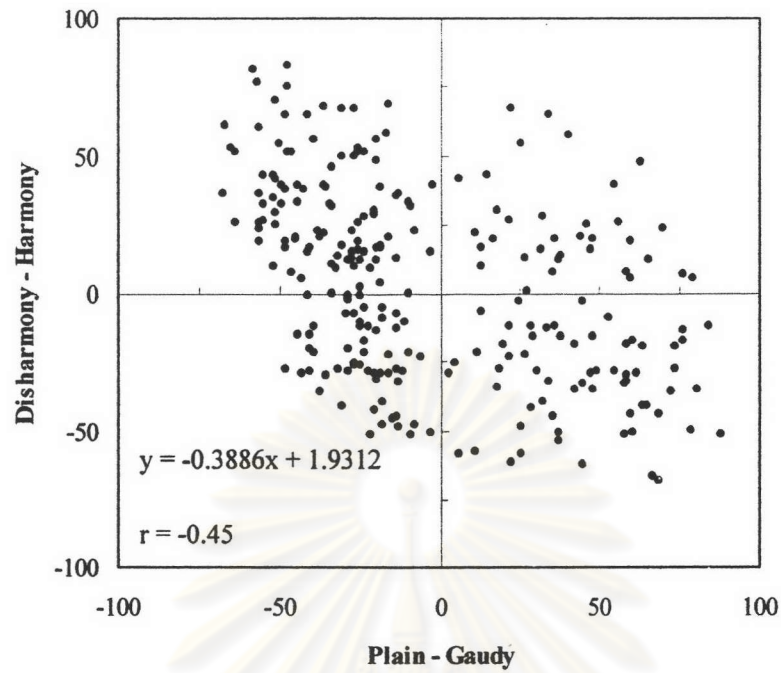


Figure 4-168. Relationship between the visual scores of Plain - Gaudy and the visual scores of Disharmony - Harmony

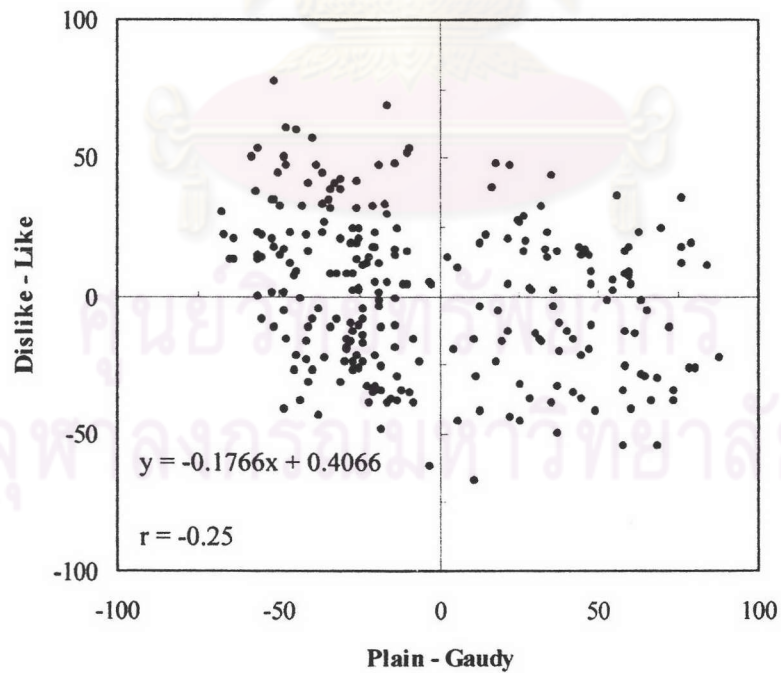


Figure 4-169 Relationship between the visual scores of Plain - Gaudy and the visual scores of Dislike - Like

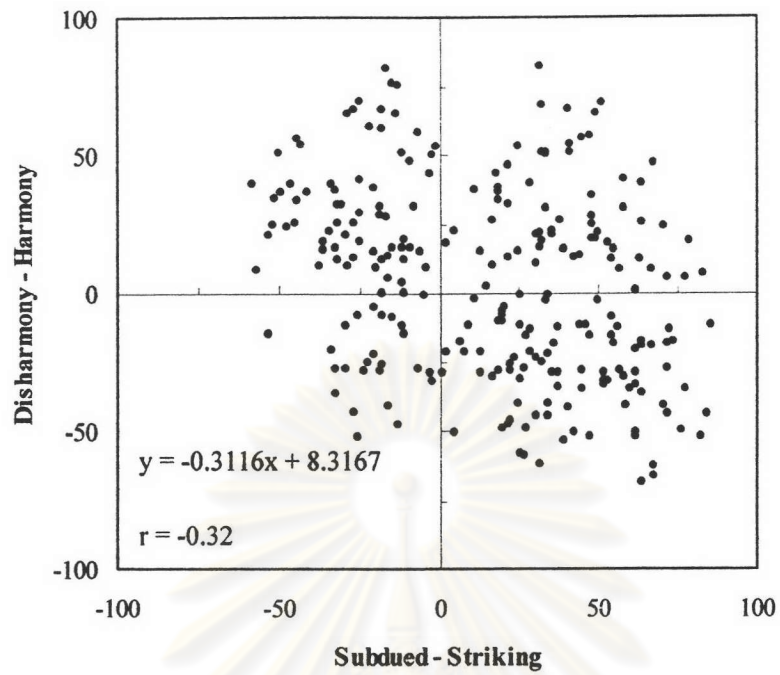


Figure 4-170 Relationship between the visual scores of Subdued - Striking and the visual scores of Disharmony - Harmony

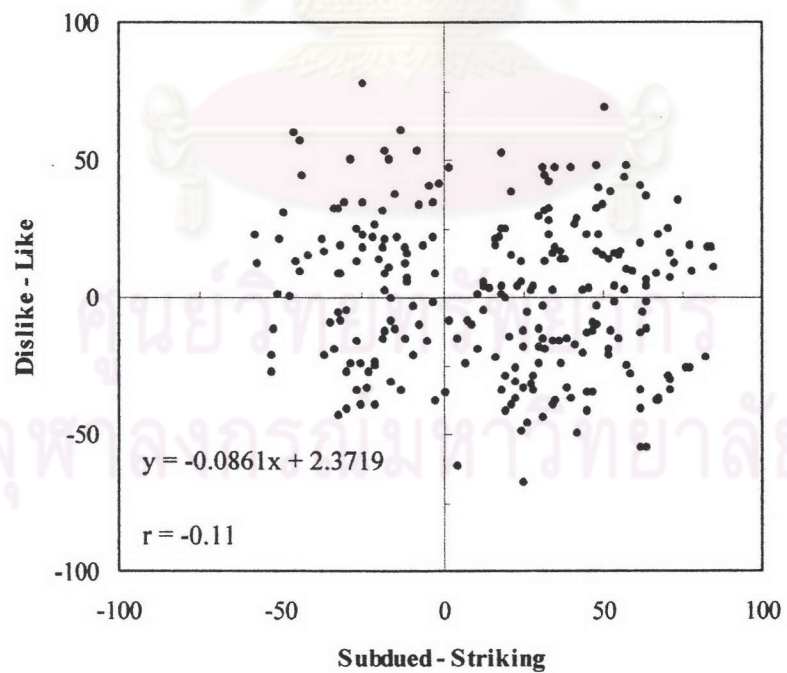


Figure 4-171 Relationship between the visual scores of Subdued - Striking and the visual scores of Dislike - Like

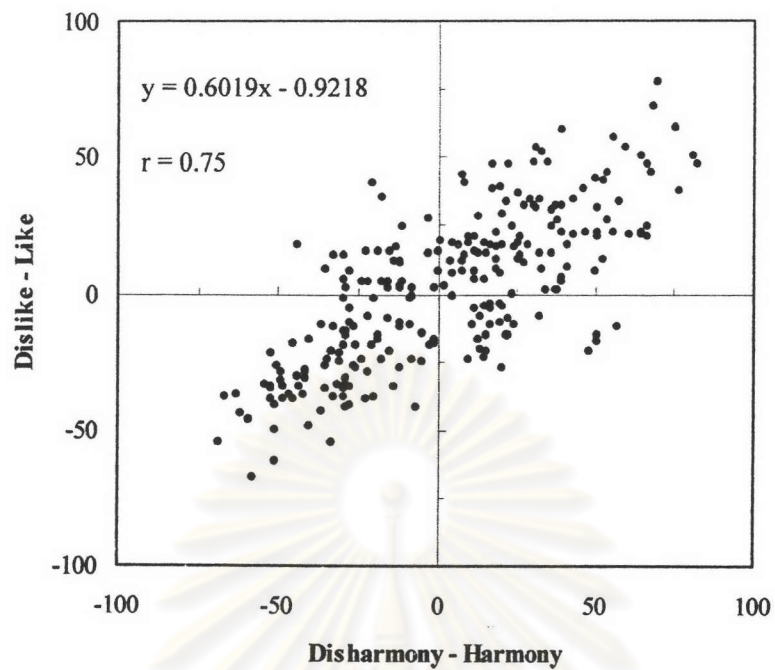


Figure 4-172 Relationship between the visual scores of Disharmony - Harmony and the visual scores of Dislike - Like

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