DCS Color Preference Methodology

Introduction

By using distinctive stimuli, a Chroma/value/hue testing system, this study elicited a non-cognitive, physiological response by asking participants to, "Select the color that they preferred to look at." Our research, with record-breaking accuracy, indicated "Best-Fit Careers," and the five globally recognized personality traits.

Using Color as an Indicator

"First-ever images of living human retinas have yielded a surprise about how we perceive our world. Researchers at the University of Rochester have found that the number of color-sensitive cones in the human retina differs dramatically among people—by up to 40 times—yet people appear to perceive colors the same way" 10

DCS study supports these claims.

1. Everyone experiences the same color Circuitry
2. Each test-hue was experienced uniquely. As evidenced by the fact, all 15 test-hues contributed to the final results.

Everyone Experiences the Same Color Circuitry

"Those early experiments showed that everyone we tested has the same color experience despite this really profound difference in the front-end of their visual system," says Hofer. "That points to some kind of normalization or auto-calibration mechanism—some kind of circuit in the brain that balances the colors for you no matter what the hardware is."

Color Choices are Personal

"We were able to precisely image and count the color-receptive cones in a living human eye for the first time, and we were astonished at the results," says David Williams, Allyn Professor of Medical Optics and director of the Center for Visual Science. "We've shown that color perception goes far beyond the hardware of the eye, and that leads to a lot of interesting questions about how and why we perceive color."

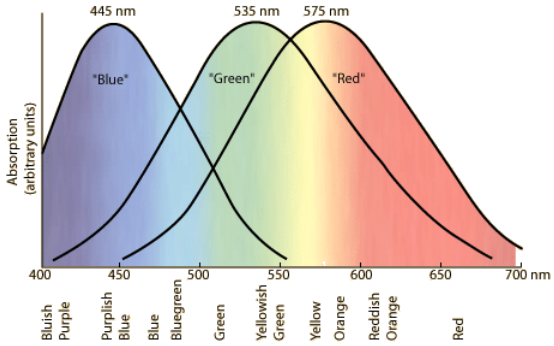
Our study strongly suggests that color choice is a personal experience in that each color was perceived separately. This was accomplished by using test colors with the maximum chroma for each individual hue. This was best described in terms of physical properties: Hue, saturation (chroma), and brightness (value). See Section 3, step one. Note that there are test deficiencies such as physical—color blindness and cultural influences—Chinese brides traditionally marry in red. (Color Blindness)

Color Perception Influenced Color Choices;

Our study suggest that color preference is physiological, closely aligned with the color cones sensitivity to perceive a color hue.

"The Color-Sensitive Cones "

- "In 1965 came experimental confirmation of a long expected result - there are three types of color-sensitive cones in the retina of the human eye, corresponding roughly to red, green, and blue sensitive detectors. (Graph confirmed by Abramowitz & Davidson, 2003)



"Painstaking experiments have yielded response curves for three different kind of cones in the retina of the human eye. The "green" and "red" cones are mostly packed into the fovea centralis. By population, about 64% of the cones are red-sensitive, about 32% green sensitive, and about 2% are blue sensitive. "

- Yellow is the nanometer low point. (Blue hue Graph was adapted for blue cone sensitivity-blue cones the lowest)
- There are twice as many cone sensitive red hues as green hues, which contain 50% Yellow. This makes in effect, 4 times red hues than yellow hues

- See test hue chart below. Yellow hues combinations are least preferred Blue and Red preferences diminish quickly with addition of yellow-based hues.

Blue Hues Most Preferred Choices

"The "blue" cones have the highest sensitivity and are mostly found outside the fovea. The shapes of the curves are obtained by measurement of the absorption by the cones, but the relative heights for the three types are set equal for lack of detailed data. There are fewer blue cones, but the blue sensitivity is comparable to the others, so there must be some boosting mechanism. In the final visual perception, the three types seem to be comparable, but the detailed process of achieving this is not known. "

Highly Sensitive Blue Cones outside the fovea created the highest preferred color choices. Indigo, Blue and Purple.. See chart, Blue correlated as the # 2 test most preferred test-hue, .3 % below Indigo.

Blue Test-Hue Correlation:
See below, the lower the saturation of the Blue Hue, the lower the Test-Hue Rank.

Blue + Red, Ranked High

Blue % With Red	Test-Hue % Rank	%
Indigo (¾)	1	17.8
Purple (½)	4	9.0
Magenta (¼)	7	4.6

Blue + Yellow Subtracts Preference
Yellow + Blue, subtracts from blue test-hue preference.

Yellow % Of Blue	Test-Hue % Rank	%
Teal (¼)	6	7.0
Green (½)	7	4.6
Lime Green (¾)	9	2.5.

Yellow + Red, Subtracts more than Blue
Yellow subtracts test-hue rank, as it did with the blue Hues creating the least preferred choices.

Yellow and Red Combined

Yellow % Of Red	Test-Hue % Rank	%
Red Orange (¼)	12	.7
Orange (½)	11	1.5
Gold (¾)	10	1.2

Test-Hue Totals = Color Cone Wavelength Peaks

- Testers' overall color preference choices validated against the color cones three distinctly tuned wavelength peaks. Often referred to as photopic vision, cone vision is dominant at normal light levels, both indoors and out. (Abramowitz & Davidson,

Comparative Analysis
The study strongly suggests that color is an unbiased, physiological assessment tool. This was further indicated by low race and age correlation levels. Gender was not evaluated separately in arriving at the Color Career Indicator 4.0 results.

Test-Hue Composite Totals
The number of the participants that chose blue, green, and red totals ranked significantly higher than yellow and orange hue-test colors. See Table below.

Composite Score: Favorite to Least Favorite

Rank	Color	Rank %
1.	**Indigo**	17.8
2.	**Blue**	17.5
3.	**Red**	16.9
4.	**Purple**	9.0
5.	**Yellow**	5.6
6.	**Teal**	5.1
7.	**Magenta**	4.6
8.	**Green**	4.5
9.	**Lime Green**	2.5
10.	**Orange**	1.5
11.	**Gold**	1.2
12.	**Red-Orange**	.75

The above charts are based on our 1996 study of 3,000 participants by Dr. Michael McIntyre, Research Professor at the University of Tennessee. This same study was used by Dr. Rense Lange in an earlier publication of the *North American Journal of Psychology* (Dec, 08).

Each test-hue was experienced uniquely.

Each of the 15 test-hues was a vital ingredient in the correlation**. Every color testing hue contributed to the final results in the Color Career Indicator 4.0.**

"Color Perception Is Not In the Eye of the Beholder: It's In the Brain. "
Quote below from Science Daily (Oct. 26, 2005)

"The findings, on the cover of this week's journal Neuroscience, strongly suggest that our perception of color is controlled much more by our brains than by our eyes."

Research has proven that core personality is also physiological. "All traits and personality characteristics, from height to fear of heights, are driven by a complex interplay of genes and environmental feedback. We now know that the lion-share of human genes are expressed in the brain and that almost all normal and disordered behaviors are polygenic, meaning that they are influenced (not to say caused) by multiple genes." (Genetics Psychology Today) Science supports the assertion that color selection is a physiological response. Other non-language color studies have recognized this relationship between color and personality. For example, in a 2009 study published in the journal *Science*, researchers found red or blue can cause very different brain reactions depending on the task involved. (Zhu*, 2009)

Behavior is Both Innate and Environmental
The brain is hard-wired to display certain characteristics with environmental input. In the following studies, behavior is both innately wired to brain neurons and environmentally adapted into our brain circuitry. The studies below support this claim

- Ducks prefer their mother's call. Yet if they are deprived of hearing the sounds of their mother and sibling in the egg, they do not experience "hard-wired" imprinting.
- Fish, as shown in similar studies, have an innate sense of geometric direction. Yet if they are not allowed to explore the tank, their sense of direction is dramatically impaired.

Color Preference Biometrics indicated individuals in this study that could best perform career specific tasks. Our "Test-Hues Displayed Distinctive Correlation Patterns" section strongly supports the statement that human behavioral skills are hard-wired. (See Test and Retest XXX). How we manage our lives, however is influenced by environment and determined by each individual.

Like the duck and fish, humans also need environmental input to fully realize their potential. Further investigation, implementing such studies as test and re-test over a 20+ year time period, are needed to determine the extent of environmental impact.

Perhaps, new studies on epigenetics explains, "how the life we live," can reach into our double helix and alter our traits.

Our study, however, makes no claims that it indicates:

- "Hard-wiring"
- "Environmental stimuli"
- .Or a combination of both

This is not of primary concern. Whatever the above case, we have established through color preference is a way to indicate most enjoyable careers. Our research arrived at these results from individuals that "strongly agree' that enjoy their current career.

2: Color Career Indictor Overview

The Color Career Indicator is a non-language career evaluation with two United States patents. (Sadka, 2005). It is a occupational enjoyment evaluation for ages five—kindergarten—to 100+. Students or adults simply pick their favorite colors from a prescribed palette and receive a list of career paths that fit best for them. There are no language questions, only colors to choose from. The CCI 4.0 uses only color preference to predict, at record-breaking accuracy, best career fits. The test gives a language even to school-age children. This in itself has astounding potential. Knowing a child's interest at a young age creates the opportunity to expose/introduce them to actual careers that they will view as fun.

Non-Language Methodology
Unlike other evaluations, our testing model avoided self-deception by creating a model without language—no personality questions.

In a a study, "The Elements of Scientific Theory of Self-Deception, "(Robert Trivers, Rutgers University, Dept. of Anthropology) states that, "Information is

stored within an organism, but with a bias. The true is stored in the unconscious mind."

In an additional MIT study* " The first and perhaps, most startling fact is that while it takes a nervous signal only about 20 ms to reach the brain, it requires a full 500 ms for a signal reaching the brain to register in consciousness! This is all the time in the world, so to speak, for emendations, changes, deletions, and enhancements to occur. Indeed, neurophysiologists have shown that stimuli, at lease as late as 100 ms before an occurrence reaches consciousness, can affect the content of the experience.

"We know that processes of self-deception-active misrepresentation of reality to the conscious mind-are an everyday human occurrence, that struggling with one's own tendencies toward self-deception is usually a life-long enterprise, and that at the level of societies (as well as individuals) such tendencies can help produce major disasters (e.g. the US war on Viet Nam).

*Libet, B. 1996, neuronal time factors in conscious and unconscious mental functions. In Toward a Science of Consciousness: The First Tucson Discussion and Debates. S.R. Hameroff, A.W, Kaszniak & A. Scott, Eds: 337-347 MIT Press, Cambridge, MA.

Our study involved three core applied principles.

The Demographic Sheet

- Current Career Identified: Testers were asked to check their current career, by-industry, by-job description from a list of 176 job descriptions, later combined with "similar careers' to 750 job descriptions>
- Job-Fit Satisfaction Level: Testers selected from satisfaction menu ranging from "Highly Enjoy" to "Don't Enjoy."

The Sample Base:

- *Enjoy* Current Career Only: Sample base included only those testers who selected "highly enjoy" or "enjoy"(Weighted more than for "highly enjoy")
- 1,200 By-Job Description Sample Bases: For example, only those testers who selected "highly enjoy" or "enjoy" from the job category *Engineers* were extracted from the Engineer sample base of approximately 20,000.

The Correlations:

- Tester Process: Evaluated the color preference data of 1200 occupations against each Testers' color choices.
- Top to Worst Careers Listed: Correlations distinguish from the #1 best fit to the # 1,200 worst fit.

Section 3: Procedure

We based our work on the application of four core procedures.

Step 1: Choosing Distinctive High Chroma Test Colors

- Step 2: Creating a Non-Language, Current-Career "Highly Enjoy" Criterion.
- Step 3: Acquiring a 750,000 Sample Base to identify 1,200 Careers.
- Step 4: Model Fit Information using a Single Rasch Scaling method.

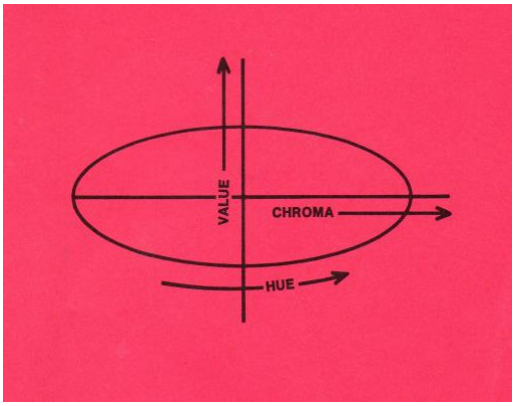
First we designed a high response (high chroma) test entity. Then we added a questionnaire that asked for current career and if the tester enjoyed doing it. Dr Lange took the large sample base and identified the 176 careers. (We choose to refer to our Cognitive Auto heuristic Distributed-Intelligence entity early on as a collection of interconnected evolving agents.) Second—costing an enormous amount in hardware and core time—we let the system build its own heuristics, deploy them as agents and evolve them by running a set of evolutionary cascades within probabilistic Bayesian domains.

Step 1: Stimuli

Participant response was achieved by choosing distinctive test-hues. They consisted of twelve chromatic hues with the maximum Chroma and 3 achromatic test-hues.

Selection variables, Hue, Chroma and Value were quantified by using The Munsell Color System, the world's standard for identifying all visible colors—approximately 10,000. Albert Munsell in 1918 created a precision color measurement system by placing it on a sphere that closely resembles how the eye perceives light. See Figure 1.

Figure 1

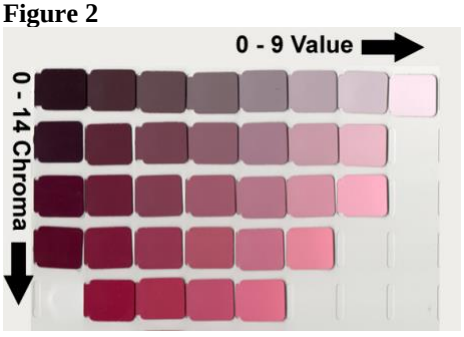


Chromatic Test-Hue Selection
Hue Distinction: Each of the 12 chromatic test colors maintains hue equidistance on the spectrum wheel.

- Chroma: Maximum testing response was achieved by selecting by-hue the highest the chroma within each hue category.
- Value: Colors selected indicated no lightness or darkness to ensure maximum chroma and maintain test hue continuity.

Figure 2 shows the Red test color located in the bottom left; Chroma: 17.44—the maximum for Red, Value: 4.6—no lightness or darkness distracting from the chroma.

Figure 2



Achromatic Test-Hue Selection
Black, Brown and White were also used. The Test-Achromatic-Hues displayed no spectrum color.

Table 3: Dewey Color System Test Colors

Color	Value	Chroma
Yellow	9.61	12.75
Blue	4.27	14.03
Red	4.6	17.44
Green	5.27	10.78
Purple	2.43	15.96
Orange	5.9	17.15
Lime Green	9.13	14.28
Indigo	3.32	16.76
Red-Orange	5.44	18.21
Magenta	2.8	12.63
Teal	4.85	6.79
Gold	7.71	12.88
Black	7.71	12.88
White	9.9	0.03
Brown	2.54	6.02

Prior Color Testing
The color preference test pioneer, The Lüscher Color Test, did not include 12 distinctive, spectrum test-hues or the achromatic test-hues. The test-hues selected also did not maximize chroma or have consistent value.

This study indicated that each test-hue makes a significant contribution. Recognizing the full spectrum test-hue representation was an integral ingredient.

Step 2: Creating a Non-Language, Current-Career "Highly Enjoy" Criterion

Many times each industry's job descriptions are different skill levels for the same job title. This profile separates each skill by-industry. The demographic sheet was arranged to incorporate two factors.

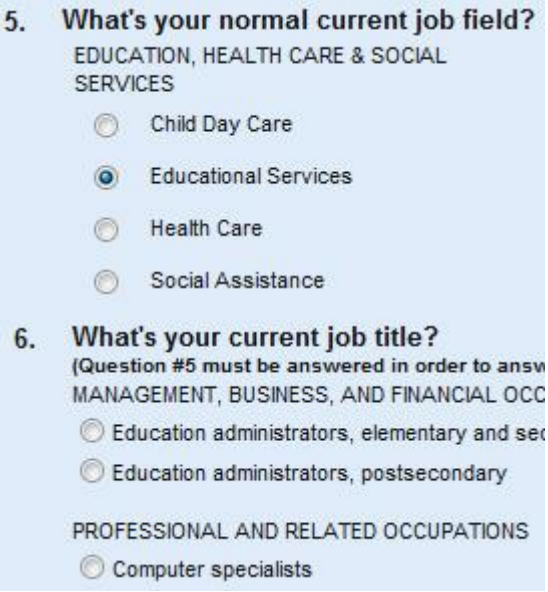
1. Tester's Current Career: Job descriptions, by-industry were identified using the US Department of Labor job descriptions.
2. On-the-Job Enjoyment Level: Testers were asked how much they enjoyed their current career and were asked to not consider their current employer likes or dislikes.

This process allowed us to create 1,200 career-specific sample bases that measured with specificity a by-industry job description.

Demographic Questionnaire Examples:

"How much do you enjoy your current career question?"

Figure 3



Sample Base Included only "Highly Enjoy."

Step 3: Acquiring a 750,000 Sample Base

Web-Based

- 750,000 sample base in a partnership arrangement with Career Path.com, a division of CareerBuilder.
- Test period from September 8, 2008 to June 9, 2009.
- Utilized web-safe colors that were identical to pen and paper booklets.

References

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