# THE MUNSELL BOOK OF COLOR

NEARLY NEUTRALS COLLECTION

## The Munsell Color-Order System

The Munsell Color-Order System is a way of precisely specifying colors and showing the relationships among color. Every color has three qualities or attributes: Hue, Value and Chroma. Professor A.H. Munsell established numerical scales with visually uniform steps for each of these attributes. *The Munsell Book of Color* displays a collection of colored chips arranged according to these scales. Each chip is identified numerically using these scales. The color of any surface can be identified by comparing it to the chips, under proper illumination and viewing conditions. The color is then identified by its Hue, Value and Chroma. These attributes are given the symbols H, V, and C, and are written in the form H V/C, which is called the "Munsell Notation."

## Hue

Hue is that attribute of a color by which we distinguish red from green, blue from yellow, etc. There is a natural order of Hues: red, yellow, green, blue, purple. One can mix paints of adjacent colors in this series and obtain a continuous variation from one to the other. For example, red and yellow may be mixed in any proportion to obtain all the Hues red through orange to yellow. The same is said of yellow and green, green and blue, blue and purple, and purple and red. This series returns to the starting point, so it can be arranged around a circle. Munsell called red, yellow, green, blue, and purple "Principal Hues" and placed them at equal intervals around a circle. He inserted five intermediate Hues: yellow-red, green-yellow, blue-green, purple-blue and red-purple, making ten Hues in all. For simplicity, he used the initials as symbols to designate the ten Hue sectors: R, YR, Y, GY, G, BG, B, PB, P, and RP.

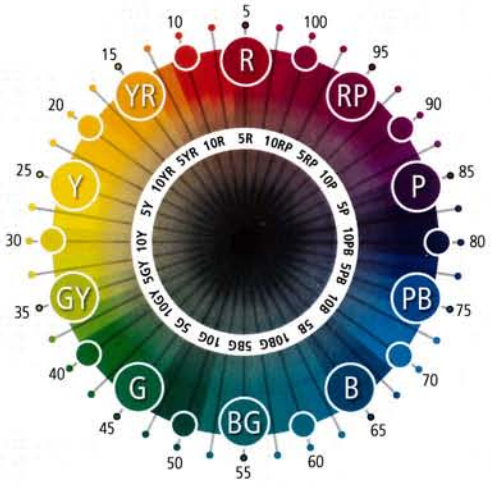



*Figure 1: Munsell Hue Designations*

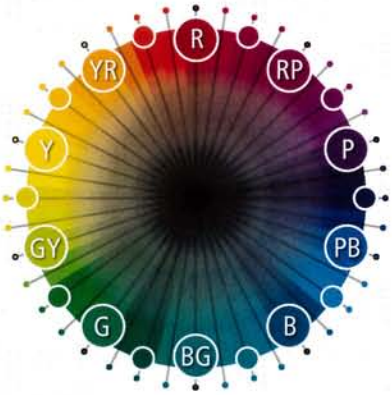
Munsell arbitrarily divided the Hue Circle into 100 steps of equal visual change in Hue, with the zero point at the beginning of the red sector, as shown in Figure 1. Hue may be identified by the number from 0 to 100, as shown in the outer circle. This may be useful for statistical records, cataloging and computer programming. However, the meaning is more obvious if the Hue is identified by the Hue sector and the step, on a scale of ten, within that sector. For example, the Hue in the middle of the red sector is called "five red", and is written "5R." (The zero step is not used, so there is a 10R Hue, but no 0 YR.) This method of identifying Hue is shown on the inner circle.

## The Primary Hue Circle

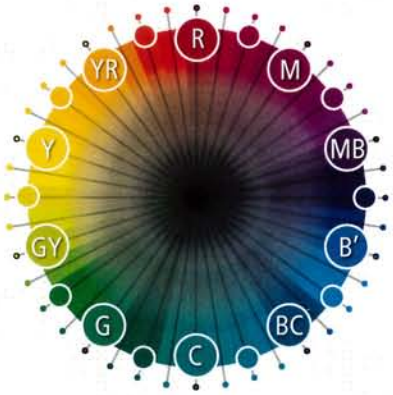
In 1993, Cal McCamy proposed a series of Hue names for the Hue Circle, using the additive primaries – red, green and blue; the subtractive primaries – yellow, magenta and cyan; and four intermediate Hues. The names are applied to the same set of Hue sectors as the Munsell Hues. This proposal corrects a well-known displacement of blue on the Munsell Hue Circle, and it accommodates the thinking of the large number of people who work with color photography, color printing, color television, color copying and color computer monitors – technologies based on the additive and subtractive primaries. The correspondence between the Munsell Hue Circle and the primary Hue Circle is given in Table 1. Blue is the only instance where the same name has a different meaning (resulting from the deliberate use of the name for a different sector). In this case, the new word and symbol are distinguished from the old, when necessary, by the prime mark (Blue' and B').

The addition of this set of Hue names does not involve any changes whatsoever to the colors in *The Munsell Book of Color* or any Munsell color standards. It is merely an alternate way of designating the same Hues, for use in those fields in which it is found useful.

*Table 1:* Correspondence Between the Munsell Hue Circle and the Primary Hue Circle




**Munsell Hue Circle**




**Primary Hue Circle**

| Hue | Symbol | Hue | Symbol |
|---|---|---|---|
| Red | R | Red | R |
| Yellow-Red | YR | Yellow-Red | YR |
| Yellow | Y | Yellow | Y |
| Green-Yellow | GY | Green-Yellow | GY |
| Green | G | Green | G |
| Blue-Green | BG | Cyan | C |
| Blue | B | Blue-Cyan | BC |
| Purple-Blue | PB | Blue' | B' |
| Purple | P | Magenta-Blue | MB |
| Red-Purple | RP | Magenta | M |

## Value

Value indicates the lightness of a color. The scale of Value ranges from 0 for pure black to 10 for pure white. Black, white and the grays (as shown in figure 2) between them are called "Neutral Colors". They have no Hue. Colors that have a Hue are called "Chromatic Colors." The Value Scale applies to chromatic as well as Neutral Colors. The Value Scale is illustrated for all Neutral Colors on the chart labeled Neutrals, included in this book of color.

## Chroma

Chroma is the departure degree of a color from the Neutral Color of the same Value. Colors of low Chroma are sometimes called "weak," while those of high Chroma (as shown in figure 3) are said to be "highly saturated," "strong," or "vivid." Imagine mixing a vivid red paint, a little at a time, with a gray paint of the same Value. If you started with gray and gradually added red until the vivid red color was obtained, the series of gradually changing colors would exhibit increasing Chroma. The scaling of Chroma is intended to be visually uniform and is very nearly so. The units are arbitrary. The scale starts at zero, for Neutral Colors, but there is no arbitrary end to the scale. As new pigments have become available, Munsell color chips of higher Chroma have been made for many Hues and Values. The Chroma scale for normal reflecting materials extends beyond 20 in some cases. Fluorescent materials may have Chromas as high as 30.

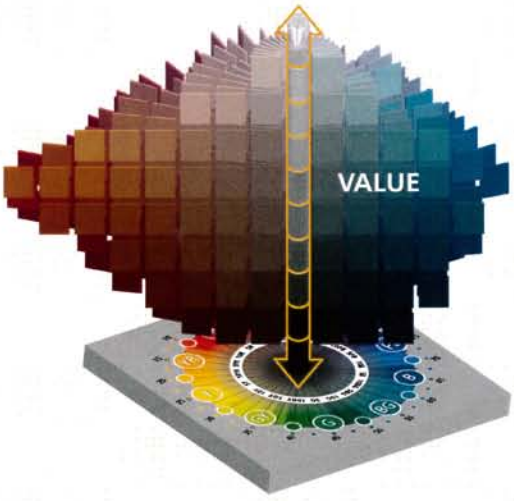



*Figure 2: Munsell Value Diagram*

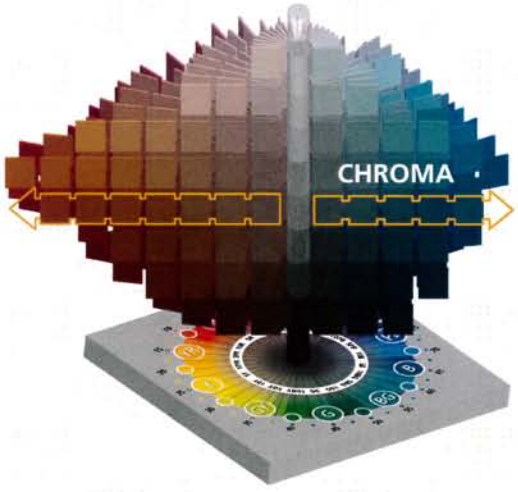



*Figure 3: Munsell Chroma Diagram*

## Munsell Notation

The complete Munsell notation for a chromatic color is written symbolically: H V/C. For a vivid red having a Hue of 5R, a Value of 6 and Chroma of 14, the complete notation is 5R 6/14. When a finer division is needed for any of the attributes, decimals are used. For example, 5.3R 6.1/14.4. When the Hues of the primary Hue Circle are used, the notation is written in the same way, for example 2B 5/4. The notation for a Neutral Color is written: N V/. (The Chroma of a Neutral Color is zero, but it is customary to omit the zero in the notation) The notation N 1/ denotes a black, a very dark neutral, while N 9/ denotes a white, a very light neutral. The notation for a middle gray is N 5/.

## Munsell Color Space

Munsell Hue, Value and Chroma can be varied independently so all colors can be arranged according to the three attributes in a three-dimensional space. The Neutral Colors are placed along a vertical line, called the "neutral axis" with black at the bottom, white at the top and all grays in between. The different Hues are displayed at various angles around the neutral axis. The Chroma scale is perpendicular to the axis, increasing outward. This three-dimensional arrangement of colors is called the "Munsell Color Space."

## Munsell Color Solid

All colors lie within a specific region of the Munsell Color Space called the "Munsell Color Solid". Hue is limited to one turn around the circle. The scale of Value is limited on the lower end by pure black, which is as dark as a color can be, and on the top by pure white, which is as light as a color can be. For a given Value, there is a limit to the Chroma that is possible, even with theoretically ideal coloring agents. Real coloring agents, with less than ideal characteristics, impose further limitations on physical representations of the color solid. The Munsell Color-Order System itself is applicable to all possible colors. The highest Chroma yellow colors have rather high Values, while the highest Chroma blue colors have lower Values. Thus the Munsell Color Solid has the irregular shape shown in Figure 4.

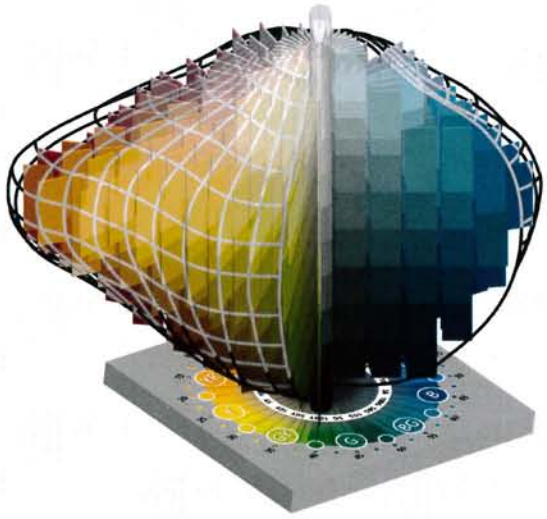


*Figure 4: Munsell Color Solid*

## Standard Viewing Conditions

The observed color of a surface depends on the spectral quality of the illumination, the direction of illumination, the direction of viewing, the surround or background, the nature of any light that might be reflected from the surface and the nature and state of adaptation of the eyes of the observer.

It is standard practice to view specimens illuminated by daylight from a lightly overcast north sky (south sky in the southern hemisphere) or the artificial equivalent of this illumination. Viewing light booths that provide controlled artificial daylight and other common illuminants are available from X-Rite, Incorporated Their use is recommended because the light is much more reproducible than natural daylight, they provide standard viewing conditions at any hour. In interior rooms, they provide a neutral ambient surround and they exclude extraneous light. Specimens should be viewed along their normal (the line of sight perpendicular to the surface) and to illuminate them at 45º. These conditions are described in a standard from the American Society for Testing and Material (ASTM): D 1729 Standard Practice for Visual Evaluation of Color Differences of Opaque Materials.

Before anyone is required to judge colors, they should be tested to assure that they have normal color vision. About one in twenty men and one in fifty women have defective color vision, commonly called color blindness. Even among normal observers, there is variation in aptitude for judging colors. Normally this capability gradually diminishes with age. Even among normal expert observers, differences in judgments, due to normal variation in the human eye, are not uncommon. Color vision can be evaluated by the use of the Farnsworth-Munsell 100 Hue Test, which is available from X-Rite, Incorporated.

## Development of the Munsell Color-Order System

Professor Albert H. Munsell, an artist and art teacher, developed the basic principles of the system and published them in a small book, *A Color Notation*, in 1905. In 1915, he published *The Munsell Atlas of Color*, displaying colored specimens of a range of Values and Chromas for ten Hues. He formed the Munsell Color Company to produce color standards in 1918, but died the same year. His son sponsored studies at the National Bureau of Standards and in the Munsell Color Laboratory, which led to the improved color scales in the 1929 edition of *The Munsell Book of Color*, which displayed 20 Hues.

A subcommittee for the Optical Society of America studied the visual spacing of the scales and published recommended changes in 1943. Those recommendations are called the Munsell renotations. The recommended spacing was specified by the system of color measurement standardized by the International Commission on Illumination (identified by the initials, CIE, of its name in French), using CIE Illuminate C and CIE 1931 (2 degrees) Standard Observer. The renotations provide a method of converting color measurement data to Munsell notations and provides the specifications for producing Munsell color standards. The Munsell renotations were standardized by the American Society for Testing and Material in D 1535 Standard Test Method for Specifying Color by the Munsell system.

Around 1950, the number of Hues in *The Munsell Book of Color* was doubled, from 20 to 40 Hues. In the early editions of *The Munsell Book of Color*, the chips had a matte surface. In 1958, a glossy version was introduced, to improve the reliability of comparisons of the standards to paints, plastics and other materials with glossy surfaces. Both matte and glossy versions are in widespread use today. The Nearly Neutrals Collection, introduced in 1990, provides a number of pale colors often used for cosmetics, interior design and computer hardware.

The Munsell color-order system has gained international acceptance. It is described in unabridged dictionaries and encyclopedias as well as in specialized publications on art, design, color photography, television, printing, paint, textiles and plastics. It is recognized as a standard system of color specification in standard Z138.2 of the American National Standards Institute, Japanese Industrial Standard for Color JIS Z 8721, the German Standard Color System, DIN 6164 and several British national standards. The Munsell color-order system has been widely used in many fields of color science, most notably as a model of uniformity for colorimetric spaces and has, itself, been the subject of many scientific studies.

## Special Purpose and Custom Color Standards

Munsell Color provides special collections of color standards for identifying soil colors, for judging the results of tests involving the filtration of colored particulates, for judging the browning of french fried potatoes, and for appraising the color rendition of color reproduction processes, such as photography, printing, television, computer displays and color copying.

Scales are made to exhibit a range of different degrees of gloss. Special sets of colors are formulated to exhibit metamerism, the phenomenon that occurs when pair of colors match under one light source and mismatch under another. A series of colors exhibiting extremely small color differences are produced and assembled in the Farnsworth-Munsell 100-Hue Test, designed for testing color vision.

The Munsell Color Laboratory produces custom colors to order, to meet the needs of industry, commerce and government. There may be a need for colors lying between the regular steps displayed in *The Munsell Book of Color*. These might be the colors of products, the colors of packaging or trademarks, or colors exemplifying the requirements of government laws or regulations. Coatings may be applied to special substrates, such as plastics, foil or sheet metal. Special types of coatings, such as metallic or pearlescent paints, fluorescent coatings or coatings with a specified gloss may be used.

In industrial production of colors there is always some color variation, so the specification of a color for mass production requires the notation of the ideal color and the colors that deviate from the ideal by just acceptable amounts. Designers, quality control experts and the color specialists in the Munsell lab agree on the tolerances

and then a color standard is produced representing the ideal color and the acceptable upper and lower limits of Hue, Value, and Chroma. Such color tolerance sets are widely used to maintain colors of products and packaging and to assure that component parts made in various places match. Even when color is controlled by measurements, a color tolerance set is a useful aid in visualizing color tolerances and reaching clear understandings among buyers, sellers and producers.

## Munsell Books of Color

Munsell Books of Color display color chips according to the Munsell Color Order System comprised of the three attributes of color—Hue, Value and Chroma. Each page represents one Hue, spaced by Hue steps and arranged by Value and Chroma. Value increases from the bottom of the page to the top, and Chroma increases outward from left to right. The Hue is listed at the top of each page. Value steps are printed along the left hand side with the Chroma steps printed along the bottom of the page. The standard way to describe a color using Munsell notation is to write the alpha-numeric designation for the Hue (H) and the numeric designation for Value (V) and Chroma (C) in the form
of H V/C.

The Munsell Color Order System is based on the human visual system and color physics principles; therefore, there are a number of nuances between the Glossy, Matte and Nearly Neutrals Books of Color, which have been highlighted in Table 2.

## Production of Munsell Color Standards

Munsell color standards are made by applying a stable coating to a paper or polymer substrate, using the most stable colorants available. The colors are made according to the specifications contained in the final report of the subcommittee of the Optical Society of America on the spacing of the Munsell colors, J. Opt. Soc. Am., 33, 385-418 (1943). Samples of each production lot are measured with a spectrophotometer and are visually inspected at the time of production and periodically thereafter.

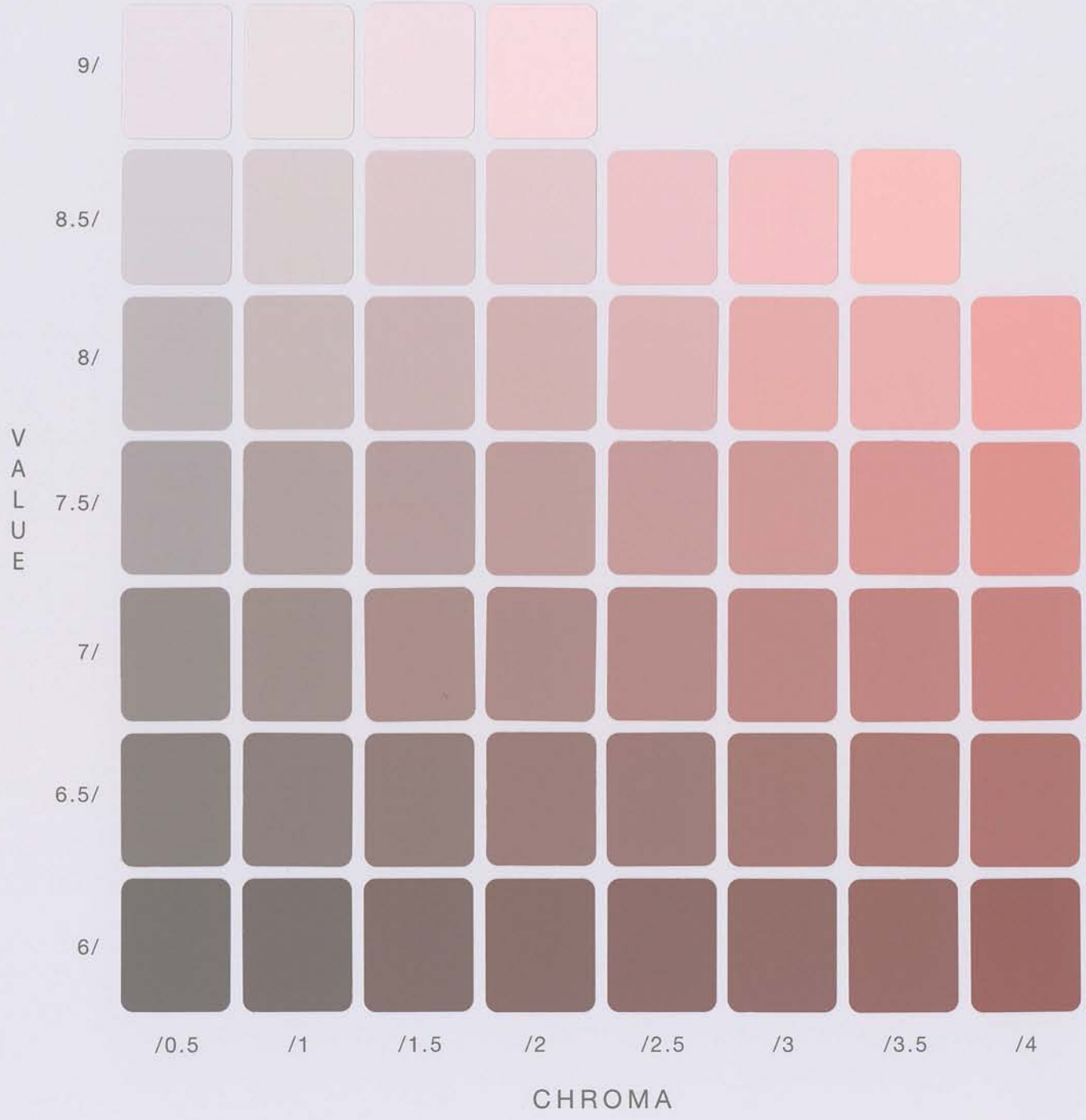
Colors in the Munsell Books of Color are manufactured to tolerances of using the Munsell color space that is equal to a CMC 2:1 DE of 0.4 or less. The manufacturing tolerances for the colors in the Munsell Book of Color are based upon the Munsell Color Space, and the reproduction of each color will visually match from production run to production run. However, there are exceptions in the Glossy Collection for colors that have been added to the Glossy Collection to extend the Chroma limits. These colors represent Chromas ranging from 1.0 – 1.8 steps above the colors to their immediate left on the page. The exceptions include the following Munsell notations:

| | | | | | |
|---|---|---|---|---|---|
| 2.5YR 2/4 | 2.5YR 5/14 | 7.5YR 2/4 | 7.5YR 6/14 | 10YR 3/6 | 10YR 4/8 |
| 7.5Y 6/10 | 5GY 3/6 | 2.5G 9/4 | 10BG 5/10 | 2.5B 7/8 | 5B 6/10 |
| 5B 7/8 | 10B 3/10 | 10B 5/12 | 10B 8/6 | 2.5PB 8/6 | 5PB 8/6 |
| 7.5PB 7/8 | 10PB 7/8 | 2.5P 7/8 | 7.5RP 5/14 | | |

*Table 2:* Munsell Books of Color Comparison

| | **Glossy Collection** 1600 removable chips | **Matte Collection** 1181 removable chips | **Nearly Neutrals Collection** 1100 fixed chips |
|---|---|---|---|
| **Hue** | 40 pages, 2.5 Hue steps apart | | 20 pages, 5 Hue steps apart |
| **Value** | Scale from 1 (darkest) to 9 (lightest) increasing in increments of 1<br>*Notes:*<br>• Darkest colors have a value of 2 in the Glossy Collection and 2.5 in the Matte Collection. A special color series of value 8.5 is displayed in the Glossy Collection for the Y Hue and the Matte Collection for Y and GY Hues.<br>• A special series of neutral colors (black, white, and grays) ranging in .25 step value intervals from 0.5 (black) to 9.5 (white) in the Glossy Collection and 2 (black) to 9.5 (white) in the Matte Collection can be found on the Neutrals page at the back of the Munsell Book of color. | | Scale from 6 (darkest) to 9 (lightest) increasing in increments of 0.5<br>*Notes:*<br>• Unlike the Glossy and Matte collections, which represent the widest possible gamut of colors, the Nearly Neutrals collection only represents an expanded display of the pastel region of color space. Pastel colors require a finer spacing than the stronger colors found in the Glossy and Matte collections<br>• An additional page displays a gray scale ranging in value from 5 to 9.5 in steps of 0.5 and a 20-step hue circle called Nearly Whites. The Nearly Whites have a value of 9.25 and chromas ranging from 0.5 to 2.5, based on the maximum achievable chroma for a particular hue. |
| **Chroma** | Increasing in increments of 2<br>*Notes:*<br>• For low-chroma colors, those that are gray, small differences in chroma are readily apparent, while hue differences are less apparent. For this reason, colors with a chroma of 1 have been created for only 20 hues in the collection. These 1-chroma colors can be found in the back of the book in the Munsell Gray pages.<br>• *At high chromas, hue differences between adjacent hues in the book appear larger. Therefore it is desirable to have colors between adjacent hues. Where achievable, colors with chromas of 12 and higher have been produced for the hues midway between the 40 hue pages. These 78 Supplementary Colors are interspersed in relation to the hues to which they are closest. They can be found in the lowest row of colors labeled "Supplementary Colors."<br>*Applies to Glossy Collection only. | | Scale from 0.5 (weak) to 4 (strong) increasing in increments of 0.5 |

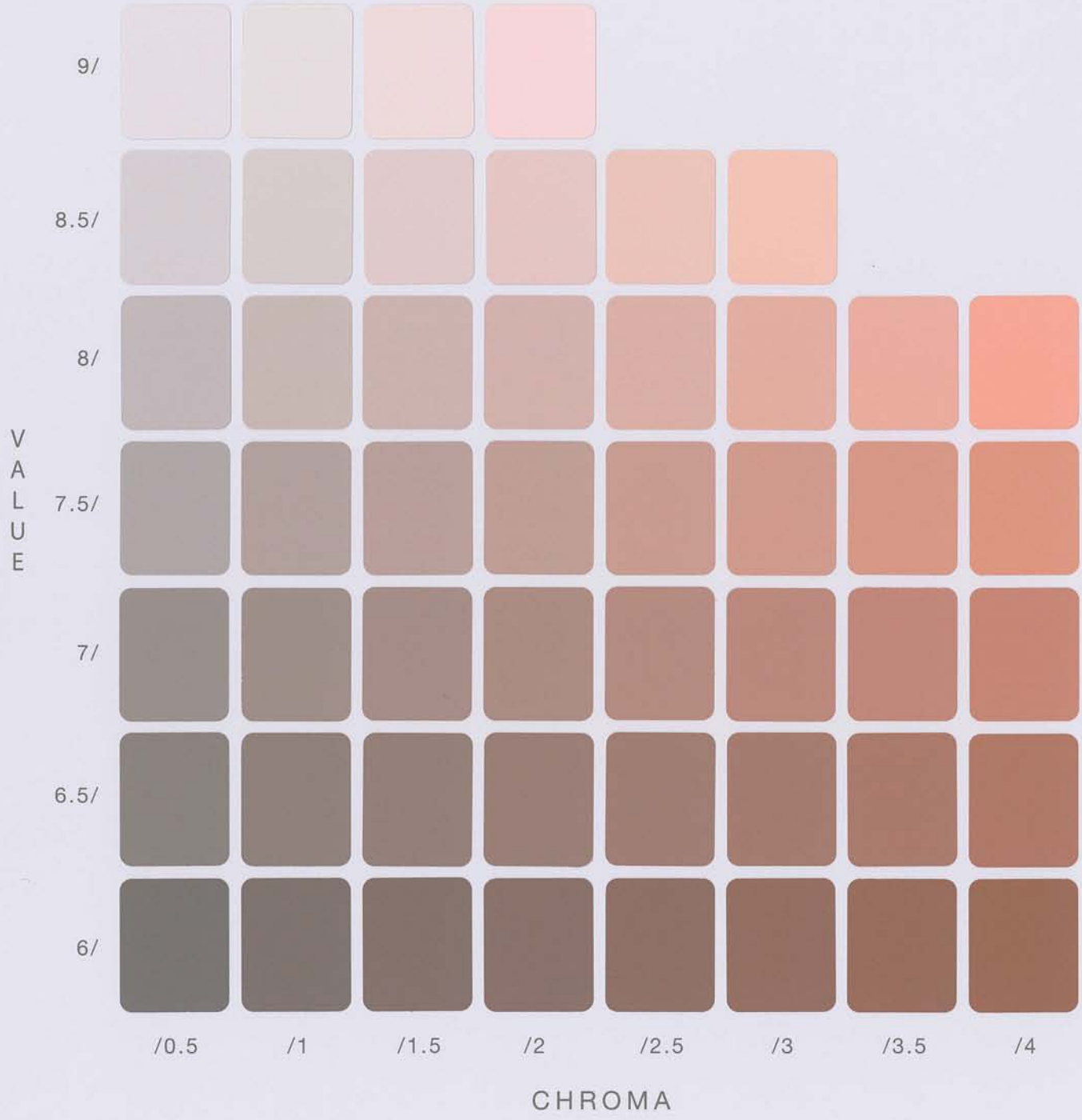
HUE: 5R



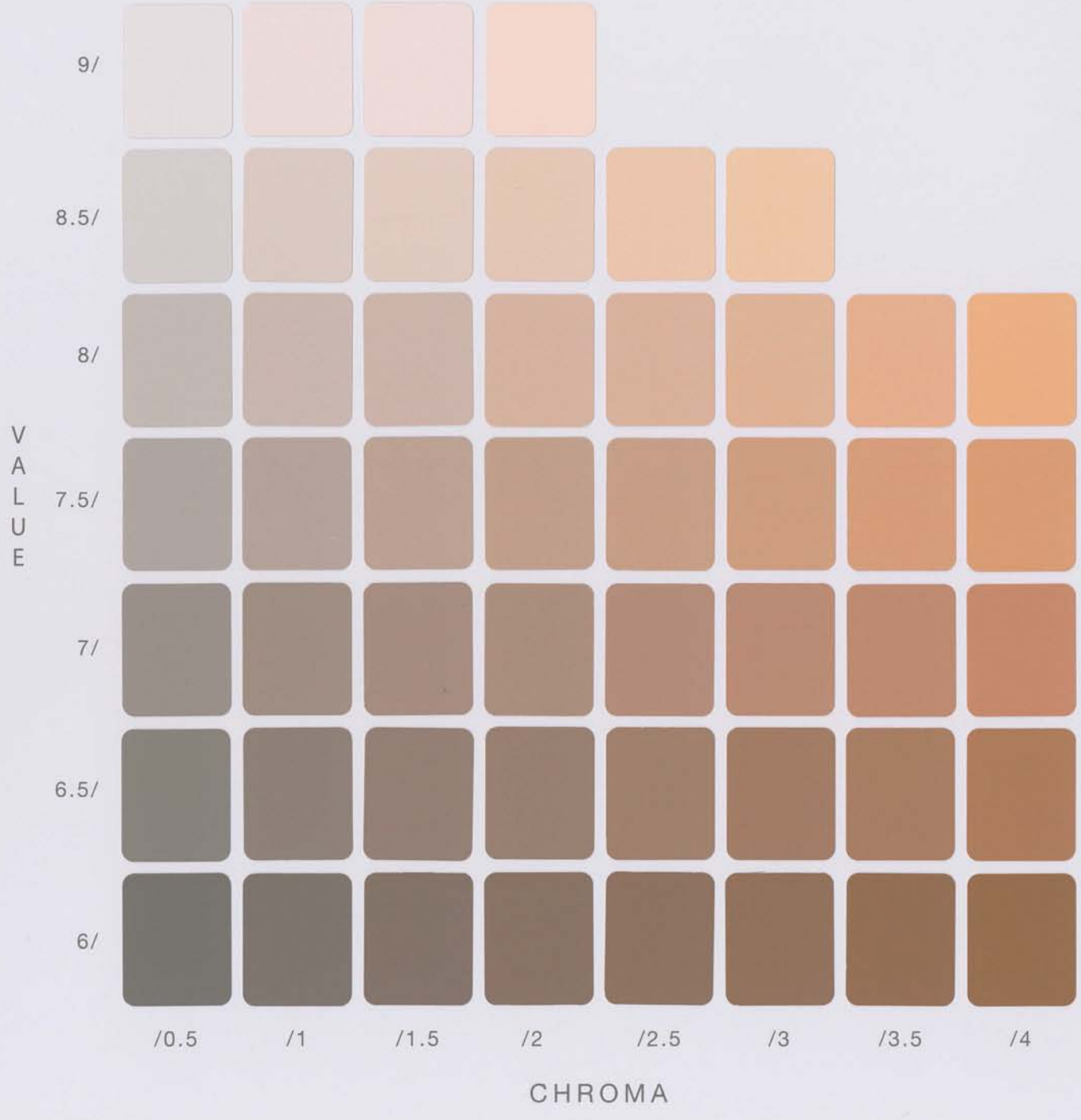
# THE MUNSELL BOOK OF COLOR

NEARLY NEUTRALS

**HUE: 10R**



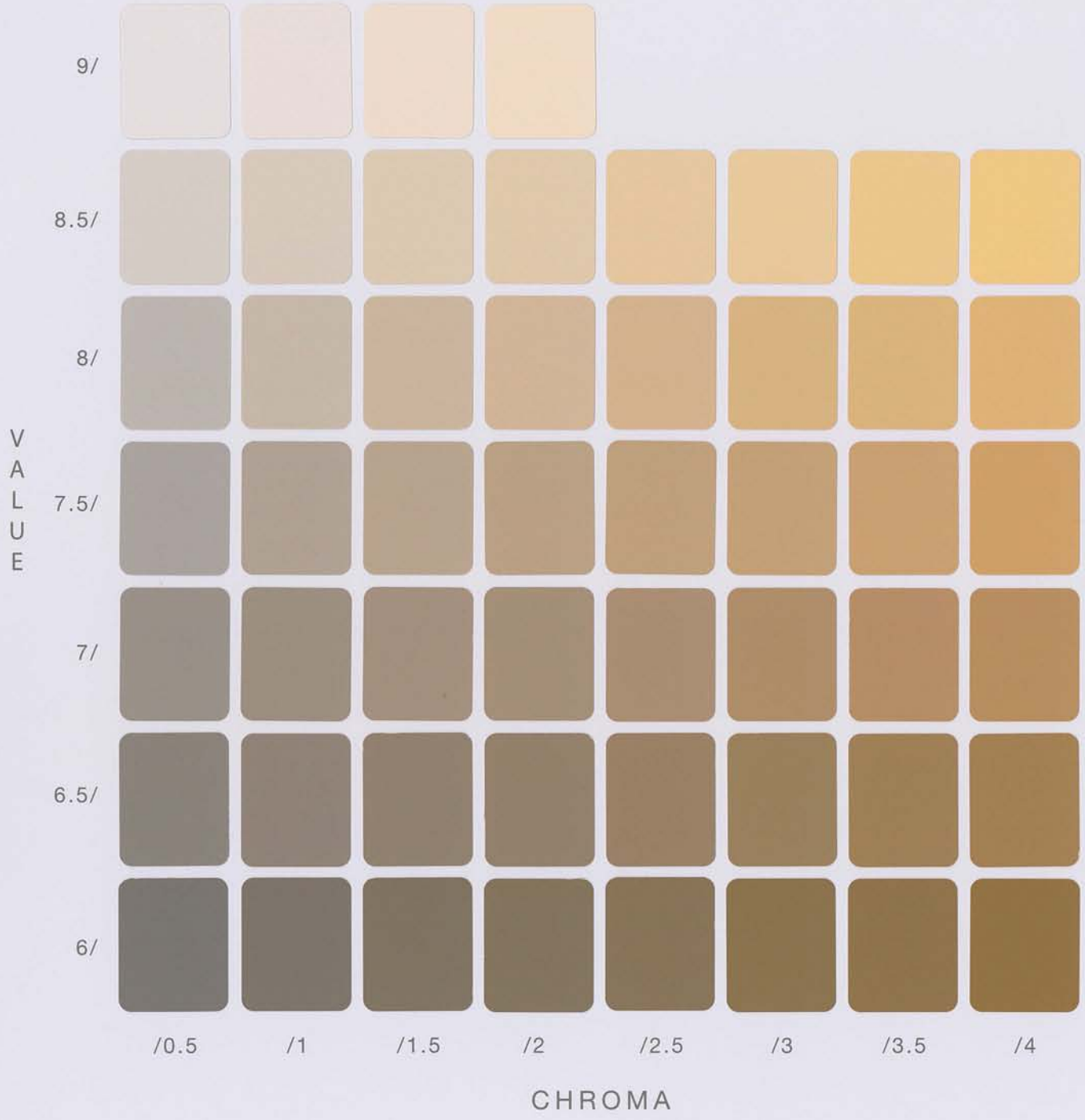
HUE: 5YR



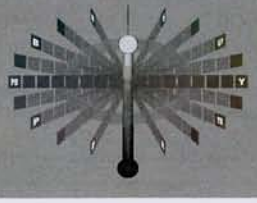
# THE MUNSELL BOOK OF COLOR

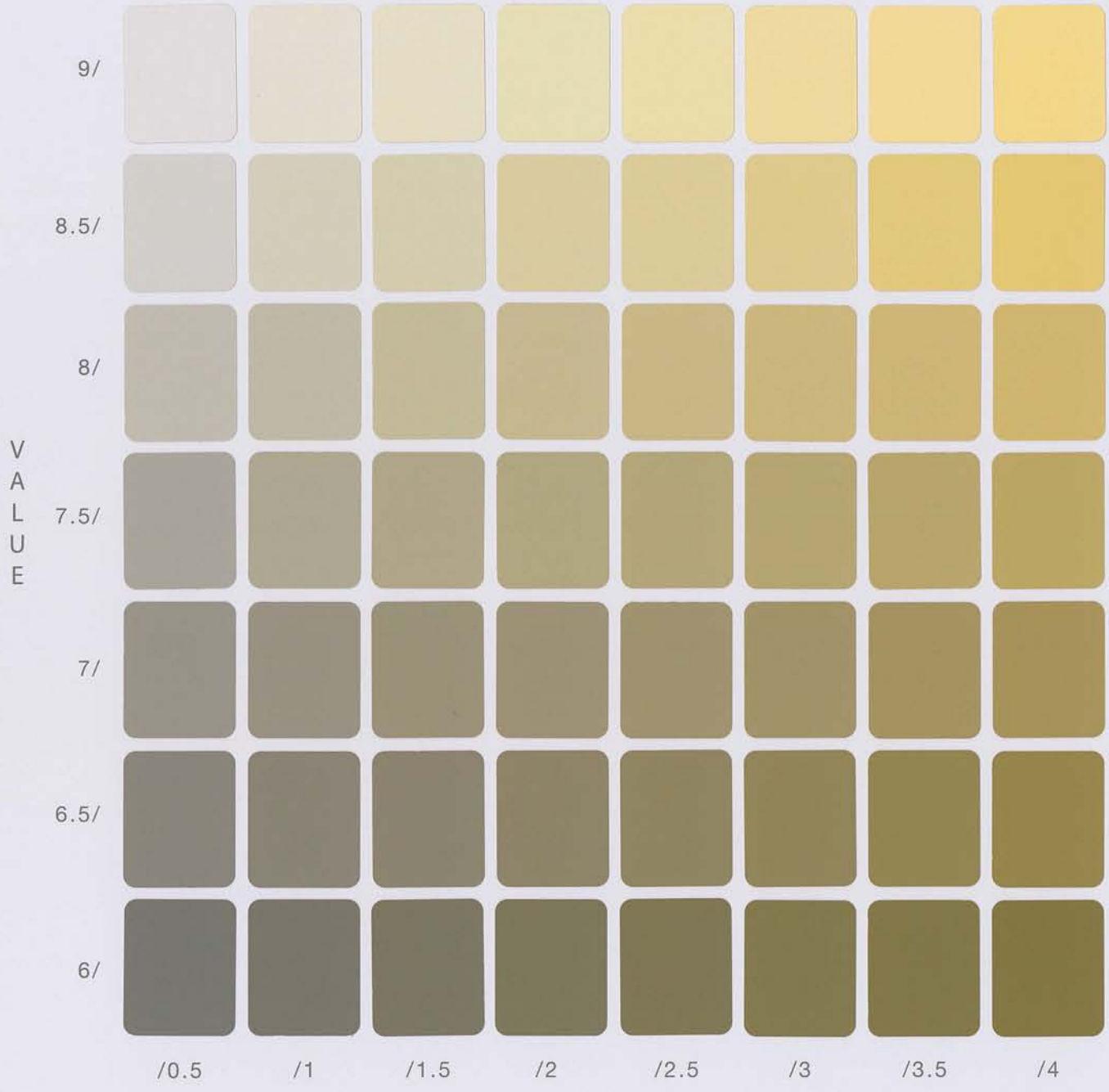
NEARLY NEUTRALS

**HUE: 10YR**



HUE: 5Y



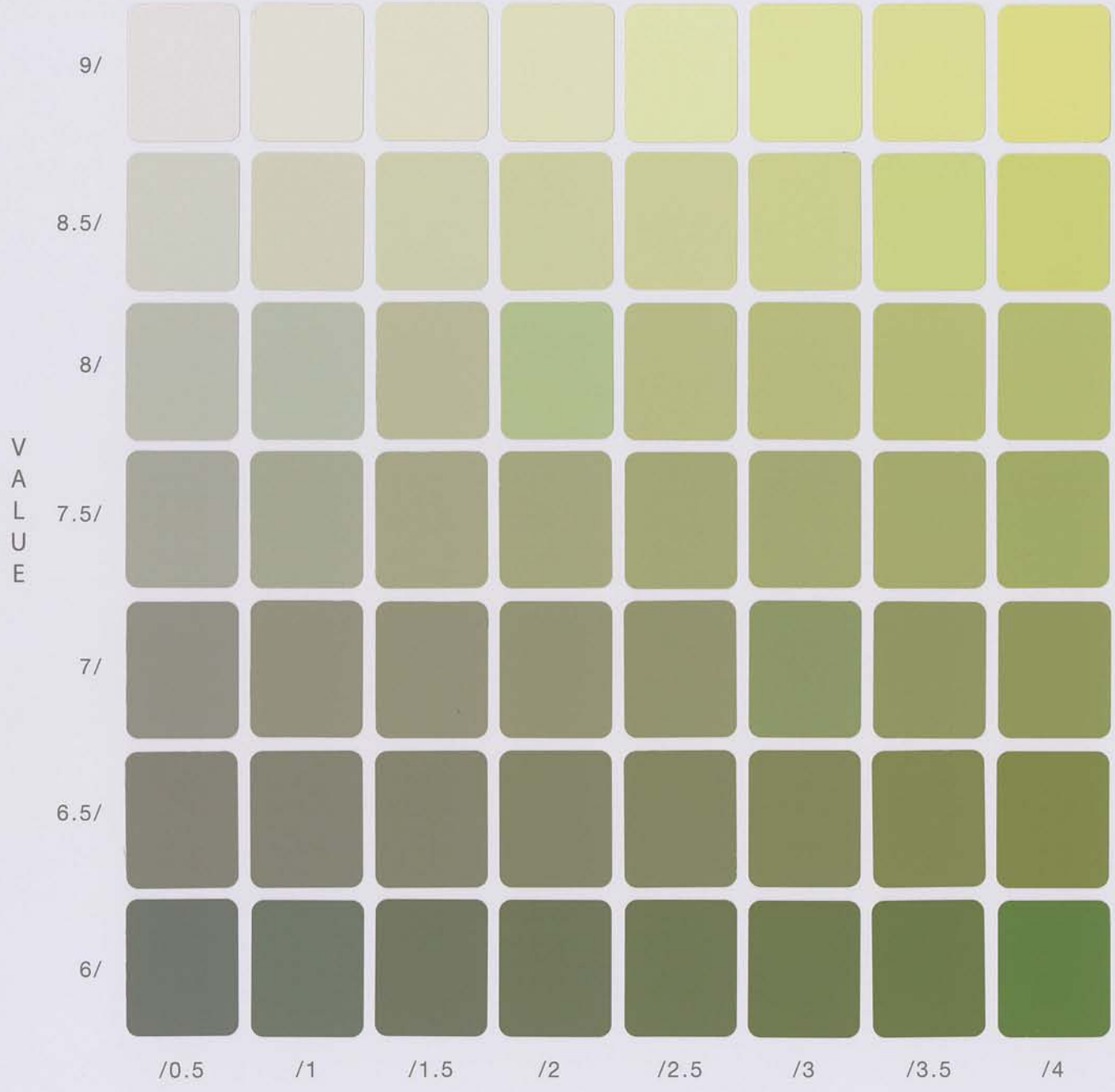


# THE MUNSELL BOOK OF COLOR

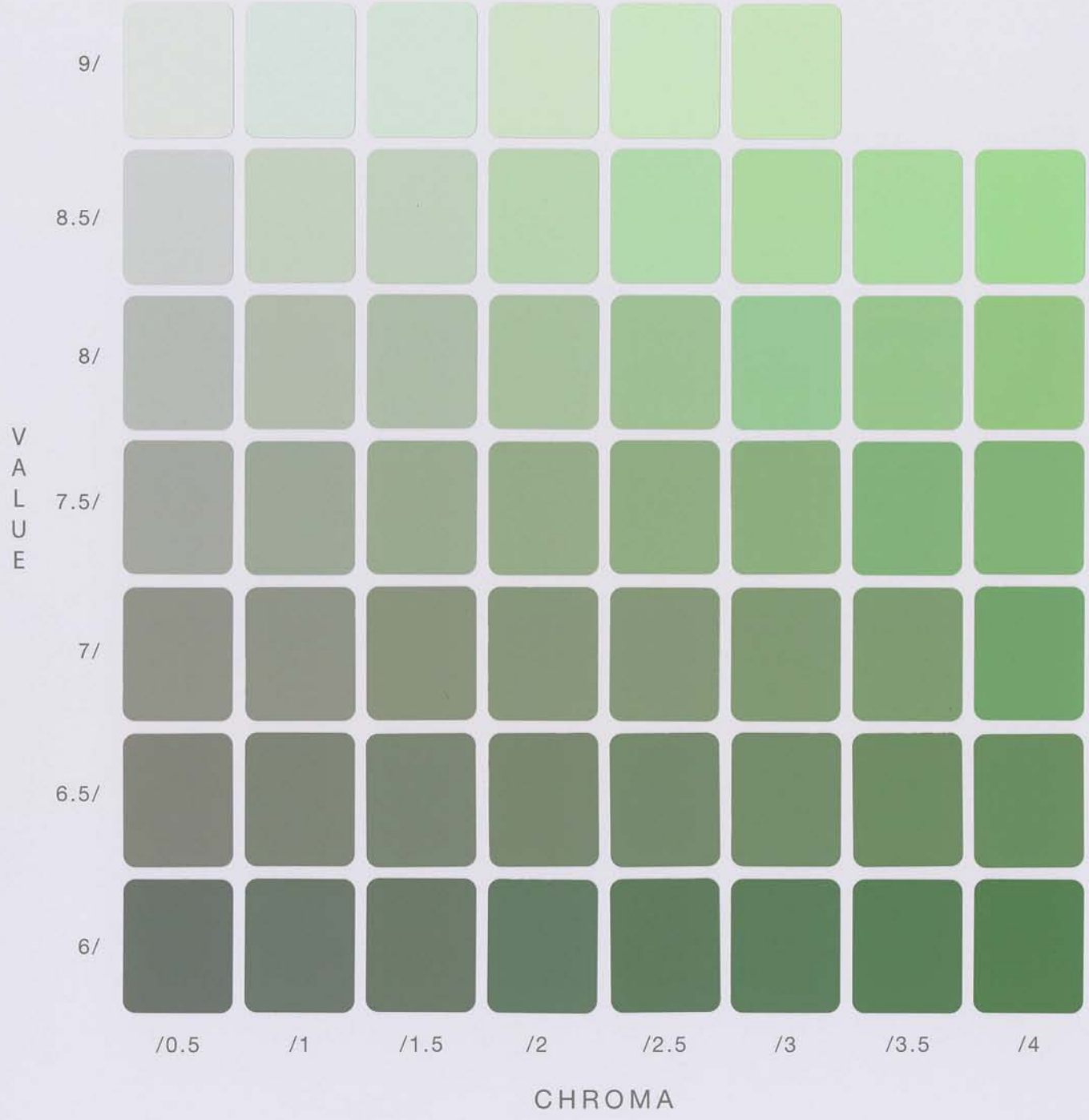
NEARLY NEUTRALS

**HUE: 10Y**

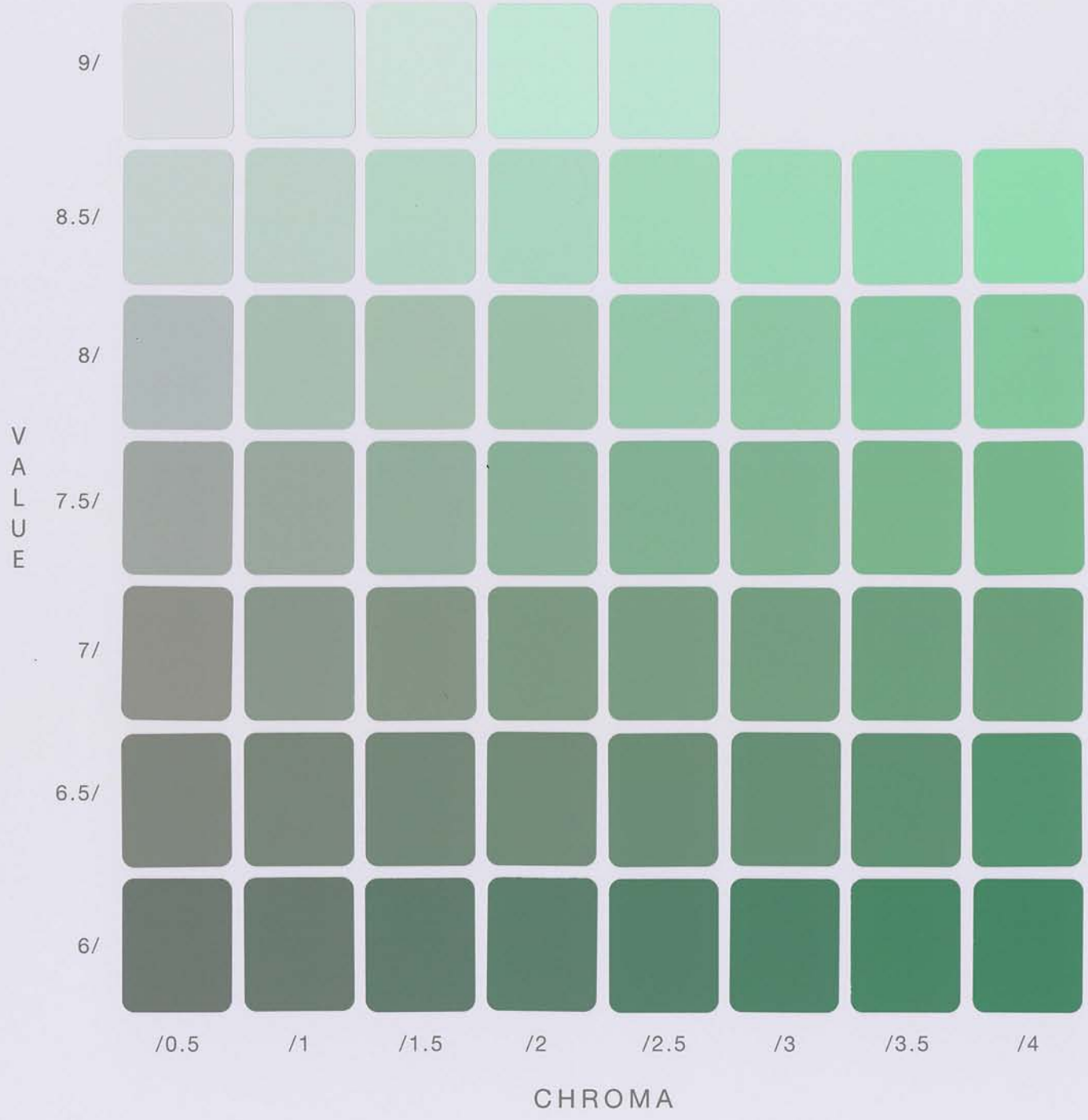
**HUE: 5GY**



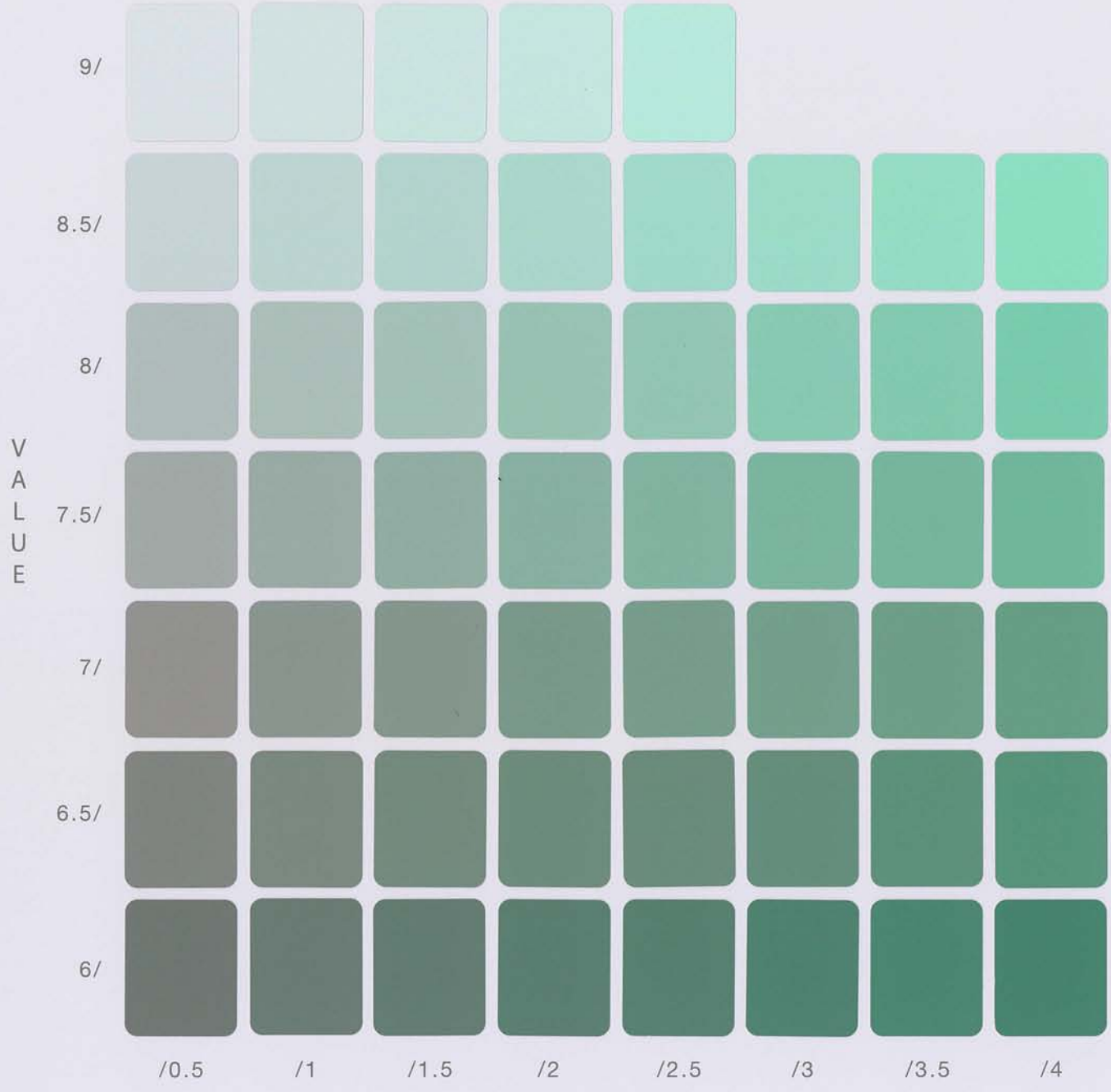
HUE: 10GY



HUE: 5G



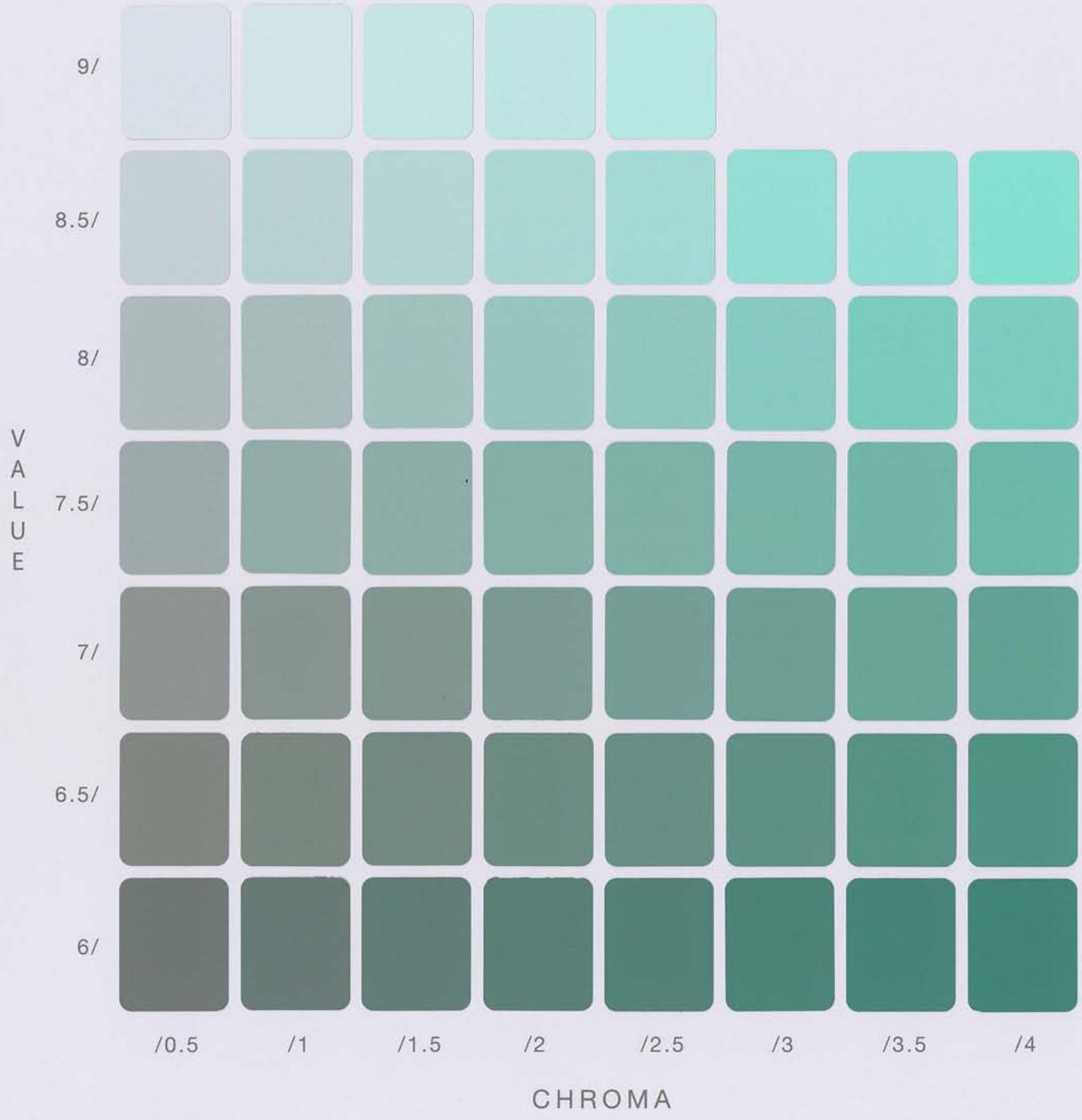
HUE: 10G



# THE MUNSELL BOOK OF COLOR

NEARLY NEUTRALS

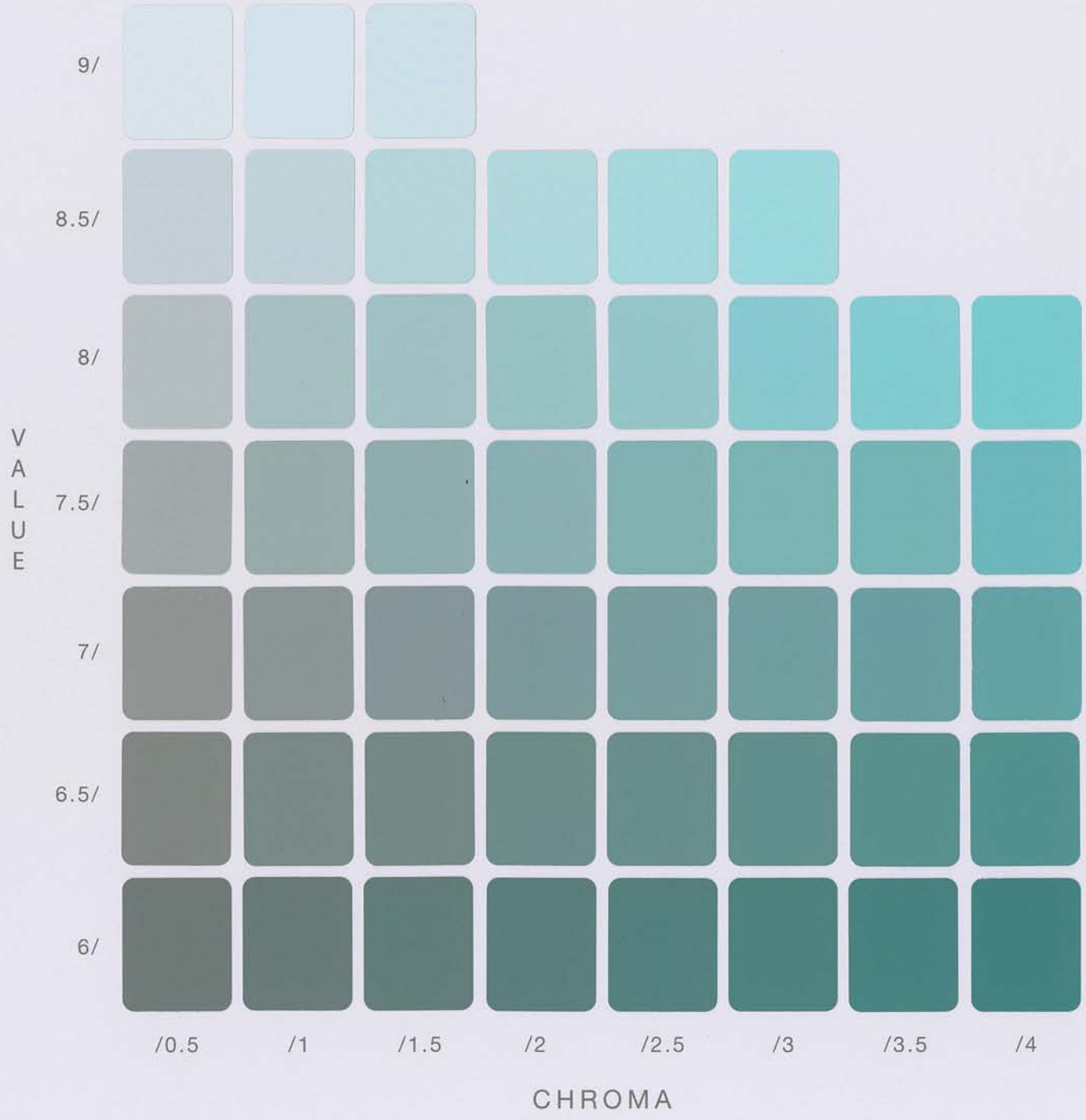
**HUE: 5BG**



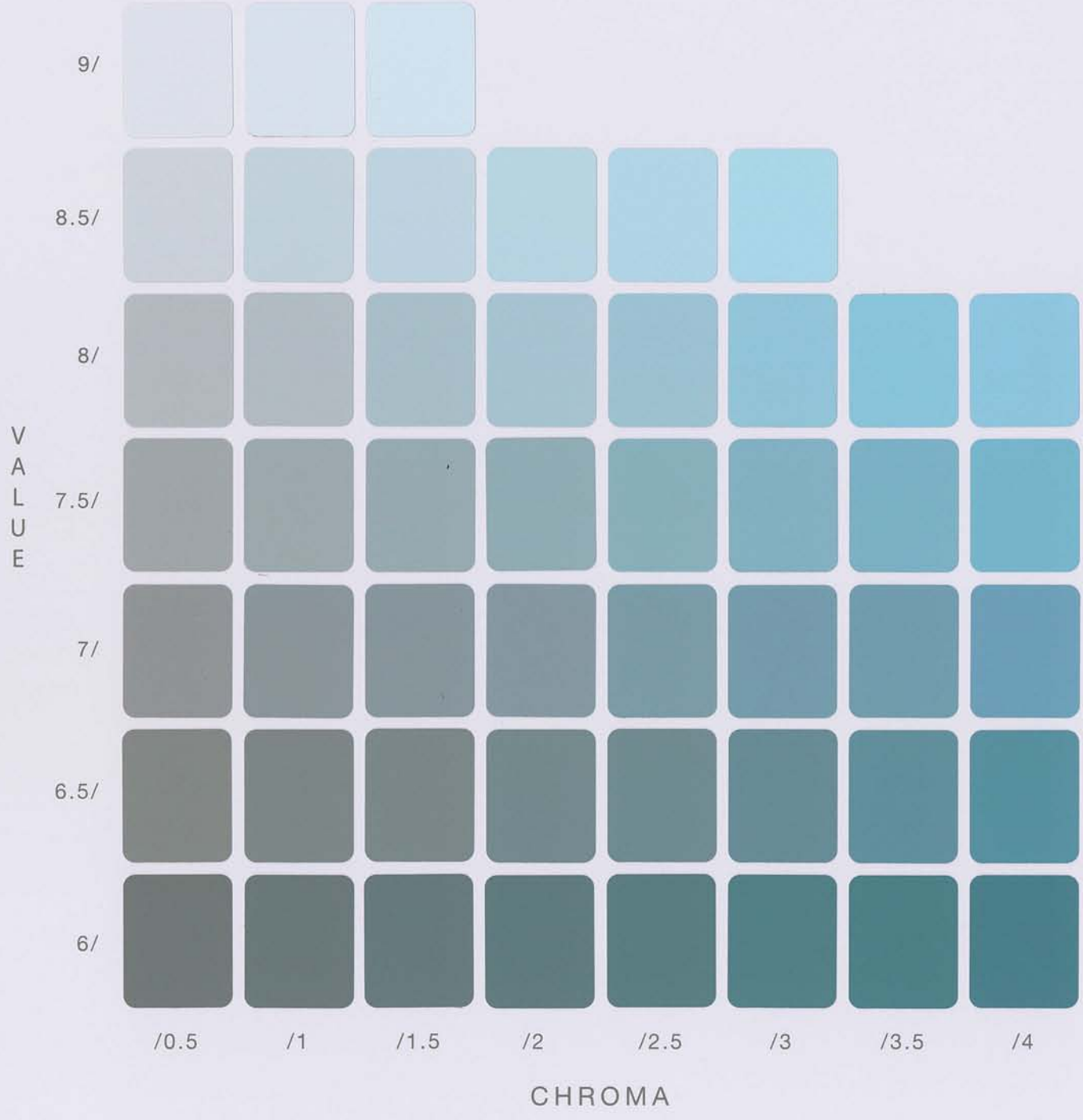
# THE MmunsELL BOOK OF COLOR

NEARLY NEUTRALS

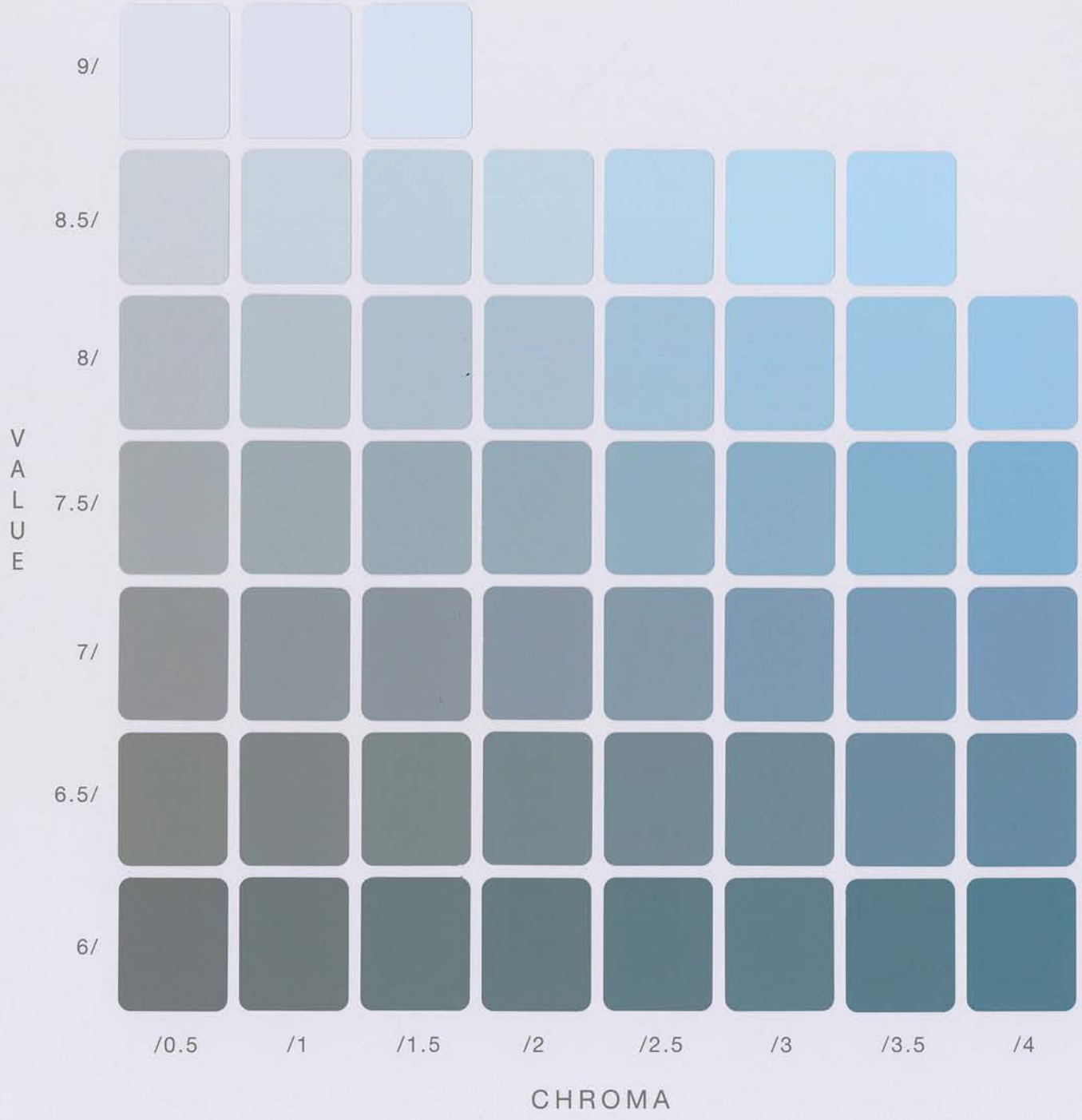
**HUE: 10BG**



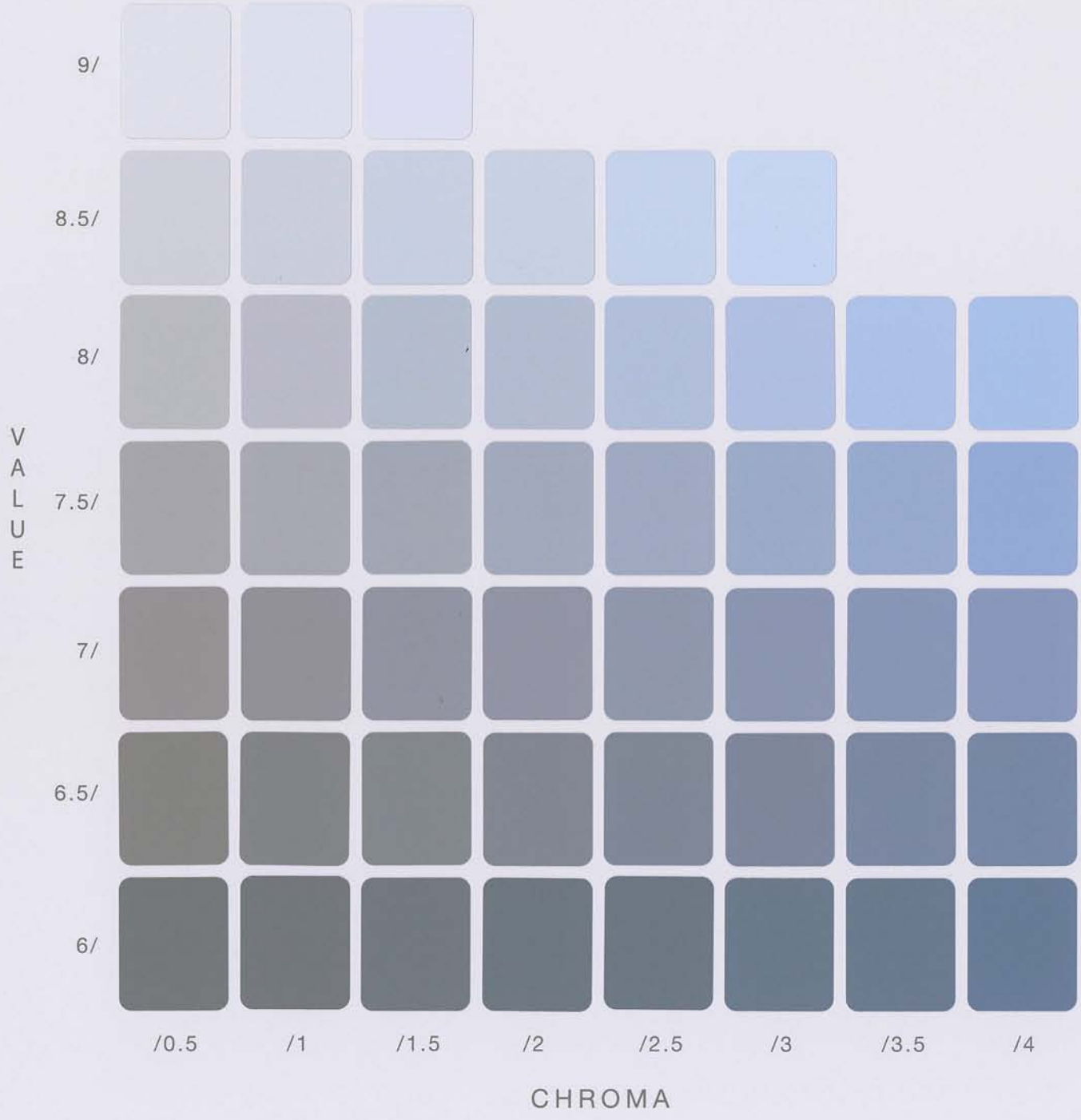
HUE: 5B



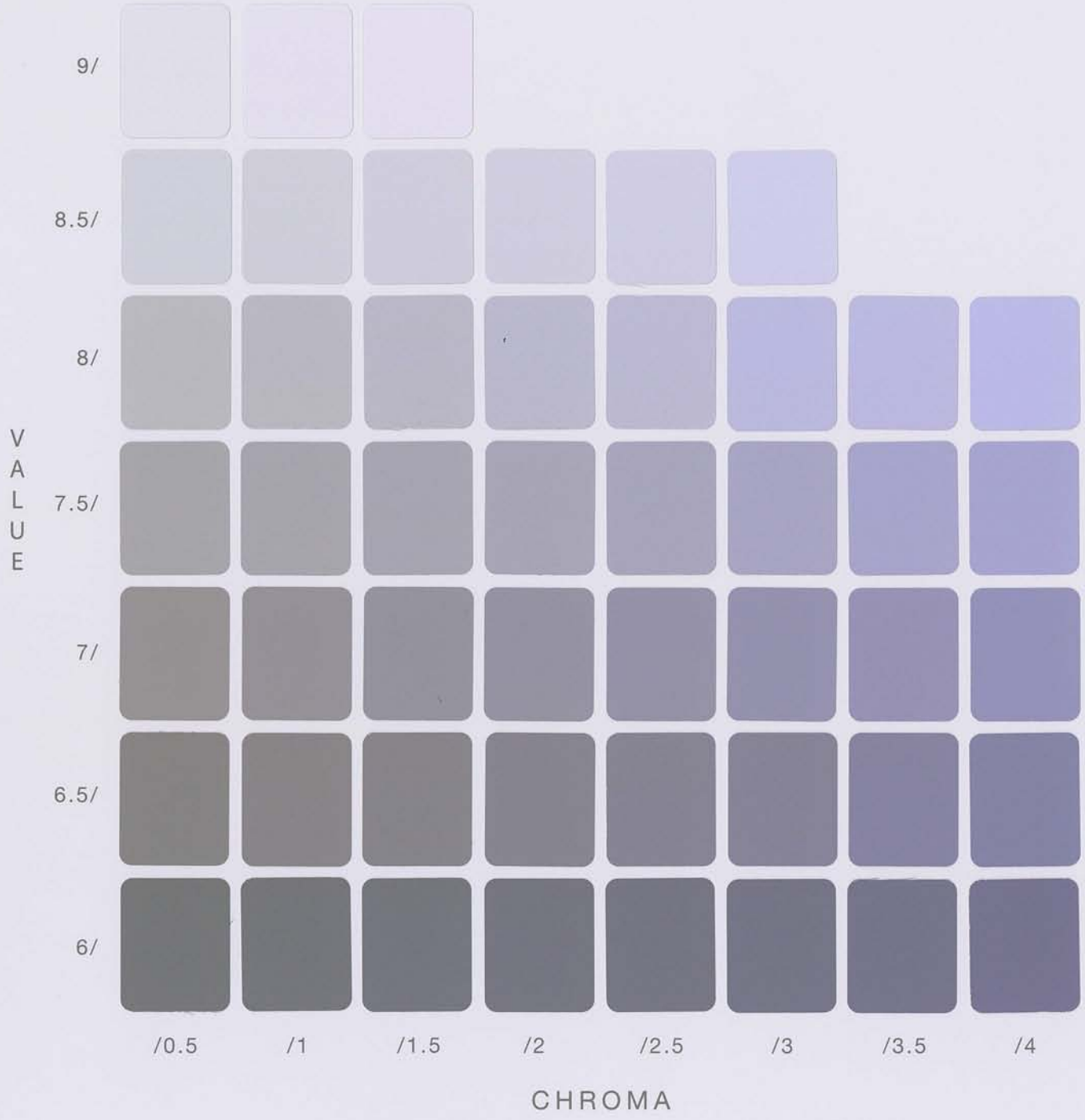
**HUE: 10B**



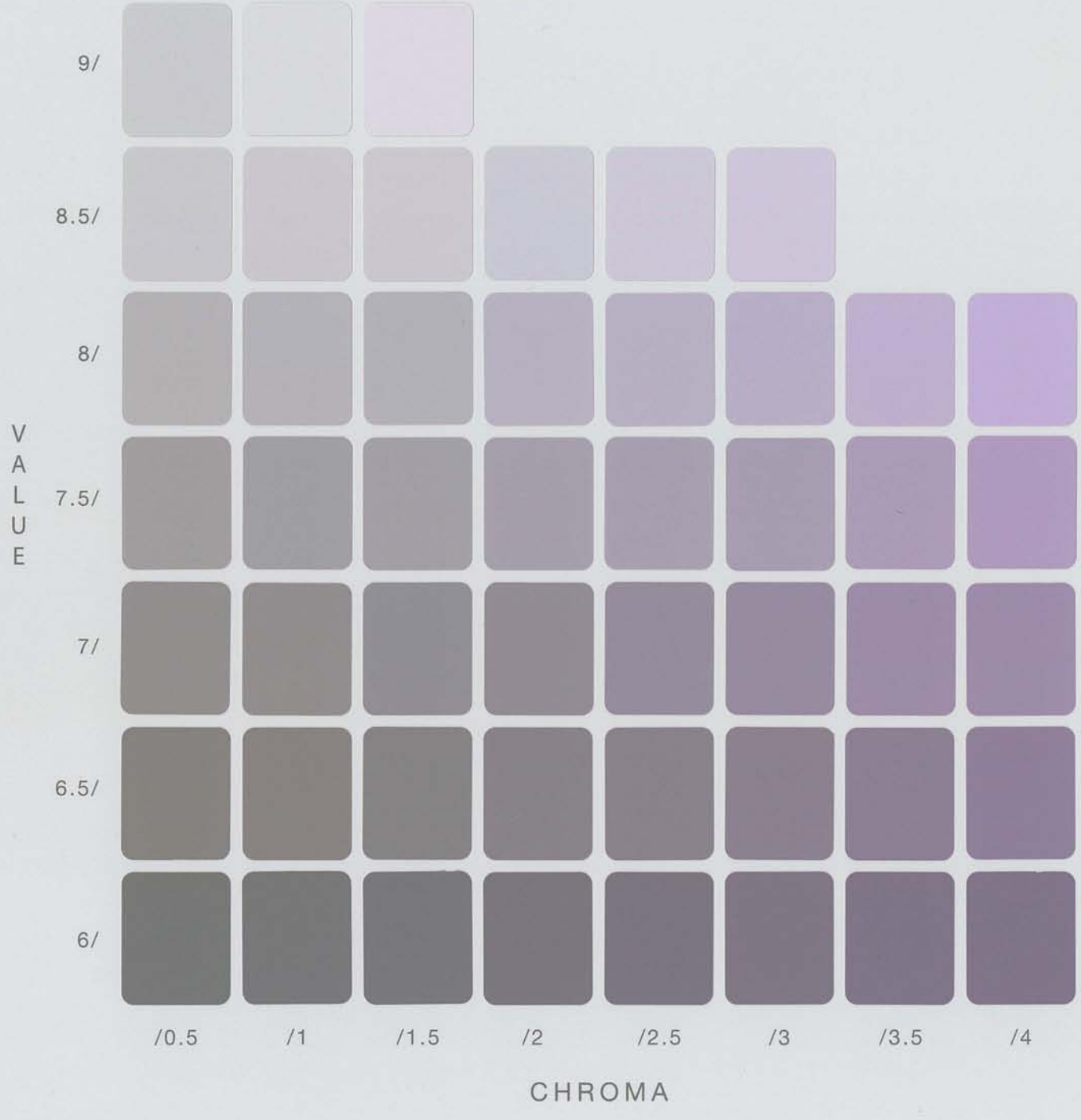
**HUE: 5PB**



HUE: 10PB



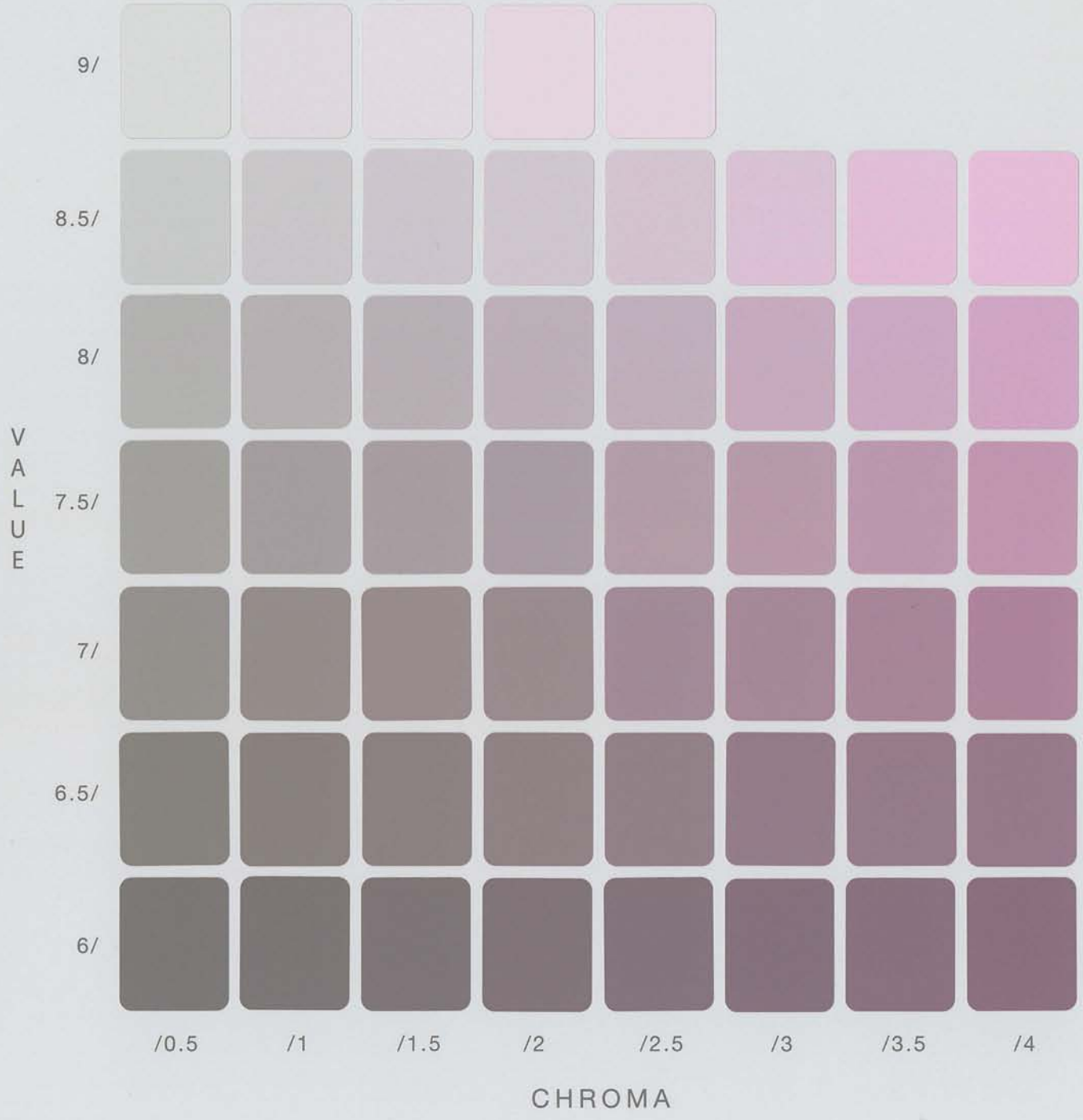
HUE: 5P



# THE MUNSELL BOOK OF COLOR

NEARLY NEUTRALS

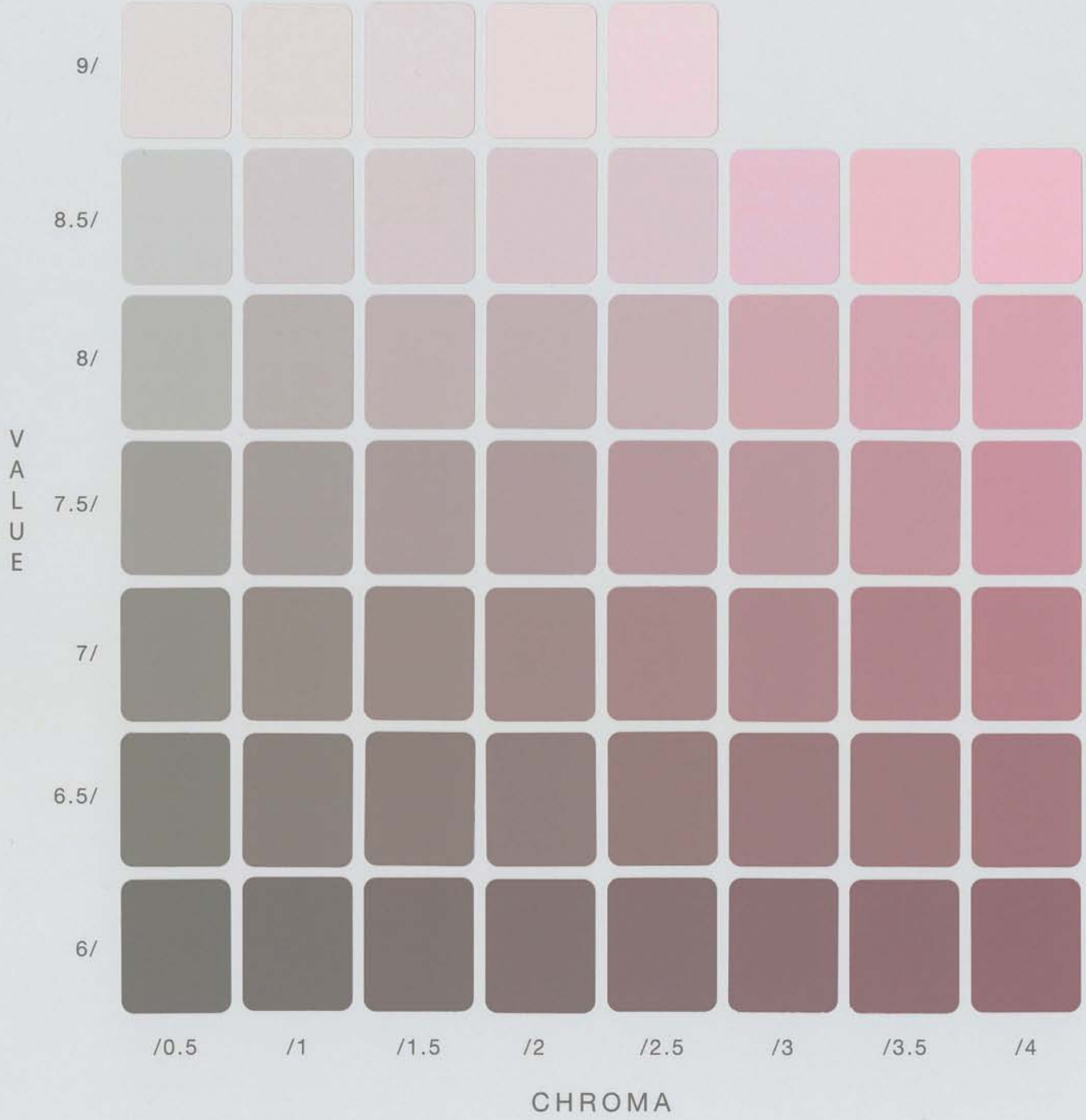
**HUE: 10P**



# THE MUNSELL BOOK OF COLOR

NEARLY NEUTRALS

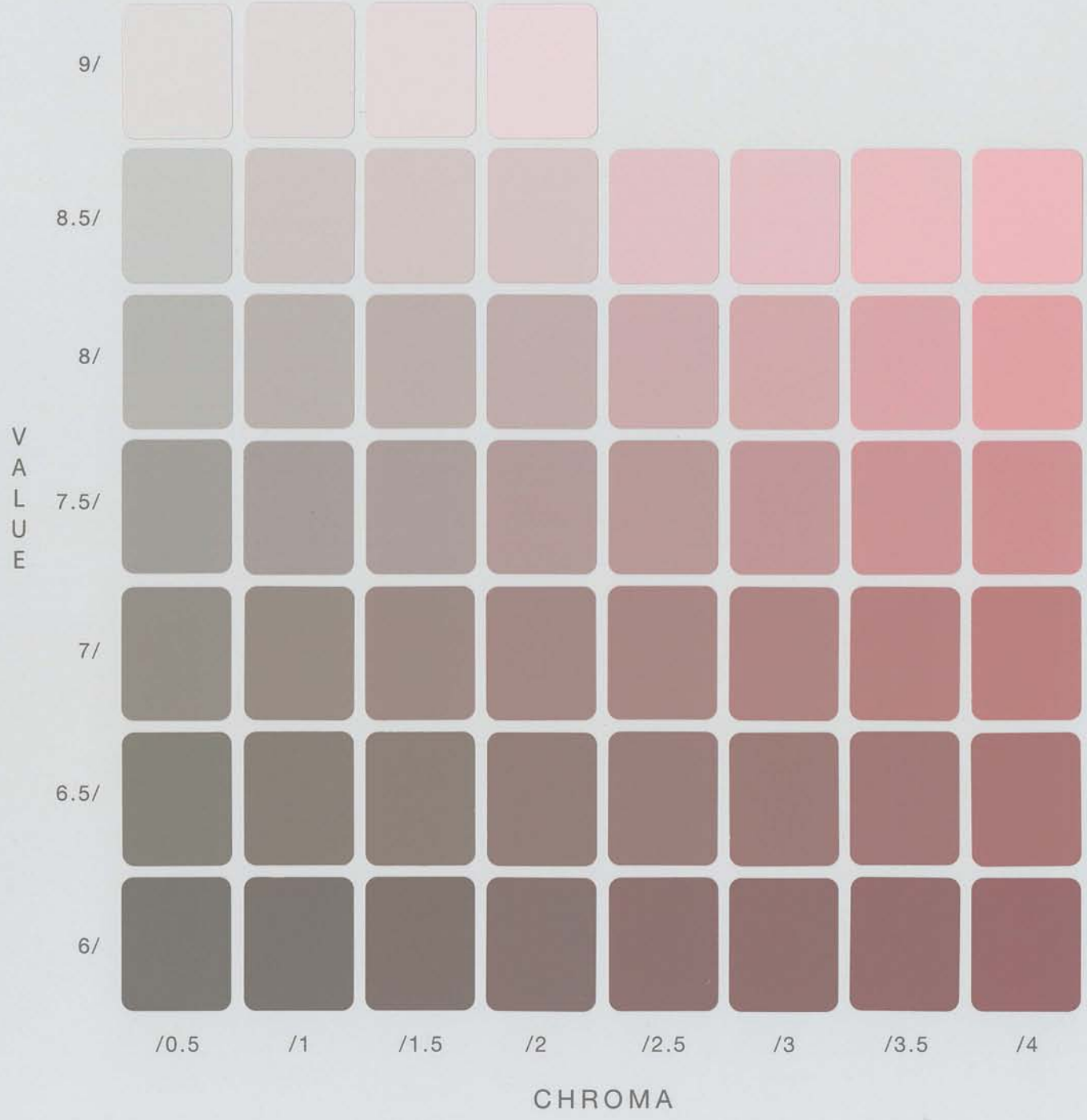
**HUE: 5RP**



# THE MUNSELL BOOK OF COLOR

NEARLY NEUTRALS

HUE: 10RP



## NEARLY WHITES HUE CIRCLE

5R
10R
5YR
10YR
5Y
10Y
5GY
10GY
5G
10G
10PB
5PB
10B
5B
10BG
5BG
10RP
5RP
10P
5P

/2.5 | /2 | /1.5 | /1 | /0.5
CHROMA

Nearly Whites have a constant Value of N 9.25/

N 9.5/
N 9/
N 8.5/
N 8/
N 7.5/
N 7/
N 6.5/
N 6/

NEUTRALS