

Mathematical Model of Cognition with Cartoon Film Movement, Contrast Sensitivity, and Complementary Color Afterimages: The Ability to Convert Digital to Analog Information by Damped Oscillation in Living Creatures

HIDEAKI YANAGISAWA

Gunma Plant, General Affairs Team

Marelli Corporation

132 Shin-nakano, Ora-cho, Ora-gun, Gunma 370-0612

JAPAN

Abstract: - Verdigris appears after red disappears. In addition, there are two illusions of cognition as shown below: an image of a cartoon film that continuously moves, and a black background that makes a gray circle look lighter as well as a white background that makes it look darker. Cognition to them is explained using a mathematical model.

Living creatures convert digital information to analog information for cognition because “smooth continuation” is considered most important. Each process converted through damped oscillation is different based on time or space, but such differences are insignificant. In digital movies, “smooth continuation” acts according to changes throughout time. One feels that its rolling width is larger than the true width in changes of digital information such as in a cartoon film. It also acts to changes in space (length) in contrast sensitivity and afterimages. A black background makes a gray circle appear lighter, and a white background makes it appear darker. Finally, verdigris appears after red disappears. Through damped oscillation, digital information is recognized as analog information among living beings.

Key-Words: digital, analog, information, contrast sensitivity, complementary afterimages, smooth continuation, damped oscillation, animation

Received: April 17, 2025. Revised: May 19, 2025. Accepted: June 15, 2025. Published: November 24, 2025.

1 Introduction

Verdigris appears after red disappears. Goethe discovered this phenomenon of complementary color afterimages [1-3]. In addition, there are two illusions of cognition as shown below: an image of a cartoon film that continuously moves, and a black background that makes a gray circle look lighter as well as a white background that makes it look darker [3]. However, no studies have explained these using a mathematical model. It was also reported that among living creatures, “smooth continuation” is the most important [4]. Therefore, living beings must convert digital information to analog information [4].

In this report, three illusions of cognition are explained by a mathematical hypothesis in which digital information is converted to continuous analog information through damped oscillation [5]. According to this hypothesis, one feels that the recognized rolling width is bigger than the true rolling width during changes in digital information as in a cartoon film movie.

2 Method

Hypothesis: Among living creatures, digital information is converted to continuous analog information through damped oscillation [5].

2.1 Explanation of Digital Information Using a Mathematical Method

In Figure 1, each solid line (A, B, and C) represents digital information. The vertical axis refers to the level, and the horizontal axis refers to time or length. The horizontal axis indicates the time in the digital information as in a cartoon film and the length of space in the digital information as in complementary afterimages. There is no continuation between the solid lines (A and B) and between the solid lines (B and C).

2.2 Damped Oscillation Equation as a Method for Providing Continuation between Each Digital Condition

A damped oscillation equation [5] is as follows:

$$x = As^{-\gamma t} \cos(\omega t + \alpha), \omega = \sqrt{\omega_0^2 - \gamma^2} \quad (1)$$

Here, "t" represents time and "s" represents second. "A" and "α" are the optional constants. When Equation 1 is under damped, it is expressed as a dotted curve in Figure 2. Here,

$$\omega_0 = 0.30s^{-1} \quad (2)$$

$$v_0 = 0ms^{-1} \quad (3)$$

$$\gamma = 0.18s^{-1} \quad (4)$$

The vertical axis is x (level) and the horizontal axis is t (second). The x temporarily becomes minus when t is between 10 and 20. In the condition with Equations 2, 3, and 4,

$$x = -As^{-\gamma t} \cos(\omega t + \alpha), \omega = \sqrt{\omega_0^2 - \gamma^2} \quad (5)$$

Equation 5 is expressed as a dotted curve in Figure 3.

$$x = As^{-\gamma(-t)} \cos[\omega(-t) + \alpha], \omega = \sqrt{\omega_0^2 - \gamma^2} \quad (6)$$

Equation 6 is also expressed as a dotted curve in Figure 4.

$$x = -As^{-\gamma(-t)} \cos[\omega(-t) + \alpha],$$

$$\omega = \sqrt{\omega_0^2 - \gamma^2} \quad (7)$$

Equation 7 is yet again expressed as a dotted curve in Figure 5. In addition, t is changed in each equation because living creatures have a rapid ability to connect information [4]. For example, when t is changed to 10t, the speed increases 10 times. From Equations 1, 5, 6, and 7, $x = As^{-\gamma(10t)} \cos[\omega(10t) + \alpha], \omega = \sqrt{\omega_0^2 - \gamma^2}$

$$(8)$$

$$x = -As^{-\gamma(10t)} \cos[\omega(10t) + \alpha], \omega = \sqrt{\omega_0^2 - \gamma^2} \quad (9)$$

$$x = As^{-\gamma(-10t)} \cos[\omega(-10t) + \alpha],$$

$$\omega = \sqrt{\omega_0^2 - \gamma^2} \quad (10)$$

$$x = As^{-\gamma(-10t)} \cos[\omega(-10t) + \alpha],$$

$$\omega = \sqrt{\omega_0^2 - \gamma^2} \quad (11)$$

Equations 8, 9, 10, and 11 are expressed as dotted curves in Figures 6, 7, 8, and 9.

2.3 Process to Connect Digital Information, such as a Cartoon Film, in Terms of Time

The previous condition is the basis in this case. The dotted curve in Figure 7 is used to connect the solid lines (A and B) in Figure 1, and the dotted curve in Figure 6 is used to connect the solid lines (B and C) in Figure 1. They are expressed in Figure 10. The vertical axis refers to level and the horizontal axis represents time. Solid line B (One) with basis solid line A (Zero) is recognized as the higher level (Point B₁) than the original line B. Meanwhile, solid line C (Zero) with basis line B (One) is recognized as the lower level (Point C₁) than original line C. Thus, digital information through the course of time is converted to analog information with some illusions

of recognition. According to this hypothesis, one feels that its rolling width is bigger than its true width during changes in digital information as in a cartoon film. The center solid line in Figure 11 is insignificantly higher than that in Figure 12. For example, if Figures 11 and 12 are interchanged momentarily, one would feel the movement of a central solid line. They would feel that its rolling width is larger than its true width in Figure 13. Figure 13 is Figures 11 and 12 put together.

2.4 Method to Connect Digital Information such as Color in Terms of Space

The background condition is the basis in this case. The dotted curve in Figure 7 is used to connect the solid lines (A and B) in Figure 1, and the dotted curve in Figure 9 is used to connect the solid lines (B and C) in Figure 1. They are expressed in Figure 14. The vertical axis is the color level, and the horizontal axis is the length because of the difference in space. For example, the background white is the basis, and the changed color is gray in Figure 14. Here the gray with the white background is recognized as darker (dotted line D) than the original gray (solid line B). Similarly, the gray with the black background (solid lines E and F) is recognized as lighter (dotted line G) than the original gray in Figure 15. Thus, the digital information with space is converted to analog information. Figure 16 is Figures 14 and 15 put together, and Figure 17 is a true example of contrast sensitivity [3]. One feels that the center gray of the left side is lighter than that of the right side. Thus, contrast sensitivity can be explained using this hypothesis.

2.5 Difference between a Red with a Basis White and the Original Red

A red with a basis white (solid lines A and C) is recognized as more red (dotted line D) than the original red (line B) in Figure 18. When the red suddenly disappeared, living beings will see the basis white. Therefore, the white with basis red (dotted line E and F) will be recognized as not the original white (solid line H) but rather the verdigris (dotted line G) in Figure 19 [2]. Complementary afterimages can be explained using this hypothesis, too.

3 Results

The three illusions of cognition were explained by a damped oscillation equation: an image of a cartoon film that continuously moves, a black background that makes a gray circle look lighter and a white background that makes it appear darker, and the appearance of verdigris after red disappears. This means that digital information is converted to analog information for cognition among living creatures. One feels that the recognized rolling width is bigger than its true width as digital information changes like in a cartoon film.

4 Discussion

There is no report that one feels a larger rolling width than true width in a digital movie. However, one would confirm this phenomenon through this report. Light and dark adaptation can be explained with this theory, too. There is the course of time in all natural phenomena except mathematics and past facts [4]. Certain changes always exist in all phenomena inside nature. Because time occurs with change [4], the course of time always exists inside nature. Therefore, continuous covariation with time mediations exists in all phenomena. Time is continuous. Therefore, all natural phenomena are analog. Because there is no digital information inside nature, such information must be converted to analog information during the cognition of living creatures. In this process, damped oscillation is used.

Next, the relation between chaos theory and damped oscillation equations is explained. It has been reported that chaos theory is adhered to because of continuous covariation with the course of time [4]. However, damped oscillation is dominant when continuous covariations are few, as in many physical phenomena. Earthquakes, chemical reactions, and other phenomena obey the damped oscillation equations with continuous covariant relations to others. Therefore, converting digital to analog information according to a damped oscillation equation is merely one of many physical phenomena. They never contradict chaos theory because all phenomena with damped oscillation are a part of chaotic phenomena.

5 Conclusions

Cognitions with cartoon film movement, contrast sensitivity, and complementary afterimages can be explained by a damped oscillation equation. In living beings, digital information is converted to analog information for cognition because “smooth continuation” is crucial. Therefore, a black

background makes a gray circle look lighter, and a white background makes it appear darker. Red also leads to verdigris when it suddenly disappears. Similarly, one feels that the recognized rolling width is bigger than its true width when digital information changes as in a cartoon film.

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(in Japanese)

Author Contributions:

This author alone thought this article.

Sources of Funding

This author has no conflicts of interest to declare that are relevant to the content of this article.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

This article is the work of Hideaki Yanagisawa alone.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of Interest

The authors have no conflict of interest to declare.

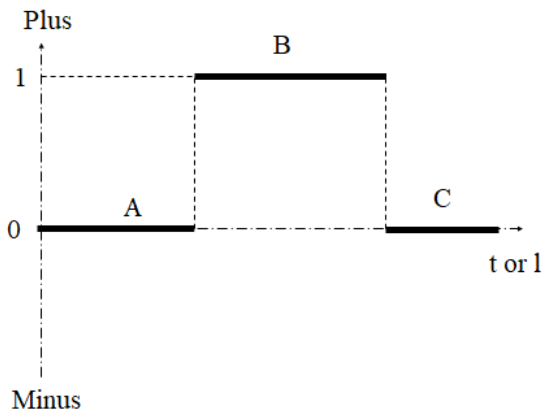


Figure 1: Each solid line (A, B, and C) is not continuous.

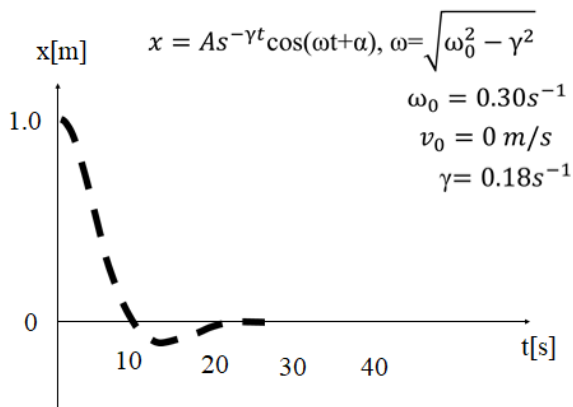


Figure 2: Equation 1 is expressed as a dotted curve.

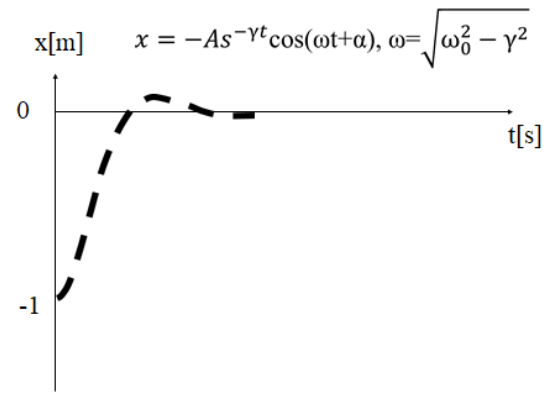


Figure 3: Equation 5 is expressed as a dotted curve.

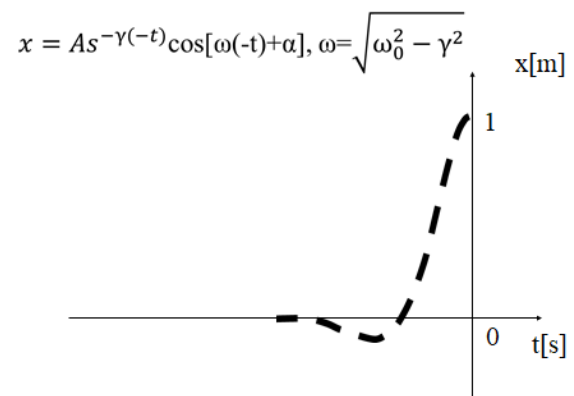


Figure 4: Equation 6 is expressed as a dotted curve.

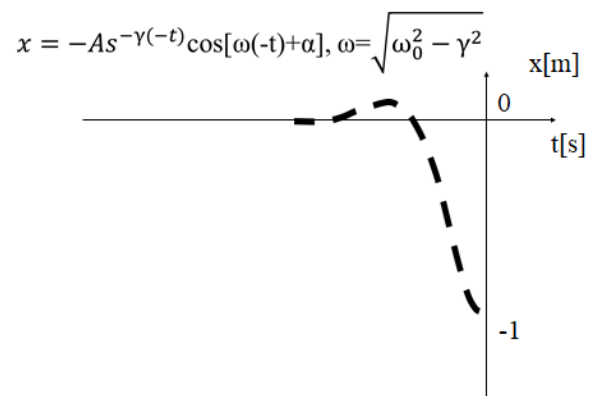


Figure 5: Equation 7 is expressed as a dotted curve.

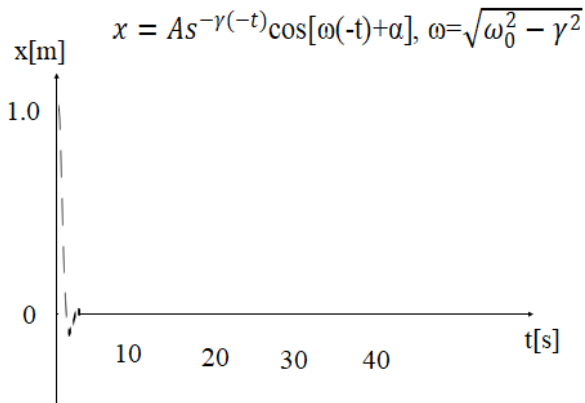


Figure 6: Equation 8 is expressed as a dotted curve.

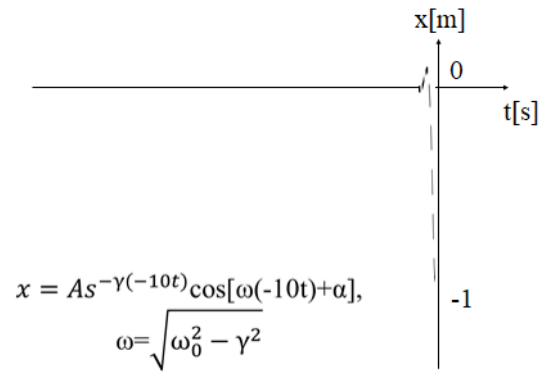


Figure 9: Equation 11 is expressed as a dotted curve.

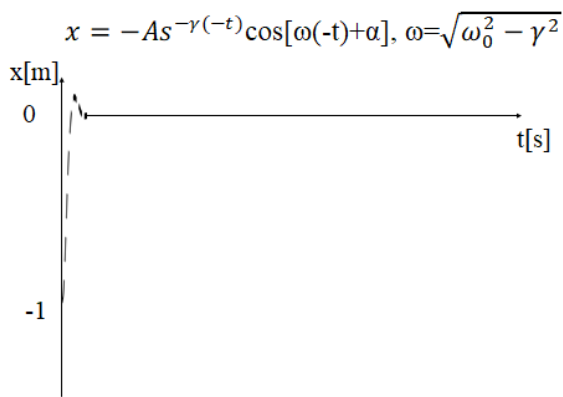


Figure 7: Equation 9 is expressed as a dotted curve.

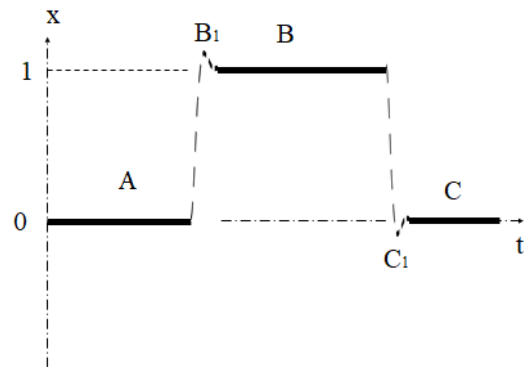


Figure 10: Connection between digital information and course of time; the previous condition is the basis.

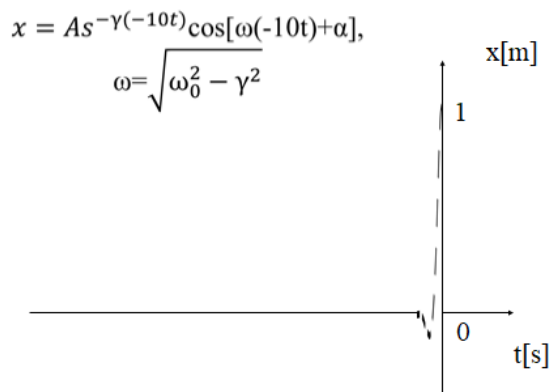


Figure 8: Equation 10 is expressed as a dotted curve.

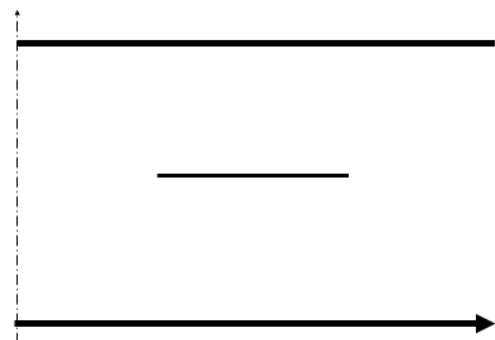


Figure 11: The solid line at the center is insignificantly higher.

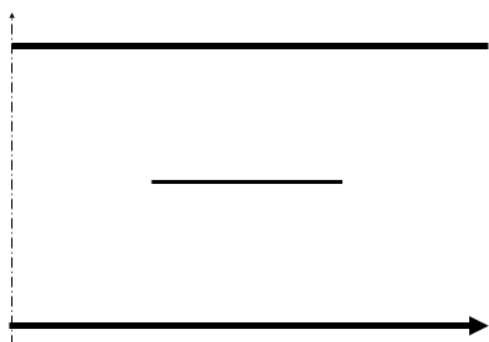


Figure 12: The solid line at the center is insignificantly lower than in Figure 11.

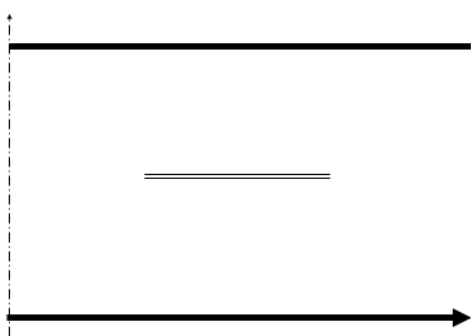


Figure 13: Figures 11 and 12 together.

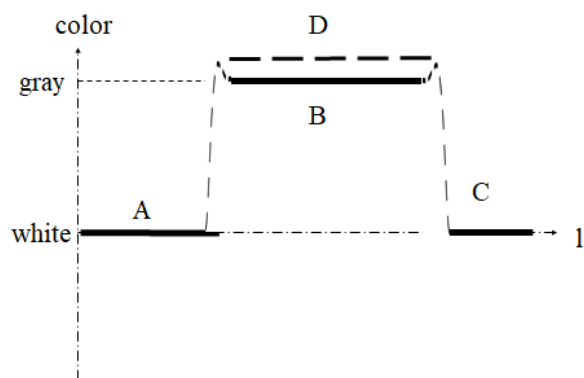


Figure 14: The gray with the white background is recognized as darker (dotted line D) than the original gray (solid line B).

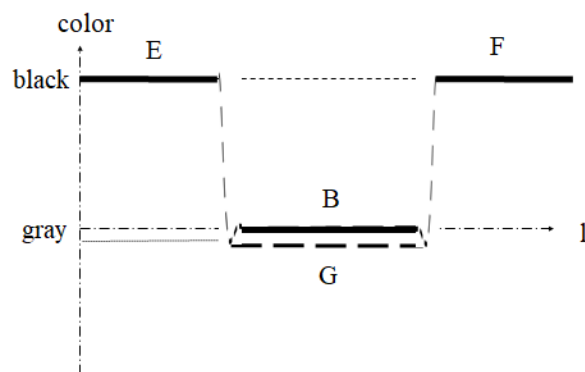


Figure 15: The gray with the black background is recognized as lighter (dotted line G) than the original gray.

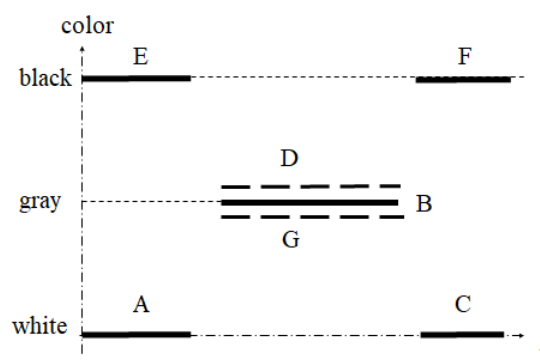


Figure 16: Figures 14 and 15 together.

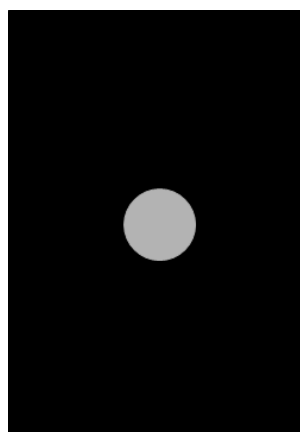


Figure 17: Example of contrast sensitivity.

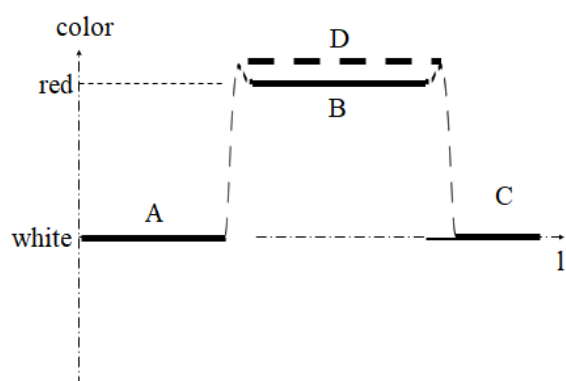


Figure 18: A red with a basis white (solid lines A and C) is recognized as more red (dotted line D) than the original red (line B).

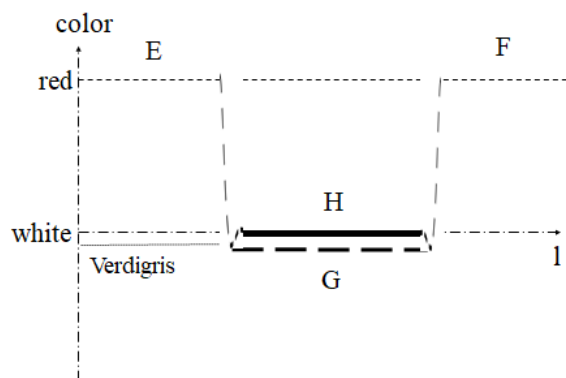


Figure 19: When the red suddenly disappears, the white with basis red (dotted line E and F) will be recognized as not original white (solid line H) but rather verdigris (dotted line G).