Semantic-Conditioned Peripheral Vision Acuity Fading Awareness (PVAFA)

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Abstract. This is a pilot study report that explores one of the factors that influence one's awareness of the extent of vision acuity other than biological reasons. Semantic factor is chosen to put to test to match the tests' linguistic nature of words reading. Look-then-answer style of self-report method is adopted to better reflect this experiment's goal of understanding how one "consciously knows" his or her quality of vision at that moment of words reading. By comparisons of fixating and gazing at a two-character segment of a reading line set in forms of Chinese and Korean characters of right-reading and wrong-reading versions, it can be checked to see how semantic factors influence one's *Peripheral Vision Acuity Fading Awareness* (PVAFA). Results show the tendencies that partially support semantic-conditioned interpretations that: (1) the better a reading line's semantic meaning understood, e.g., native Chinese readers gaze at Chinese characters, the more peripheral visions smeared than gazing at Korean characters; (2) the harder the lexical information can be identified, i.e., gazing at wrong-reading characters (in this case, upside-down typesetting), the lenient the PVAFA effect to occur. A follow-up discussion stresses how semantic factors mingle with vision acuity awareness in a lab set-up is worthy further hypothesized to probe its broader implications on visual form perception in both real world situations and human-computer interacted environments.

Keywords: foveal visions, vision acuity, visual form perception, visual logics.

1 Introduction

Foveal vision is an area or region of the retina within which an image has its sharpest resolution and thus shows the best clarity. Because sharp vision is restricted to a much smaller region as mentioned, foveal vision subtends a very small angle of view, while impressions in the parafovea (the region surrounding the fovea) are somehow less distinct [1]. The span of material clearly seen at each fixation point is stringently limited due to the narrow field of foveal vision.

In general, one gazes longer at interesting or puzzling things and shorter at mundane or simple things. It is during this fixation period that one "sees" a feature before moving on to another feature [1]. Thus, the fixation of a gazing is not only about biophysical vision acuity, but also a matter of psychological visual understanding.

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Even for biological reasons, there are different kinds of factors that singly or confoundedly affect vision acuity. According to Bursill's findings, under hot conditions, peripheral signals at greater eccentricities were more likely to be missed through a "funnel" of the field of awareness [2]. Sanders suggests that the functional vision fields may be elastic or sensitive to the overall information-procession demands [3].

These studies certainly suggest that the useful field of view is sensitive to overall task demands, and most agree that increases in foveal load should hurt performance more and more at increasing eccentric locations [4]. But it is difficult to ascertain whether the effect was cognitive in nature or due to the visual complexity of the foveal information [5].

Early foveal vision researches mostly started from reading material tests. In addition to pure biologics-driven theories, those reading-test studies reveal factors causing vision acuity fading other than mere biological reasons. There is also a large body of evidence suggesting that higher lever linguistic factors affecting fixation duration [6]. Some studies even have shown that semantic information is extracted up to 6-8 characters to the right of the fixation location [7]. And, lexical information may induce more on foveal load that prevents attentiveness to disperse into peripheral vision zone and beyond.

Our understanding is that word reading is a state of visual perception, which in one way draws data from the sensation of physical input through biological cannels, and in the other induces his or her previously stored concepts to participate in the current visualization process. Semantic factor is one of the most obvious ones that impose a person's foveal load of word reading and that in turn delineate the extent peripheral vision acuity fading awareness (PVAFA) can be dispersed to.

We tested our conjecture by conducting a series of test-run experiments in forms of cross comparison on Chinese and Korean characters presented in both right-reading and wrong-reading fashions to see how semantic factor influences the peripheral vision acuity fading awareness (PVAFA), and to see whether any further formal and larger-scale experiment should be carried forward for a long-shot expectation of theorizing a form-content(meaning) interactive model of general visual form perception theory.

2 Methods

2.1 Subjects

Opportunity sampling is used to recruit testees for the investigation. Though Opportunity sampling might produce biased sample, it is still adequate when investigating processes that are assumed to work in a similar way in all "normal" individuals, especially for a cognitive experiment like this one. A total of 7 Ph.D. students and 5 master students and 14 undergraduate students from the College of Design of YUNTECH served as testees. A number of them wore spectacles, but all demonstrated the capability to read and the sufficiency to recognize and understand all the Chinese characters that have been printed on A4 photocopy papers which were viewed at the normal reading distance in the tests. None of these testees speaks Korean language and no one recognizes or understands Korean characters either.

2.2 Design

Repeated measure design (also called related measures or within group design) is adopted not only for the benefit of small number of needed participants it requires, but also for its consistence in terms of participants' variables.

2.3 Apparatus

Three 4-ft fluorescent tubes in a ceiling fixture illuminated the testing room without Lucite covered. A standard light-gray color office desk (720mm high) and a matched-color height-adjustable office chair, which can be adjusted to match every testee's hip height was used to sit him or her. No other testee was presented while the tests were conducted except one taster who sat next to the testee's right side giving instructions and administered the tests. Subject would be instructed to sit on the chair with his or her back fully straightened up and bellbottom lightly pressed to the desk's edge panel.

2.4 Stimuli

A 210mm x 297mm regular white A4 photocopy paper was used for each test. All the printed characters were horizontally typeset of 5mm height in a one-line fashion in the middle and across the paper surface with blank margin of 15mm to both edges. Two kinds of language characters—Chinese and Korean were used. Only one side of each paper sheet was printed with black ink, one with Chinese characters, one with Korean.

2.5 Procedure

We conducted four rounds of tests. The first test round included two separate non-comparison tests. Each of the rest three test rounds included a pair of in-tandem comparison tests. Before all the tests took place, the tester introduced testees what they were going to do with what material, and all were told to answer ONLY what the tester would ask and nothing else. Each subject was then instructed to sit and rest his or her both hands on the tabletop with palms facing downward. After the tester helped adjusting the testee's head in a position paralleling his or her face with the desktop surface to a distance about 350mm in between.

In the first round of tests, two tests were conducted with a short intermission in between: First, a right-reading Chinese characters (CR) test sheet was laid on the table surface between the testee's two resting palms. Subject was then asked to look at the printed line and was guided to concentrate on the target area—a two-character segment locates right in the middle of the printed line which was underlined by the tester with an inkless ballpoint pen tip.

While telling the testee to keep on gazing at the targeted segment for about 3 seconds, the tester started to ask the testee if he or she had the awareness of fading vision acuity on both extending sides of the targeted area by answering: "Yes", "No" or "Not sure". Once the answer given, the testee was told to stop gazing and look away

from the test sheet. The test sheet was then replaced by a right-reading Korean characters (KR) test sheet in the same position. The subject was then told to get back to the testing position and postured as instructed before and repeated the same procedure as he or she did in the first test. Once the same question was asked and answered, a 60-second intermission was announced to conclude the first round tests.

For the second round tests, the same right-reading Chinese characters (CR) test sheet was used and the same question was asked ("Have you the awareness of fading vision acuity on extending sides of the character line besides the targeted area's characters?"). Once the question answered, the test sheet was turned upside down to form a wrong-reading Chinese characters (CW) line, and the testee was immediately asked to gaze as before and compare previous "right-reading (CR)" line with then current "wrong-reading (CW)" one by saying which had him or her "stronger" peripheral vision acuity fading awareness (PVAFA) or "not sure (NS)".

After one more 60-second break, in the third round tests, both "right-reading" and "wrong-reading" test sheets were tested in the same fashion as the second round tests did. Only this time with Korean characters lines printed instead which can be simply coded as KR and KW respectively.

The fourth round tests were conducted in identical procedures as previous rounds did, but with a straight comparisons on Chinese characters line with Korean characters line and on "right-reading" versions only.

3 Results

Four rounds of tests were conducted and five sets of congruent answers were collected. All 26 testees took tests. Two responses of theirs were eliminated due to failures to meet the minimal requirements of stable reading postures and adequate verbal responses. The overall responses, in terms of peripheral vision acuity fading awareness (PVAFA), are presented as follows:

Test round 1

Test 1: 18 testees reported "Yes" to "right-reading Chinese characters" for PVAFA effect. 2 testees answered "No". 4 testees answered "Not sure (NS)".(See figure 1).

Test 2: 12 testees reported "Yes" to "right-reading Korean characters" for PVAFA effect. 8 testees answered "No". 4 testees answered "Not sure (NS)" (See figure 2).

Test round 2

11 testees reported that "right-reading Chinese characters (CR)" induced stronger PVAFA effect than "wrong-reading Chinese characters (CW)" did. 7 testees gave opposite answers and 6 testees responded "Not sure (NS)" (See figure 3).

Test round 3

5 testees reported that "right-reading Korean characters (KR)" induced stronger PVAFA effect than "wrong-reading Korean characters (KW)" did. 7 testees gave opposite answers and 12 testees responded "Not sure (NS)" (See figure 4).

Test round 4

15 testees reported that “right-reading Chinese characters (CR)” induced stronger PVAFA effect than “right-reading Korean characters (KR)” did. 6 testees gave opposite answers and 3 testees responded “Not sure (NS)” (See figure 5).

Fig. 1. Right-reading Chinese characters test sheet and the frequency of each answer

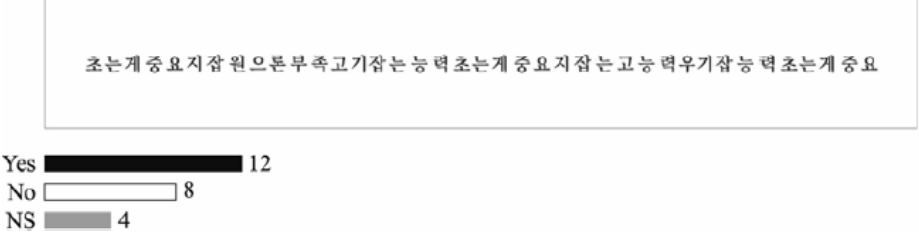

Fig. 2. Right-reading Korean characters test sheet and the frequency of each answer

Fig. 3. Right-reading Chinese characters (CR) vs. wrong-reading Chinese characters (CW) test sheets and the frequency of each answer

Fig. 4. Right-reading Korean characters (KR) vs. wrong-reading Korean characters (KW) test sheets and the frequency of each answer

Fig. 5. Right-reading Chinese characters (CR) vs. right-reading Korean characters (KR) test sheets and the frequency of each answer

4 Discussion

According to the test results—a tendency of stronger induced PVAFA effects on "Chinese" over "Korean" (figure 1 and 2, 5) characters lines and "right-reading" over "wrong-reading" of Chinese characters lines (figure 3), initial conclusions can be drawn to support most of our conjecture that a reading material's semantic factors do influence the range a foveal vision to be able to encompass, and that in turn cause peripheral visions to lose their degree of acuity.

On the other hand, the lenient impact of PVAFA effect on Korean "right-reading" materials (Figure 2) and smaller differences between "right-reading" and "wrong-reading" Korean characters (Figure 4), further strengthen semantic-conditioned hypothesis by demonstrating that the harder the characters' lexical message to be detected, the weaker the impact of fading peripheral vision acuity to be aware of.

Yet, due to the experiments' test-run nature and the tentative arrangement of apparatus, the whole procedure did have encountered several uncontrollable situations. Some of them are foreseeable and are anticipated, and some are newly discovered. All of which are invaluable to be incorporated into the consideration in our future formal experiments.

In addition to the aforementioned shortcomings, the too small number of valid testees (total of 24) is too bare-boned to meet the minimum requirements of being a representative sample. Also, a counter-balance technique should be considered to minimize the elusive testee's expectancy effects.

Finally, since this is a "self report" kind of test, how to construct a more precise verbal wording to better direct the viewers to truly stick to the "target zone" would also greatly decide the overall outcomes to be valid and reliable or else.

5 Conclusion

This is the first paper in a series that attempts to explore two levels of investigation: First, to probe factors that might condition the awareness of fading peripheral vision acuity other than biological reasons, and the second, to bring those findings to a higher level investigation about visual logics in visual form perception. Just as Engle mentioned that as the shape and/or size similarity among targets increased, search performance deteriorates [8], our propositions can push the prospects of vision acuity study beyond specific factor domain identification and point to the understanding of a higher rank of structural aspects of visual logics and to untangle some theoretical dimensions about a person's visual form perception around his or her daily life situations and around human-computer interacted environments.

Our current study focuses on the initial level of the investigation starting with a single variable—semantic factor of reading material. We carried out these bare-bone experiments to see whether an elusive phenomenon with confound factors like peripheral vision acuity fading awareness can be explained with simple yet elegant concepts or not.

The overall tendency toward the semantic-conditioned phenomenon not only suggests that the study of peripheral vision acuity fading awareness (PVAFA) needs more full-fledge experiments, it is also encouraging that one-more-notch-up research target on issues of visual logics that are capable of dealing with more abstract concepts and deeper regularities of visualization deserves further exploration.

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