

Effects of priming in attention and consciousness among males and females

Radha Agnihotri¹, I. L. Singh², Trayambak Tiwari³

^{1,2,3}Cognitive Science Laboratory, Department of Psychology, Banaras Hindu University, Varanasi, U.P., India

Corresponding Author Email: radhaagnihotri2@gmail.com

Abstract— The process of selectively concentrating on one aspect of the environment while simultaneously ignoring others can be defined as attention. On the other hand, consciousness can be defined as a state of arousal in which individuals are capable of receiving signals from their surroundings. According to scholars, there is a close relationship between cognitive processes, attention, and consciousness. The aim of the current study was to manipulate stimulus strength, cue validity, and congruency in order to investigate the priming effect on attention and consciousness across genders. Fifty students with age ranged from 20 to 30 years from Banaras Hindu University were participated in the study. The experiment was divided into two parts. In the first part, participants were subjected to subliminal condition (with extremely weak prime) whereas, second part of the experiment presented primes in the clearly visible conditions. The findings of this study suggested that participants (both male and female) perform better in visible condition than subliminal condition on reaction. Further, the congruent trials facilitate, whereas incongruent trials interfere the performance of the participants in terms of reaction time. The overall result showed that males and females both are similar in cognitive abilities, especially in visual attention and consciousness processing.

≥ 13, and the word span scores were evaluated as discrete variable

Keywords: Attention, Consciousness, masked priming.

I. INTRODUCTION

Our visual system becomes aware of diverse semantic and relevant stimuli in the environment. Human cognitive system involved in this process of selecting, filtering, and analyzing of information. This type of processing is accomplished by various cognitive subsystems, which one is attention. The attention system included the following in this processing: Top-down (endogenous) and bottom-up (exogenous) attention, as well as spatial attention to locations, sensory characteristics, moments in time, or complete perceptual objects. On the other hand, consciousness can be defined as the state of arousal and refers to our awareness of innovative thoughts, feelings, sensation, and our visual environment. Baars (1997) introduced a variety of content that can include forms of consciousness i.e. visual images, silently talking to us, our memory of life events, our perception of the world, activities of daily life, and view toward the others. Recent researches reported that visual attention and awareness related to each other. This does not suggested that everything that is attended by our visual system is accessible to visual awareness, or vice-versa. This is a debated view that on how visual attention may interconnect with visual awareness. One way to enhance our understanding that visual attention may independent to visual consciousness. Further, some of the studies demonstrated that the male and female differ in their cognitive processing (Michelon, 2006). Females perform better in perceptual speed, fine motor skills, accuracy, and verbal fluency, while males perform better in spatial, working memory and mathematical abilities than females (Miller & Halpern, 2014; Hyde et al., 2019). The present study tried to examine the exact nature of the relation between attention and consciousness and also explore the gender difference on attention and consciousness processing. First discuss the basic concept related to attention, consciousness and the relationship between attention and consciousness. The evidences showed that attention and consciousness share same mechanism. For example, in-attentional blindness: where a very silent object presented for a few seconds, sometimes the object goes unobserved, if it is not appropriately attended (Wolfe et al., 2005). Similarly, an attentional blink phenomenon, where target stimuli pay attention and another target that rapidly follows it in temporal succession is implausible to be seen (Chun & Potter, 1995). In the phenomena of change blindness, where a major change between two successive images may go unobserved (Tse, 2004). Further, load-induced blindness, where visual sensitivity decrease due to the distraction of attention (Macdonald & Lavie, 2008).

The attentional manipulation of non-conscious priming and the effect of invisible stimuli on attentional cuing demonstrated that attention can be manipulated without consciousness (Sumner et al., 2006; Kentridge et al., 2008; Finkbeiner & Palermo,

2009; Bussche et al., 2010; Tapia et al., 2010). Attentional cueing effects on sub-threshold or invisible stimuli are also evidence for the existence of attentional deployment without conscious registration of a stimulus (Jiang et al., 2006; Lin & He., 2009).

Numerous authors claim that there is proof of awareness without attention. Dual- task paradigm such as categorization of natural scene (Li et al., 2002), discrimination of gender (Reddy et al., (2004), and face identification (Reddy et al., 2006) experimentally support that consciousness in the near absence of attention. Using dual task paradigm, they presented subjects with a variety of images related to natural scene and asked them to report the presence of an animal or vehicle. Although each image was presented for less than 30 milliseconds, subjects were able to achieve high level of performance on these tasks regardless of the availability of attention. These findings demonstrated that natural stimulus processing is not limited by the availability of the attentional resources (Koch & Tsuchiya, 2007; Li et al., 2002; Lamme, 2010; Dehaene et al., 2006). Several studies reported that the independent manipulation of attention and consciousness (Kanai et al., 2006).

Various scientific analogies have been put forward to settle the debate. Most recently leap in opposite direction towards evolution perspective has been put forward, (Haladjian & Montemmayor, 2015) and explained that most of cognitive psychologist would agree attention is an early adaptation of humans in order to select and filter incoming information's while consciousness must be a late adaptation with increasing complexity to some form of discrepancy between the two processes can be based on our system formation itself. To resolve this debate further evidence on how discrimination is carried in near absence of attention and nature of stimulus to which it is limited to has to examined, subtle categorization of good candidate against pre-attentive processing of animals words should be used in prime and target.

II. OBJECTIVES

The aim of the study is to explore how information is accessed in male and female with different processing states. This study is also inspired by the lack of current understanding of functional mechanism underlying two distinct systems of attention and their causal relationship with visual awareness. The major objective of this study as follows:

1. To examine the different processing states of visual attention and consciousness in male and female participants.

HYPOTHESIS

1. Priming in terms of novel and repeated prime trails would not affect performances of males and females in attention and consciousness on reaction time measure.

III. METHODS

III.I. PARTICIPANTS

Fifty students (29 male and 21 female) who were randomly selected from various courses (UG, PG and Ph.D.) of Banaras Hindu University (mean age = 23.80 years; $SD=2.62$ Age range = 20-30 years) consented and participated in this study. All the participants were checked for normal or corrected-to-normal visual acuity with the help of Snellen chart and were having no prior information about the task and purpose of the experiment. Participants who fulfilled these criteria were given the experimental task comprising both subliminal and clearly visible conditions. The participants were given their written consent before the beginning of the experiment.

III.II. TOOLS/EQUIPMENT AND SOFTWARE

Super lab 4.0™ software was used for designing stimulus presentation and recording of behavioral data. Each participant was made comfortable and sits nearly 120cm away from the screen in lab situation. Subject would have to use keyboard to response.

III.III. EXPERIMENTAL TASK

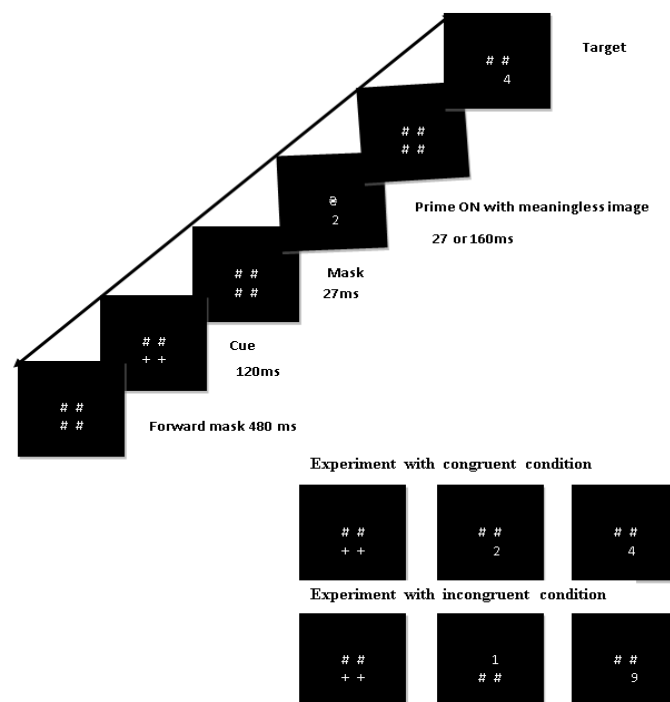
In the field of cognitive psychology priming paradigm has become more popular over the past few decades. In this paradigm, participants are performed with a series of trials, each trials consists of the presentation of a prime stimulus followed by a target stimulus. Crucially, the relationship between prime stimulus and the target stimulus is manipulated. Some of the trials both prime and target are different (novel prime trial), whereas some of the trials both prime and target are the same (repeated prime trial). The processing of target stimulus is enhanced when it is preceded by a related prime target stimulus compare to

when it is preceded to a different prime target stimulus (Glaser & Anaji, 1999). The priming effect is expressed by a faster and more accurate response to related prime target pair compared to unrelated prime target pairs. In the present study, the experiment was divided into two parts. All participants were given the subliminal condition in the first part of the experiment. In this condition, prime had weak strength of stimulus (27ms). In the sequence of experimental events, at both locations, a 480 ms mask consisting of two hash marks (##) was displayed. The cue (++) was then given for 120 milliseconds in one place, followed by a 27 millisecond mask (##). Then, for 27 milliseconds, a prime appeared in one of the two places, while a meaningless image was displayed in the other location. Subsequently, both prime and meaningless image were replaced by an 80 ms mask. Finally, the target displayed at the pre-determined place of cued location and remained there until the participant responded. The inter-trial interval was kept 1000 milliseconds. After completion of the first part of experiment, participants were given second task. In second part of the task, primes were presented in clearly visible conditions as stimulus strength was strong enough (120ms). A 480 ms mask (##) was presented at both place in the clearly visible condition first. The cue (++) was then given for 120 milliseconds in one location, followed by a 27 millisecond mask (##). Then, for 160 milliseconds, a prime appeared in one of the two places, while a meaningless image displayed in the other. Finally, until the participants responded

III.IV. STIMULI

In both part of the experiment, participants had to classify numbers as smaller as and larger than five. Number 1, 4, 6, 9 were used as prime and target where numbers 2,3,7,8 presented as only primes. In addition, a lower case symbol ‘x’ was used as neutral prime. Leading to this 36 prime- target combinations (9 prime × 4 targets) were formed. Stimuli were presented black background, range from 5×5 cm in width. In the present experiment, participants had to classify digits larger than five and smaller than five. Every participant was given to clear instruction for respond. They were pressed ‘P’ when prime and target both was same and pressed ‘R’ when prime and target both was different. Leading to this response assignment there were 36 prime-target combination (9 prime × 4 target) and four place combination (2 unattended × 2 attended) were formed. In the unattended condition prime and target both was presented different location and in the attended condition prime and target both was presented at the same location. In this way 144 combination i.e. 36 prime target combination and 4 place combination was formed. Further, these 144 combinations would be divided in to congruent, incongruent and neutral condition. In these combinations 64 were congruent condition, which consisted cue, prime and target all was presented at the same location and prime-target smaller or all are larger than 5, 64 incongruent condition, which consisted cue, prime and target all are different location and prime smaller than 5 and target larger than 5 or vice-versa, and 16 combination consisted neutral prime with neutral target. All participants received 16 trials for practice in the beginning of the experiment.

III.V. EXPERIMENTAL TASK



III.VI. DESIGN

A 2 (gender: male and female) x 2 (stimulus strength: subliminal and visible condition) x 2 (cue validity: unattended and attended) x 3 (congruency: neutral, congruent and incongruent) mixed factorial design was used in the present study.

Proceeding to the experimental task all the participants were asked to fill-up informed consent were also attained. After that, they were properly seated in front of the computer screen in laboratory setting. All participants required to complete both condition of the experimental task i.e. subliminal condition and clearly visible condition. First 16 trial training block were provided to all participants before running the experimental task.

After execution of the task, experimenter was asked for a verbal feedback about the experiment. The beginning of the experiment, the following instructions are given to all participants.

“You’re welcome in the cognitive science laboratory. This present experiment is the related to the relationship between attention and consciousness. In this experiment you will perform tasks which have two conditions i.e. subliminal condition and visible condition. In the subliminal condition, where prime digit will be appear very short period of time. It appears 27 ms followed by a filler symbol. The prime digit will also appear both of the location i.e. upper right and left location and lower right and left location. The cue always validly indicated location of the target but only half of the trial cue indicated the prime digits. When the prime and target both are lower and upper than 5 (i.e. 1-4, 6-9), press the ‘P’ button of the keyboard. On the other hand, when prime and target belong to different side (i.e. 2-6, 9-1), press ‘R’ button of the keyboard. After completing the first condition of experiment, you perform the second condition that is visible condition. In this condition the prime will appear 160 ms followed by a filler symbol. You perform the same as previous condition. You have to response on both conditions of the task as fast as possible. You can ask any queries related to experiment without any hesitation.”

III.VII. STATISTICAL ANALYSES

The mean and standard deviation were calculated for both response measures under each experimental condition. To examine the main effect and its interaction effect, the data were subjected to mixed Analysis of Variance (ANOVA) with gender (i.e. male and female) as between subject factor and stimulus strength (subliminal and visible condition); cue validity (unattended and attended); congruency (neutral, congruent and incongruent) as within subject factors. The alpha 0.05 was used for all statistical analyses unless otherwise stated.

IV. RESULT

Means and standard deviations on reaction time measure were calculated for each experimental condition and the obtained results are presented in Table 1 and these results are also graphically displayed in Figure 2, respectively.

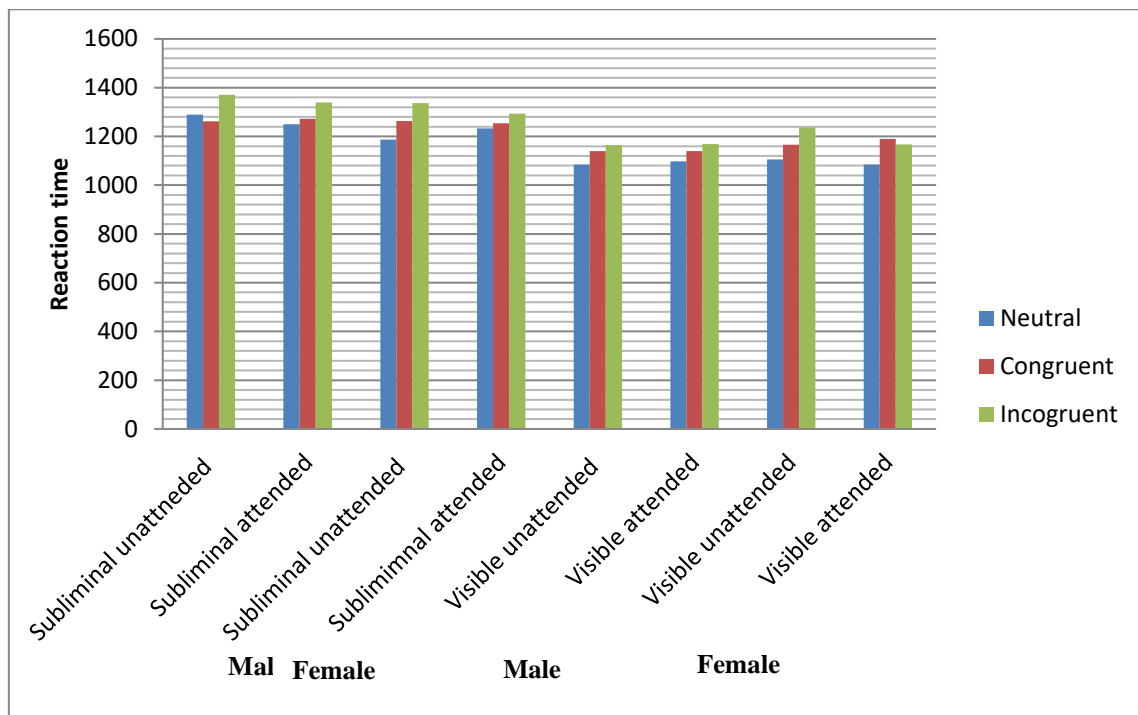
The mean reaction time performance for the novel prime trials indicated that male participants performed slower on subliminal unattended neutral condition, subliminal unattended incongruent condition, subliminal attended neutral condition, subliminal attended congruent condition, subliminal attended incongruent condition, visible attended neutral conditions than their counterparts (i.e., female participants), except for subliminal unattended congruent condition and visible unattended incongruent conditions where mean reaction time scores were found almost similar for both male and female participants. However, male participant performed better on visible unattended neutral, visible unattended congruent, visible unattended incongruent, visible attended congruent than female participants (see Table 1).

Table1. Means and standard deviations of reaction time measure (in ms) for the novel prime trials as a function of gender, stimulus strength, cue validity and congruency.

Gender	Stimulus strength	Cue validity	Neutral	Congruent	Incongruent	
Male	Subliminal	Unattended	1288.89 (441.95)	1262.15 (406.76)	1371.08 (417.22)	
		Attended	1249.60 (389.51)	1272.14 (336.86)	1339.05 (408.43)	
	Visible	Unattended	1084.89 (328.58)	1139.80 (307.50)	1165.10 (324.09)	
		Attended	1097.44 (328.26)	1139.16 (253.51)	1168.10 (306.24)	
	Female	Subliminal	Unattended	1186.57 (382.79)	1262.53 (412.09)	1336.78 (406.77)
			Attended	1232.81 (354.42)	1253.44 (417.45)	1293.24 (384.58)
Visible		Unattended	1105.47 (336.32)	1165.95 (340.61)	1237.00 (369.29)	
		Attended	1084.26 (340.87)	1189.87 (377.05)	1166.62 (315.79)	

Standard deviations in parenthesis

Figure2. Mean reaction time performance as a function of gender, stimulus strength, cue validity and congruency.



The data were further subjected to a 2 (Gender: Male and female) X 2 (Stimulus strength: Subliminal and visible) X 2 (Cue validity: Unattended and attended) X 3 (Congruency: Neutral, congruent and incongruent) a mixed analysis of variance (ANOVA) in order to find out the main and its interaction effects, if any, among variables. The gender was treated as a between subject factor, whereas stimulus strength, cue validity and congruency were treated as within subject factors. The obtained results are presented in Table 3. The analysis of variance results revealed significant main effect of stimulus strength ($F_{(1,48)}=16.33, p=.001$). This result indicated that the trial with visible condition on average responded faster than subliminal condition. Moreover, the main effect of cue validity was not found significant ($F_{(1,48)}=.87, p=.35$), which indicated that cue validity did not significantly modulate the observed priming effect. The main effect of congruency was also found significant ($F_{(2,96)}=10.73, p=.001$), which reflected that overall in congruent trials, participants responded faster than incongruent trials. Further, the main effect of gender was also not found significant which suggested that priming effect in visual attention and consciousness was similar for both males and females. However, none of the interaction effect (viz., stimulus strength \times cue validity; stimulus strength \times congruency; cue validity \times congruency; stimulus strength \times cue validity \times congruency) was found significant.

V. CONCLUSION

Visual properties that can be derived with minimum attention have been studied for a long time. Attention is a cognitive capacity that allows you to focus on a particular item while ignoring other distracting information. On the other hand consciousness can be defined as the state of arousal in which individuals are mentally responsive to messages from their surrounding environment (Bayne & Pacherie, 2004). Posner clarified three aspect of consciousness, the first is the level of consciousness, which includes various brain body states that determine our ability to respond (coma, vegetative state, sleep, awake), the second is sensory awareness, which is defined by knowledge of the surrounding environment, and we hold the notion that we are fully aware of the environment through our focused awareness.

Previous studies also demonstrated that gender differences in various cognitive skills including characteristics like attention, perception, memory (short-term memory, working memory, and long-term memory), motor ability, language, visual and spatial processing, and executive functions (Michelon & Zacks, 2006). These cognitive characteristics are not the same in males and females. In general, females perform better in verbal fluency, perceptual speed, accuracy and skills related to fine motor movements, while males perform better in spatial, working memory and mathematical abilities (Miller & Halpern, 2014; Hyde, et al., 2019). In addition, a great number of studies have revealed that male perform better on spatial abilities such as

mental rotation whereas female perform better in verbal fluency and reading ability (Reilly, 2019). On the other hand some studies demonstrated that male and female have almost identical ways of processing information related with different cognitive processing (Hyde, 2019).

The present study showed no gender difference under attention and consciousness processing. The possible reason of this finding is the small sample size. Thus, attention is one of the basic phenomena where we attend stimulus without being conscious while analyzing of any information consciousness play an important role. This finding also concerned different area of psychology i.e. cognitive psychology, neuropsychology and neurophysiology. Present study also expands the area of top down attention and visual consciousness and gives theoretical support of the field of cognitive psychology.

REFERENCES

1. Baars, B. J. (1997). In the theatre of consciousness. Global workspace theory, a rigorous scientific theory of consciousness. *Journal of consciousness Studies*, 4(4), 292-309.
2. Bayne, T., & Pacherie, E. (2004). Bottom-up or top-down: Campbell's rationalist account of monothematic delusions. *Philosophy, Psychiatry, & Psychology*, 11(1), 1-11.
3. Bussche, E. Van den, Hughes, G., Humbeeck, N. Van, Reynvoet, B. (2010). The relation between consciousness and attention: An empirical study using the priming paradigm. *Consciousness and Cognition*, 19(1), 86-97.
4. Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance*, 21(1), 109-127.
5. Dehaene, S., Changeux, J. P., Naccache, L., Sackur, J., & Sergent, C. (2006). Conscious, preconscious, and subliminal processing: a testable taxonomy. *Trends in cognitive sciences*, 10(5), 204-211.
6. Finkbeiner, M., & Palermo, R. (2009). The role of spatial attention in non-conscious processing: a comparison of face and non-face stimuli. *Psychological Science*, 20, 42-51.
7. Haladjian, H. H., & Montemayor, C. (2015). On the evolution of conscious attention. *Pschonomic Bulletin & Review*, 22(3), 595-613.
8. Hyde, J. S., Bigler, R. S., Joel, D., Tate, C. C., & Van Anders, S. M. (2019). The future of sex and gender in psychology: Five challenges to the gender binary. *American Psychologist*, 74(2), 171.
9. Hyde, J. S., Bigler, R. S., Joel, D., Tate, C. C., & Van Anders, S. M. (2019). The future of sex and gender in psychology: Five challenges to the gender binary. *American Psychologist*, 74(2), 171.
10. Jiang, Y., Costello, P., Fang, F., Huang, M., & He, S. (2006). A gender- and sexual orientation-dependent spatial attentional effect of invisible images. *Proceedings of the National Academy of Sciences of the United States of America*, 103, 17048-17052.
11. Kanai, R., Paffen, C. L., Hogendoorn, H., & Verstraten, F. A. (2006). Time75uy dilation in dynamic visual display. *Journal of vision*, 6(12), 8-8.
12. Kentridge, R. W., Nijboer, T. C., & Heywood, C. A. (2008). Attended but unseen: Visual attention is not sufficient for visual awareness. *Neuropsychologia*, 46(3), 864-869.
13. Koch, C., & Tsuchiya, N. (2007). Attention and consciousness: two distinct brain processes. *Trends in cognitive sciences*, 11(1), 16-22.
14. Lamme, V. A. (2010). How neuroscience will change our view consciousness. *Cognitive Neuroscience*, 1(3), 204-220.
15. Li, F. F., VanRullen, R., Koch, C., & Perona, P. (2002). Rapid natural scene categorization in the near absence of attention. *Proceedings of the National Academy of Sciences of the United States of America*, 99(14), 9596-9601.
16. Li, F. F., VanRullen, R., Koch, C., & Perona, P. (2002). Rapid natural scene categorization in the near absence of attention. *Proceedings of the National Academy of Sciences of the United States of America*, 99(14), 9596-9601.
17. Lin, Z., & He, S. (2009). Seeing the invisible: The scope and limits of unconscious Rensiprocessing in binocular rivalry. *Progress in Neurobiology*, 87, 195-211.
18. Macdonald, J. S., & Lavie, N. (2008). Load induced blindness. *Journal of Experimental Psychology: Human Perception and Performance*, 34(5), 1078.
19. Michelon, P. & Zacks, J. (2006). Two kinds of visual perspective taking. *Perception and Psychophysics*, 68 (2), 327-337.
20. Michelon, P. & Zacks, J. (2006). Two kinds of visual perspective taking. *Perception and Psychophysics*, 68 (2), 327-337.

21. Miller, D. I., & Halpern, D. F. (2014). The new science of cognitive sex differences. *Trends in cognitive sciences*, 18(1), 37-45.
22. Miller, D. I., & Halpern, D. F. (2014). The new science of cognitive sex differences. *Trends in cognitive sciences*, 18(1), 37-45.
23. Reddy, L., Moradi, F., & Koch, C. (2006). Top-down biases win against focal attention in the fusiform face area. *Neuroimage*, 38, 730-739.
24. Reddy, L., Wilken, P., & Koch, C. (2004). Face- gender discrimination is possible in the near-absence of attention. *Journal of Vision*, 4, 106-117.
25. Reilly, D. (2019). Gender can be a continuous variable, not just a categorical one: Comment on Hyde, Bigler, Joel, Tate, and van Anders (2019). *American Psychologist*, 74(7), 840-841.
26. Sumner, P., Tsai, P. C., Yu, K., & Nachev, P. (2006). Attentional modulation of sensorimotor processes in the absence of perceptual awareness. *Proceedings of the National Academy of Sciences of the United States of America*, 103(27), 10520-10525.
27. Tapia, E., Breitmeyer, B. G., & Shooner, C. R. (2010). Role of task-directed attention in non-conscious and conscious response priming by form and color. *Journal of Experimental Psychology: Human Perception and Performance*. 36, 74–87.
28. Tse, P. U. (2004). Mapping visual attention with change blindness: new directions for a new method. *Cognitive Science*. 28, 241–258
29. Wolfe, J. M. (1994). Guided search 2.0 a revised model of visual search. *Psychonomic Bulletin & Review*, 1(2), 202-238.