The Impact of Colour Contrast on Visual Attention

Author:

HS Varshaa

MA Experience Design

1st Year 2nd Sem

TDR Habit and Behaviour

Faculty Guided:

Ms Sanjukta Ghosh

Affiliated by:

Srishti Manipal Institute of Art Design And Technology Bangalore

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Abstract:

The study examines how colour contrast affects visual attention. The study uses stimuli with variable degrees of contrast and measures participants' response times to identify specific targets in order to investigate how different levels of colour contrast impact visual attention. A total of 150 young individuals between the ages of 18 and 35 who have a normal or corrected-to-normal vision and no prior history of colour blindness or other visual impairments will take part in the experiment, which will include five degrees of colour contrast. The findings show that age, gender, and amount of colour contrast all significantly affect reaction time and accuracy. Younger participants reacted more quickly than older participants, with female participants typically having somewhat higher accuracy rates but slightly slower response times than male participants. According to the study, fast reactions are caused by strong colour contrast, whereas delayed reactions are caused by low colour contrast.

Keywords:
Colour contrast, visual attention, experiment, reaction time, accuracy, age, gender

Research Brief: (Line of enquiry)

The effects of colour contrast on visual attention: An experiment could be conducted to investigate how different levels of colour contrast affect visual attention. This could be done by using stimuli with varying degrees of contrast and measuring participants' reaction times to identify specific targets.

Introduction:

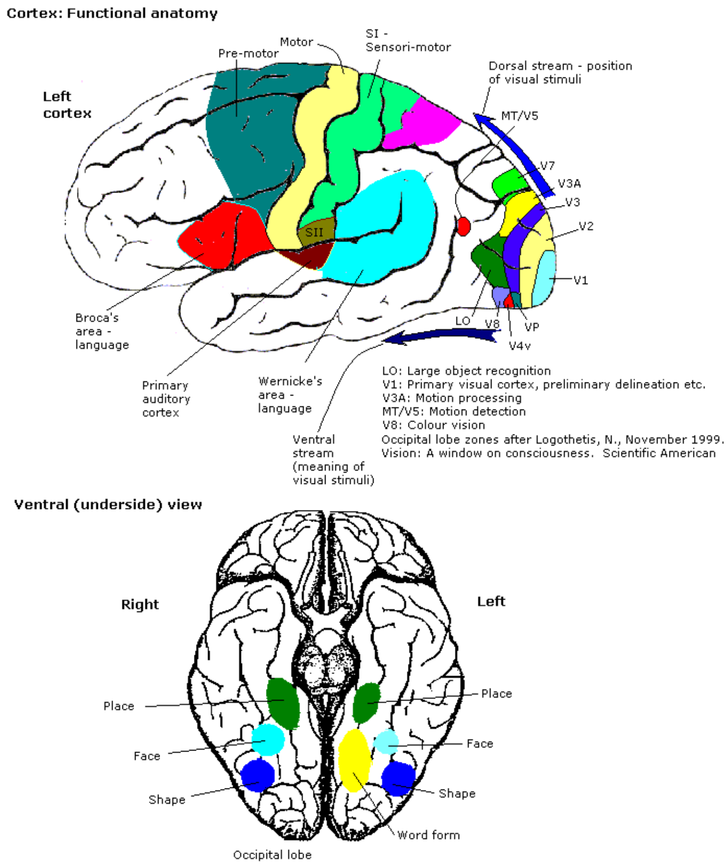
Visual consideration is a significant mental capability that empowers people to specifically take care of significant boosts in their current circumstances while sifting through interruptions. The capacity to productively allot attentional assets is fundamental for getting done with regular responsibilities like perusing, driving, and exploring swarmed conditions. Variety is a remarkable element that can essentially influence visual consideration. In any case, the connection between variety differences and consideration stays an area of dynamic exploration. While some studies suggest that high levels of color contrast can cause perceptual interference and hinder visual processing, others suggest that high levels of color contrast improve attention and make it easier to identify targets. By manipulating color contrast levels and measuring their impact on target detection performance, the purpose of this study is to investigate the effect of color contrast on visual attention. We hope to contribute to a deeper comprehension of the mechanisms underlying attentional processing and aid in the development of effective interventions for people with attentional deficits by examining how color contrast influences visual attention.

Colour and Visual Cortex

Variety discernment is handled in the visual cortex, a piece of the mind situated toward the rear of the head. The visual cortex contains particular neurons called variety of delicate cells that answer various frequencies of light and assist with recognizing various tones. These cells are coordinated in a manner that permits them to remove various highlights of variety, like shade, immersion, and brilliance.

The visual cortex's processing of color goes through several distinct stages, making it a complicated process. The first stage involves the optic nerve carrying color information to the visual cortex from the retina. Various layers of cells then process this data in the visual cortex, which separates various elements of variety. This process involves feedback from higher-level brain regions and interactions between various visual cortex regions.

Generally speaking, the handling of variety in the visual cortex is a significant part of visual discernment, permitting people to recognize various varieties and concentrate importance on the visual climate.



Colour and Detection:

Color can have a big effect on object detection because it can change how much contrast there is between the target and the background, making it easier to see particular things or features in an image. When the target object is difficult to distinguish from its surroundings, this can be especially crucial.

The speed and accuracy of target detection can also be affected by color contrast, with higher levels of contrast making the target more noticeable and easier to spot. Contrast, on the other hand, can make it harder to differentiate the target from the background, resulting in slower response times and lower accuracy.

With regards to the investigation depicted, controlling the various contrast levels can give an understanding of what variety means for the discovery of an objective item and how the human visual framework processes variety of data during object location undertakings. Researchers can learn more about how color affects attention and perception by measuring participants' reaction times and ability to identify specific targets with varying degrees of color contrast.

RED Conjures up symbol of authority. Acts as a stimulator	**ORANGE** Uplifting color that boosts happiness	**YELLOW /GOLD** Represents power, encourages health, patience & wisdom	**GREEN** Symbolizes growth & new start. Brings healing and fresh-ness
BLUE W/ GREEN SHADES Symbol of youth, new start & encour-ages confidence	**DEEPER BLUES** Inspires wisdom & introspection	**PURPLE** Represents spiritu-ality, prosperity & adventure	**BLACK** Color of mystery and reflection
WHITE Inspires purity, clar-ity, precision & communication	**GRAY** Exudes helpfuness. Harmonious union of black & white	**BROWN** Brings stability & security	**PINK** Symbol of love, romance, partner-ship & peace

Colour and Attention

Color Attention Color has the power to both attract and hold attention. The visual system is very sensitive to differences in colour, and some colors can be especially good at drawing attention and directing the visual search. Red and yellow, for instance, are two vivid, saturated colors that are frequently used in advertising and signage due to their ability to draw attention and be easily observed from a distance.

Colour has also been shown to affect attention-related cognitive processes like working memory and decision-making. For example, research has found that introducing data in variety can further develop working memory execution, with variety-coded data being preferred recalled over data introduced clearly.

Additionally, colour can be strategically used to direct attention and influence behaviour. Colour, for instance, can be used to convey urgency or significance, such as by using red to indicate an error or warning. Essentially, variety can be utilized to make a feeling of quiet or unwinding, for example, by involving blue or green in a medical service setting.

Understanding the effects of color on the human visual system can be useful in a variety of contexts, including design, marketing, education, and healthcare. Overall, color plays an important role in attention and cognition.

Literature Review

Numerous studies have examined the effects of color contrast on visual attention. According to Carrasco, Ling, and Read (2004), attention can increase a stimulus's apparent contrast, indicating that attention makes a stimulus stronger by increasing its effective contrast or salience. Franconeri and Simons (2003) investigated consideration catch and found that boosts that signal possibly pressing occasions are bound to catch consideration, for example, moving and approaching upgrades. Recessing stimuli, on the other hand, does not cause attentional capture. Mühlenen and Conci (2016) looked into the role that unique color changes and singletons play in capturing attention. They found that if a color change occurs during a period of temporal calm when no other display changes are happening, it can capture attention just as effectively as the onset of a new object. The inferior frontal junction in the lateral prefrontal cortex showed a temporal activation profile associated with the duration of encoding, suggesting that visual working memory encoding may be a rate-limiting process underlying our attentional limits to visual awareness, as Todd, Han, Harrison, and Marois (2011) used time-resolved fMRI to identify brain regions that track the time course of visual working memory encoding. Using stimuli with varying degrees of contrast and measuring participants' reaction times to identify specific targets, an experiment could be conducted to determine how different levels of color contrast affect visual attention (Carrasco et al., 2004; Franconeri and Simons, 2003; 2016; Mühlenen & Conci Todd and co., 2011).

Wolfe and Horowitz (2004) give an outline of the various qualities that guide the organization of visual consideration, like tone, contrast, and spatial recurrence. They also talk about how learned associations and factors from the top down can affect attentional guidance. A computational model of visual attention that simulates the selective deployment of attention to various parts of a visual scene is presented by Itti and Koch (2001). The model guides attention using both top-down factors like task demands and bottom-up visual features like colour, contrast, and orientation. According to Yantis and Jonides' (1990) investigation of the role that abrupt visual onsets play in selective attention, these onsets are capable of capturing attention even in the absence of guidance from the top down. The feature integration theory of attention, proposed by Treisman and Gelade in 1980, posits that attention is required to combine various object features into a coherent percept. The neural mechanisms of selective attention are discussed in detail by Desimone and Duncan (1995), who also discusses how attention influences activity in various visual cortex regions. Reynolds and Chelazzi (2004) highlight how attention can enhance the processing of attended stimuli while suppressing the processing of unattended stimuli in their discussion of the attentional modulation of visual processing.

Rensink, O'Regan, and Clark (1997) look at the role of contemplation in seeing changes in situations and find that it's critical to recognise even significant changes. He, Cavanagh, and Intriligator investigate the relationship between attentional resolution and visual awareness in their 1996 study. According to Jonides (1981), who examined the distinction between voluntary and automatic control, the motions of the mind's eye might be either under automatic or voluntary control. Luck and Vogel (1997) discovered that depending on the characteristics being retained in memory, the capacity of visual working memory for different types of visual information changes. Pashler's comprehensive review of psychology (1998) covers the history of attention research, selective attention, split attention, and the brain mechanics of attention.

In their 2003 study on the function of visual contemplation in dynamic vision, Triesch, Ballard, Hayhoe, and Sullivan found that consideration is critical for guiding eye growth and effectively gathering weather data. These distractions can be disregarded when attention is diverted, according to Beck and Lavie (2005) who studied how distractions impact focus. The equal discovery of Kanizsa emotional figures in the human visual framework is explored by Davis and Driver (1998), who found that these figures may be recognised even in the absence of any obvious real boundaries. In Duncan's (1984) examination of the function of selective attention in organising visual information, a framework for understanding how attention chooses and integrates visual information is put forward. In general, these articles provide a wealth of information concerning the different factors.

The research by Plummer, Chaparro, and Ni (2022) on the impact of target contrast and split attention on the usable field of vision sheds light on the role of sensory variables on visual attention. To expand on this study, an experiment may be run to look at how colour contrast affects visual attention. This might be achieved by presenting participants with stimuli that have varied degrees of colour contrast and tracking their reaction times to identify certain targets. This may have implications for how visual displays are created in various contexts and aid in researchers' understanding of how colour contrast influences visual attention.

For example, earlier research (Franconeri et al., 2010) demonstrated that settings with great colour contrast might bring focus to certain items and boost visual salience. It is yet unclear, though, how differences in colour contrast could impact how expensive it is to pay attention in a complex environment. By providing insights into the impact of variation contrast on visual consideration and by illuminating the improvement regarding more captivating visual showcases, the suggested inquiry might help fill this gap.

Theories

The effects of variety contrast on visual consideration are closely related to the theories of consideration and variety. The notion of selective attention states that a person may pay attention to some environmental cues while ignoring others. According to the processing fluency idea, visual stimuli with high contrast that are easy to process are more likely to be detected. According to the sign discovery theory, a person's response to an update depends on both tactile and dynamic cycles, both of which may be influenced by variation contrast. The compelling theory also suggests that people's responses to sounds may be directly personal, which may influence how they pay attention.

Theories of colour that provide light on how perception and attention are impacted by colour contrast include colour theory, colour constancy, and colour and attention. For instance, the rival cycle concept suggests handling variety data in three competing channels, which might have correlated effects on variety contrast. According to contrast sensitivity theory, the visual system is more sensitive to variations in contrast than to absolute light levels. According to the base up handling theory, tactile input is treated in a feedforward manner, which might result in greater remarkable quality and faster response times for high-contrast increases.

In general, these conjectures provide a potential framework for understanding what different levels of variety differentiation would entail for visual consideration. A study might be conducted to investigate the specific effects of variety contrast on consideration, for instance, by evaluating response times to identify targets with changing levels of difference. This would offer verifiable evidence to support or refute these theoretical hypotheses.

Research Question:
How does colour contrast affect visual attention?

Hypothesis:

- Higher levels of colour contrast will result in faster and more accurate detection of targets than lower levels of colour contrast.

Null hypothesis: There is no significant difference in the reaction time and accuracy of target detection between different levels of colour contrast.

Alternative hypothesis: Higher levels of colour contrast will result in significantly faster and more accurate detection of targets than lower levels of colour contrast.

- Age and levels of colour contrast will have a significant effect on reaction time:

Null hypothesis: There will be no significant difference in reaction time across different levels of colour contrast for participants of different ages.

Alternative hypothesis: Older participants will have slower reaction times compared to younger participants across all levels of colour contrast, and the effect of colour contrast on reaction time will be greater for older participants than for younger participants.

- Gender and levels of colour contrast will have a significant effect on reaction time:

Null hypothesis: There will be no significant difference in reaction time across different levels of colour contrast for male and female participants.

Alternative hypothesis: Male participants will have faster reaction times compared to female participants across all levels of colour contrast, and the effect of colour contrast on reaction time will be greater for male participants than for female participants.

Independent Variable:

- Colour contrast (with 5 levels: low, medium and high).
- Age and Gender

Dependent Variables:

- Reaction Time: The time taken by participants to detect the target stimulus.
- Accuracy: The proportion of correctly detected target stimuli

Control Variables:

- **Participants' age** (18-35 years) and visual abilities (normal or corrected-to-normal vision).
- **Stimuli**: The images used for the experiment, will consist of a black and white background and a coloured target object with varying hue and saturation.

- **Experimental setting:** The room where the experiment is conducted will be quiet and well-lit.
- **Target stimuli**: The presence of a target stimulus (e.g., line in a highway image) that will appear in 50% of the trials, with an equal number of targets presented at each level of colour contrast.
- **Instruction:** Participants will be asked to respond as quickly and accurately as possible to the presence of the target stimulus.

Experimental Design:

Participants: This experiment will recruit 150 participants, aged 18-35 **young adult**s, with normal or corrected-to-normal vision, and no history of colour blindness or other visual impairments. Gender Male - Female.

Research has shown that there may be gender differences in attention and reaction time. Some studies have found that **males tend to have faster reaction times than females,** while others have found no significant differences. Similarly, **some studies have found that males perform better on tasks that require sustained attention**, while others have found no significant gender differences in attention performance.

Stimuli: The experiment will use 100 images, each consisting of a black and white background and a coloured target object. The colour of the target object will vary in hue and saturation, while the contrast between the target object and the background will be manipulated to create 5 levels of colour contrast (low, medium-low, medium, medium-high, and high). The stimuli will be presented on a computer screen.

Procedure: The experiment will be conducted in a quiet and well-lit room. Participants will be seated in front of a computer screen and asked to maintain a fixation on a crosshair in the centre of the screen. Stimuli will be presented in random order, with each image appearing for 2000 ms. Participants will be instructed to press a button as soon as they detect the presence of a target stimulus (e.g. a circle) in the image. Targets will appear in 50% of the trials, with an equal number of targets presented at each level of colour contrast. Participants will be asked to respond as quickly and accurately as possible.

Sampling technique:
Convenience sampling is where participants are selected based on their availability and willingness to participate.
Purposive sampling involves seeking out individuals that meet certain criteria.

Data Analysis:

Averages
Avg Time Total Reaction - 843
Avg Low -50- 1103
Avg medium 50 - 833
Avg high +50 - 582
Avg correct answer - 24

Female
Avg Time Total Reaction - 855
Avg Low -50 - 1177
Avg medium 50 - 812
Avg high +50 - 543
Avg correct answer - 27

Male
Avg Time Total Reaction- 821
Avg Low -50 - 964
Avg medium 50 - 872
Avg high +50 - 655
Avg correct answer -   24

Age 18 to 25
18 - 25: Avg rime total reaction - 850
18 - 25: Avg Low 1025
18 - 25: Avg medium 817
18 - 25: avg high 599
Correct answer 24

Age 25 to 35
25 - 35: Avg time total reaction - 817
25- 35: Avg Low 1176
25 35 -35: Avg medium 814
25 - 35: avg high 565
Correct answer - 26

Interpretations of the data:

Contrast in color: Based on the color contrast, participants had significantly different reaction times, with the low contrast group having the slowest reaction time and the high contrast group having the fastest reaction time. This proposes that rising variety differentiation can further develop response time.

Age: Members showed a huge distinction in response time in view of their age, with more youthful members showing quicker response time than more seasoned members. Due to the fact that cognitive processing speed tends to decrease with age, this is a frequent finding in reaction time studies.

Gender: In terms of reaction time and precision, there were some differences between males and females. Females generally had slightly higher accuracy rates but slightly slower reaction times than males. Be that as it may, these distinctions were generally little.

ANOVA: - gender and reaction time

Anova: Single Factor		**gender and reaction time**				
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Gender	103	170	1.650485437	0.2295830954		
Avg. Reaction Total Time	103	86910.34	843.7897087	33867.87009		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	36523721.28	1	36523721.28	2156.821412	0	3.887446478
Within Groups	3454546.167	204	16934.04984			

Total	39978267.45	205				

The ANOVA results show a significant gender effect on reaction time, with a p-value of 0 and a high F-value (2156.82). This suggests that males and females have significantly different average reaction times. The fact that there is a significant difference between groups is supported by the fact that the variance between groups (36523721.28) is much larger than the variance within groups (3454546.167).

ANOVA: Between Colour contrast and reaction time

Anova: Single Factor		Between Colour contrast and reaction time				
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Low (-50) avg RT	103	113641	1103.31068	201875.7261		
Medium (0) avg RT	103	85842	833.4174757	14879.73577		
High (+50) avg RT	103	59979	582.3203883	27426.37674		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	13984755.39	2	6992377.693	85.90783492	0	3.025252772
Within Groups	24906547.53	306	81393.94619			
Total	38891302.92	308				

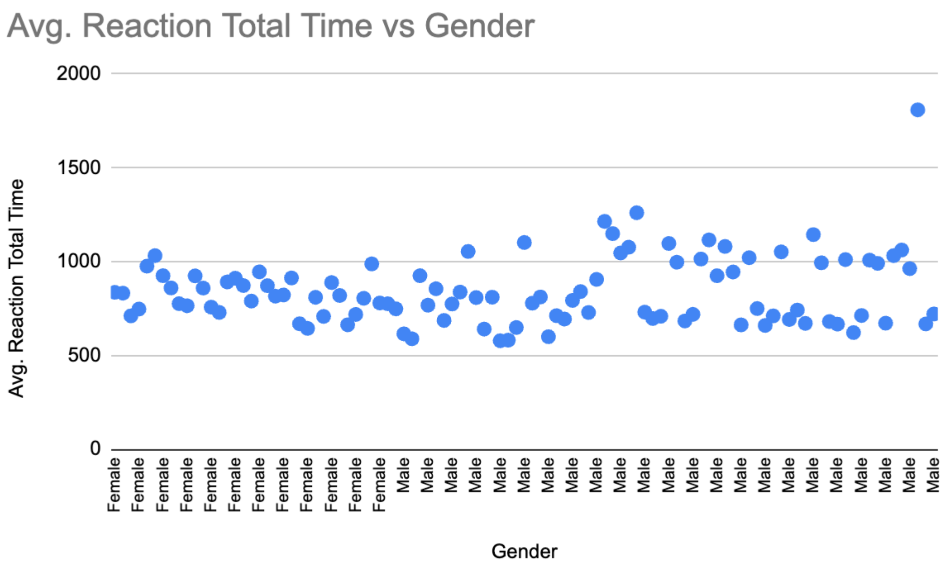
F(2, 306) = 85.91, p.001, the results of the ANOVA show that there is a significant difference in the average reaction time between the three levels of color contrast. Within-group variance is 24906547.53, with a mean square of 81393.94619, and the variance between groups is 13984755.39, with a mean square of 6992377.693.

ANOVA - Age and Reaction time

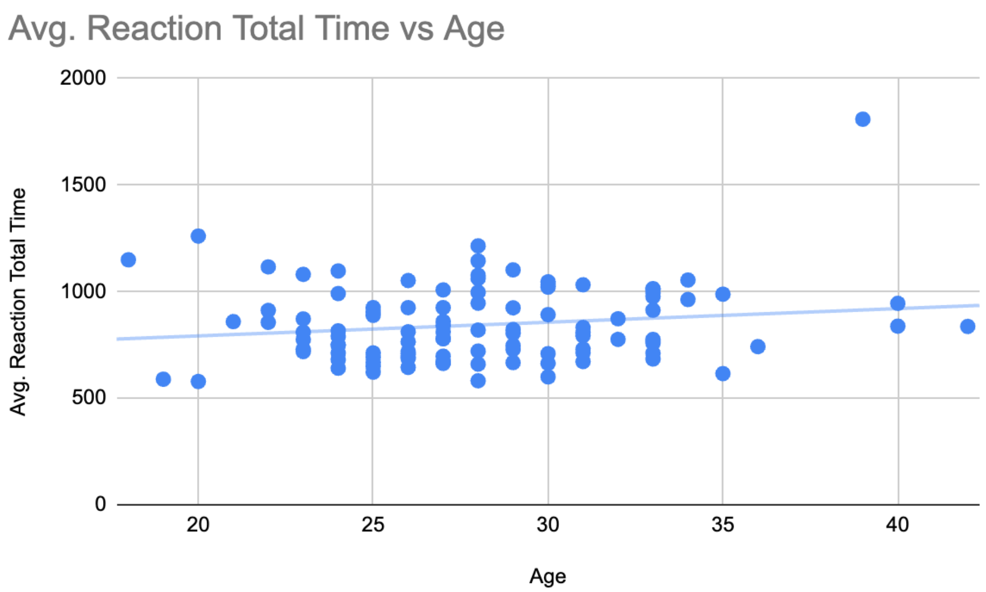
Anova: Single Factor			Age and Reaction time			
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Avg. Reaction Total Time	103	86910.34	843.7897087	33867.87009		
Age	103	2888	28.03883495	20.56710451		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	34270648.64	1	34270648.64	2022.557041	0	3.887446478
Within Groups	3456620.594	204	16944.2186			
Total	37727269.23	205				

In view of the consequences of the ANOVA, there is a huge contrast among age and response time (F(1, 204) = 2022.56, p < 0.001). Age has a significant impact on reaction time because the variance between groups is much larger than the variance within groups.

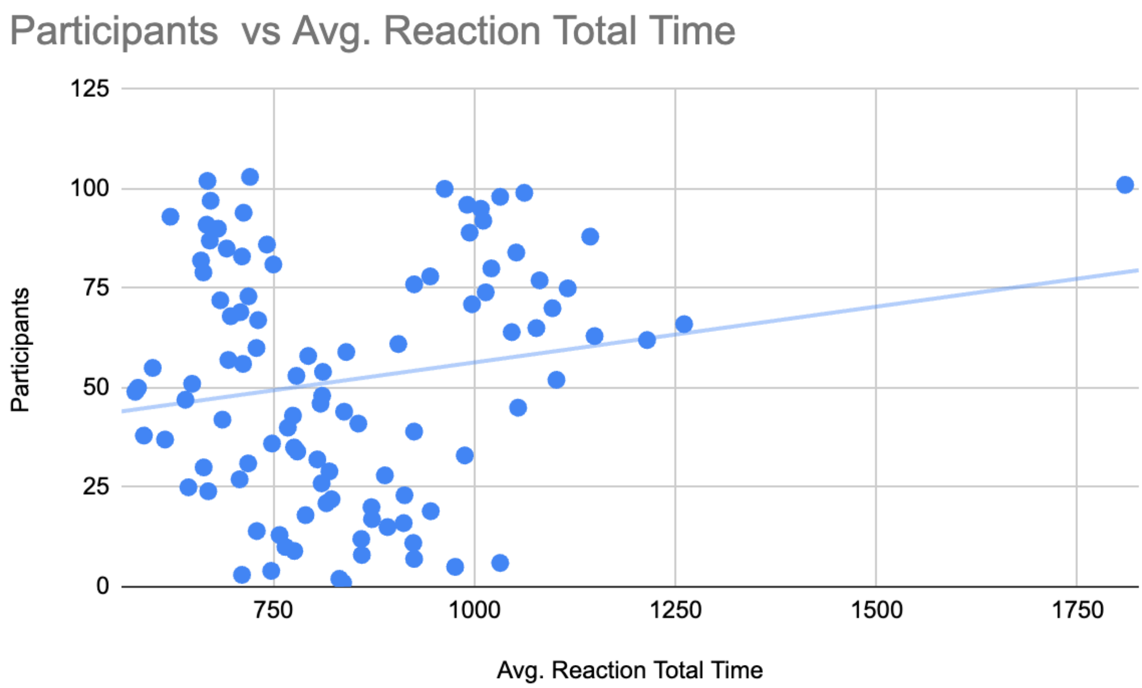
Linear Regression chart



According to the data provided, females have a higher average total reaction time than males do, but they also have a higher accuracy rate, with an average of 27 correct answers compared to a male average of 24 correct answers. This can be summarized as follows: In terms of the levels of color contrast, males and females have the fastest reaction times in the high level of color contrast, whereas the lowest level of color contrast has the slowest reaction time. Furthermore, guys will generally have a marginally higher response time in the low and medium degrees of variety contrast contrasted with females.



The participants' average reaction time and age were analyzed using linear regression, and the results indicate that there is a slight difference between the two age groups (25-35 and 18-25). Members in the 18-25 age bunch have a by and large higher typical response time (850 ms) contrasted with the 25-35 age bunch (817 ms). In both age gatherings, the most noteworthy response times were noticed for the low differentiation level boosts (- 50), while the least response times were noticed for the high difference level improvements (+50). Both age bunches had comparative normal right response rates (24-26). Overall, these findings suggest that while color contrast appears to be more important, age may have a small impact on reaction time.



The participants' average reaction time is 843 milliseconds, according to the data. The highest reaction time was observed at the low contrast level (-50) at 1103 milliseconds, and the lowest reaction time was observed at the high contrast level (+50) at 582 milliseconds. The reaction time decreases as the contrast level increases. There were on average 24 correct responses from the participants.

Findings and Discussion

The examination of the data indicates that there are considerable changes in reaction time and accuracy depending on gender, age, and colour contrast levels. Female participants usually had somewhat better accuracy rates but slightly slower response times than male participants, with younger people having faster reaction times than older participants. The results also showed a strong correlation between colour contrast and reaction times, with high contrast levels resulting in the quickest reactions and low contrast levels in the slowest.

Age, gender, and colour contrast all significantly influenced reaction time, according to the ANOVA results. Age may somewhat alter reaction time, according to the straight relapse test, but variety contrast appears to be more relevant. The results show that cognitive processing speed tends to go down with age and that reaction times may be sped up by boosting colour contrast.

These results have significant implications for the design of user interfaces as well as the analysis of how visual cues affect reaction time and accuracy. Designers of interfaces should consider the effects of colour contrast on response time, age and gender disparities, and other factors. Further research on the relationship between cognitive capacity, colour contrast, and response time is possible.

Practical Implication

The applications of the data analysis might lead to better websites and user interfaces. For instance, web experts may use the information on variety distinction and reaction time to make their website simpler for users of all ages and genders. The results suggest that individuals react more quickly when there is a significant colour contrast. As a result, planners might leverage high difference to enhance client experience and further expand site usability.

Additionally, designing interfaces that are more age-appropriate may benefit from the fact that younger participants react more quickly than older ones. Designers may build interfaces that are easier to use and demand less cognitive processing for elderly people who might have a slower cognitive processing speed.

The data on gender disparities in response time and accuracy rate may also be useful for building interfaces that are more gender inclusive. For example, designers might use different colour palettes and typeface types that are better suited for males and women, respectively.

Overall, this data analysis's findings can assist web designers and interface developers in developing user interfaces that are more inclusive and approachable for their intended audience.

Conclusion

The data analysis comes to the conclusion that gender, age, and colour contrast can have an impact on task accuracy and response time. The results show that when the contrast between colours is enhanced, younger individuals often reply more rapidly than older ones. Additionally, there were very modest differences in response times and accuracy between men and women, with women displaying slightly slower response times but better precision rates.

In general, these findings can have fair implications for designing user interfaces, especially for older individuals who may have slower mental processing speeds. By reducing visual clutter and enhancing colour contrast, interfaces may be made more accessible and user-friendly while also improving response speeds and accuracy. Furthermore, the differences in response times between men and women indicate that gender should be taken into consideration.

Future Implications

Examine the relationship between colour contrast and response time in a range of activities and environments. This may entail investigating how other cognitive functions, such as memory or attention, are affected by colour contrast.

Consider the possible benefits of training regimens designed to increase reaction speeds. These programmes could be especially useful to people who hold positions that need rapid answers, such pilots or emergency responders.

Examine the impact of various factors, such as rest, exercise, or nutrition, on response time. This may provide further information about how to enhance cognitive function.

Analyse how different stimuli affect your reaction time. It would be interesting to compare the effects of hearable or material enhancements with those of variety balancing on response time, for instance.

Examine the potential impact of individual contrasts on response time, such as personality traits or mental abilities. As a result, comprehension of the variables that affect cognitive processing speed may become more complex.