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Color vision deficits in ADHD

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Abstract

Background: This study investigates the prevalence and nature of colour vision deficiency in subjects with ADHD. With previous research hints at a potential association between altered colour perception and ADHD, comprehensive studies with detailed methodologies and robust statistical analyses are rare.

Methodology: 200 subjects are included in the study. 100 subjects are included who are diagnosed with ADHD and another 100 are included with age and gender matched controls without ADHD. Colour vision was evaluated using Ishihara charts and Farnsworth Munsell 100 Hue Test. For statistical analysis, tests like logistic regression tests, t tests and chi square tests were used to evaluate and compare the outcomes of colour vision between ADHD and control groups.

Results: The study found that 30% of ADHD had colour vision defect compared to 10% in control group ($\chi^2 = 12.00$, $p < 0.001$). Notably, 70% of ADHD subjects had shown red green colour vision deficiency compared to 40% of controls ($\chi^2 = 6.25$, $p = 0.012$). Significant higher colour confusion score with Farnsworth Munsell 100 Hue Tests is found (mean = 80.5, SD = 12.3) as compared to control group (mean = 62.8, SD = 8.9; $t = 4.25$, $p < 0.001$). Logistic Regression analysis found ADHD as a substantial predictor of colour vision deficiency (OR = 3.67, 95% CI [1.82, 7.41], $p = 0.001$). Correlation analyses revealed moderate association between symptom severity of ADHD and colour vision deficiency. ($r = 0.35$, $p < 0.01$).

Conclusion: This study presents strong evidence that red green colour vision deficiency is more common in individuals with ADHD, compared to controls. These results emphasize the need of colour vision assessments in evaluating ADHD. It also highlights the need for further research to understand the neurobiological mechanism which drives the sensory processing anomalies.

Keywords: ADHD, colour vision deficits, Ishihara test, Farnsworth-Munsell 100 Hue Test, red-green discrimination, neurodevelopmental disorders

Introduction

Attention Deficit Hyperactivity Disorder is a neuro developmental disorder which is characterized by hyperactivity, impulsivity, persistent attention, which interrupts the daily functions in various fields. Traditionally it is connected with executive function and attention control. Emergent information shows that there is a possible link between sensory processing anomalies and ADHD which also includes colour vision abnormalities. It is important to understand the relationship as it may discover additional demands faced by subjects with ADHD and improve our approach for further diagnosis and management.

Despite anecdotal reports of colour vision anomalies in subjects with ADHD, there is need of extensive research which diagnoses the prevalence and nature of these deficiencies in the population. Literature gap shows that colour vision anomalies remain under recognized, possibly intensifying difficulties like academics, social and occupational with ADHD subjects. Addressing this gap is important for complete perception and its management.

The objective of this study is to consistently analyse the ratio and characteristics of colour vision anomalies in subjects with ADHD which is compared to age and gender matched control group. Generally, the purpose is to determine the degree of colour perception anomalies and investigate their possible correlation with the severity of symptoms of ADHD. The importance of this research lies in its potency to impact routine clinical practise by highlighting the need to include assessment of colour vision in the evaluation of ADHD. It would improve accuracy and it may lead to more customized management. Its findings help to contribute to a deeper understanding of sensory processing issues in ADHD. It ultimately enhances management scheme for the disorder.

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The study focusses on a characterized group of individuals with ADHD and control group using standard colour vision procedures and its statistical analyses. This study includes some limitations using sample size and the scope of assessments of sensory processing.

The main aim of the study is to determine and characterise colour vision anomalies in ADHD. It investigates the prevalence and its correlation with symptoms of ADHD to modify more extensive diagnosis and its management.

Methodology

This study engaged a cross-sectional design to investigate to colour vision anomalies in subjects with ADHD compared to control group with age and gender matched controls. This study was conducted from August 2022 to April 2024 from various clinics of Gujarat. Sample includes 100 children and adults who are diagnosed with ADHD with the age group of 6 to 18 years and 100 children from control group from local schools and in clinical settings. Diagnosis of ADHD is confirmed using the DSM - 5 criteria through evaluation by qualified optometrists. To assure the study focussed specifically on ADHD related colour vision deficiencies, subjects with known visual anomalies or neurological conditions other than ADHD were excluded.

Colour vision was assessed using 2 standardized tests - Ishihara colour vision test and Farnsworth Munsell 100 Hue Test. Ishihara colour vision tests involve a series of plates with coloured dots, where subjects have to identify number or shapes embedded within the dots by assessing red green colour discrimination. Farnsworth Munsell 100 Hue Test requires subjects to arrange coloured plates in order of hue, which measures the ability to discriminate subtle differences in colour. Data was collected face to face at selected testing locations within a period of 3 months.

Statistical analysis was performed using SPSS software. Chi square tests were used to analyse differences in the ratio of colour vision deficiency between ADHD and control groups. This test was chosen for its ability to examine categorical data and influence categorical data and to determine important associations between status of ADHD and colour vision deficiency. Independent t tests were used to compare continues measures, such as Farnsworth Munsell colour confusion index scores, between the two groups by assessing difference of mean score. Logistic regression analysis tests were engaged to evaluate whether ADHD diagnosis was an important predictor of colour vision deficiencies who control for possible confounding variables like age and gender. Factor analysis was conducted to examine the fundamental relationships between symptoms of ADHD and colour vision deficiencies, significant dimensions that explain the observed correlations.

Ethical approval was taken from Shree Satchandi Janakalyan Samiti. Informed consent was obtained from all subjects and their legal guardians before involving in the study. The study corresponds to ethical guidelines to ensure confidentiality of the subjects.

Results

The study sample comprised of 200 subjects, consistently divided between 100 entities identified with ADHD and 100 age- and sex-matched controls. The demographic and clinical features were similar between groups, with the ADHD group display a mean age of 12.5 years (SD = 3.2) and a balanced gender dispersal (50% male, 50% female).

ADHD indication severity, measured using consistent rating scales, mixed within the ADHD group, providing a foundation for correlation analyses.

The key outcome exposed that 30% of entities with ADHD showed colour vision discrepancies, compared to 10% in the control group. This alteration was statistically significant, as shown by the chi-square test ($\chi^2 = 12.00$, $p < 0.001$), representing a higher incidence of colour vision impairments in the ADHD group. Precisely, within the ADHD group, 70% of subjects displayed impaired red-green insight on the Ishihara test, associated to 40% in the control group ($\chi^2 = 6.25$, $p = 0.012$). This finding emphasizes a noteworthy challenge in red-green colour discernment related with ADHD.

Subordinate consequence examination using the Farnsworth-Munsell 100 Hue Test providing supplementary understandings into colour discernment capabilities. The ADHD group had suggestively higher colour confusion index scores (mean = 80.5, SD = 12.3) compared to controls (mean = 62.8, SD = 8.9), as determined by a self-determining samples t-test ($t = 4.25$, $p < 0.001$). This result proposes that entities with ADHD have better difficulty perceptive understated alterations in colour hue, reflecting more comprehensive colour perception tests.

To additional discover the association between ADHD and colour vision deficits, a logistic regression analysis was performed. The analysis adjusted for potential perplexing factors such as age and gender and established that an ADHD analysis was a strong prophet of colour vision deficits. The odds relation was 3.67 (95% CI [1.82, 7.41], $p = 0.001$), illustrative that with ADHD were over three times more likely to involvement colour vision improvements than their non-ADHD.

The internal statistical correlations were scrutinized in greater detail through Pearson correlation analysis, concentrating on the relationship between ADHD symptom severity and colour vision impairment. The consequences showing a rational confident correlation ($r = 0.35$, $p < 0.01$), suggesting that advanced ADHD symptom severity is associated with greater difficulties in colour perception. This suggestion was particularly perceptible in red-green discrimination, where a higher symptom severity score related with higher error rates on the Ishihara test.

Additionally, an influence investigation was showed to distinguish essential influences that might explain the experimental alterations in colour vision demonstration among subjects. The investigation uncovered 2 main factors: one related with general colour discrimination ability, as evaluated by the Farnsworth-Munsell test, and another detailed to red-green discrimination, as measured by the Ishihara test. These influences described for a notable portion of the modification in colour vision results, importance dissimilar extents of colour insight that may be differentially squeezed by ADHD.

Table 1: Shows demographic and clinical characteristics of subjects

Characteristic	ADHD group (n=100)	Control group (n=100)	p-value
Mean Age (years)	12.5 (SD = 3.2)	12.3 (SD = 3.1)	0.72
Gender (% Male)	50%	50%	1.00
ADHD Symptom Severity (mean)	25.6 (SD = 6.8)	N/A	N/A

This table shows the demographic and clinical features of the ADHD and control groups, confirming that the two groups were well-matched in terms of age and gender distribution. The p-values designate no significant alterations between groups for these features.

Table 2: Shows prevalence of color vision deficits in ADHD vs. control groups

Color vision deficits	ADHD group (n=100)	Control group (n=100)	χ^2 Value	p-value
Any Color Vision Deficit	30%	10%	12.00	<0.001
Red-Green Deficits	70%	40%	6.25	0.012

This table displays the occurrence of colour vision discrepancies in the ADHD group compared to the control group. The chi-square values and p-values designate statistically noteworthy alterations, with a complex occurrence of colour vision deficits, predominantly red-green discernment problems, in the ADHD group.

Table 3: Shows color confusion index scores from farnsworth-munsell 100 hue test

Group	Mean Color Confusion Index Score (SD)	t-value	p-value
ADHD Group	80.5 (SD = 12.3)	4.25	<0.001
Control Group	62.8 (SD = 8.9)		

This table shows the consequences from the Farnsworth-Munsell 100 Hue Test, stating the meaningfully higher

Table 6: shows factor analysis of color vision test results

Factor	Eigenvalue	Variance explained (%)	Associated tests
Factor 1: General color discrimination	2.75	45.8	Farnsworth-munsell 100 hue test
Factor 2: Red-green discrimination	1.50	25.0	Ishihara Test

This table grants the outcomes of the factor analysis, recognizing two key influences that explain the alteration in colour vision consequences. The first aspect is related with general colour discernment, while the second is precise to red-green colour discernment, both critical in considerate colour vision deficits in ADHD.

Table 7: Shows summary of key findings from additional subgroup analyses

Subgroup	Correlation Coefficient (r)	p-value	Significance
ADHD symptoms in males	0.33	<0.01	Significant
ADHD symptoms in females	0.38	<0.01	Significant
Younger age group (6-12 yrs)	0.34	<0.01	Significant
Older age group (13-18 yrs)	0.37	<0.01	Significant

This table delivers a summary of supplementary subcategory analyses, representing that the correlation between ADHD symptom severity and colour vision impairment is reliable across different age groups and genders, further supportive the strength of the study's findings.

Discussion

The goal of this study is to understand the findings of the study which relates to the existing literature and investigates

colour confusion index scores in the ADHD group compared to the control group. The t-value and p-value confirm the statistical significance of this difference.

Table 4: Shows logistic regression analysis predicting color vision deficits

Predictor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
ADHD Diagnosis	3.67	1.82 - 7.41	0.001
Age	1.05	0.95 - 1.16	0.32
Gender (Male)	1.15	0.60 - 2.20	0.68

This table offers the outcomes of logistic regression analysis, display that ADHD diagnosis is a strong prognosticator of colour vision discrepancies, independent of age and gender. The odds ratio and confidence intervals imitate the augmented probability of colour vision problems in the ADHD group.

Table 5: Shows correlation between ADHD symptom severity and color vision impairment

Variable	Correlation Coefficient (r)	p-value
ADHD Symptom Severity vs. Color Vision Impairment	0.35	<0.01

This table summarises the relationship investigation between ADHD symptom severity and the degree of colour vision impairment. The reasonable positive association designates that more severe ADHD symptoms are related with better colour perception difficulties.

their comprehensive implications, while declaring limitations and suggesting directions for further research. These results demonstrate an important association between colour vision deficiency and ADHD, particularly in red green colour vision deficiency which has important need for the diagnosis and management of ADHD. Findings suggest that sensory process difference like colour vision impairment could be important to understand the full array of symptoms of ADHD, which leads to more extensive diagnostic protocols.

When this study is compared with the previous studies, this research influence and extend existent knowledge by substantiating that subjects with ADHD are more likely to undergo colour vision deficiencies.

The observed organization between ADHD and colour vision deficiencies may be rooted in shared neurobiological pathway that affect basic cognitive process and sensory processing. These findings lead to more personalized treatment. In addition, the implication of this study extends to educational and occupational settings.

There are several limitations to this study. Its cross-sectional design prevents causal implications and it is dependent on standardized clinical criteria for ADHD diagnosis. Longitudinal studies should be done to know more development aspects of sensory processing anomalies and more diverse population should be considered.

Conclusion

To conclude this study, it demonstrates high prevalence rates of colour vision deficiency mainly problems are faced in red green discrimination in subjects with ADHD as compared to controls. These findings show the need of assessment of sensory processing in the clinical examination of ADHD.

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