RESEARCH PAPER

Convergence Insufficiency & Its Relationship To Somatic Sensations, Visual Impairment And Cognitive Function: A Structural Analysis

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Abstract

Background: Convergence insufficiency (ci) is a binocular vision disorder characterized by an inability to efficiently maintain eye alignment during near tasks. Asthenopia is the most common complaint in urban children, most likely due to school activities, and is characterized by a wide range of symptoms such as blurred vision, trouble concentrating at various distances, ocular pain or irritation, and headaches when the eyes are used for extended periods.

Aims & Objectives: To determine the sub scores relationship between somatic sensations, impaired vision, and cognitive performance in undergraduate & post graduate students using the factor structure of the ciss questionnaire.

Methodology: A cross sectional study was conducted among 83 university students (undergraduate and postgraduate) aged 18-30 years, r. L. Jalappa hospital and research, kolar.

Results: A majority of participants reported somatic (51.73%) and cognitive (47.9%) symptoms, while impaired vision was noted in 27.3%. This indicates that visual strain and related discomfort are highly prevalent among university students engaged in prolonged near-work. The predominance of somatic and cognitive symptoms suggests that ocular fatigue extends beyond visual alignment issues, influencing concentration and reading efficiency. Environmental and digital-screen factors may further contribute to these findings.

Conclusion: Somatic and cognitive symptoms are more common than direct visual disturbances. High symptom prevalence emphasizes the need for early screening of convergence insufficiency and related asthenopic complaints.

Keywords: Convergence Insufficiency, Cognitive Function, Somatic Sensations, Visual Impairment, Outcome.

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INTRODUCTION:

Convergence insufficiency (CI) is a binocular vision disorder characterized by an inability to efficiently maintain eye alignment during near tasks. Even with normal visual acuity and with no binocular vision anomaly, reading and other close activities may become difficult and unpleasant due to the symptoms such as eye fatigue, text movement, blurring, and lack of focus.[1] Asthenopia is the most common complaint in urban children, most likely due to school activities, and is characterized by a wide range of symptoms such as blurred vision, trouble concentrating at various distances, ocular pain or irritation, and headaches when the eyes are used for extended periods.[2]

Refractive asthenopia and muscular asthenopia are the two forms of asthenopia. Refractive asthenopia is found to be associated with uncorrected refractive error, while muscular asthenopia is related to convergence and/or accommodation changes.[3] Somatic sensations are found to be associated with complaints about accommodative effort and refractive issues.[4]

University students and school-aged children, who engage in prolonged near visual activities, are especially vulnerable to these symptoms, even in the absence of measurable visual acuity deficits or overt binocular vision anomalies.[1]

Symptoms of CI are typically assessed using the Convergence Insufficiency Symptom Survey (CISS), a standardized and validated instrument widely used in clinical and research contexts.[5] Originally developed to provide a global symptom score, recent studies have proposed a multidimensional structure of the CISS, identifying distinct domains such as somatic sensations, impaired vision, and cognitive performance.[5] The CISS has also been adapted and validated in multiple languages, ensuring its relevance in diverse populations and enhancing its psychometric reliability.[6]While earlier research primarily focused on changes in overall CISS scores before and after treatment.[7] newer analyses emphasize the need to evaluate specific symptom categories, particularly in populations such as university

students who may report high levels of near-task discomfort.[5]

Additionally, CI and other oculomotor dysfunctions have been linked to academic difficulties, including slower reading speed and reduced comprehension in children with reading disabilities, further highlighting the importance of efficient binocular vision for cognitive performance.[8] Given the increasing demands on near visual tasks in academic environments, this study aims to explore the relationships among the three proposed symptom domains of the CISS in our students.Although previous studies have utilized the Convergence Insufficiency Symptom Survey (CISS) to assess visual discomfort, they often relied on aggregate scores and lacked statistical justification for symptom categorization. There is limited research exploring the multidimensional symptom structure (somatic sensations, impaired vision, and cognitive performance) in young adults, especially university students frequently engaged in near-vision tasks. This study addresses this gap by validating the factorial structure of the CISS and exploring the interrelation among these symptom dimensions which may contribute to more targeted interventions and improve the identification and management of visual discomfort associated with CI.

Aims & Objectives: To determine the sub scores relationship between somatic sensations, impaired vision, and cognitive performance in undergraduate & post graduate students using the factor structure of the CISS questionnaire.

Methodology: A cross sectional study was conducted among 83 University students (undergraduate and postgraduate) aged 18-30 years , R. L. Jalappa Hospital and Research, Kolar. Sample size was estimated by using correlation coefficient (r) between somatic sensation and impaired vision at 0.539 (i.e. r = 0.539) from the study by Biswas V et al [3] Using these values at 99.99% confidence level and 99% power and substituting in the below formula, sample size of 80 was obtained. Considering 10% Non response rate a sample size of 80 + 2.5 = 83 subjects were included in the study. Students who had Presence of strabismus (eye misalignment) and History of any eye surgery were excluded.

Data for this study were collected using a digital, self-administered questionnaire approach. The instrument employed was the Portuguese version of the Convergence Insufficiency Symptom Survey (CISS), which consists of 15 items rated on a 5-point Likert scale ranging from “Never” to “Always.” Prior to participation, all individuals had provided with an informed consent form embedded within the survey link, explaining the purpose of the study, confidentiality measures, and the voluntary nature of participation.

Data entry and analysis: Data were entered into Microsoft excel data sheet and were analyzed using SPSS 22 version software (IBM SPSS Statistics, Somers NY, USA). Categorical data were represented in the form of Frequencies and proportions. Continuous data were represented as mean and standard deviation. Pie diagrams and Bar diagrams were used to represent data graphically. ANOVA test was the test of significance for Quantitative data. P value less than 0.05 considered as a stastically significant.

Results:

Table 1. Somatic sensation among study participants

ITEMS	FREQUENCY				
Somatic sensation	NEVER	INFREQUENTLY	SOMETIMES	FAIRLY OFTEN	ALWAYS
S1. Eye tiredness related to near activities	29	15	36	6	0
S2. Eye discomfort related to near activities	32	19	29	6	0
S3. Headaches related to near activities	26	22	31	7	0
S4. Sleepiness related to near activities	36	20	24	5	1
S5. Concentration loss related to near activities	35	19	22	9	1
S6. Eye pain related to near activities	36	22	18	10	0
S7. Eye soreness related to near activities	39	25	17	5	0
S8. Eye “pulling” feeling related to near activities	43	23	16	3	1

Eye tiredness (S1) was most commonly reported as “Sometimes” (36), followed by “Never” (29) and “Infrequently” (15), with very few participants experiencing it “Fairly often” (6) and none reporting “Always.” Similarly, eye discomfort (S2) was mainly experienced “Never” (32) or “Sometimes” (29), with minimal reports of frequent occurrence. Headaches related to near activities (S3) also followed a comparable trend, with the majority reporting “Sometimes” (31) and “Never” (26), while very few experienced them “Fairly often” (7). Sleepiness (S4) and concentration loss (S5) were more commonly reported as “Never” (36 and 35 respectively), although a notable proportion experienced these symptoms “Sometimes” (24 and 22). Only a very small number reported these symptoms “Always” (1 each). Eye pain (S6) and eye soreness (S7) were predominantly reported as “Never” (36 and 39 respectively), with decreasing frequencies in higher categories, indicating that these symptoms were less frequent among participants.

Lastly, the sensation of eye "pulling" (S8) was least commonly reported, with the majority indicating "Never" (43), followed by "Infrequently" (23) and "Sometimes" (16), and very few reporting it "Fairly often" (3) or "Always" (1). [Table 1]

Among impaired vision symptoms, double vision related to near activities (I1) was predominantly reported as "Never" (65), with very few participants experiencing it "Sometimes" (6) or "Fairly often" (3), and none reporting it "Always." Similarly, text motion while reading (I2) was mostly absent, with the majority reporting "Never" (60), while small proportions experienced it "Infrequently" (13) or "Sometimes" (11), and only one participant each reported "Fairly often" and "Always." Text defocusing during near activities (I3) also followed a similar pattern, with most participants indicating "Never" (55), followed by "Infrequently" (14) and "Sometimes" (12), while very few reported frequent or constant occurrence.

Regarding cognitive performance, trouble remembering reading text (C1) was reported as "Never" by 40 participants, though a notable number experienced it "Sometimes" (21) and "Infrequently" (19), suggesting mild cognitive strain in a subset. Slow reading sensation (C2) was primarily reported as "Never" (42) or "Infrequently" (25), with fewer participants experiencing it "Sometimes" (15), and only a small number reporting it "Fairly often" or "Always" (2 each). Loss of orientation while reading (C3) was also largely absent, with most participants reporting "Never" (47), followed by "Infrequently" (24), and fewer reporting higher frequency categories.

However, the need to re-read the same line of words (C4) showed relatively higher occurrence compared to other cognitive symptoms, with a considerable proportion reporting "Sometimes" (26), along with "Never" (31) and "Infrequently" (21), indicating this as one of the more common issues experienced during near work. [Table 2]

Table 2. Impaired vision and cognitive performance of study participants.

Variables	n	Mean±SD	ANOVA TEST (P value)
Somatic sensation	86	18.0±1.6	0.0021
Impaired vision	86	14.6±1.1	
Cognitive performance	86	16.0±1.6	

Table 3. Comparison between somatic c=sensation, impaired vision and cognitive performance

ITEMS		FREQUENCY			
Impaired vision	NEVER	INFREQUENTLY	SOMETIMES	FAIRLY OFTEN	ALWAYS
I1. Double vision related to near activities	65	12	6	3	0
I2. Text motion while reading	60	13	11	1	1
I3. Text defocusing in near activities	55	14	12	4	1
Cognitive performance					
C1. Trouble remembering reading text	40	19	21	5	1
C2. Slow reading sensation	42	25	15	2	2
C3. Loss of orientation in text during reading	47	24	7	6	2
C4. Need to re-read the same line of words	31	21	26	7	1

On applying ANOVA test, there was a statically significant difference found between somatic sensation, impaired vision and Cognitive performance. [Table 3]

Discussion: The present study evaluated the distribution of somatic sensations, impaired vision, and cognitive performance symptoms among university students using the CISS questionnaire, and the findings were compared with previously published original research. In the domain of somatic sensations, symptoms such as eye tiredness (S1), eye discomfort (S2), and headaches (S3) were most commonly reported as "sometimes," indicating moderate but clinically relevant symptomatology. This pattern is consistent with the findings of Borsting et al., who reported that asthenopic symptoms like eye strain and headaches are frequently experienced intermittently rather than persistently among individuals with convergence insufficiency (CI) [9]. Similarly, a study by Rouse et al. demonstrated that eye fatigue and discomfort during near work are among the most prevalent complaints in CI patients, supporting the moderate frequency distribution seen in the current study. [10] However, unlike the present study where "always" responses were negligible, higher severity scores were noted in clinical populations in these studies, likely due to inclusion of symptomatic patients rather than a general student population.

Symptoms such as sleepiness (S4) and concentration loss (S5) were predominantly reported as "never," though a significant proportion experienced them "sometimes." This aligns with the observations of Maples et al., who found that while cognitive fatigue-related symptoms are present in CI, they tend to be less frequent

than primary ocular symptoms. [11] Eye pain (S6), soreness (S7), and pulling sensation (S8) were largely reported as "never" or "infrequently," suggesting lower prevalence of severe somatic manifestations. This is comparable to findings by Scheiman et al., who noted that severe ocular pain and pulling sensations are less commonly reported compared to general eye strain and discomfort. [12] The relatively lower frequency in the present study may be attributed to the non-clinical nature of the sample and absence of diagnosed CI cases.

In terms of impaired vision, symptoms such as double vision , text motion, and defocusing were predominantly reported as "never," indicating that classic binocular vision disturbances were less prevalent. This is in agreement with the study by Cacho-Martínez et al., which found that symptoms like diplopia and text movement are less commonly reported in general populations and are more specific to clinically diagnosed CI cases. [13] Similarly, Rouse et al. observed that visual blur and diplopia are less frequent compared to asthenopic symptoms in non-clinical samples. [10] The low frequency of these symptoms in the present study further supports the notion that impaired vision complaints are less prominent in early or subclinical CI.

Regarding cognitive performance, symptoms such as trouble remembering (C1), slow reading (C2), and loss of orientation (C3) were mostly reported as "never" or "infrequently," although a notable proportion reported "sometimes." These findings are consistent with those of Borsting et al., who reported that CI can affect reading efficiency and cognitive processing, though these effects are often mild to moderate in non-clinical populations. [14] Interestingly, the need to re-read text (C4) showed relatively higher frequency, with many participants reporting it "sometimes." This observation is supported by a study by Scheiman et al., which identified re-reading and reduced reading comprehension as common functional impairments associated with CI. [12] This suggests that even in the absence of overt visual symptoms, subtle cognitive inefficiencies during near work may be present.

The comparison of mean scores across the three domains revealed that somatic sensations had the highest mean, followed by cognitive performance and impaired vision, with a statistically significant difference ($p = 0.0021$). This pattern is consistent with the multidimensional analysis of CISS conducted by Biswas et al., who reported that somatic and cognitive symptoms are more prominent than visual disturbances in young adults. [15]Similarly, a study by Horwood and Riddell highlighted that symptoms of CI often extend beyond visual deficits and significantly impact comfort and cognitive function during prolonged near tasks. [16]The higher prevalence of somatic symptoms in the present study may be attributed to increased screen time, prolonged academic activities, and environmental factors affecting visual ergonomics.

Overall, the findings of the present study are in agreement with existing literature, demonstrating that somatic and cognitive symptoms are more prevalent than impaired vision symptoms in non-clinical student populations. Variations in symptom frequency compared to other studies may be due to differences in study population, diagnostic criteria, and exposure to near work. The results underscore the importance of early screening and targeted interventions focusing not only on visual function but also on associated somatic and cognitive symptoms.

Conclusion: Somatic and cognitive symptoms are more common than direct visual disturbances. High symptom prevalence emphasizes the need for early screening of convergence insufficiency and related asthenopic complaints. Education on visual hygiene, optimal posture, and regular visual breaks should be encouraged.Addressing these factors can improve visual comfort, reading performance, and academic efficiency in young adults.

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