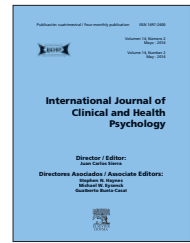International Journal
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ORIGINAL ARTICLE

Symptoms of Meares-Irlen/Visual Stress Syndrome in subjects diagnosed with Chronic Fatigue Syndrome

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Abstract Several diagnostic symptoms of the visual-processing deficit Meares-Irlen/Visual Stress Syndrome are remarkably similar to symptom manifestations reported by individuals with chronic fatigue syndrome (CFS). We surveyed the specific incidences of nine widely-recognised symptoms of visual stress (VS) in a group of subjects ($n = 20$) previously diagnosed with CFS. The presence of each symptom of VS in the CFS group was compared to its respective presence in both an age and sex matched healthy comparison group ($n = 46$), and an age and sex matched group comprised of individuals ($n = 14$) diagnosed with VS. Results showed the frequencies of all nine VS symptoms in the CFS-diagnosed group to be significantly higher ($p = .032 - p < .0005$) than in the comparison group, with only two symptoms being statistically less frequent in the CFS group than in the VS-diagnosed group. The average number of VS symptoms reported by the CFS group was also significantly higher than the comparison group, yet not significantly different from the VS group. Thus, the occurrence of VS symptoms in subjects diagnosed with CFS appears to be far greater than previously reported, which in turn may indicate the interplay of some yet to be identified underlying factor(s) common to both conditions.
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Resumen Algunos síntomas del Síndrome de Estrés Visual/Meares-Irlen son similares a los informados por individuos con síndrome de fatiga crónica (SFC). Se evaluó la incidencia de nueve síntomas ampliamente reconocidos de estrés visual (EV) en un grupo de sujetos ($n = 20$) con síndrome de fatiga crónica. La presencia de cada síntoma de EV en el grupo con SFC se comparó con un grupo control de sujetos sanos ($n = 46$) y con un grupo de individuos ($n = 14$) con diagnóstico de EV, equiparables en sexo y edad. Los resultados mostraron una frecuencia en los nueve síntomas de EV en el grupo diagnosticado SFC significativamente mayor ($p = 0,032$-$p < 0,0005$) que en el grupo de comparación, con sólo dos síntomas estadísticamente menos frecuentes en el grupo SFC que en el grupo EV. El número medio de síntomas EV señalados por el grupo SFC también fue significativamente mayor que el del grupo de comparación, aunque no significati-

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vamente diferente el grupo EV. Por lo tanto, la presencia de los síntomas de EV en sujetos con diagnóstico de SFC parece ser mucho mayor que la informada, lo que puede indicar la interacción de algún factor/s subyacente/s aún no identificado/s comunes a ambas condiciones.

During the past two decades, there has been converging evidence of visual processing problems which can affect reading ability and are the primary pathology present in as many as one in four cases of dyslexia (Ramus et al., 2003; White et al., 2006). Visual stress (VS), also known as Meares-Irlen syndrome or scotopic sensitivity syndrome, is a visual processing deficit believed to affect at least 5% of the general population (Allen & Hollis, 2008; Kriss & Evans, 2005). While fMRI studies have indicated that hyper-excitability of the visual cortex is observable in subjects with VS (Huang et al., 2011), other studies have produced evidence of aberrant visual-signal processing en route to the visual cortex via the magnocellular pathway (Solan, Shelley-Tremblay, Hansen, & Larson, 2007; Stein, 2003), though it stands to reason that the latter might give rise to the former. Moreover, the 'magnocellular theory' has been questioned by some, in part because a large number of non-dyslexic individuals also have magnocellular deficits (Allen, Evans, & Wilkins, 2012; Skoyles & Skottun, 2004, 2008).

The key characteristics of VS include visual distortions of print when reading, such as the text appearing to move or vibrate, with these symptoms occurring despite an absence of optometric or ophthalmological abnormalities (Robinson, 1994; Stein, 2003). An additional hallmark of VS is that an individual's span of word recognition (the number of words seen in one eye fixation) is significantly reduced, as is their ability to maintain extended reading (Loew & Watson, 2012b; Robinson, 1994). Symptoms of VS are also known to be exacerbated by fluorescent lighting (Loew, Fernández, & Watson, 2013; Winterbottom & Wilkins, 2009) and the use of coloured filters has frequently been reported as an effective means of ameliorating these symptoms (Allen et al., 2012; Loew & Watson, 2012b; Wilkins & Evans, 2009), while others have found no measurable benefits to reading (Ritchie, Della Sala, & McIntosh, 2011).

Estimates of the prevalence of VS in the general population vary from 5% using very strict criteria, such as an immediate improvement in reading speed of 25% or greater when a subject reads through coloured overlays (Kriss & Evans, 2005), to as high as 22% when the reported symptom levels of VS form the basis of diagnosis (Allen & Hollis, 2008; Robinson, Hopkins, & Davies, 1995), while there appears to be general consensus of a 12% occurrence of moderate symptoms of VS. A number of studies have referred to VS as a sub-type of dyslexia (Sparkes, Robinson, Roberts, & Dunstan, 2006), however this categorisation remains highly contentious. Others describe VS as a separate entity which can occur with or without dyslexia, albeit significantly more prevalent (31-46%) in the dyslexic population (Irlen, 1994; Kriss & Evans, 2005; Kruk, Sumbler, & Willows, 2008). It is also significant that, although fewer in number, most studies of VS morbidity in adult populations have reported virtually identical incidences to those observed in children and adolescents (Evans & Joseph, 2002; Robinson & Conway, 2000).

Although symptoms of VS inherently affect reading, writing, spelling and visual attention, the degree of impact upon literacy and learning can vary greatly amongst affected individuals. This variation may in large part be due to the severity of VS morbidity being a continuum (Evans & Joseph, 2002), but it also is likely to occur because the condition is equally prevalent across all levels of intellectual ability and many individuals are thus able to compensate for their inefficient reading. As a result, the few overt symptoms of VS, such as a dislike of reading aloud, poor handwriting and inattentiveness, might easily be misinterpreted as laziness or being signs of other learning disorders by parents, teachers and physicians.

The epidemiology of VS is complicated by the fact that similar or identical symptoms have been identified in a number of independent disorders, including: developmental dyslexia (Northway, Manahilov, & Simpson, 2010; Rodríguez-Pérez, González-Castro, Álvarez, Álvarez, & Fernández-Cueli, 2012; Wright & Conlon, 2009); attention deficit/ hyperactivity disorder (ADHD) (Loew & Watson, 2013; Taurines et al., 2010); autism spectrum disorders (Ludlow, Taylor-Whiffen, & Wilkins, 2012); migraine and photosensitive epilepsy (Wilkins, Huang, & Cao, 2007); and chronic fatigue syndrome (CFS) (Loew & Watson, 2012a; Robinson, McGregor, Roberts, Dunstan, & Butt, 2001). Although unusually high rates of comorbidity with VS have been confirmed in dyslexia, ADHD, migraine and autism, further investigative studies of VS comorbidity or symptom overlap in CFS are lacking.

Some researchers of CFS epidemiology, such as Robinson et al. (2001), have reported exceptionally high incidences of VS comorbidity in their CFS subjects. However, follow-up studies aimed at directly measuring the degree of symptom overlap between the VS and CFS disorders appear to be limited if not absent from the scientific literature. CFS pathology does, however, occupy a sizeable portion of the literature pertaining to human neurobiological disorders. In contrast to the VS condition, CFS is a debilitating disorder that is characterised by continual and incapacitating fatigue, muscle and joint pain, and impaired cognitive function. Estimates of CFS prevalence in the population are in the order of 0.25% (Reyes et al., 2003). According to the Australasian College of Physicians, the diagnostic criteria for CFS are: Unexplained incapacitating fatigue for at least six months, plus any four of the following symptoms: Impaired memory or concentration; Joint pain; Sore throat; Headaches; Tender glands; Unrefreshing sleep; Muscle pain; Post-exertional malaise.

Though classed as separate disorders, many widely utilised diagnostic criteria for CFS (i.e. ME/CFS Guidelines: Canadian Clinical Criteria, 2003) include a notable number of visual perception and visual attention symptoms that are also recognised diagnostic criteria for VS. It is therefore somewhat surprising that investigations of symptom overlap between these separately categorised human disorders appear to be under-represented in the literature. This is especially pertinent upon noting that clearly defined causal mechanisms for either of these conditions remain elusive. The present study endeavours to ascertain the presence of diagnostic symptoms of VS in subjects diagnosed with CFS and then compare these to their respective frequencies in a healthy comparison group, and in a group of subjects diagnosed with the VS condition itself.

Method

Participants

The data utilised in this study was obtained from a sample of 80 university students and academics recruited from the University of New England, Australia. There were three groups of participants in the current study: Individuals (n = 20) medically diagnosed with CFS, individuals (n = 14) with diagnoses of VS by certified Irlen/VS screeners, and a comparison group (n = 46) with no histories of CFS, VS, or ADHD. The CFS and comparison groups were matched for age and gender. The difference in average age between the CFS group (M = 36.50, SD = 11.60 years) and the comparison group (M = 31.00, SD = 10.19) was not statistically significant ($t_{(64)}$ = 1.93, p > .05), and the difference in sex composition between the CFS group (75% female) and the comparison group (74% female) was not statistically significant ($\chi^2_{(1)}$ = 0.01, p > .05).

The CFS and VS groups were also matched for age and gender. The difference in average age between the CFS group (M = 36.50, SD = 11.60 years) and the VS group (M = 34.21, SD = 9.80) was not statistically significant ($t_{(32)}$ = 0.60, p > .05). Similarly, the difference in sex composition between the CFS group (75% female) and the VS group (50% female) was also not statistically significant ($\chi^2_{(1)}$ = 2.25, p > .05). All participants were from similar sociological and academic backgrounds and, despite some variation in monetary incomes, none of the participants reported backgrounds fitting the definition of lower socio-economic status. Prior to inclusion in the study, each of the participants were interviewed and fully informed of the study's protocol before signing an informed consent form.

There were no participant applicants with ophthalmological conditions, or optometric problems which had not recently (< 2 years) been corrected. None of the participants had been treated for any psychological or mood disorders or prescribed any form of psychotropic medication in the two years prior to the interview, thus it was not necessary to exclude any of the applicants on these bases. Each of the participants included in the CFS group (n = 20) reported as having a prior medical diagnosis of CFS attributed by the Australian healthcare system, and not having any reading or visual perception problems. The participants included in the VS group (n = 14) reported a previous diagnosis of VS from a certified Irlen/VS screener or diagnostician, and no prior history of CFS. The current validity of a participant's VS diagnosis was verified in a pre-trial VS screening by a certified VS/Irlen screener (Loew). However, CFS symptoms in the VS group were not screened as a qualified CFS diagnostician was not readily available to assess symptoms of CFS in the time-frame in which most of the participants were available for interview.

Instruments

The participants completed a self-report questionnaire designed to survey the incidences of nine diagnostic symptoms of VS (Table 1) as per those described by Kruk et al. (2008), Whiting, Robinson, and Parrott (1994), and the Irlen Reading Perceptual Scale (Irlen, 1994). For each symptom, participants were required to indicate whether they have the symptom on a 3-point scale of: *Yes, No,* or *Sometimes*. For the purposes of data analysis, responses of *Yes* and *Sometimes* were classified as indicating the presence of a symptom. Therefore, the range of possible scores was from 0 to 9.

Procedure and data analysis

The aim of the study was to examine the presence of VS symptoms in individuals diagnosed with CFS in comparison to (a) a "normal" comparison group and (b) a group diagnosed with VS, and provide analysis of data in a non-complex format (Hartley, 2012). A one-way between groups ANOVA with post-hoc tests was utilised to examine differences between the three groups on total symptoms of VS. Analysis of differences between the CFS group and each of the other two groups for specific symptoms of VS was undertaken by chi-square tests for independence. Ethics approval was granted by the University of New England Human Research Ethics Committee (approval: HE12-108). The study was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki, 2008) for research involving humans.

Results

A one-way between-groups analysis was conducted to examine the differences between the three groups on their respective total scores on the questionnaire. There was a statistically significant difference in total VS symptom score for the three groups, $F_{(2, 77)}$ = 26.15, p < .001. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the comparison group (M = 2.28, SD = 2.13) was significantly different from the mean score for both the CFS group (M = 5.60, SD = 2.64, p < .0005) and the VS group (M = 6.64, SD = 2.50, p < .0005). In contrast, the difference between the mean scores for the CFS and VS groups was not statistically significant (p > .05).

Prevalence of visual stress symptoms in the chronic fatigue syndrome and comparison groups

As the data presented in Table 1 shows, the incidences of all nine symptoms of VS were far more prevalent in the CFS

Table 1   Presence of VS symptoms in the CFS and comparison groups: (no. of subjects; % of group; significance of variation).

Symptom	CFS group (n = 20)	Comparison group (n = 46)	χ^2
Slow reading	10 (50%)	10 (22%)	5.27*
Strain & fatigue with extended reading	17 (85%)	20 (44%)	9.76*
Print distortions, esp. with black print on white paper	8 (40%)	7 (15%)	4.88*
Preference for reading text printed on coloured paper	6 (30%)	3 (7%)	6.52*
Lack of depth perception or difficulty in judging distances	11 (55%)	7 (15%)	11.12*
A feeling of clumsiness when negotiating uneven terrain	13 (65%)	8 (17%)	14.56*
Dislike of bright light or glare (photophobia)	14 (70%)	19 (41%)	4.59*
Dislike of reading/writing under fluorescent lighting	17 (85%)	13 (28%)	18.10*
Difficulty maintaining train of thought during conversation	16 (80%)	18 (39%)	9.32*

Note. The table shows that the CFS group reported significantly increased frequencies of all nine symptoms of VS surveyed.
  *$p < .05$; CFS = Chronic fatigue syndrome.

Table 2   Presence of VS symptoms in the CFS and VS groups: (no. of subjects; % of group; significance of variation).

Symptom	CFS group (n = 20)	VS group (n = 14)	χ^2
Slow reading	10 (50%)	11 (79%)	2.85
Strain & fatigue with extended reading	17 (85%)	13 (93%)	0.49
Print distortions, esp. with black print on white paper	8 (40%)	12 (86%)	7.11*
Preference for reading text printed on coloured paper	6 (30%)	11 (79%)	7.77*
Lack of depth perception or difficulty in judging distances	11 (55%)	9 (64%)	0.29
A feeling of clumsiness when negotiating uneven terrain	13 (65%)	6 (43%)	1.64
Dislike of bright light or glare (photophobia)	14 (70%)	9 (64%)	0.12
Dislike of reading/writing under fluorescent lighting	17 (85%)	11 (79%)	0.23
Difficulty maintaining train of thought during conversation	16 (80%)	11 (79%)	0.01

Note. The table shows statistically significant between-group differences concerning only two of the nine VS symptoms.
  *$p < .05$; CFS = Chronic fatigue syndrome; VS = Visual stress.

group (frequencies ranging from 50 to 85%), than their corresponding incidences in the comparison group (frequencies ranging from 7 to 44%). All between-group differences in the occurrence of each symptom were statistically significant. With respect to the typical number of VS symptoms present in the CFS-diagnosed participants, 15 (75%) of the subjects in the CFS group reported having five or more of the nine symptoms of VS listed in the questionnaire. Interestingly, 13 (87%) of these 15 individuals also indicated that their VS symptoms were present well prior to the onset of their CFS symptoms.

Prevalence of visual stress symptoms in the chronic fatigue syndrome and visual stress groups

The presence of each symptom of VS in the CFS group was compared to its respective frequency in the group of participants expected to have such symptoms, namely, the VS-diagnosed group. Statistical analysis of the data revealed no significant differences between the CFS and VS groups concerning seven of the nine diagnostic symptoms of VS which were surveyed (Table 2). The two exceptions were the symptoms: *"Print distortions, especially with black print on white paper"* (p = 0.008) and *"Preference for*

reading text printed on coloured paper" (p = .005). In both instances, the VS group reported significantly higher frequencies of these symptoms than did the CFS group.

Discussion

The purpose of this study was to carry out a preliminary investigation of the extent to which symptoms of VS are present in individuals with CFS. It was further anticipated that if symptoms of VS were reported by subjects diagnosed with CFS, it would be likely that the VS symptoms were present prior to the onset of their CFS symptoms. The basis for this expectation was that VS is a congenital disorder which has been shown to have a high heritability index (Robinson et al., 1995), whereas CFS is a disorder that is more commonly reported in adults than in children and young adolescents. Consistent with this expectation, 18 (90%) of the CFS subjects (n = 20) indicated in the survey that the symptoms of VS they had acknowledged were either present since childhood, or first became present at the same time as the onset of their CFS symptoms.

Results from the present study showed that all nine VS symptoms surveyed were significantly more represented in

the CFS group than in the comparison group of healthy adults. The study also found that there were no significant differences between the CFS and VS groups in the frequencies of seven of the VS symptoms. The findings therefore indicated that the presence of symptoms of VS in subjects diagnosed with CFS is far greater than previously reported. A plausible explanation could be the existence of a common underlying factor (or factors) in both conditions.

The symptoms of VS that did vary significantly in presence between the CFS and VS groups were the symptoms of *'Print distortions, especially with black print on white paper'* and *'Preference for reading text printed on coloured paper'*. However, it is possible that this difference was due to awareness of the nature of VS by those who have been diagnosed with the condition. Firstly, almost all text is printed with black ink on white paper, and it is thus likely that most people seldom have the opportunity to notice if reading from non-white paper reduces print distortions and/or if coloured paper is preferable. Secondly, individuals with VS are routinely advised upon diagnosis that the use of coloured or even off-white paper when reading, in place of contemporary ultra-white paper, can greatly reduce the intensity of their symptoms (Irlen, 1994; Wilkins, Huang, & Cao, 2004). Thus, all individuals in the study's VS-diagnosed group were probably aware of the possible benefits of coloured paper for reading discomfort, and this could have potentially skewed the results of the comparisons between the CFS and VS groups relating to these two symptoms.

The fact remains, however, that the frequencies of seven of the nine diagnostic symptoms of VS surveyed in in the CFS group were remarkably similar to frequencies in the VS group. In considering this, and because the manifestations of CFS include a large neurological component which can affect sensory stimulation and VS is a neurological disorder affecting the visual system, it would seem reasonable to postulate that common physiological mechanisms may play a role in both conditions. It may even be possible that certain factors causing morbidity for one syndrome might predispose an affected individual to subsequent development of the other syndrome. Indeed, in an earlier study investigating biochemical anomalies in CFS, Robinson et al. (2001) reported that 38 (62%) of their CFS subjects (n = 61) were identified as having moderate to severe symptoms of VS, while in the general population VS is estimated to affect 5-12% of individuals. That study also found that anomalies in metabolite levels (particularly lipids) correlated strongly with the intensity of VS symptoms reported by the CFS subjects.

In the present CFS group (n = 20), 15 (75%) of the subjects reported experiencing five or more of the nine VS symptoms surveyed. The data relating to the histories of VS and CFS symptoms in this sub-group indicated that the onset of CFS is perhaps more likely to occur in individuals with a life-long history of VS symptoms. Of the above 15 individuals: 8 (53%) reported that their symptoms of VS were present since childhood and well before the onset of CFS; a further 5 (33%) subjects reported first experiencing VS symptoms at the same time as the onset of CFS; and only 2 (13%) subjects stated that the onset of CFS had clearly preceded their symptoms of VS. Thus, if future research were to identify common underlying factors in CFS and VS, then the symptom histories of the participants in this study suggest that in most cases of CFS-VS comorbidity the preceding condition would likely be VS.

It is recognized that limitations of the present study include the relatively small numbers of participants in the CFS and VS groups. Nevertheless, previous research has shown that even a small number of subjects can provide data of statistical significance. A comprehensive medical history of each participant would have provided additional information, and genetic predisposition (e.g., heritability) could have been more readily implied if a family history was available. Biochemical data from participants would also have provided useful information, for example, lipid profiles of HDL/LDL cholesterol, triacylglycerides and omega-3/6 fatty acids may have identified possible correlations of lipid metabolism and the syndromes under investigation. Assessments of the presence of CFS symptoms in the VS group could have clarified if an overlapping of the symptoms of both disorders exists, however, though one of the researchers in the present study was qualified to design a scientific survey of VS symptoms and to screen for VS morbidity, none of the researchers were certified to diagnose or evaluate CFS symptomology.

In summary, our preliminary findings indicated that nine recognised symptoms of VS were far more frequent in the CFS subjects than in the comparison group, and that each of these variations was statistically significant. In marked contrast, when the frequencies of VS symptoms in the CFS group were compared to those reported by the group of subjects diagnosed with VS, the variations between the groups in seven (78%) of the symptoms were not statistically significant. If future research should confirm that comorbidity between the VS and CFS disorders is exceptionally high, then the lifetime duration and higher prevalence of VS perhaps suggest that the underlying causes of that disorder might predispose certain individuals to the subsequent development of CFS. However, larger scale studies including comprehensive clinical data of participants are needed to determine if CFS symptoms may also occur in VS subjects and, if confirmed, to differentiate 'symptom overlap' from 'comorbidity' in these conditions. In addition, future research investigating whether children diagnosed with VS have an increased risk of developing CFS in adulthood is particularly warranted.

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