

Neuropsychological Assessment in Conversion Disorder



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SUMMARY

Objective: Conversion disorder is characterized by functional impairment in motor, sensory, or neurovegetative systems that cannot be explained by a general medical condition. Diagnostic systems emphasize the absence of an organic basis for the dysfunction observed in conversion disorder. Nevertheless, there is a growing body of data on the specific functional brain correlates of conversion symptoms, particularly those obtained via neuroimaging and neurophysiological assessment. The present study aimed to determine if there are differences in measures of cognitive functioning between patients with conversion disorder and healthy controls. The hypothesis of the study was that the patients with conversion disorder would have poorer neurocognitive performance than the controls.

Materials and Methods: The patient group included 43 patients diagnosed as conversion disorder and other psychiatric comorbidities according to DSM-IV-TR. Control group 1 included 44 patients diagnosed with similar psychiatric comorbidities, but not conversion disorder, and control group 2 included 43 healthy individuals. All participants completed a sociodemographic questionnaire and were administered the SCID-I and a neuropsychological test battery of 6 tests, including the Serial Digit Learning Test (SDLT), Auditory Verbal Learning Test (AVLT), Wechsler Memory Scale, Stroop Color Word Interference Test, Benton Judgment of Line Orientation Test (BJLOT), and Cancellation Test.

Results: The patient group had significantly poorer performance on the SDLT, AVLT, Stroop Color Word Interference Test, and BJLOT than both control groups.

Conclusion: The present findings highlight the differences between the groups in learning and memory, executive and visuospatial functions, and attention, which seemed to be specific to conversion disorder.

Keywords: Conversion disorder, neuropsychological tests, cognitive functions

INTRODUCTION

Conversion disorder (CD) is characterized by involuntary alteration in physical functioning instead of direct expression of a psychological conflict or need (Hollifield 2005). Generally, signs of a loss, decrease, or increase in functioning in locomotor, sensory, and neurovegetative systems are observed without a structural basis (Öztürk and Uluşahin 2008). CD is a somatoform disorder according to the revised fourth edition of the Turkish version of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR), which states that following an adequate workup the observed signs and deficits must not be related to a systemic medical condition; in other

words, they must not be of somatoform origin (American Psychiatry Association 2000). Nonetheless, some recent publications have suggested that there may be cerebral dysfunction in patients manifesting signs of CD (Kranick et al. 2011; Nicholson et al. 2011; Schoenfeld et al. 2011)

Initial functional imaging studies were sporadic case reports (Harvey et al. 2006), which were then followed by more large-scale studies (Voon et al. 2010; Werring et al. 2004; Vuilleumier et al. 2001; Yazıcı and Kostakoglu 1998). A study on CD patients with walking difficulties reported that 4 patients had regional decrease in blood flow in the left temporal lobe and 1 had regional decrease in blood flow in the

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left parietal lobe (Yazıcı and Kostakoglu 1998). Some studies have suggested that manifestations of CD might be indicative of functional differences due to suppression of somatosensory processes by limbic regions (Mails-Gagnon et al. 2003). A study based on functional brain imaging by Spence et al. (2000) reported that there was a decrease in the effectiveness of the left dorsolateral prefrontal cortex in CD patients that progressed with hemiparetic symptoms. Another study on CD patients with sensorimotor deficits reported that there was a decrease in regional blood flow in the thalamus, putamen, and caudate nucleus in the contralateral side of the symptomatic body side, and that there was recovery of cerebral blood flow after symptomatic improvement (Vuilleumier et al. 2001). It is thought that motor commands are mediated by the cingulate cortex with the aid of the orbitofrontal cortex (OFC). Activation of the cingulate cortex provides necessary motivation for the realization of an action (Winterer et al. 2002; Marshall et al. 1997; Tiihonen et al. 1995). According to some investigators, volition is intact, but there is a problem with initiation of the act. These studies support the notion that symptoms of conversion are related to neural feedback loops connecting volition, movement, and perception (Black et al. 2004).

Labate et al. (2011) suggested that motor and premotor regions in the right hemisphere and cerebellum play an important role in the development of psychogenic seizures (Labate et al. 2011). Voon et al. (2011) observed lower activity levels in the left supplementary motor region, but higher activity in the right amygdala, left anterior insula, and bilateral posterior cingulate than that in healthy individuals. In addition, they noted that the functional relationship between the left supplementary motor region and the bilateral prefrontal dorsolateral regions is minor (Voon et al. 2011).

The first neuropsychological studies on the symptoms of conversion focused on the importance of laterality, but consistent findings were not obtained. The data available to date reinforce the assumption that an increase in frontal and limbic activity triggered by emotional stress suppresses the basal ganglia-thalamocortical pathways, leading to inhibition of conscious sensorimotor processing (Harvey et al. 2006). Neuropsychological testing based on the Halstead-Reitan battery of tests showed that there was slight cognitive deterioration, attention deficits, and visuospatial alterations (Hollifield 2005), and that there was impairment in verbal communication, memory, and affect (Çevik 1999). In order to more effectively use functional imaging for the psychopathological analysis of CD a cognitive model of the information processing underlying the symptoms of CD is required.; however, the neural components of consciousness remain largely unknown, which complicates any proposed cognitive model related to components of unconsciousness.

Based on data suggesting that symptoms of conversion originate from certain cerebral regions, and functioning of the transmission pathways between these regions, we hypothesized that cognitive function and performance would be lower in patients with CD than in healthy individuals, and that cognitive functioning in patients with psychiatric diseases other than CD would differ from those in patients with CD. In particular, that attention, learning, memory, executive functions, and visuospatial perceptual performance would be lower in those with CD. The aim of the present study was to investigate cognitive functioning in patients diagnosed as CD, and in those with psychiatric disorders other than CD (control group 1) and in healthy controls with no psychiatric illness (control group 2).

MATERIALS and METHODS

The study included consecutive patients and healthy volunteers that were referred to Gaziosmanpaşa University, School of Medicine, Psychiatry Outpatient Clinic between August 2010 and January 2011. The CD group consisted of 43 treatment-naïve patients diagnosed as CD according to DSM-IV-TR. Comorbid diagnoses according to DSM-IV-TR were also evaluated in the CD group. Control group 1 included 44 sociodemographically-matched patients with psychiatric illnesses other than CD. Control group 2 included 43 sociodemographically-matched healthy volunteers. Interviews with the 3 study groups were carried out by the first investigator, a certified neuropsychological test administrator. Patients with physical disease or cognitive deficits preventing completion of an interview or questionnaire were excluded from the study. All participants provided written informed consent, and then completed the questionnaires and scales. The study protocol was approved by the Gaziosmanpaşa University Committee for The Evaluation of Scientific Investigations

Sociodemographic and medical information form

This form which was formulated by the investigators and contained items related to age, level of educational, gender, marital status, occupation, place and type of residence, family structure, social security status, duration and onset of disease, comorbidities, conversion subtype, familial and personal psychiatric history, and symptoms of conversion.

Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)

SCID-I is a structured clinical interview that was developed by First et al. (1997) and is published by the American Psychiatry Association. The scale is used for the establishment of major DSM-IV Axis I diagnoses (First et al. 1997). The

Turkish version was reported to be valid and reliable for use in Turkey (Özkürkçügil et al. 1999).

Neuropsychological test battery

The test battery was designed to evaluate numerous cognitive functions. In the present study assessment consisted of 6 tests focused on learning and memory, executive functions, perceived visual position, and attention. These tests have been used extensively in previous investigations. The neuropsychological tests used and the functions evaluated are listed below.

I. Learning and Memory

1. Serial Digit Learning Test (SDLT)

SDLT consists of 2 separate sets of tests that each includes a mixed series of digits ranging from 1 to 9. Which of the 2 tests is administered is based on age and level of education. The digits are read in succession, and then examinees are requested to remember and repeat the number set verbally in the correct order. This procedure is repeated a maximum of 12 times. When an examinee recalls the digit series correctly twice the test is terminated. Assessments were based on the number of attempts to achievement correct recall twice and total score. This test was developed by Zangwill (1943) (Benton et al. 1998), and was reported to be valid and reliable for use in Turkey (Karakaş 2006).

2. Auditory Verbal Learning Test (AVLT)

AVLT is used to evaluate auditory verbal learning and memory abilities. The test is based on a list of 15 unrelated words. Examinees are requested to repeat each word they can recall. This test is administered a maximum of 10 times. When an examinee recalls all 15 words correctly the test is terminated. Then, 40 min after termination of the test examinees are again requested to repeat as many words as they can recall. Evaluation is based on immediate memory score, complete learning score (number of trials for complete recall), total learning score (sum of the words recalled during each trial), peak learning score (maximum number of words recalled), and long-term memory score. This test battery was developed by Rey (1964), and was reported to be valid and reliable for use in the Turkish population (Öktem 1992).

3. Wechsler Memory Scale (WMS)

The WMS includes subtests related to general information, mental control, logical memory, and backward and forward digit repetition. The present study did not use the figural memory or associative verbal learning subtests. The test plays an important role in the evaluation of short-term memory and instant attention. The WMS was developed by Wechsler (1945) (Lezak 1995; Uluğ and Özgüzel 1985).

II. Executive Functions

Stroop Color Word Interference Test (ST)

The Stroop Color Word Interference Test (ST) is used to evaluate attention, mental control, and the ability to flexibly exhibit reactive responses or resistance to interference from outside stimuli. The test consists of 4 white cards, each of which has a random list of 6 lines that contain 4 items. The first card is white and includes the names of colors printed in black text. The second card includes the names of the colors printed in colored text that does not correspond to the name of the color; for example the word red is printed in yellow. This card is the basic stimulus and the critical component of the test. The third card contains circles 0.4 cm in diameter that are printed in different colors. The fourth card contains neutral words (as much as, weak, if, middle) that are printed in different colors. ST test cards contain stimulant items and particular reactions are expected and required from the examinees. Another part of the ST requires examinees to identify and name colors; it is a critical phase of the test during which interference becomes manifest. Other parts of the test include control phases in which basic levels of reading and naming colors are determined. Error score, adjustment score, and time to completion of the tests were determined. The ST was developed by Stroop (Stroop 1935) and was reported to be valid and reliable for use in Turkey (Karakaş 2006).

III. Visuospatial Perception

Benton Judgment of Line Orientation Test

This test is widely used for the evaluation of disorders of visuospatial judgment and orientation. On the upper part of a test booklet page are 2 lines in diverse position and orientation pointing to different directions, and at the bottom are 11 lines on a 180° horizontal plane separated equidistance by 18° angles. Examinees are requested to identify 2 lines on the bottom of the page that are in the same position, direction, and orientation as the 2 lines at the top of the page; the total score of correct responses is recorded. The test was developed by Benton et al. (Benton et al. 1978), and was reported to be valid and reliable for use in Turkey (Karakaş 2006).

IV. Attention

Cancellation Test

This test is widely used to evaluate visuospatial neglect. An A4 sheet of paper contains 4 quadrants that each contains a target stimulus and scattered random stimuli. Examinees are requested to mark the target stimulus (i.e. the letter A or a circle intersected by a line) with a pen. Target stimuli that are marked correctly on the left and right side of the paper are counted to calculate the score. The test was developed by

Table 1. Sociodemographic characteristics of the CD and control groups.

		CD	Control 1	Control 2
Age (years)		31.09 ± 11.65	31.86 ± 10.78	36.02 ± 11.29
Level of education (years)		8.35 ± 3.80	9.61 ± 3.48	9.35 ± 4.38
		n (%)	n (%)	n (%)
Gender	female: n (%)	37 (86.0)	35 (79.5)	36 (83.7)
	Male: n (%)	6 (14.0)	9 (20.5)	7 (16.3)

Mesulam (Mesulam 2000), and was reported to be valid and reliable for use in Turkey (Karakaş 2006).

Statistical analysis

One-way ANOVA was used to compare the study parameters, following the Levene homogeneity of variance test. The Kruskal-Wallis variance test was used for parameters with non-normal distribution and a P value <0.05. In cases of significant intergroup differences based on ANOVA, groups were compared in pairs using post hoc Tukey's HSD test. The Mann-Whitney U test with Bonferroni correction was used if there were significant intergroup differences in parameters used for Kruskal-Wallis variance analysis. The chi-square (χ^2) test was used to compare categorical variables.

RESULTS

1. Sociodemographic characteristics

The CD group consisted of 37 females and 6 males with a mean age of 31.09 ± 11.65 years. Control group 1 included 44 patients (35 female and 9 male; mean age: 31.86 ± 10.78 years) with psychiatric diagnoses other than CD that had similar sociodemographic characteristics and comorbidities as those in the CD group. Control group 2 consisted of 43 healthy individuals (36 female and 7 male; mean age: 36.02 ± 11.29 years) with similar sociodemographic characteristics, but without any psychiatric disorder. There wasn't significant intergroup difference in age or gender ($F = 2.397$ and $P = 0.095$, and $\chi^2 = 0.673$ and $P = 0.714$, respectively).

Mean level of education in the CD group, control group 1, and control group 2 was 8.35 ± 3.80 years, 9.61 ± 3.48 years, and 9.35 ± 4.38 years, respectively; the difference between groups was not significant ($F = 1.265$, $P = 0.286$). Sociodemographic characteristics of the 3 groups are shown in Table 1.

2. Clinical characteristics

In the CD group mean duration of disease was 79.70 ± 93.29 months and mean age at disease onset was 24.40 ± 8.96 years. In control group 1 the mean duration of disease was 25.59 ± 38.01 months and the mean age at disease onset was 29.84 ± 10.60 years. In the CD group 40 (93%) patients had a

psychiatric comorbidity and 3 (7%) did not. Comorbidities in the CD group were as follows: major depressive disorder: $n = 15$ (37.5%); major depressive disorder plus generalized anxiety disorder (GAD): $n = 25$ (62.5%). In control group 1 major depressive disorder ($n = 19$; 43.2%) and major depressive disorder plus GAD ($n = 25$; 56.8%) were noted.

DSM-IV-TR groups manifestations of CD as motor, sensory symptoms, seizures, convulsions, and mixed types. Among the subtypes in the CD group, subtype with mixed manifestations was most common ($n = 37$; 86%), followed by subtype with or without motor symptoms ($n = 3$; 7%), subtype with seizures or convulsions ($n = 2$; 4.7%), and subtype with or without sensory manifestations ($n = 1$; 2.3%). In the CD group personal ($n = 22$; 51.2 %) and familial history ($n = 26$; 60.5 %) of a psychiatric disorder or conversion ($n = 20$; 46.5 %) were observed. Clinical features of the CD group are shown in Table 2.

3. Neuropsychological Evaluation

3.1. Serial Digit Learning Test (SDLT)

A significant difference was observed between the CD group and both control groups in terms of SDLT scores, but not between the 2 control groups. A significant intergroup

Table 2. Clinical characteristics of the CD group

Duration of the disease (years)		79.70 ± 93.29
Age at disease onset (years)		24.40 ± 8.96
		n (%)
Distribution of comorbidities	major depressive disorder	15 (37.5)
	major depressive disorder plus generalized anxiety disorder	25 (62.5)
Subtypes of conversion	mixed	37 (86)
	motor	3 (7)
	convulsive	2 (4.7)
	sensory	1 (2.3)
Psychiatric history	yes	22 (51.2)
	no	21 (48.8)
Family psychiatric history	yes	26 (60.5)
	no	17 (39.5)
Family conversion history	yes	20 (46.5)
	no	23 (53.5)

difference was noted in SDLT complete learning; in the CD group, control group 1, and control group 2, respectively, 20 (46.5%) participants, 5 (11.4%) participants, and 7 (16.3%) participants could not learn the digit series, whereas, respectively, 23 (53.5%), 39 (88.6%), and 36 (83.7%) participants were able to learn the digit series.

3.2. Auditory Verbal Learning Test (AVLT)

There were significant differences in AVLT maximal learning, delayed memory, total, and complete learning scores. A significant difference was observed between the CD group and both control groups in maximal learning, delayed memory, and total learning, but not between the 2 control groups. A significant intergroup difference in total learning was observed: 34 participants in the CD group (79.1%), 15 (34.1%) in control group 1, and 12 (27.9%) in control group 2 were unable to learn the word list, versus, respectively, 9 (20.9%), 29 (65.9%), and 31 (72.1%) that were able to learn the word list.

3.3. Wechsler Memory Scale (WMS)

WMS general information, orientation, mental control, and logical memory scores differed significantly. In terms of WMS general information, there wasn't a significant difference between the CD group and control group 1, whereas there was a significant difference between the CD group and control group 2, and between the 2 control groups. A significant difference was observed in orientation, mental control, and logical memory between the CD group and both control groups, but there wasn't a difference between the control groups. There weren't any significant intergroup differences in attention, or forward and backward digit repetition.

3.4. Stroop Test (ST)

A significant difference in ST phase 1-5 scores was observed between the CD group and both control groups, but not between the 2 control groups.

3.5. Benton Judgment of Line Orientation Test (BJLOT)

There was a significant difference in BJLOT scores between the CD group and control group 2, but not between the 2 control groups.

3.6. Cancellation Test (CT)

Significant differences in the time to complete the CT tests for structured and random letters and shapes, and the random shapes error scores were observed between the CD group and both control groups, but not between the 2 control groups. Time to complete the tests for structured and random shapes and letters differed significantly between the CD group and control group 1, but not between the CD group and control group 2 or between the 2 control groups. A significant difference in total error scores for random shapes was observed

between the CD group and control group 2, but not between the CD group and control group 1 or between the 2 control groups. Neuropsychological test results for the study groups are compared in Table 3.

DISCUSSION

Cognitive performance in the present study's CD group, as measured via neuropsychological testing, was significantly lower than in both control groups. The present findings highlight differences in learning and memory, executive functions, visuospatial perception, and attention that are specific to conversion. Most studies that have investigated the organic basis of CD are based on functional cerebral imaging. To the best of our knowledge the present study is the first to investigate CD via neuropsychological testing.

SDLT performance in the present study's CD group was significantly lower than that in both control groups, but did not differ between the 2 control groups. Only 54% of the CD group correctly learned the arrays of digits, versus, 89% and 84% in control groups 1 and 2, respectively. Drachman and Arbib (1966) reported that there was a significant degree of deterioration in SDLT performance in patients with hippocampal dysfunction. The hippocampus is responsible for the transfer of new information to long-term memory^{3/4}in other words^{3/4}for reinforcement of memory traces. SDLT is a test related to learning that is considered a measure of functioning in the temporal, hippocampal, (Lezak 1995), and prefrontal (Karakaş and Karakaş 2006) regions of the brain.

In the present study AVLT performance in the CD group was markedly low; as compared with both control groups the maximal number of words recalled, the number of words retained in memory 40 min after termination of the test, and the total number of words recalled during each trial were significantly lower in the CD group. In all, 79% of those in the CD group were unable to learn all the words, versus 34% and 28% in control groups 1 and 2, respectively. The number of words recalled after the first repetition of the word list did not differ between the 3 study groups. AVLT measures information-processing criteria related to verbal materials from many aspects, including verbal learning, immediate memory, backward interferential effect, free recall, and recognition memory. Poor AVLT performance is a reliable indicator of destructive changes in the left cerebral hemisphere (Spreen and Strauss 1991).

The present findings show that there was a marked decline in WMS orientation, mental control, and logical memory subtests in the CD group; however, there wasn't a difference in general information subtest performance between the CD group and control group 2. Since the same significant difference was observed between the healthy group, and the other

Table 3. Neuropsychological test results in the CD and control groups.

		CD	Control 1	Control 2						
					P1	Z	P2	Z	P3	Z
SDLT scores		9.10 ± 8.22	15.30 ± 6.54	14.56 ± 7.22	0.004	-2.913	<0.001	-3.518	0.689	-0.400
complete learning						x ²	p			
unable to learn:	n (%)	20 (46.5)	5 (11.4)	7 (16.3)	20.407		<0.001			
learners:	n (%)	23 (53.5)	39 (88.6)	36 (83.7)						
AVLT					P1	Z	P2	Z	P3	Z
maximal learning		12.84 ± 1.95	14.30 ± 1.25	14.14 ± 1.75	<0.001	-4.126	<0.001	-4.256	0.748	-0.322
delayed memory		10.51 ± 2.41	12.80 ± 1.66	12.77 ± 2.16	<0.001	-4.585	<0.001	-4.567	0.689	-0.400
total learning		101.98 ± 18.17	115.09 ± 15.76	117.07 ± 19.68	<0.001		0.002		0.864	
complete learning						x ²	p			
unable to learn:	n (%)	34 (79.1)	15 (34.1)	12 (27.9)	29.589		<0.001			
learners:	n (%)	9 (20.9)	29 (65.9)	31 (72.1)						
WMS					P1	Z	P2	Z	P3	Z
general information		5.81 ± 0.45	5.89 ± 0.39	6.00 ± 0.00	0.006	-2.743	0.327	-0.979	0.044	-2.012
orientation		4.77 ± 0.43	4.93 ± 0.25	4.98 ± 0.15	0.004	-2.889	0.033	-2.138	0.320	-0.995
mental control		6.63 ± 1.63	8.41 ± 1.04	8.58 ± 0.76	<0.001	-5.457	<0.001	-4.998	0.707	-0.376
logical memory		5.36 ± 3.03	7.20 ± 2.61	7.24 ± 2.18	0.003		0.004		0.997	
Stroop					P1	Z	P2	Z	P3	Z
Stroop-1 score		11.49 ± 3.43	8.68 ± 2.37	8.81 ± 1.96	<0.001	-4.233	<0.001	-4.746	0.481	-0.705
Stroop-3 score		15.19 ± 4.29	12.39 ± 2.24	12.87 ± 3.80	0.005	-2.777	0.001	-3.333	0.936	-0.076
Stroop-4 score		21.93 ± 7.88	18.03 ± 4.01	18.54 ± 6.31	0.039	-2.069	0.030	-2.165	0.815	-0.233
Stroop-5 score		32.41 ± 11.46	24.49 ± 5.71	27.16 ± 9.43	0.029	-2.185	0.001	-3.472	0.264	-1.116
Stroop-2 score		12.38 ± 3.67	9.76 ± 3.94	9.87 ± 3.02	0.004		0.002		0.988	
BJLOT					P1		P2		P3	
correct responss (n)		17.56 ± 4.74	20.32 ± 4.64	21.19 ± 4.28	0.001		0.015		0.649	
CT					P1	Z	P2	Z	P3	Z
Time to complete structured letter test (min)		128.23 ± 42.65	98.55 ± 21.93	106.91 ± 29.16	0.014	-2.466	<0.001	-3.898	0.238	-1.180
structured shape test (min)		106.14 ± 31.21	86.50 ± 16.31	93.65 ± 25.37	0.054	-1.931	0.001	-3.248	0.270	-1.104
random letters test (min)		121.60 ± 38.83	100.27 ± 16.10	107.35 ± 31.21	0.111	-1.594	0.013	-2.476	0.377	-0.883
random shapes test (min)		96.58 ± 31.81	79.86 ± 15.02	84.51 ± 25.62	0.080	-1.749	0.008	-2.662	0.650	-0.454
random shapes total no of errors scores		3.91 ± 3.29	3.16 ± 2.23	2.51 ± 2.19	0.039		0.380		0.483	

P1: CD group-control group 2; P2: CD group-control group 1; P3: Control group 1-control group 2.
P ≤ 0.05: Significant.

patient group and any difference could not be found between the conversion group, and the other patient group, we cannot assert that this deterioration is unique to the conversion. All WMS subtests were designed to measure storage and recall times of information presented visually or verbally. The test is important for the assessment of short-term memory and instant attentional functioning (Lezak 1995; Uluğ and Özgüzel 1985). In the present study there weren't any intergroup differences in WMS backward or forward digit recall, or measurement of attentional functioning. As these subtests evaluate both attentional functioning and immediate memory, these findings are consistent with the observed AVLT immediate memory subset results.

Studies that have investigated brain structures related to learning and memory using functional imaging have highlighted the role of hippocampal dysfunction in somatoform disorders (García-Campayo et al. 2009; Kwan et al. 2005). During cognitive stress patients with somatoform pain disorders exhibited an increase in activation in the temporal and prefrontal regions, and there was a decrease in temporal activation during emotional stress, without an increase in hippocampal volume despite these functional differences (Stoeter et al. 2007). A study that compared patients with somatoform disorder and healthy controls reported that semantic memory and verbal episodic memory performance in the patient group were lower (Al-Adawi et al. 2010; Niemi et al. 2002).

Recent imaging studies reported that functional differences were observed in the hippocampal, temporal, and prefrontal regions in patients with somatoform disorders (Bell et al. 2011; Koh et al. 2010; García-Campayo et al. 2009). The impairment observed in the present study's CD group based on 3 tests that measure learning and memory performance is consistent with previous reports. Koh et al. (2010) observed hyperperfusion in the left upper temporal gyrus and hypoperfusion in the right parahippocampal gyrus in patients with panic somatoform disorders, which differed from the observations in the healthy control group. As such, they suggested that these neural activities were common to both panic and somatoform disorder patients (Koh et al. 2010). In the present study WMS general information subtest performance in the CD group and control group 1 was lower than that in control group 2, which we think might be indicative of common neural activity in neurocognitive functions; in this respect the present study is similar to Koh et al.'s (2010).

In our test a distinct alteration was observed in the ST completion times in the conversion group. Control of attention and mental processes, shifting reaction mechanism, and a decline in the ability to resist against interferential effects are expected outcomes, which are different from healthy controls; however, the same significant difference was also observed in the first control group with depression, and anxiety, which suggests that this impairment might be specific to executive

dysfunction unique to the conversion. The ST measures the ability to suppress a habitual behavioral pattern and to exhibit an unusual behavior expressed as interferential effect. In essence, these functions are related to the brain's frontal lobe, and generally indicate impaired ability of behavioral programming (Spren and Strauss 1991).

Recently performed neurophysiologic and functional brain imaging studies reported data reinforcing the present findings. In patients with somatoform disorders marked impairment in executive functions was observed, as compared to healthy controls (Bell et al. 2011; Al-Adawi et al. 2010), and an association was observed between symptoms of dissociative disorders and hysteria, and increased activity in the prefrontal cortex (Bell et al. 2011). In the present study alterations in ST completion times in the CD group were not observed in control group 1; therefore, it can be concluded that executive functions in CD are affected in a way not observed in patients with depression or anxiety. Similarly, a study on patients with panic disorders, depression, and somatoform disorders reported differences between the groups' ST test findings (Lim and Kim 2005). The present findings are consistent with those of another study that observed a decrease in frontal and subcortical circuits related to motor control during hysterical paralysis (Vuilleumier 2005), which the researchers suggested were due to the presence of abnormal processing ability and information processing rates concerning heeded and unheeded stimuli.

In the present study BJLOT was used to measure visuospatial perception and showed that there was significant deterioration in the CD group. This test evaluates spatial perception, orientation disorders, and correct spatial positioning, and measures right hemisphere functions, particularly the right parietal area (Riccio and Hynd 1992). The CT also measures parietal lobe functions, visuospatial perception, and sustained attention. In the present study a significant alteration in CT screening times was observed in the CD group. Alterations in completion times of structured letter tests were particularly more prominent than other screening times (in arraying structured shapes, random letters, and shapes). A sensory component related to perceptual errors, a motor component related to screening and detection of stimuli, and a motivational component with emotional characteristics are thought to be involved in CT performance of (Mesulam 1985). In the present study's CD group disruptions in mental functions as visual screening strategies, stimulation, and inhibition of rapid reactions, and sustained attention might be conceivably associated with altered attention, slow down of a general reaction or one-sided spatial neglect.

A study that investigated the role of cognitive functions in somatization disorders reported that the patients' performance on visuospatial perception and attention tests was lower than that of the controls (Niemi et al. 2002). Another study

suggested that a potential mechanism of CD is impaired selective attention and stimulus processing (Gordon et al. 1986). Functional imaging studies indicate that there is an increase in activation in parietal regions during cognitive stress and a decrease during emotional stress in patients with somatoform pain disorders (Stoeter et al. 2007). Garcia-Campayo et al. (2009) reported that there was a decrease in parietal lobe volume and impaired memory coding in patients with dissociative disorder (Garcia-Campayo et al. 2009). Koh et al. (2010) observed the presence of hyperperfusion in the lower parietal lobe in patients with somatoform disorders (Koh et al. 2010). In summary, BJLOT and CT both measure visuospatial perception, which is generally sensitive to right cerebral hemisphere functions (Kurt and Karakaş 2000), and in the present study both tests indicated there were changes unique to CD.

Several studies have reported abnormalities based on neuropsychological testing in those with depression and anxiety disorders, whereas other studies have not. In the present study only WMS general information performance was lower in control group 1 (depression and anxiety disorders) than in control group 2 (healthy controls). In the present study diagnosis of and the severity of psychiatric disorders in all participants were determined based on SCID-I interviews, and the severity of depression in those experiencing depressive episodes was considered to be moderate.

The present study has some limitations. First, it was not a follow-up trial, but a cross-sectional study. Structured interview scales were used in all 3 study groups, and the CD group and control group 1 included only patients that were using medication. The sample size is such that it could be considered a limitation; however, when compared with similar studies with even smaller samples we think that our inclusion of 2 age-, gender-, and level of educational-matched control groups provides sufficient statistical power. An additional

control group with similar comorbidities was included in order to overcome any limitations attributed to the presence of the high rate of psychiatric comorbidities in the CD group. The number of patients in the CD group with mixed subtype precluded comparison between the conversion patients according to subtypes. Larger studies are needed in order to compare conversion subtypes. The lack of functional imaging studies of relevant cerebral regions restricts causal assessment of the obtained data. Additional investigation of these 2 areas in combination will provide additional information on the etiology of CD.

The present study's most important findings are the observations of impairment in neuropsychological functions specific to CD. SDLT and AVLT learning and memory, ST executive functions, and BJLOT performance were significantly lower in the CD group than in both control groups, but did not differ between the 2 control groups.

Conclusion and Suggestions

Previously, CD was explained based on psychodynamic mechanisms; however, signs of cerebral dysfunction have recently been reported. In the present study learning, memory, executive functions, visuospatial perception, and attention performance were all lower in the CD group. As such, the findings are in agreement those reported by functional imaging studies and provide new data on the type and mechanism of action of influential factors on cognitive functions. As our knowledge of the neurobiology of CD increases, CD can be evaluated within the context of cognitive processes. As such, discrepancies and labeling related to these frequently encountered psychiatric manifestations will decrease, enabling implementation of preventive measures against cognitive disorders recognized in their earlier stages of development.

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