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Munts, A.G.

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## How psychogenic is dystonia? Views from past to present

Alexander G. Munts, MD,<sup>1,2</sup> and Peter J. Koehler, MD, PhD, FAAN<sup>3</sup>

<sup>1</sup>Department of Neurology, Kennemer Gasthuis, Haarlem, The Netherlands

<sup>2</sup>Department of Neurology, Leiden University Medical Centre, Leiden, The Netherlands

<sup>3</sup>Department of Neurology, Atrium Medical Centre, Heerlen, The Netherlands

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## **Abstract**

In the last few centuries there has been a constant sway between organic and psychogenic explanations for dystonia. In the current study we investigate this history, assuming the perspective of a spectrum from organic to psychogenic, between which ideas were moving. We have focussed on (i) primary generalised dystonia; (ii) cervical dystonia; (iii) writer's cramp; and (iv) fixed dystonia related to complex regional pain syndrome. We have studied medical texts published since the 19<sup>th</sup> century and their references. Jean-Martin Charcot advocated the concept of hysteria: disorders in which, besides predisposition, environmental factors were involved in its pathogenesis. Sigmund Freud introduced psychoanalysis as an explanatory therapy for psychic disorders. Previous theories, together with the lack of an organic substrate for dystonia, made a strong case for psychogenic explanations. Consequently, many dystonia patients were told that they suffered from psychological conflicts and were treated for them. However, after the description of new hereditary cases in the 1950s, the limited efficacy of psychotherapy in torsion dystonia, the effects of surgical treatments and the lesion studies in the 1960s, more physicians became convinced of the organic nature. The culminating point was the discovery of the DYT1 gene in 1997. In the meantime, experts had already convinced the neurological community that cervical dystonia and writer's cramp were focal dystonias, i.e. minor forms of generalised dystonia, and therefore organic disorders. In contrast, the pathophysiology of fixed dystonia related to complex regional pain syndrome remained controversial. Knowledge of this history, which played on the border between neurology and psychiatry, is instructive and reflects the difficulty in discriminating between them. Today, new insights from functional imaging and neurophysiological studies again challenge the interpretation of these disorders, while the border between psychogenic and organic has become more blurred. Abnormalities of sensorimotor integration and cortical excitability that are currently supposed to be the underlying cause of dystonia bring us back to Sherringtonian physiology. We suggest that this may lead to a common explanation of the four afflictions of which we have traced the history.

## Introduction

For many years, physicians have observed and discussed the remarkable signs of what we nowadays call dystonia. The introduction of the term dystonia as an abnormality of tone with coexistent hypo- and hypertonia goes back to 1911 when the well-known Berlin neurologist Hermann Oppenheim (1858-1919) introduced *dystonia musculorum deformans*, which was later renamed early-onset generalised torsion dystonia.<sup>1</sup> In 1967, Wolfgang Zeman (1921-2001) and Paul Dyken reported the presence of milder forms of dystonia in dystonia musculorum deformans families, including cases of isolated writer's cramp.<sup>2</sup> In 1976, David Marsden (1938-1998) proposed the term focal dystonia for blepharospasm, oromandibular dystonia, dystonic writer's cramp, and torticollis, as well as for axial dystonias, arguing that these were closely related to generalised dystonia.<sup>3</sup> Up to the present, this view has not changed. Over the years, however, there has been a discussion on whether the aetiology of dystonia is either organic or psychogenic. In this paper we study the evolution of ideas with respect to dystonia, in particular whether or not it was considered an organic or psychogenic affliction. We will put the historical evolution against the background of present-day knowledge resulting from functional imaging and neurophysiological studies, and of the blurred border between organic and psychogenic.

## Methods

We started our search on dystonia history using two standard books on the history of medicine.<sup>4,5</sup> Furthermore, we used the PubMed database by entering the term 'dystonia' with limitation to 'history of medicine'. In addition, we used medical and neurological textbooks from the 19<sup>th</sup> and 20<sup>th</sup> century written in English, French, German, or Dutch.<sup>6-16</sup> In the tables of contents and subject indexes we searched for dystonia, spasm(s), spasmodic contortion or contraction, torticollis, wryneck, (writer's) cramp, scrivener's palsy, occupational neurosis (English); dystonie, torticollis (mental), spasme clonique (du sterno-mastoïdien), spasme fonctionel (du sterno-mastoïdien), crampe fonctionelle, crampes des écrivains (French); Dystonie, Torticollis, Schreib(e)krampf, Funktionskrämpfe, Beschäftigungsneurose (German); dystonie, torticollis, (ver)kramp(ing), and schrijverskramp (Dutch). In addition, we searched for relevant literature in the reference lists of consulted books and papers. As many nineteenth- and early twentieth-century primary textbooks refer to the work of Duchenne and Bell, we chose to discuss their descriptions

in more detail. When dealing with the question whether a particular author considered a disorder psychogenic or organic, we assumed a spectrum from organic to psychogenic between which ideas of the individual authors could be placed, as far as could be derived from the text.

#### *Definition of dystonia*

The word *dystonia* was introduced in 1911.<sup>1</sup> Later its meaning was changed several times. For example, Derek Denny-Brown (1901-1981) considered dystonia a disorder with a fixed posture or oscillation between two or more fixed postures (Denny-Brown, 1965; Denny-Brown, 1966). The modern definition is "a syndrome of sustained muscle contractions, frequently causing twisting and repetitive movements, or abnormal postures".<sup>17</sup> In this article, we use the latter definition.

#### *Definitions of neurosis and hysteria*

In the late 18<sup>th</sup> and early 19<sup>th</sup> century, neurosis was defined as the category of clinically well-characterised nervous diseases without known pathological substrates.<sup>18,19</sup> Throughout the 19<sup>th</sup> century, this category became smaller when neuropathological substrates of several of these diseases were established.<sup>20</sup> Hysteria was a subcategory within the neuroses, in which neurological signs were similar to those in patients who suffered from nervous diseases with known anatomic lesions, although somewhat different and usually more extensive. In the late 19<sup>th</sup> century, Charcot assumed that hysteria arose from a lesion of an undetermined structural or functional nature and he expected that the pathological basis would be found in due course. The neurological defect was believed to result from a combination of hereditary predisposition and an environmental, provocative factor, which usually was a physical or emotional shock.<sup>21</sup> Therefore, throughout history the term psychogenic cannot always be considered equal to non-organic, in particular in the pre-Freudian period. After this period non-organic mostly did mean psychogenic. The meanings of neurosis and hysteria changed and finally the terms were used solely in descriptions of psychiatric diseases. At present, the terms are used less often, and no longer listed in the Diagnostic and Statistical Manual of Mental Disorders.<sup>22</sup> In this article, where needed, we clarify the context of these words.

## Results

### *Primary generalised dystonia*

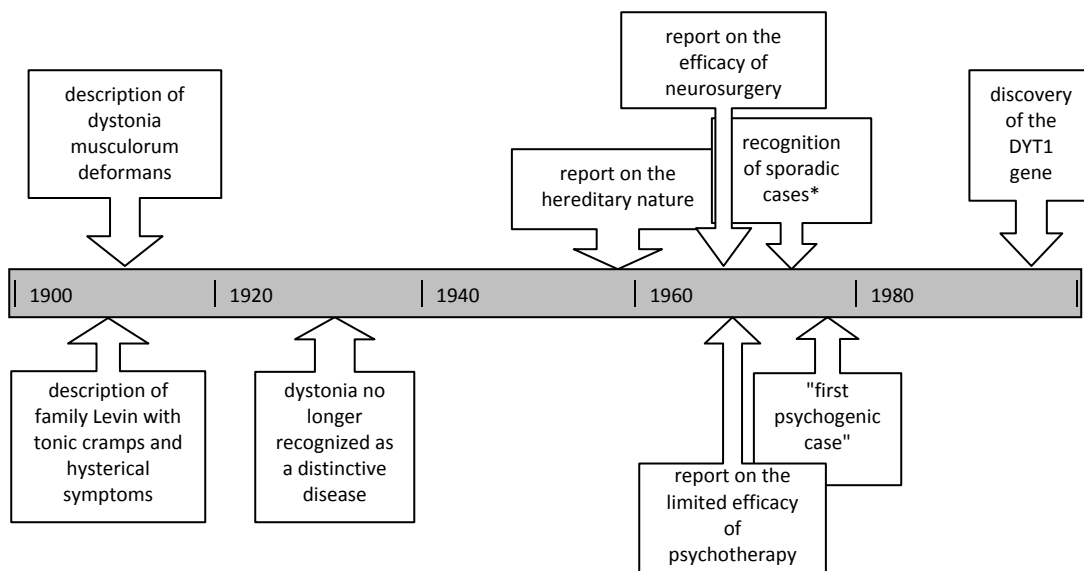
In 1871 William Hammond (1828-1900) reported on three patients "in which the most characteristic symptoms are an inability to retain the fingers and toes in any position in which they may be placed, and their continual motion".<sup>23</sup> He mentioned the acquired disorder 'athetosis' and hypothesised on a striatal lesion. Hammond's patients may not be considered dystonic patients – although today most authors consider athetosis part of the dystonia spectrum<sup>24</sup> but it is important to mention Hammond's coining of the term athetosis. In 1897, the Spanish physician Lluís Barraquer i Roviralta (1855-1928) reported another patient with athetosis, which later was considered the first description of generalised torsion dystonia.<sup>25,26</sup> In 1908, the German Marcus Walter Schwalbe (1883-1927) described hysterical symptoms in the siblings Fanny, Heimann, and Wulf Levin, suffering from tonic cramps, which is now recognised as early-onset generalised torsion dystonia (Figure 2.1).<sup>27,28</sup> Among the most important hysterical characteristics there was the presence of pressure points (called 'hystero-genic zones' in Charcot's work<sup>21</sup>), i.e. body areas in which cramps may be provoked by pressure.

Familial involvement was another feature. In 1911 Oppenheim launched the term *dystonia musculorum deformans* for the same disorder.<sup>1</sup> He reported on four patients, who were Jewish children. Illustrative is the description of a 14-year old girl with a 'dromedary gait' "indem der sätelförmige ausgebuchtete Rücken in eine fast horizontale Lage kommt, und zwar fällt die Rumpfbeugung zusammen mit dem Aufsetzen des linken Beins, während der Rumpf sich hebt beim Schwingen des linken Beins" [because the saddle-shaped back acquires an almost horizontal position, in which the left leg posture phase is accompanied by trunk flexion, and the swing phase by trunk elevation]. He was convinced that it was an organic disease without concomitant hysteria.

Subsequently, *dystonia musculorum deformans* became a collective term for a variety of neurologic disorders.<sup>29</sup> There was a continuing discussion on the characteristics of the disorder, and a pathological substrate was still unknown. For these reasons, the concept of dystonia as a disease was demolished during the tenth Réunion Neurologique Internationale Annuelle in Paris (1929). Subsequently, the Danish physician Auguste Wimmer (1872-1937) concluded that dystonia was no more than a syndrome.<sup>30</sup> In the meantime, a psychogenic explanation had emerged for various nervous disorders without anatomic lesions. One of the founders of psychogenesis was Sigmund Freud (1856-1939). From 1888 to 1910 he described several patients who suffered from hysteria and in whom

symptoms were related to conflicts and psychological defence.<sup>31</sup> The effectiveness of psychological intervention supported this new and revolutionary theory. Exploring and resetting the unconscious mind, by means of 'psychoanalysis', became a successful therapy in many cases of hysteria. Since then, many patients with generalised dystonia underwent this or other forms of psychotherapy.

In 1944, Ernst Herz (1900-1965) published three frequently cited articles on his studies of dystonia cases. He considered dystonia a "clinical entity" with "characteristic irregular, involuntary motor phenomena", "a peculiar distribution of 'excess of motion' and 'excess of tension'", and "without recognizable etiologic factors at onset".<sup>32-34</sup> In 1959 the hereditary nature of dystonia musculorum deformans was demonstrated<sup>35</sup> and ten years later a report was published on the limited efficacy of psychotherapy in 44 patients with torsion dystonia.<sup>36</sup> In the same year, Irving Cooper (1922-1985) reported on a 77% success rate after unilateral or bilateral surgery of the thalamus or globus pallidus in 144 dystonia musculorum deformans patients.<sup>37</sup> In the 1960s Denny-Brown reported his landmark studies on dystonia. He caused selective lesions in monkey brains which led to uncontrollable abnormal postures and movements resembling dystonia. It was remarkable



**Figure 2.1.** Developments on generalised dystonia in the 20<sup>th</sup> century. See the text for references.

\*Not for the first time but more convincing than ever before.

to observe that damage in different anatomical structures might have the same consequences. Denny-Brown assumed that dystonia resulted from an imbalance of reflex responses in the central nervous system.<sup>38-40</sup> In 1975, an International Symposium on Dystonia was organised. In the preface of the conference book, Eldridge and Fahn wrote:

In the past, many victims of dystonia and their families have been caused anguish and hardship over and above that caused by the disease itself owing to the frequent misdiagnosis of the symptoms as manifestations of a psychiatric ailment. We hope that the present volume will facilitate accurate diagnosis, assist practicing physicians in treating their dystonic patients, encourage them to report their observations and results, and stimulate clinical and basic research workers in efforts to elucidate the causes and eventual treatment of dystonia and related disorders.<sup>41</sup>

At this symposium, Marsden emphasised the existence of sporadic torsion dystonia.<sup>42</sup> Fahn and Eldridge stated that psychologically based dystonia was a rare or non-existent condition.<sup>43</sup> However, three years after the symposium (1978), the "first case of psychogenic dystonia" was reported<sup>44</sup> and in 1983, at the 35<sup>th</sup> annual meeting of the American Academy of Neurology, another five followed.<sup>45</sup> The first patient was a 15-year-old girl who had simulated her dystonic symptoms and signs. She was admitted after a failed suicide attempt and told that she had faked her symptoms: "she discarded her leg brace, and the sustained contractions in her leg and arm immediately improved". The histories of the other five patients were not included in the publication.

In 1984, an *ad hoc* committee, consisting of members of the Scientific Advisory Board of the Dystonia Medical Research Foundation, re-defined dystonia as "a syndrome of sustained muscle contractions, frequently causing twisting and repetitive movements, or abnormal postures".<sup>17</sup> Four years later a classification for psychogenic dystonia followed (Table 2.1).<sup>46</sup> The first locus (9q32-34 region) for idiopathic dystonia (DYT1) was found in 1989<sup>47</sup> and ten years later the same group identified the gene, describing a unique 3-base pair deletion in the coding region, which was responsible for almost all their cases with early-onset, but for only a few with late-onset idiopathic torsion dystonia.<sup>48</sup>



**Table 2.1.** Definitions on the degree of certainty of the diagnosis of a psychogenic dystonia<sup>46</sup>

Documented	Persistent relief by psychotherapy, by the clinician utilizing psychological suggestion including physiotherapy, or by administration of placebos (again with suggestion being a part of this approach), or the patient must be witnessed as being free of symptoms when left alone supposedly unobserved
Clinically established	The dystonia is inconsistent over time or is incongruent with classical dystonia, plus at least one of the following features: <ul style="list-style-type: none"> <li>- other neurologic signs are present that are definitely psychogenic, e.g. false weakness, false sensory findings, and self-inflicted injuries</li> <li>- multiple somatizations are present</li> <li>- an obvious psychiatric disturbance is present</li> </ul>
Probable	<ul style="list-style-type: none"> <li>- The dystonia is inconsistent over time or is incongruent with classical dystonia, but there are no other features, or</li> <li>- The dystonia is consistent and congruent with organic dystonia, however at least one of the following features is present: <ul style="list-style-type: none"> <li>- other neurologic signs are present that are definitely psychogenic, e.g. false weakness, false sensory findings, and self-inflicted injuries</li> <li>- multiple somatizations are present</li> </ul> </li> </ul>
Possible	The dystonia is consistent and congruent with organic dystonia, however, an obvious emotional disturbance is present

*Cervical dystonia (Table 2.2)*

One of the earliest descriptions of cervical dystonia was given by the Swiss physician Felix Platerus, also known as Plater (1536-1614).<sup>49,50</sup> He described a case of 'spasmi species, in qua caput in sinistrum latus torquebatur' [a kind of spasm in which the head was turned to the left side]. The Dutch Nicolaas Tulp, or Tulpius (1593-1674), well-known from the famous Rembrandt painting *The Anatomy Lesson* of 1632, described dissection of the sternocleidomastoid muscle as a therapy for what he called 'obstipi capitis' [crooked head] in his *Observationes medicae*.<sup>51,52</sup> However, this patient had had torticollis from childhood and the origin was probably mechanical.

**Table 2.2 (continued on next pages).** Historical descriptions on cervical dystonia

Year	Author	City	Terminology	O/P	Comments
1614	Plater <sup>49,50</sup>	Basel (CH)	spasmi species, in qua caput in sinistrum latus torquebatur	O	case report; explained as a disorder of the muscle and surrounding tissue
1641	Tulp <sup>51,52</sup>	Amsterdam (NL)	obstipi capitis	O	probably mechanic origin; dissected the involved muscle
1765	Lorry <sup>50,53</sup>	Paris (FR)	colli singularem omninò distortionem	P	case report in a monography on melancholia; explained as due to boredom and therefore aversion to life
1768	Boissier de Sauvages <sup>54,55</sup>	Montpellier (FR)	obstipitas spasmodica	O	classified as partial tonic spasms, together with strabismus, tics, contractures, ankylosis, cramps and priapism
1822	Dupuytren <sup>56</sup>	Paris (FR)	torticolis, caput obstipum	O	divided the sternocleidomastoid muscle
1825	Middlesex Hospital <sup>57</sup>	London (UK)	spasmodic affection of the muscles of the neck	U	case report
1825	Gilby <sup>58</sup>	Bristol (UK)	contraction of the muscles of the neck	O?	efficaciously used electricity in the corresponding contralateral muscles
1838	Stromeyer <sup>59</sup>	Hannover (DE)	Krampf des Kopfnickers	O	dissected the involved muscle(s)
1844	Bell <sup>60</sup>	Edinburgh (UK)	spasmodic contortion of the head and neck	O	suspected a diseased nerve
1846	Romberg <sup>61</sup>	Berlin (DE)	Halsmuskelkrampf	U	in most cases unknown cause, sometimes due to physical strain; described that some think that it may be

1861	Duchenne <sup>62</sup>	Paris (FR)	spasme du sternomastoïdien	O	due to intense emotions may be cured by continuous stretch to the antagonists by means of an apparatus; no success with electricity
1867	Middlesex Hospital <sup>63</sup>	London (UK)	spasmodic contraction of cervical muscles	O?	case report; spinal accessory nerve was dissected, although without efficacy
1872	Jaccoud <sup>64</sup>	Paris (FR)	hyperkinésie de l'accessoire de Willis	O	clonic form: rare, unknown cause; tonic form: either congenital, vertebral disorder or due to pressure on sensible nerve (reflex cramp)
1873	Charing Cross Hospital <sup>65</sup>	London (UK)	clonic torticollis	O	case report; improvement by electricity together with rhythmical exercise
1888	Charcot <sup>66</sup>	Paris (FR)	spasme clonique du sterno-mastoïdien et du trapèze	O ≈ P	case report; improvement with electricity to the atrophied contralateral muscle
1888	Gowers <sup>10</sup>	London (UK)	spasmodic wry-neck	O + P	'not-organic' variant (= hysterical = partly moral, partly physical) tends to spread from the neck to the trunk
1889	Freud <sup>67</sup>	Vienna (AT)	Genickkrämpfe	O	case report (Frau Emmy v. N...); hysteria patient who underwent hypnosis; Genickkrämpfe were not considered hysterical
1890	Keen <sup>68,69</sup>	Philadelphia (US)	spasmodic wry neck	U	divided the dorsal rami of the C1-C3 spinal nerves in a patient in whom

1893	Brissaud <sup>70</sup>	Paris (FR)	torticolis mental	P	spinal accessory nerve division was unsuccessful; some improvement believed that torticolis was a tic (P), not a spasm (O); the touch that was able to correct proved the psychic nature
1894	Voisin <sup>71</sup>	Paris (FR)	torticolis intermittent	P	case report; cured with suggestion during hypnosis
1894	Oppenheim <sup>13</sup>	Berlin (DE)	Krämpfe im Bereich der Halsmuskeln	O ≈ P	hereditary or congenital instability of kinetic centres in the cerebral cortex
1896	de Quervain <sup>72</sup>	La-Chaux-de-Fonds (CH)	torticolis spasmodique	O?	efficaciously dissected involved muscles and nerves (method from Kocher); treatment effect might be due to suggestion of a cortical center
1900	Babinski <sup>73</sup>	Paris (FR)	torticolis spasmodique	O	case report with extensor toe response
1902	Meige & Feindel <sup>74</sup>	Paris (FR)	torticolis mental	P	the 'geste antagoniste efficace' is characteristic; careful and prolonged observation is needed to distinguish it from 'torticolis-spasme' (O)
1905	Kollarits <sup>75,76</sup>	Budapest (HU)	torticollis mentalis	P	geste antagoniste was named "Brissauds Handgriff"
1907	Curschmann <sup>77</sup>	Mainz (DE)	spasmodischen torticollis	O	vestibular disorder; quinine was efficacious
1914	Mohr <sup>12</sup>	Koblenz (DE)	Torticollis mental	O < P	often in neuropathic patients; organic causes must be excluded (ocular, auricular; cervical spine, or brain)

1914	New York Neurological Society <sup>78</sup>	New York (US)	mental torticollis	P	disease) Clark reported on the efficacy of psychotherapy; was criticised by others
1923	Wartenberg <sup>79</sup>	Freiburg im Breisgau (DE)	Torticollis	O > P	
1923	Cushing <sup>80</sup>	Boston (US)	spasmodic torticollis	U	pathophysiological description on the influence of sensible input in extrapyramidal disorders (including the geste antagoniste) performed surgery with unilateral division of the spinal accessory nerve and ventral and dorsal 1 <sup>st</sup> to 3 <sup>rd</sup> roots, with success
1935	Yaskin <sup>81</sup>	Pennsylvania (US)	spasmodic torticollis	O < P	psychotherapy before surgery distinguished: psychogenic; postencephalitic; associated with an extrapyramidal disease; and progressive spasm of doubtful nature
1938	Critchley <sup>82</sup> at the Annual Meeting of the British Medical Association	London (UK)	spasmodic torticollis	O or P	
1940	Kinnier Wilson <sup>11</sup>	London (UK)	torticollis	O or P	distinguished: neuralgic, occupational (P), spasmodic, paralytic, hysterical (P) and congenital torticollis and torticollis tic (P)
1943	Patterson and Little <sup>83</sup>	Ann Arbor (US)	spasmodic torticollis	O >> P	103 cases; promoted surgery
1945	Paterson <sup>84</sup>	Edinburgh (UK)	spasmodic torticollis	O or P	21 cases; psychotherapy is the treatment of choice
1949	Herz and Glaser <sup>85</sup>	New York (US)	spasmodic torticollis	O	43 cases; though organic in nature, the clinical picture may be

1965	Denny-Brown <sup>38,39</sup>	Boston (US)	torticollis	O	influenced by psychogenic factors performed experiments in monkeys; described that torticollis arises from damage to the pretectal region, and is due to distortion of optokinetic reflexes
1967	Brierley <sup>86</sup>	Newcastle-upon-Tyne (UK)	spasmodic torticollis	O or P	efficaciously used behaviour therapy with conditioning through electric shocks
1971	Mitscherlich <sup>87</sup>	Düsseldorf (DE)	spasmodic torticollis	P	psychoanalytical treatments in 60 patients; >5,000 hours; severe ego-regression in all cases
1974	Brudny <i>et al.</i> <sup>88</sup>	New York (US)	torticollis	O?	improvement with sensory feedback therapy (13 cases); also improvement in spasticity patients
1976	Marsden <sup>3</sup>	London (UK)	torticollis	O	focal dystonia; suspected an abnormality in the extrapyramidal system
1985	Tsui <i>et al.</i> <sup>89</sup>	Vancouver (CA)	spasmodic torticollis	O	first report on the efficacy of botulinum toxin
1987	Rentrop and Straschill <sup>90</sup>	Berlin (DE)	spasmodic torticollis	O + P	stated that in some cases psychotherapy is indicated

O = organic; P = psychogenic; O > P = majority of cases is organic; O or P = cause is organic in some cases and psychogenic in other cases; O + P = cause is a combination of organic and psychogenic factors in every; U = unknown cause.

The well-known Scottish surgeon-anatomist Charles Bell (1774-1842) stated that the origin of 'spasmodic contortion of the head and neck' was nerve rather than muscle dysfunction.<sup>60</sup> One of his patients, Mary Preston, developed the disease following a hard and protracted labour. In Bell's view, a disorder of the accessory nerve but not other

nerves, due to strain, might lead to unbalanced muscle drive and thus to the disease. Interestingly, the same case was also reported elsewhere,<sup>57</sup> but according to these authors, the disease was not limited to the distribution of the accessory nerve. Their disagreement with Bell was underlined by their commentary "We have frequently had occasion to notice the very ingenious manner in which Mr. Bell perverts facts, in order to meet his own particular views of a case". The French physician Guillaume-Benjamin Duchenne (1806-1875), who applied electricity for a variety of disorders in Paris hospitals, reported that 'spasme fonctionnel du sterno-mastoïdien' is quite resistant to treatment.<sup>62</sup> Instead, he advised therapy by applying continuous stretch of the antagonists with the use of an instrument.

During one of his well-known Tuesday Lessons, on June 26, 1888, Charcot presented a 63-year old man with 'spasme clonique du sterno-mastoïdien et du trapèze' [clonic spasm of the sternocleidomastoid and the trapezius muscles], which had been present for eight months.<sup>66</sup> The disorder started after the patient, who was a stockbroker, had lost all his money. On July 10, 1888, he was presented again after being successfully treated with electricity. Five years later, one of Charcot's former students, Edouard Brissaud (1852-1909), introduced the term 'torticollis mental'.<sup>70</sup> In his view, the condition was psychogenic, which was evident from the fact that the patient was able to correct the powerful muscle activity by simply touching the head, later named the 'geste antagoniste efficace'.<sup>74</sup> Emphasizing the psychogenic nature again, the Hungarian Jenő Kollarits (1870-1940) reported on six 'torticollis hystericus' cases in 1905.<sup>75</sup> Therapeutic dissection of the involved muscles or nerves, as performed by the Swiss surgeon Fritz de Quervain (1868-1940),<sup>72</sup> was considered malpractice according to Kollarits, who, instead, stated that therapy should be based on suggestion.

In this period, there was much discussion on torticollis in the scientific community. At the New York Neurological Society (1914), Pierce Clark (1870-1933) presented an adult man with 'mental torticollis' which, he said, was the consequence of pleasurable stroking movements by his mother, before the age of six.<sup>78</sup> In reaction, Bernard Sachs (1858-1944) said, "if this indicated the future trend for our present-day neurology, then the less we hear of it, the better". The debate went on for several decades. In 1935 Joseph Yaskin (1891-1955) wrote that before surgery, every case of 'spasmodic torticollis' should receive a trial of psychotherapy.<sup>81</sup> In 1943 Patterson and Little reported on 103 cases with spasmodic torticollis,<sup>83</sup> stating that the aetiology was usually organic and that surgery, intradural rhizotomy in particular, was very satisfactory. However, in 1945 the Scottish

physician Paterson presented 21 cases, concluding that psychotherapy was the treatment of choice unless gross signs of neurological disease were present.<sup>84</sup>

At the 1975 International Symposium on Dystonia (*vide supra*), Marsden presented arguments that spasmodic torticollis, as well as blepharospasm, oromandibular dystonia and dystonic writer's cramp (*vide infra*), were focal dystonias with an organic aetiology. He summarised the reasons why they had been regarded psychogenic (Table 2.3),<sup>3</sup> and subsequently explained his ideas about functional abnormalities in the extrapyramidal motor system.<sup>3</sup> Obvious arguments were their occurrence in early-onset generalised torsion dystonia and the similarities with late-onset generalised torsion dystonia: both focal dystonia and late-onset generalised torsion dystonia had a comparable age of onset and were usually neither progressive nor hereditary. A new name was introduced in the 1980s: 'cervical dystonia'. In 1985 the Canadian Tsui reported for the first time the successful use of botulinum toxin injections in 12 patients,<sup>89</sup> which eventually became the standard treatment. During the past few decades hardly any reports on psychogenic cervical dystonia cases have been published.

**Table 2.3.** Seven reasons why focal dystonias were regarded as psychogenic<sup>3</sup>

1	The bizarre nature of the dyskinesias
2	Their appearance frequently only on certain actions, other motor acts employing the same muscles being carried out normally
3	Their relief by certain inexplicable trick actions
4	Their exquisite sensitivity to social and mental stress
5	The failure so far to find any anatomical, physiological, or biochemical abnormality in any of these conditions
6	The belief that such patients show overt psychiatric disturbance
7	A psychopathological interpretation of the significance of, for example, eye closure or neck turning

#### *Writer's cramp*

In 1713 the Italian physician Bernardino Ramazzini (1633-1714) recognised intense fatigue of the hand and arm, which resulted in failure of power, as an occupational disorder in professional writers.<sup>91</sup> In 1844 (published posthumously), Bell most probably described writer's cramp when he reported on an ambiguous condition in which writing had become impossible while the arm strength remained normal.<sup>60</sup> In 1861 Duchenne reported on 'crampe des écrivains' in which electricity was not a very successful therapy. However, he



advised an ingenious prosthesis.<sup>62</sup> He preferred the names 'spasme fonctionnel' and 'paralysie musculaire fonctionnelle' because the disorder was not restricted to cramps and could be provoked not only by writing but also by other manual actions.

En résumé, les faits et les considérations exposés précédemment démontrent, comme je l'ai dit au commencement de cette note, qu'il existe une maladie caractérisée par un spasme douloureux ou indolent (contracture, contractions clonique, tremblements), ou par une paralysie musculaire; que ces troubles se manifestent seulement pendant l'exercice de certains mouvements volontaires ou instinctifs; enfin, qu'ils peuvent siéger dans des régions fort diverses.<sup>62</sup> [In summary, the former findings and considerations show, as I described in the beginning of this report, that there is a disease which is characterised by painful or painless spasms (contracture, jerks, tremor) or paralysis in which the signs only occur during certain (in-)voluntary actions; the involved body parts are diverse.]

Similar to the situation in cervical dystonia, the debate on aetiology started in the early 20<sup>th</sup> century. In 1914 the German Fritz Mohr (1874-1957) summarised the two conflicting theories in Lewandowsky's *Handbuch der Neurologie*.<sup>12</sup> Writer's cramp was explained by some authors as a purely organic disorder, e.g. as a reflex cramp through motor nerves that was initiated by painful sensory input. The German physician Moritz Romberg (1795-1873) was mentioned as one of the early advocates (with reference to the 1853 edition of Romberg's *Lehrbuch der Nervenkrankheiten des Menschen*<sup>92</sup>). Others, including Mohr himself, believed that only people with certain personality characteristics were prone to develop the disorder, a psychological factor possibly being involved. From that view, accurate psychoanalysis would be the best therapy for patients with writer's cramp. Kinnier Wilson's (1878-1937) 1940 edition of *Neurology*, described 'writers' cramp' as an occupational neurosis, physiologically akin to hysteria, and assumed a cortical dysfunction.<sup>11</sup> Prevention by excluding people prone to develop 'spasms' from certain occupations, was considered the best treatment.

As in other focal dystonias, Marsden advocated the organic nature of writer's cramp (*vide supra*),<sup>3</sup> which he and Sheehy further demonstrated in a report on 29 patients, (1982).<sup>93</sup> However, in 1983 Cottraux (France) *et al.* reported on the success of behavioural therapy and biofeedback in 9 of 15 patients with writer's cramp,<sup>94</sup> and the 1985 edition of John Walton's *Brain's Diseases of the nervous system* stated:

I find the conclusions of Sheehy and Marsden inherently implausible and unacceptable. In my experience even subtle physical signs are absent in the many 'simple' cases that I have seen and neither focal dystonia nor any other organic disorder could in my view impair movements only when they take part in one co-ordinated act while leaving totally unaffected all other precise and complex voluntary actions involving the affected member.<sup>95</sup>

The 1993 edition stated that writer's cramp had "in the past been attributed to psychological factors, but there is now good evidence that this is not so". Interestingly, the author referred to the same single publication of Sheehy and Marsden.<sup>93,96</sup> In 1991 Rivest *et al.* reported for the first time on the use of botulinum toxin for writer's cramp,<sup>97</sup> which is currently considered the most effective treatment.

*Fixed dystonia related to complex regional pain syndrome*

In 1864 Silas Weir Mitchell (1829-1914) described a series of American Civil War (1861-1865) victims with gunshot wounds who developed burning pain and a shiny red skin after nerve injury.<sup>98,99</sup> He suspected that traumatic nerve irritation was the cause and named the condition 'causalgia'. He recognised that patients might come into an unendurably painful hyperaesthetic state. In 1892, Charcot demonstrated another entity in two patients: 'oedème bleu des hystériques', a painful condition with oedema and blue discoloration of the skin, which may occur in combination with an hysterical limb contracture or paralysis.<sup>100</sup>

L'historique de cette affection n'est pas bien long. Je l'ai pour la première fois mentionnée et distinguée à propos d'un malade de cet hospice [with reference to the *Leçons du Mardi* from 1889], que je suis d'ailleurs à même de vous présenter de nouveau. Puis, à plusieurs reprises je l'ai observée chez des personnes de la ville, combinée tantôt avec des altérations de la sensibilité (anesthésie ou hyperesthésie), tantôt avec des troubles du mouvement (paralysies et contractures). Il s'agissait presque toujours de sujets marqués, par la présence des stigmates, au sceau de l'hystérie la mieux caractérisée.<sup>100</sup> [This disorder has a short history. For the first time [in 1889], I reported on a patient from this hospital [Hospice de la Salpêtrière]. From then, I recognised more cases. In a number of them, I observed sensory abnormalities (anesthesia or

hyperesthesia) or movement disturbances (paralysis and contractures). Mostly, patients were extraordinary persons having characteristics which may be considered hysterical.]

In 1946, Evans renamed the latter disorder 'reflex sympathetic dystrophy', because he suspected involvement of spinal reflexes as well as sympathetic efferent fibres.<sup>101</sup> It was different from causalgia in that it occurred in the absence of major nerve trauma. However, in 1994, the International Association for the Study of Pain introduced the name CRPS for both conditions: type 1 (reflex sympathetic dystrophy) and type 2 (causalgia).<sup>102</sup> The diagnostic criteria for CRPS type 1 were: (i) presence of an initiating noxious event, or a cause of immobilization (not obligatory item); (ii) continuing pain, allodynia, or hyperalgesia with which the pain is disproportionate to any inciting event; (iii) evidence at some time of oedema, changes in skin blood flow, or abnormal sudomotor activity in the region of the pain; and (iv) no other condition that would account for the degree of pain and dysfunction. CRPS type 2 has the same characteristics, but is accompanied by nerve injury.<sup>102</sup>

In 1984 Marsden *et al.* reported on four 'reflex sympathetic dystrophy' patients who had dystonia, characterised by fixed, predominantly flexion, postures.<sup>103</sup> They believed it to be 'a distinct clinical syndrome'. Six years later Schwartzman *et al.* reported on motor disturbances in 43 patients with 'reflex sympathetic dystrophy', in whom the most dramatic characteristic was a dystonic posture in all patients.<sup>104</sup> The authors hypothesised on a spinal cause. In 1993, a series of 18 patients with similar characteristics was reported.<sup>105</sup> However, it was remarkable that many patients met the criteria for psychogenic dystonia from 1988 (*vide supra*) (Table 2.1). They concluded that the aetiology of this disorder, psychogenic or organic, was unknown.<sup>105</sup> In 2004 it was reported that many patients with features of CRPS and dystonia also had features of psychogenic dystonia.<sup>106</sup> In the same year it was stated that a very large proportion had a primary psychogenic disorder.<sup>107</sup> In a more recent paper on 110 CRPS type 1 patients with dystonia predominantly characterised by tonic flexion postures, the authors hypothesised that maladaptive plasticity with disinhibition of spinal mechanisms might be the cause.<sup>108</sup>

## Discussion

There has been a continuous vacillation between psychogenic and organic explanations for (i) primary generalised dystonia; (ii) cervical dystonia; (iii) writer's cramp; and (iv) CRPS-

related fixed dystonia. Although at first sight the attributions of the terms psychogenic and organic in Table 2.2 seem quite obvious, it seems more realistic to assume a spectrum with two ends between which attributions were moving. Moreover, the discussion between an organic and psychogenic aetiology has not always been explicit (particularly in the 19<sup>th</sup> century). The opinions of several authors could only be derived or interpreted from their hypotheses on aetiology and their therapies.

An example is Schwalbe's description of hysterical symptoms in siblings with generalised dystonia. In the late 19<sup>th</sup> century, Charcot considered hysteria a neurosis, similar to paralysis agitans, epilepsy and chorea, which were diseases without known pathology. For paralysis agitans he expected that the lesion would be discovered.<sup>109</sup> Hysteria appeared a more difficult obstacle for Charcot's clinical-anatomic method and, when describing male traumatic neurosis, he moved towards a psychological conception of hysteria.<sup>109</sup> This was further elaborated by Freud and his followers.<sup>110</sup> Hysteria evolved from a disease in which an organic pathophysiology was suspected but not found, to a psychogenic disease in the late 19<sup>th</sup> and early 20<sup>th</sup> century. Recent functional imaging studies in these patients have shown specific cerebral abnormalities.<sup>111,112</sup> From these studies, it is suspected that affective or stress-related factors modulate cerebral sensorimotor representations through interactions between limbic and sensorimotor networks. It is hypothesised that primitive reflexive mechanisms of protection and alertness, which are partly independent of conscious control, are involved.

#### *Primary generalised dystonia*

The patients of Oppenheim made him move to the organic end of the spectrum, whereas Freud and his followers in psychoanalysis, moved in an opposite direction. The improved description of the 'clinical entity' in the 1940s (Herz), the new hereditary cases described in the 1950s (Zeman), and the limited efficacy of psychotherapy in torsion dystonia, as well as the effects of surgical treatments and the lesion studies in the 1960s (Eldridge, Cooper, and Denny-Brown respectively) pushed the explanatory ideas back into the organic again. This culminated in Eldridge's & Fahn's 1975 statement (published in 1976). However, a new movement towards psychogenesis soon followed with the recognition of psychogenic dystonia. Meanwhile, the remaining dystonias kept their position on the organic side of the spectrum, not in the least because of the discovery of the DYT1 gene. Nevertheless, one cannot be too rigid because dystonic disorders with a genetic origin can be triggered by emotional stress.<sup>113</sup>

### *Cervical dystonia*

Bell and Duchenne probably assumed an organic cause for cervical dystonia (Table 2.2). Not much later Charcot, and certainly his student Brissaud, moved to the psychogenic view, in which the interpretation of observing the 'geste antagoniste' played an important role. At the time, such terms as 'torticollis mental' and 'torticollis hystericus' were used on both sides of the Atlantic and dealt with likewise. Psychological and surgical treatments were applied simultaneously in different patients at different places around the 1940s. After Marsden's 1975 presentation, the aetiological ideas on cervical dystonia clearly moved away from the psychogenic to the organic side of the spectrum.

### *Writer's cramp*

To explain writer's cramp, Ramazzini used such terms as 'fatigue' and 'failure of power'. These should be interpreted in the humoral pathophysiological concepts of the time, i.e. animal spirits that flow through the nerves with less power than usual. One would be inclined to consider an organic aetiology here; however, we may question whether Ramazzini was concerned with this question at all. From Bell's description a century later and also from Romberg's work, an organic viewpoint may be recognised. Duchenne again used the term 'functional', which, however, does not necessarily imply that he meant a psychogenic aetiology. A clearer distinction came about in the early 20<sup>th</sup> century, when Mohr mentioned personality characteristics and a psychological factor, and suggested psychoanalysis for treatment. An interesting position was taken by Kinnier Wilson, assuming cortical dysfunction but comparing it to hysteria. Once more, Marsden's 1975 presentation pushed the aetiology of writer's cramp toward the organic side, with a few exceptions in the 1980s.

### *Fixed dystonia related to complex regional pain syndrome*

Charcot's demonstration of two patients with 'oedème bleu des hystériques' occurred in a period in which he was moving towards a psychological explanation of hysteria. Marsden *et al.* expressed the opinion that the similarities between CRPS cases with dystonia over the world suggested its existence as a distinct clinical syndrome.<sup>103</sup> In contrast, Sa *et al.* stressed that most cases satisfied the criteria for psychogenic dystonia, and should, therefore, be considered as such.<sup>107</sup> But these are based on expert opinion. Such statements are not like a gold standard and should, therefore, be used with caution. Moreover, it is remarkable that the reasons why CRPS-related fixed dystonia is considered psychogenic are at least partly the same as the arguments that were used in the past to

explain why focal dystonia was psychogenic (Table 2.3): (i) the dystonia in CRPS may be considered incongruent with classical dystonia; (ii) may be inconsistent over time; (iii) weakness, described in the majority of CRPS cases, might be interpreted as false; (iv) sensory abnormalities, which fit the diagnosis of CRPS, might be interpreted as false sensory findings; and (v) sometimes, psychiatric abnormalities are present. In recent times significant motor cortex abnormalities were found in CRPS.<sup>114,115</sup>

It is clear that the discussions on the psychogenic or organic aetiology of dystonia have been emotional. In some of the periods, particularly during the 20<sup>th</sup> century, strong believers as well as non-believers may be recognised. Charcot isolated hysterical disorders from other neurologic diseases. In his view, environmental factors ('agents provocateurs') were involved in its pathogenesis. The rise of the psychoanalytic movement, following the work of Freud at the beginning of the 20<sup>th</sup> century, caused important disagreements between supporters of organic and psychogenic explanations. This was not specific to the interpretation of dystonia, but more generally reflected the division between biologically and psychoanalytic oriented neuropsychiatrists at the time. The success and popularity of psychoanalysis, as well as the lack of an organic substrate for dystonia, encouraged psychogenic theories. As the 20<sup>th</sup> century proceeded, knowledge in favour of a somatic origin of early-onset generalised dystonia accumulated. Marsden, a leading neurologist in movement disorders, convinced the neurological community in the 1970s and 1980s that both generalised and focal dystonia were somatic entities. However, psychogenic dystonia re-emerged, but as a special category. Nowadays, psychogenic dystonia is thought to be "common" in specialised movement disorders clinics.<sup>116</sup>

The recognition of the hereditary character of dystonia played an important role in attributing an organic nature in the first as well as the last decades of the 20<sup>th</sup> century. If dystonia had existed as an entity and its hereditary character had been recognised previously, it would probably have been interpreted in a different way, because of the particular concepts of the late 19<sup>th</sup> century. In this period several neuroses were considered hereditary, in fact a favourite subject in the interpretation models of Charcot.<sup>117</sup> Similar to contemporary psychiatrists (the French Benedict-Augustin Morel (1809-1873) and Valentin Magnan (1835-1916)), he assumed that degeneration was a constitutional factor in certain families ('neuropathic families') in which neuroses including hysteria, alcoholism, and epilepsy could be transformed during the passage from one generation to the next. Hysteria in a parent could be inherited as epilepsy in the child.<sup>109,118</sup> In the 20<sup>th</sup> century, following delineation of dystonia as an entity and following

new discoveries in genetics, the hereditary character led to new insights. Today it is recognised that more than 14 genes are implicated in different monogenic dystonia syndromes, which are frequently inherited as autosomal dominant conditions with reduced penetrance. Most cases of early-onset torsion dystonia are associated with the DYT1 gene mutation.<sup>113</sup> Familial occurrence of cervical dystonia or writer's cramp has been described but appears to be rare.<sup>119</sup>

Medical problems nearly always unravel because of the advent of a new technology, skill, or understanding of a hitherto unknown system of disease. One example is the unravelling of the electric nature of nerve action in the 18<sup>th</sup> and 19<sup>th</sup> century. Ideas on whether or not animal electricity existed and played a role in the nature of nerve conduction, were put forward at the end of the 18<sup>th</sup> century by Galvani and denied by Volta.<sup>120,121</sup> The confirmation had to await more sophisticated sensitive measuring devices such as the galvanometer invented by Du Bois-Reymond in the 1840s, after which observation of the action potential became possible.

What will be the future 'sophisticated sensitive measuring device' that will finally lead to the understanding of dystonia? We believe that the increasing knowledge resulting from neurophysiological and imaging studies, combined with genetic methods, will provide the insight that the explanation of dystonia cannot just be interpreted in terms of organic or psychogenic. These modern methods may show that the interaction of genetic and environmental factors is more complex than was previously thought. When reviewing the pathophysiology of primary adult-onset focal dystonia, Defazio *et al.* suggest that in human focal dystonia there may be an overload of a predisposed sensory system resulting from peripheral injury or repetitive motor activity in a certain part of the body, or both, causing sensory receptive changes in the corresponding cortical brain areas and leading to abnormal regulation of inhibitory interneuronal mechanisms at brainstem or spinal cord level.<sup>119</sup> There seems to be an abnormality of sensorimotor integration and cortical excitability beyond the symptomatic body part. In both generalised and focal dystonia neurophysiological and functional imaging studies indeed point towards abnormalities in the sensorimotor circuitry, which result in a vulnerable central nervous system. Some of these phenomena have been found in asymptomatic gene carriers, as well as in representations of unaffected body parts. It is suspected that a 'second hit' is needed to bring the central nervous system out of balance, which leads to dystonia.<sup>113,119</sup> Musician's dystonia is an interesting example. In a transcranial magnetic stimulation study, cortical changes were found in musicians compared to healthy controls, and these changes were

more marked in those with musician's dystonia. It is hypothesised that musician's dystonia is a form of training-induced dystonia.<sup>122</sup>

These suggestions, in particular the assumption of abnormal regulation of inhibitory interneuronal mechanisms at brainstem or spinal cord level, bring us back to Sherringtonian neurophysiology as already suggested by Denny-Brown in the 1960s, when he found that damage in different anatomical structures could have the same consequence, pointing to a basic neurophysiological principle, the final common path, that had been conceived around the turn of the 19<sup>th</sup> to the 20<sup>th</sup> century by his teacher Charles Scott Sherrington (1857-1952).<sup>123,124</sup> This may still be a valid explanation of the phenomenology, if not the underlying causation of dystonia in modern terms.

Today, psychogenic dystonia is considered a disorder that results from an underlying psychiatric illness. Its diagnostic criteria have remained unchanged for decades (Table 2.1). In the meantime, however, the border between neurology and psychiatry has been less well defined. For example, schizophrenia,<sup>125</sup> autism,<sup>126</sup> and primary dystonia<sup>113</sup> are now considered neurofunctional disorders. Additionally, it has been shown recently that patients with cervical dystonia or blepharospasm have distinct neuropsychiatric and personality profiles of the anxiety spectrum.<sup>127</sup> Another study shows high psychiatric comorbidity in cervical dystonia, which is unlikely to be a mere consequence of chronic disease and disfigurement.<sup>128</sup> It is attractive to see psychogenic disorders as the consequence of functional crashes in anatomically normal brains. In these disorders, abnormalities found in neurophysiological and functional imaging studies may be interpreted as signs of organic dysfunction. We have only traced two transcranial magnetic stimulation studies on psychogenic dystonia. Interestingly, one of these found similar abnormalities in both organic and psychogenic dystonia: reduced short and long-interval intracortical inhibition and cortical silent period, and an increased cutaneous silent period.<sup>116</sup> The other detected difference: patients with organic dystonia had an increased response to paired associative stimulation compared to patients with psychogenic dystonia.<sup>129</sup> The authors of the latter study concluded that abnormal plasticity is a hallmark of organic dystonia in contrast to psychogenic dystonia.

If we hypothesise further, assuming abnormal regulation of inhibitory interneuronal mechanisms as mentioned above, neurophysiological and functional imaging studies may help to explain dystonia in CRPS due to peripheral injury leading to similar sensory receptive changes. Such mechanisms may also be in play in dissociation disorders, including conversion disorder,<sup>111,112,130-132</sup> thereby associating primary dystonia, CRPS-related fixed dystonia, and sensory and motor disorders in conversion disorder.



## Conclusions

Opinions on whether dystonia is either organic or psychogenic continuously changed on a spectrum between the two extremes over the described period. Genetic studies, the limited efficacy of psychotherapy, the effects of surgical treatments, lesion studies, and the recognition that focal dystonias may be minor forms of generalised dystonia pushed the explanatory ideas in the direction of organic. We have seen how insights were influenced by contemporary general pathophysiological concepts (humoral pathophysiology in the pre-1800 period, solid pathophysiology reflected by the clinical-anatomical method thereafter, psychological pathophysiology after about 1900, and genetic and molecular pathophysiology in recent decades), as well as by various research methods, from which we have learn to be prudent with the interpretation of results and to reflect on epistemological mechanisms. Nevertheless, with these reservations in mind, modern neurophysiological and imaging studies may open new ways for the interpretation of dystonia. In both generalised and focal dystonia, studies point towards abnormalities in the sensorimotor circuitry, resulting in a vulnerable central nervous system. They indicate that the old distinction between psychogenic and organic is not easily applicable and perhaps should be abandoned. Similar mechanisms may be in play in CRPS-related fixed dystonia and sensory and motor disorders in conversion disorder. Hypotheses made on the basis of neurophysiological and functional imaging studies need further testing in these groups of patients. In addition, genetic studies may provide further insight. Until more knowledge is available, we must keep in mind the lessons from history and remember 1975:

In the past, many victims of dystonia and their families have been caused anguish and hardship over and above that caused by the disease itself owing to the frequent misdiagnosis of the symptoms as manifestations of a psychiatric ailment.<sup>41</sup>

Once hurt, twice shy.

## References

1. Oppenheim H. Über eine eigenartige Krampfkrankheit des kindlichen und jugendlichen Alters (Dysbasia lordotica progressiva, Dystonia musculorum deformans). *Neurologisches Centralblatt* 1911;30:1090-107.
2. Zeman W, Dyken P. Dystonia musculorum deformans. Clinical, genetic and pathoanatomical studies. *Psychiatr Neurol Neurochir* 1967;70:77-121.
3. Marsden CD. The problem of adult-onset idiopathic torsion dystonia and other isolated dyskinesias in adult life (including blepharospasm, oromandibular dystonia, dystonic writer's cramp, and torticollis, or axial dystonia). *Adv Neurol* 1976;14:259-76.
4. McHenry LC. Garrison's history of neurology. Springfield: Charles C Thomas, 1969.
5. Norman JM. Morton's medical bibliography. 5 edition. Aldershot (Hants): Scolar Press, 1991.
6. Biemond A. Diagnostiek van hersenziekten. Haarlem: De Erven F. Bohn N.V., 1946.
7. Bouman L, Brouwer B. Leerboek der zenuwziekten. Volume 2. Part 2. Haarlem: De Erven F. Bohn, 1930.
8. Bumke O, Foerster O. Handbuch der Neurologie. Volume 17. Berlin: Julius Springer, 1935.
9. Bumke O, Foerster O. Handbuch der Neurologie. Volume 16. Berlin: Julius Springer, 1936.
10. Gowers WR. A manual of diseases of the nervous system. Volume 2. London: J. & A. Churchill, 1888.
11. Kinnier Wilson SA. Neurology. Volume 2. London: Edward Arnold & Co, 1940:1675-84.
12. Lewandowsky M. Handbuch der Neurologie. Volume 5. Berlin: Julius Springer, 1914:458-64, 474-81.
13. Oppenheim H. Lehrbuch der Nervenkrankheiten. Berlin: S. Karger, 1894.
14. Trousseau A. Clinique médicale de l'Hôtel-Dieu de Paris. Volume 2. 6 edition. Paris: J.-B. Baillière et fils, 1882.
15. Vinken PJ, Bruyn GW. Handbook of clinical neurology. Volume 6. Diseases of the basal ganglia. Amsterdam: North-Holland publishing company, 1968.
16. Vinken PJ, Bruyn GW. Handbook of clinical neurology. Volume 7. Diseases of nerves. Part 1. Amsterdam: North-Holland publishing company, 1970.
17. Fahn S. Concept and classification of dystonia. *Adv Neurol* 1988;50:1-8.
18. Goetz CG. Charcot and psychogenic movement disorders. In: Hallett M, Fahn S, Jankovic J, Lang AE, Cloninger CR, Yudofsky SC, eds. Psychogenic movement disorders. Neurology and neuropsychiatry. Philadelphia: AAN Press, 2006:3-13.
19. López Piñero JM. Historical origins of the concept of neurosis. Translated by D. Berrios. Cambridge: Cambridge University Press, 1983.
20. Bynum WF. The nervous patient in eighteenth- and nineteenth-century Britain: the psychiatric origins of British neurology. Volume 1. In: Bynum WJ, Porter R, Shepherd M, eds. The anatomy of madness. London: Tavistock, 1985:89-102.
21. Micale MS. Approaching hysteria. Disease and its interpretations: 25. Princeton: Princeton University Press, 1995.
22. American Psychiatric Association. Diagnostic and statistic manual of mental disorders, fourth edition, text revision (DSM-IV-TR). Arlington: American Psychiatric Publishing, Inc., 2000.
23. Hammond WA. Athetosis. *Medical Times and Gazette* 1871;2:747-8.
24. Morris JG, Jankelowitz SK, Fung VS, Clouston PD, Hayes MW, Grattan-Smith P. Athetosis I: historical considerations. *Mov Disord* 2002;17:1278-80.
25. Barraquer-Bordas L, Gimenez-Roldan S. Idiopathic torsion dystonia as described by Barraquer-Roviralta. *Adv Neurol* 1988;50:665-6.
26. Barraquer L. Contribución al estudio de la atetosis. *Gaceta Medica Catalana* 1897;20:385-91.
27. Schwalbe W. Eine eigentümliche tonische Krampfform mit hysterischen Symptomen. Thesis. Berlin, 1908.
28. Truong DD, Fahn S. An early description of dystonia: translation of Schwalbe's thesis and information on his life. *Adv Neurol* 1988;50:651-64.
29. Zeman W. Dystonia: an overview. *Adv Neurol* 1976;14:91-103.
30. Wimmer A. Le spasme de torsion. *Rev Neurol* 1929;36:904-15.
31. Tomlinson WC. Freud and psychogenic movement disorders. In: Hallett M, Fahn S, Jankovic J, Lang AE, Cloninger CR, Yudofsky SC, eds. Psychogenic movement disorders. Neurology and neuropsychiatry. Philadelphia: AAN Press, 2006:14-9.

32. Herz E. Dystonia. I. Historical review; analysis of dystonic symptoms and physiologic mechanisms involved. *Arch Neurol Psychiatry* 1944;51:305-18.
33. Herz E. Dystonia. II. Clinical classification. *Arch Neurol Psychiatry* 1944;51:319-55.
34. Herz E. Dystonia. III. Pathology and conclusions. *Arch Neurol Psychiatry* 1944;52:20-6.
35. Zeman W, Kaelbling R, Pasamanick B. Idiopathic dystonia musculorum deformans. I. The hereditary pattern. *Am J Hum Genet* 1959;11:188-202.
36. Eldridge R, Riklan M, Cooper IS. The limited role of psychotherapy in torsion dystonia. Experience with 44 cases. *JAMA* 1969;210:705-8.
37. Cooper IS. Dystonia musculorum deformans: natural history and neurosurgical alleviation. *J Pediatr* 1969;74:585-92.
38. Denny-Brown D. The nature of dystonia. *Bulletin of the New York Academy of Medicine* 1965;41:858-69.
39. Denny-Brown D. *The cerebral control of movement*. Liverpool: Liverpool University Press, 1966.
40. Gilman S, Vilensky JA, Morecraft RW, Cook JA. Denny-Brown's views on the pathophysiology of dystonia. *J Neurol Sci* 1999;167:142-7.
41. Eldridge R, Fahn S. Preface. *Adv Neurol* 1976;14:V.
42. Marsden CD, Harrison MJ, Bunday S. Natural history of idiopathic torsion dystonia. *Adv Neurol* 1976;14:177-87.
43. Fahn S, Eldridge R. Definition of dystonia and classification of the dystonic states. *Adv Neurol* 1976;14:1-5.
44. Lesser RP, Fahn S. Dystonia: a disorder often misdiagnosed as a conversion reaction. *Am J Psychiatry* 1978;135:349-52.
45. Fahn S, Williams D, Reches A, Lesser RP, Jankovic J, Silberstein SD. Hysterical dystonia, a rare disorder: report of five documented cases. *Neurology* 1983;33 (Suppl 2):161.
46. Fahn S, Williams DT. Psychogenic dystonia. *Adv Neurol* 1988;50:431-55.
47. Ozelius L, Kramer PL, Moskowitz CB et al. Human gene for torsion dystonia located on chromosome 9q32-q34. *Neuron* 1989;2:1427-34.
48. Ozelius LJ, Hewett JW, Page CE et al. The early-onset torsion dystonia gene (DYT1) encodes an ATP-binding protein. *Nat Genet* 1997;17:40-8.
49. Platter F. *Observationen: Krankheitsbeobachtungen in drei Büchern*. I. Buch: Funktionelle Störungen des Sinnes und der Bewegung. Bern: Hans Huber, 1963:103-8.
50. Steyerthal A. Zur Geschichte des Torticollis spasmodicus. *Archiv für Psychiatrie und Nervenkrankheiten* 1906;41:29-48.
51. Tulp N. *Observationes medicae*. Amsterdam: Ludovicum Elzevirium, 1641:391-4.
52. Tulp N, von Wolzogen L. *Geneeskundige waarnemingen van Nikolaas Tulp*. Leiden: Juliaan Wishof, 1740:507-10.
53. Lorry AC. *De melancholia et morbis melancholicus*. Paris: P. Guillelmum Cavelier, 1765:115-6.
54. Boissier de Sauvages F. *Nosologia methodica sistens morborum classes juxtà Sydenhami mentem & botanicorum ordinem*. Volume 1. Amsterdam: Fratrum de Tourne, 1768:536-7.
55. Boissier de Sauvages F. *Nosologie méthodique, dans laquelle les maladies sont rangées par classes, suivant le système de Sydenham, & l'ordre des Botaniste*. Volume 1. Paris: Hérisant le Fils, 1771:724-6.
56. Dupuytren G. *Leçons orales de clinique chirurgicale faites à l'Hôtel-Dieu de Paris*. Volume 3. 2 edition. Paris: Germer Baillière, 1839:455-61.
57. Anonymous. Middlesex Hospital. *Lancet* 1825;4:189-92.
58. Gilby W. Efficacy of electricity in contraction of the muscles of the neck. *Lancet* 1825;4:280.
59. Stromeyer L. *Verkrümmungen des Halses*. Beiträge zur operativen Orthopädie. Hannover: Helwing'schen Hof-Buchhandlung, 1838:128-51.
60. Bell C. *The nervous system of the human body*: 414-425. 3 edition. London: Henry Renshaw, 1844.
61. Romberg MH. *Lehrbuch der Nervenkrankheiten des Menschen*. Volume 1. Berlin: Alexander Duncker, 1846:330-3.
62. Duchenne GM. *De L'électrisation localisée et de son application à la pathologie et à la thérapeutique*. 3 edition. Paris: J.-B. Baillière et fils, 1861:918-46.
63. Anonymous. A case in which severe spasmodic affection of cervical muscles is produced by movement. *Lancet* 1867;90:128-9.
64. Jaccoud S. *Traité de pathologie interne*. Volume 1. 3 edition. Paris: Adrien Delahaye, 1873:515-8.

65. Poore. Charing Cross Hospital: case of clonic torticollis treated by the continuous galvanic current and the rhythmic exercise of the involved muscles. *Lancet* 1873;102:520-1.
66. Charcot JM. Leçons du Mardi à la Salpêtrière. Policliniques. 1887-1888. Paris: Progrès Médical, 1887:489-92.
67. Breuer J, Freud S. Studien über Hysterie. 2 edition. Leipzig: Franz Deuticke, 1909:37-90.
68. Anonymous. Philadelphia Neurological Society. *J Nerv Ment Dis* 1890;15:829-32.
69. Keen WW. A new operation for spasmodic wry neck. Namely, division or exsection of the nerves supplying the posterior rotator muscles of the head. *Ann Surg* 1891;13:44-7.
70. Brissaud E. Leçons sur les maladies nerveuses (Salpêtrière, 1893-1894). Paris: G. Masson, 1895:502-20.
71. Voisin J. Torticollis intermittent survenant sous l'influence d'un rêve. Guérison par la suggestion hypnotique. *Revue de l'hypnotisme et de la psychologie physiologique* 1894;8:119-20.
72. de Quervain F. *La Semaine Médicale* 1896;16:405-9.
73. Babinski J. Sur un cas d'hémispasme (contribution à l'étude de la pathogénie du torticollis spasmodique). *Rev Neurol* 1900;8:142-7.
74. Meige H, Feindel E. Les tics et leur traitement. Paris: Masson et Cie, 1902:288-313, 490-494.
75. Kollarits J. Torticollis hystericus. *Zeitschrift für Neurologie* 1905;29:413-30.
76. Kollarits J. Weitere Beiträge zur Kenntnis des Torticollis mentalis (hystericus) mit einem Sektionsbefund. *Zeitschrift für Neurologie* 1908;35:141-51.
77. Curschmann H. Über Labyrinthkrankungen als Ursache des spasmodischen Torticollis. *Deutsche Zeitschrift für Nervenheilkunde* 1907;33:305-16.
78. Clark LP. Some observations upon the etiology of mental torticollis. *J Nerv Ment Dis* 1914;41:245-8.
79. Wartenberg R. Zur Klinik und Pathophysiologie der extrapyramidalen Bewegungsstörungen. *Zeitschrift für die gesamte Neurologie und Psychiatrie* 1923;83:303-54.
80. McKenzie KG. Intrameningeal division of the spinal accessory and roots of the upper cervical nerves for the treatment of spasmodic torticollis. *Surgery, gynecology and obstetrics* 1924;39:5-10.
81. Yaskin JC. The treatment of spasmodic torticollis with special reference to psychotherapy, with a report of a case. *J Nerv Ment Dis* 1935;81:299-310.
82. Anonymous. One hundred and sixth annual meeting of the British Medical Association held in Plymouth, July, 1938. The sections. Summary of proceedings. *BMJ* 1938;2 (4047):238-50.
83. Patterson RM, Little SC. Spasmodic torticollis. *J Nerv Ment Dis* 1943;98:571-99.
84. Paterson MT. Spasmodic torticollis. Results of psychotherapy in 21 cases. *Lancet* 1945;246:556-9.
85. Herz E, Glaser GH. Spasmodic torticollis. II. Clinical evaluation. *Arch Neurol Psychiatry* 1949;61:227-39.
86. Brierley H. The treatment of hysterical spasmodic torticollis by behaviour therapy. *Behav Res Ther* 1967;5:139-42.
87. Mitscherlich M. Spasmodic torticollis. *Psychother Psychosom* 1971;19:62-75.
88. Brudny J, Korein J, Levidow L, Grynbaum BB, Lieberman A, Friedmann LW. Sensory feedback therapy as a modality of treatment in central nervous system disorders of voluntary movement. *Neurology* 1974;24:925-32.
89. Tsui JK, Eisen A, Mak E, Carruthers J, Scott A, Calne DB. A pilot study on the use of botulinum toxin in spasmodic torticollis. *Can J Neurol Sci* 1985;12:314-6.
90. Rentrop E, Straschill M. Über die Wirkung emotionaler Einflüsse auf den Verlauf des idiopathischen spasmodischen Torticollis. *Z Psychosom Med Psychoanal* 1987;33:42-51.
91. Ramazzini B. *Diseases of Workers: 421-425*. New York: Haffner Publishing Company, 1964.
92. Romberg H. *Lehrbuch der Nervenkrankheiten des Menschen*. Berlin: A. Dunker, 1853.
93. Sheehy MP, Marsden CD. Writers' cramp-a focal dystonia. *Brain* 1982;105:461-80.
94. Cottraux JA, Juenet C, Collet L. The treatment of writer's cramp with multimodal behaviour therapy and biofeedback: a study of 15 cases. *Br J Psychiatry* 1983;142:180-3.
95. Walton JN. Psychological aspects of neurology (including consideration of memory, sleep, coma and the dementias). In: Walton JN, ed. *Brain's Diseases of the nervous system*. Oxford: Oxford University Press, 1985:636-68.
96. Harding AE. Movement disorders. In: Walton JN, ed. *Brain's Diseases of the nervous system*. Oxford: Oxford University Press, 1993:393-425.
97. Rivest J, Lees AJ, Marsden CD. Writer's cramp: treatment with botulinum toxin injections. *Mov Disord* 1991;6:55-9.
98. Koehler PJ, Lanska DJ. Mitchell's influence on European studies of peripheral nerve injuries during World War I. *J Hist Neurosci* 2004;13:326-35.

99. Mitchel SW, Morehouse GR, Keen WW. Gunshot wounds and other injuries of nerves. Philadelphia: JB Lippincott & Co, 1864.
100. Charcot JM. Hospice de la Salpêtrière. Clinique des maladies du système nerveux. Volume 1. Paris: Progrès Médical, 1892:95-116.
101. Evans JA. Reflex sympathetic dystrophy. *Surgery, gynecology and obstetrics* 1946;82:36-43.
102. Merskey H, Bogduk N. Relatively generalized syndromes. In: Merskey H, Bogduk N, eds. *Classification of chronic pain. Description of chronic pain syndromes and definitions of pain terms*. Seattle: IASP Press, 1994:40-3.
103. Marsden CD, Obeso JA, Traub MM, Rothwell JC, Kranz H, La Cruz F. Muscle spasms associated with Sudeck's atrophy after injury. *BMJ (Clinical research ed)* 1984;288:173-6.
104. Schwartzman RJ, Kerrigan J. The movement disorder of reflex sympathetic dystrophy. *Neurology* 1990;40:57-61.
105. Bhatia KP, Bhatt MH, Marsden CD. The causalgia-dystonia syndrome. *Brain* 1993;116:843-51.
106. Schrag A, Trimble M, Quinn N, Bhatia K. The syndrome of fixed dystonia: an evaluation of 103 patients. *Brain* 2004;127:2360-72.
107. Sa DS, Galvez-Jimenez N, Lang AE. Psychogenic movement disorders. In: Watts RL, Koller WC, eds. *Movement disorders: neurologic principles and practice*. New York: McGraw Hill, 2004:891-914.
108. van Rijn MA, Marinus J, Putter H, van Hilten JJ. Onset and progression of dystonia in complex regional pain syndrome. *Pain* 2007;130:287-93.
109. Goetz CG, Bonduelle M, Gelfand T. Charcot. *Constructing neurology*. New York: Oxford University Press, 1995.
110. Koehler PJ. Freud's comparative study of hysterical and organic paralyses: how Charcot's assignment turned out. *Arch Neurol* 2003;60:1646-50.
111. Vuilleumier P, Chicherio C, Assal F, Schwartz S, Slosman D, Landis T. Functional neuroanatomical correlates of hysterical sensorimotor loss. *Brain* 2001;124:1077-90.
112. Vuilleumier P. Hysterical conversion and brain function. *Prog Brain Res* 2005;150:309-29.
113. Breakefield XO, Blood AJ, Li Y, Hallett M, Hanson PI, Standaert DG. The pathophysiological basis of dystonias. *Nat Rev Neurosci* 2008;9:222-34.
114. Maihofner C, Baron R, DeCol R et al. The motor system shows adaptive changes in complex regional pain syndrome. *Brain* 2007;130:2671-87.
115. Schwenkreis P, Janssen F, Rommel O et al. Bilateral motor cortex disinhibition in complex regional pain syndrome (CRPS) type I of the hand. *Neurology* 2003;61:515-9.
116. Espay AJ, Morgante F, Purzner J, Gunraj CA, Lang AE, Chen R. Cortical and spinal abnormalities in psychogenic dystonia. *Ann Neurol* 2006;59:825-34.
117. Féré J. La famille névropathique. *Arch Neurol (Paris)* 1884;7:1-43, 173-91.
118. Berrios GE, Beer D. Unitary psychosis concept. In: Berrios GE, Porter R, eds. *A history of clinical psychiatry*. London: Athlone, 1995:313-35.
119. Defazio G, Berardelli A, Hallett M. Do primary adult-onset focal dystonias share aetiological factors? *Brain* 2007;130:1183-93.
120. Koehler PJ, Finger S, Piccolino M. The 'eels' of South-America: two mid-eighteenth century letters from the Dutch colonies on animal electricity. *J Hist Biol* 2009;42:715-63.
121. Piccolino M. Animal electricity and the birth of electrophysiology: the legacy of Luigi Galvani. *Brain Res Bull* 1998;46:381-407.
122. Rosenkranz K, Williamon A, Butler K, Cordivari C, Lees AJ, Rothwell JC. Pathophysiological differences between musician's dystonia and writer's cramp. *Brain* 2005;128:918-31.
123. Burke RE. Sir Charles Sherrington's the integrative action of the nervous system: a centenary appreciation. *Brain* 2007;130:887-94.
124. Sherrington CS. *The integrative action of the nervous system*. New Haven: Yale University Press, 1906.
125. Hendler T, Bleich-Cohen M, Sharon H. Neurofunctional view of psychiatry: clinical brain imaging revisited. *Curr Opin Psychiatry* 2009;22:300-5.
126. Mostofsky SH, Powell SK, Simmonds DJ, Goldberg MC, Caffo B, Pekar JJ. Decreased connectivity and cerebellar activity in autism during motor task performance. *Brain* 2009;132:2413-25.
127. Lencer R, Steinlechner S, Stahlberg J et al. Primary Focal Dystonia: Evidence for Distinct Neuropsychiatric and Personality Profiles. *J Neurol Neurosurg Psychiatry* 2009;80:1176-9.
128. Gundel H, Wolf A, Xidara V et al. High psychiatric comorbidity in spasmodic torticollis: a controlled study. *J Nerv Ment Dis* 2003;191:465-73.

129. Quartarone A, Rizzo V, Terranova C et al. Abnormal sensorimotor plasticity in organic but not in psychogenic dystonia. *Brain* 2009;132:2871-7.
130. Cojan Y, Waber L, Carruzzo A, Vuilleumier P. Motor inhibition in hysterical conversion paralysis. *Neuroimage* 2009;47:1026-37.
131. Marshall JC, Halligan PW, Fink GR, Wade DT, Frackowiak RS. The functional anatomy of a hysterical paralysis. *Cognition* 1997;64:B1-B8.
132. Seritan AL, Schneider A, Olichney JM, Leehey MA, Akins RS, Hagerman RJ. Conversion disorder in women with the FMR1 premutation. *Am J Med Genet A* 2009;149A:2501-6.

