Brain & Development 38 (2016) 181–187

BRAIN & DEVELOPMENT
Official Journal of the Japanese Society of Child Neurology

www.elsevier.com/locate/braindev

Original article

Motor impairment in children with Neurofibromatosis type 1: Effect of the comorbidity with language disorders

Stéphanie Iannuzzi [a,b,*], Jean-Michel Albaret [c], Céline Chignac [a], Nathalie Faure-Marie [a], Isabelle Barry [a], Caroline Karsenty [a], Yves Chaix [a,b,d]

[a] *Unité de Neurologie Pédiatrique, Hôpital des Enfants, Toulouse, France*
[b] *Inserm, Imagerie Cérébrale et Handicaps Neurologiques UMR 825, CHU Purpan, Place du Dr Baylac, F-31059 Toulouse Cedex 9, France*
[c] *Université Toulouse III, UPS, PRISSMH EA 4561, Toulouse, France*
[d] *Université de Toulouse, UPS, Imagerie Cérébrale et Handicaps Neurologiques UMR 825, CHU Purpan, Place du Dr Baylac, F-31059 Toulouse Cedex 9, France*

Received 20 May 2015; received in revised form 27 July 2015; accepted 3 August 2015

Abstract

Background: There is a body of evidence demonstrating comorbidity of motor and cognitive deficit in ûidiopathicý developmental disorders. These associations are also found in developmental disorders secondary to monogenic disorders as in Neurofibromatosis type 1 for which the principal complication during childhood is learning disabilities. The comparison of motor impairment between developmental disorders either idiopathic or secondary as in NF1 could help us to better understand the cause of the combined language/motor deficit in these populations.

Aim: The aim of this current study was to investigate motor impairment in children with NF1 for which oral language had been specified and then to compare the motors skills of the NF1 group to motor performance of children with Specific Language Disorder (SLD).

Method: Two groups of 49 children between 5 and 12 years old were included and compared, the NF1 group and the SLD (Specific Language Disorder) group. Each child completed evaluation involving cognitive, language and motor assessment.

Results: In NF1 group, motor impairment was more frequent and more severe and concerned specifically balance rather than manual dexterity or ball skills, compared to a group of children with SLD. This motor impairment was independent of language status in the NF1 group.

Conclusions: These results as well as other studies on the same topic could suggest that in NF1 children, fine motor skills impairment would be dependent on the existence of comorbidity with language disorders. Also, that gross motor skills impairment, and more precisely the balance deficit would be characteristic of NF1. This issue encourages studies of procedural learning that can involve the fronto-striatal or the fronto-cerebellar loops according to the type of motor tasks and the stage of learning.

Keywords: Neurofibromatosis type 1 (NF1); Neuropsychology; Motor skills; Speech; Language

1. Introduction

Neurofibromatosis type 1 (NF1) is an autosomal dominant genetic disorder with a birth incidence recently found of 1 in 2700 individuals [1]. Caused by

* Corresponding author at: Hôpital des Enfants, Centre de Référence des Troubles des Apprentissages et du Langage, Centre Hospitalier Universitaire de Toulouse, CHU Purpan, Place du Dr Baylac, F-31059 Toulouse Cedex 9, France. Tel.: +33 (0)5 34 55 87 07.
E-mail address: iannuzzi.s@chu-toulouse.fr (S. Iannuzzi).

http://dx.doi.org/10.1016/j.braindev.2015.08.001
0387-7604/

a mutation in a tumor suppressor gene located on the long arm of chromosome 17 (17q11.2), this neurocutaneous disorder is characterized by multiple clinical manifestations and a prognosis that remains unpredictable with diverse possible complications. Learning disabilities are the most common complications for children with NF1, with a frequency between 30% and 69% depending on studies [2–5]. Although intelligence only tends to be mildly affected (average intellectual functioning only slightly lower than unaffected children), deficits on measures of attention, executive functions, language, visual perception and motor control are common [3,4,6–9].

Previous research has described fine and gross motor delays in children with NF1 with a wide range from 32% [10] to 80% [11]. Impairments were described in the following subtests: balance (effect with the largest magnitude); fine motor precision and integration; upper limb coordination; bilateral coordination; running speed and agility; and strength [11]. Nevertheless, to date, very little is known about the potential causes of motor dysfunction in NF1.

Language problems also have been described in individuals with NF1. There is some evidence for difficulties with broad expressive and receptive language skills as well as with phonological awareness. Dilts et al. [6] examined language in a group of nineteen children (between 6 and 17 years old) with NF1 matched with unaffected siblings and found that 58% exhibited deficits in Expressive Language with or without receptive impairment. Studying preschool children (aged between 3 and 5 years old) with NF1, Thompson [12] found that approximately 68% had delay in speech, in language or in both.

Studies with subjects without NF1 have suggested that language difficulties are frequently related to motor impairment. In her review, Hill [13] reported motor deficit in 40–90% children with Specific Language Disorder (SLD). More specifically, children with SLD are reported to be typically impaired in fine motor task and particularly on time taken to complete the task and in the area of balance. However, they are unimpaired in some repetitive finger tapping tasks, in placing crosses in boxes and in visuo-spatial tasks such as Block Design and Object Assembly. Some authors tried to explain the co-occurrence between language and motor impairment. Three explanations have been outlined. First, the language disorder plays a specific role in the deficits seen on the movement tasks. If this is the case, a high correlation between language and motor impairment is to be expected. However, this is not typically reported. A second explanation is more neuroanatomical: the deficits may be the consequence of the anatomical proximity of the neural substrates associated with language and motor functions. Diamond [14] provides a review for linking motor and other cognitive skill development with one another as well as with specific brain areas, most notably the neo-cerebellum and the dorsolateral prefrontal cortex. The third potential explanation suggests that both deficits are indicators of underlying brain immaturity, pointing towards a brain development issue.

Although there are some hypothesis regarding the cause of the frequent co-occurrence between language and motor impairment, a lot of questions remain. The comparison of motor impairment between developmental disorders either idiopathic or secondary as in NF1 could help us to better understand the cause of the combined language/motor deficit in these populations.

The aim of the current study was to investigate motor impairment in children with NF1 for whom oral language had been specified and then to compare the motors skills of the NF1 group (with or without speech or language disorder) to motor performance of children with Specific Language Disorder (SLD). Firstly, because of a frequent link between language and motor impairment, we hypothesized that children with NF1 and language disorder should have more frequent motor impairment than children without language disorder. Secondly, because of a different etiology between idiopathic and monogenic developmental disorders, we hypothesized that children with NF1 and children with SLD should have different motor impairments.

2. Method

2.1. Participants

Two groups of 49 children between 5 and 12 years old were included and compared, the NF1 group and the SLD (Specific Language Disorder) group. Each child with NF1 was matched with a child of the SLD group for age (plus or minus 1 year), sex and global cognitive level. This cognitive level was determined with the total IQ of the Wechsler scale, the matching criteria was set at + or −0.5 standard deviation (sd).

Children who satisfied the National Institutes of Health criteria for NF1 were recruited a posteriori from the Toulouse Children Hospital Reference Centre for NF1.

The SLD group consisted of children with speech or language impairment (DSM IV criteria for Expressive Language disorder, Mixed Receptive–Expressive Language disorder and phonological disorder) for whom the diagnosis of NF1 was excluded clinically by the absence of "café au lait" spots and /or no familial history for NF1. Enrollment took place a posteriori in the center for learning disabilities of Toulouse.

In both groups, children with a known neurological or psychiatric disorder (epilepsy, symptomatic brain tumor, autism spectrum disorder, mental retardation with IQ below 70) or with hearing or/and visual impairment were