Language and learning disorders in handers children

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Distúrbios de aprendizagem e linguagem em crianças canhotas

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Abstract: Since a long time have been known some hypotheses scientific hypotheses that concern the brain asymmetry and functional hemispheric indecision that may characterize different language and learning disorders in handers subjects. Still today, however, these theories have not found solid proof in neuroscience's and experimental psychology's studies. For other reasons, if we look to recent studies on specific language impairment (SLI), or the observations of primary school teachers on children with specific learning disorder (SLD) or learning disabilities (LD), these effects seem to be pretty obvious. By administering of a structured questionnaire to a sample of Italian primary school teachers, in this study we'll try to examine if left-handers children that attend their classrooms have a higher percentage of language and/or learning disorders – such as dyslexia, dyscalculia and dysgraphia – compared right-handers children.

Keywords: Cerebral asymmetry. Left-handedness. Specific learning disorder (SLD). Learning disabilities (LD). Dyslexia. Dyscalculia. Dysgraphia.

Resumo: Há muito tempo são conhecidas algumas hipóteses sobre a relação entre a assimetria cerebral ou a indecisão hemisférica funcional, que às vezes caracteriza os indivíduos canhotos, e desordens específicas de aprendizagem (dislexia, discalculia e agrafia). Ainda hoje, no entanto, essas teorias não encontram muitas confirmações em estudos de neurociência e psicologia experimental. Por outras razões, se olharmos para a evidência experimental

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sobre a imparidade linguística específica (SLI), ou observações na sala de aula de crianças com desordens de aprendizagem específicas (SLD), ou dificuldades de aprendizagem (LD), ou seja, as experiências empíricas descritas pelos professores no Ensino Fundamental, esta relação parece bem-evidente. Por meio da aplicação de um questionário estruturado a professores das escolas de Ensino Fundamental italianas, no presente estudo tentamos documentar se há maior incidência de dislexia, discalculia e agrafia em crianças canhotas.

Palavras-chave: Dislexia. Discalculia. Disgrafia. Assimetria cerebral. Canhotismo.

The 'undecided' brain

For some time the researches have showed that the language functions are localized prevalently at the level of cortical and subcortical areas of the left hemisphere (Corina et al. 1992; Basic et al. 2004). Numerous studies, in fact, have investigated the relationship between brain asymmetry, hemispheric lateralization – also bilingual subjects (D'Anselmo et al. 2013) –, and other disorders of the linguistic functions. Some of these, however, appear to demonstrate significant differences, for example in the Heschl's convolutions structures, between left-handed and right-handed subjects (Marie et al. 2013), to which we must add the now classic theory on the linguistic difficulties of left-handed subjects of one of the pioneers in research on dyslexia (Orton 1937).

Moreover, several studies have demonstrated the low activation of the medial, inferior and posterior areas left temporal lobe of subjects with dyslexia (Paulesu et al. 2001; Silani et al. 2005). In other studies were examined the right hemisphere functions (Illingworth; Bishop 2009; Pernet et al. 2009), of corpus callosum (Beaton, 1997; Plessen et al. 2002), the alterations of gray matter in the temporal lobes (Eliez et al. 2000), and brain asymmetry in dyslexia (Gaillard et al. 2006; Scerri et al. 2011). Elements of atypical brain asymmetry seem to have been also demonstrated in subjects with dyslexia and schizophrenia (Edgar et al. 2006). The functions of both cerebral hemisphere (Dehaene et al. 1996), and the role of functional hemispheric indecision (Bhattacharyya et al. 2014; Kucian et al. 2011), have also been studied in subjects with dyscalculia.

For other reasons – and of course without any correlation with specific learning disorder (SLD or LD) – functional asymmetries, especially of corpus callosum, were observed in autism (FLORIS et al. 2013), and specific language impairment (SLI) (DE FOSSÉ et al. 2004). Own the specific language impairment, however, seem to bring the most compelling experimental evidence about a relationship between the forms of brain asymmetry (PECINI et al. 2005; GUIBERT et al. 2011), left-handedness and, exactly, the evidence of language disorders (BISHOP, 2005; BADCOCK et al. 2012).

The evolution of language (HAUSER et al. 2014) and functional lateralization in the cortical and subcortical areas of the left hemisphere seems to have given a disadvantaged for left-handed that don't show a marked functional asymmetry (OLDFIELD, 1971; KNECHT et al. 2000). It would be the lack of a precise hemispheric dominance and/or the representation of a bilateral language functions, or else the right hemisphere dominance (ANNETT, 1972; 1993; CORBALLIS, 1997; 2001), to make left-handed less competitive in linguistic abilities (ORTON, 1937; 998). So, in left-handed subjects it seems to delineate a kind of functional indecision between the two cerebral hemispheres that would be the basis of language disorders of different type (CROW, 1998; CROW *et al.* 1998), including specific learning disorder: dyslexia, dyscalculia, and dysgraphia.

Subjects and environment of the study

We tried to study specific learning disorder and its degree of incidence in left-handed children by administering a questionnaire to the teachers of the third, fourth and fifth classes in Italian primary school. The assessment of the subjects with dyslexia, dyscalculia and dysgraphia shown in our study refers to the periodic monitoring, as well as to the functional diagnosis made by the Infantile Neuropsychiatry service (especially by neuro-psycho-pedagogical team), of the National Health System on reporting of the teachers of institutes that we considered.

About left-handed children, instead, they have been identified through the teachers's observation (confirmed by their parents) on preferential use of upper and lower left limbs, as well as writing and/or drawing skills through the exclusive use left brachial-manual. However,

this is one of the limits of this study, because were not carried out preliminary tests of lateralization to assess hemispheric dominance and the incidence of bilateral representation (or only activation of the right hemisphere) on the language of left-handed subjects observed.

Thus, in teachers's questionnaire was included a set of 30 items closed answers to quantify the presence of dyslexic children in examined classes, and left-handed children with dyslexia. Moreover, we have tried to quantify the relationship between dyscalculia, dysgraphia and their degree of incidence in handers children.

The sample consists of 541 children (297 males and 244 females) attending I to V classes of primary school. This is because some surveys on specific learning disorder have included also the children (with a average age of 6.5 years) of I and II classes (Ghidoni, Angelini, 2007; MIUR 2011-2012). However, in our study were considered only the results of the third, fourth and fifth classes. The acquired data were compared with the values about the cases on specific learning disorder (dyslexia, dyscalculia, dysgraphia) and left-handedness.

In a later study we'll try to broaden the sample and we'll refine the statistical analysis of the experimental data (through the analysis with the Statistical Package for Social Science – SPSS) on specific learning disorder and their relationship with the left-handedness. Moreover, in further study, we will study also the relationship between left-handedness and learning difficulties of a second language (L2).

Results of a first screening in Italian schools

As we said, the data we have presented were obtained from a sample of 369 children, precisely the children who attend the III, IV and V classes: therefore, with a average age of 9 years. These are in agreement with the statistical statements about the incidence of left-handedness in the population (Coren; Porac, 1977), and respect to the incidence of the distribution masculine/feminine of left-handedness, which is around 10% (Table 1).

Table 1 Summary data sample under examination

total children	average age	males	females	left-handers	left-handers M	left-handers F
369	9	205	164	36 – 9.75%	21 – 10.24%	15 – 9.14%

Also ours survey on the incidence of dyslexia in the classes examined (4.60%) is agree with the data on the prevalence of dyslexia in the population (3-5%), but it differs from the percentage of specific learning disorder in the Italian school where the data are between 1% and 2.20%: note, however, the growing trend of the percentages of incidence of specific learning disorder (GHIDONI, ANGELINI, 2007; MIUR 2011-2012).

The most interesting results of our investigation, however, concern the relationship between dyslexia and left-handedness: in fact, they seem to show a correlation between the two phenomena.

It is note the prevalence of males children with dyslexia over females (very clear in our study with more than 94%). Among these, the percentage of left-handed children (males) with dyslexia is of 12.5%, and it's larger when compared with the total of dyslexics in our sample (4.60%). It therefore seems to be a fairly significant given (Table 2).

Even by changing the data comparison, and calculating the percentage of incidence of dyslexia on total handers and/or right-handed subjects in our sample results appear enough significant: 4.50% of dyslexic right-handed children against 9.52% of dyslexic left-handers children (Table 2).

TABLE 2 Summary of the results

	totals	total right-handed	total handers	males	females	handers M	handers F
dyslexia	17 – 4.60%	4.50%	9.52%	16 – 94.11%	1 – 5.88%	2 – 12.50%	0
dyscalculia	10 – 2.71%	2.10%	14.28%	10 – 100%	0	3 – 30%	0
dysgraphia	14 – 3.79%	2.70%	23.80%	14 – 100%	0	5 – 35.71%	0

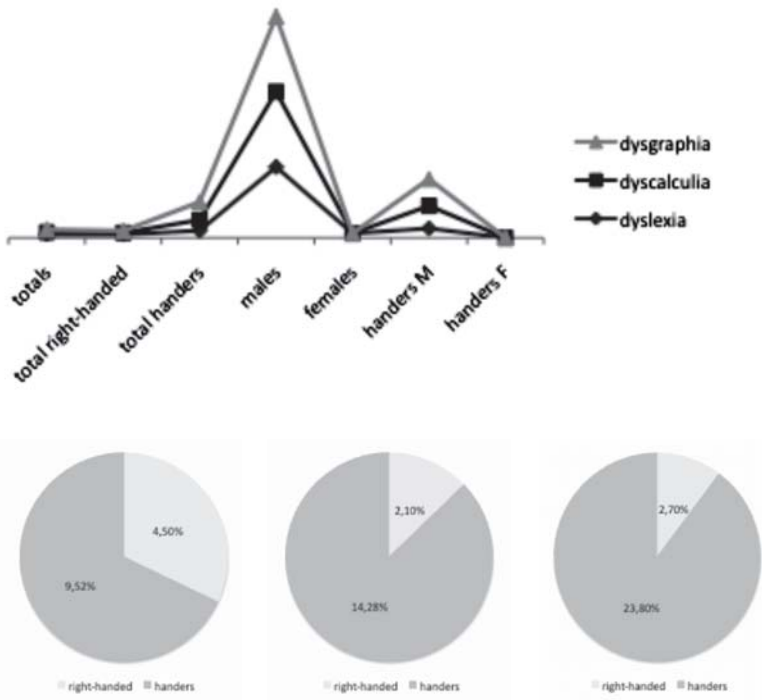
Although we think that the incidence of dyslexia, dyscalculia and dysgraphia in I and II classes have a predictive value (in our case the incidence of dyscalculia is around 1.16%, and dysgraphia 0.58%, therefore in line with the data MIUR 2011-2012), it is enough far from data concerning of the children with average age of 9 years.

In this last case, in particular, the total percentage of children (all males) of our sample with dyscalculia was of 2.71%: with a surprising incidence (30%) in left-handers children.

If it's possible, results relating to children with dysgraphia are even more significant. As demonstrated (by the Table 2), the percentage of dysgraphia in the total sample has been 3.79%, it (as the case of dyscalculia) where only males children and especially left-handers are affected: 35.71% of handers children with dysgraphia.

Similarly, the trends remain so by changing the data comparison and calculating the percentage of incidence of dyscalculia and dysgraphia of total of left-handers and/or right-handed subjects in our sample. We have in fact 2.10% of right-handed children with dyscalculia against 14.28% of dyscalculic left-handers children, and 2.70% of right-handed children with dysgraphia against 23.80% of left-handers children with dysgraphia (Table 2; Fig. 1).

Figura 1 – Incidence of dyslexia, dyscalculia and dysgraphia in the total sample



Conclusions

It is widely known, that in the majority of left-handers subjects – as in right-handers – the language functions are permitted by the specialization of the left hemisphere. It is known, moreover, that in left-handers subjects in particular can occur, for language, forms of hemispheric dominance of the right hemisphere. As may occur, always in left-handers subjects, a bilateral representation of language along with the so-called functional hemispheric indecision: i.e. phenomena of hemispheric lateralization of linguistic processes that may be ambivalent.

Though, of course, it's not possible to speak of a biunique relationship between the specific learning disorder and left-handedness, according to several studies of neuroscience there would be some correlation between language disorders such as dyslexia and left-handedness. Currently however, we don't know of other studies on the relationship between left-handedness, dyscalculia and/or dysgraphia.

Our study, through a procedure of indirect assessment, seems to confirm the higher incidence of specific learning disorder in left-handed subjects. However, more researches are needed. In a series of other investigations we will try to examine a much larger number of teachers to be interviewed, and children who attending Italian primary school to observe. Moreover, we will try to improve the tools for collecting data, of confrontation between the different variables, and assessment of the results. But above all, we will try to understand if the possible higher incidence of specific learning disorder in handers subjects is also connected to the difficulties of the same subjects in the learning of a second language (L2). Or again, if there is actually a correlation between left-handedness and the difficulties in learning a second language.

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