What we really know about mathematical learning disability?

by Irene Mammarella

Establishing the basis of mathematical learning disabilities requires careful consideration of how to select the students that we compare

In past years, the literature on mathematical learning disability (MLD) has been dominated by two hypotheses. The first is known as the ‘core deficit hypothesis’. It grew from the discovery that very young human infants (and some other animal species) can discriminate stimuli on the basis of numerosity. The core deficit hypothesis then supposes that children with MLD might be identified in terms of their ability to readily make such discriminations – registering symbolic or non-symbolic numerosity differences. Such theorists have tended to prefer the term ‘developmental dyscalculia’ for approaching MLD, inferring that this dyscalculia could derive from a late development of a “number sense module”.

Source: Bindaas Madhavi

However, within this framework, a recent meta-analysis has questioned this hypothesis, showing that there were no differences between children with such developmental dyscalculia and those with typical development in non-symbolic magnitude discrimination tasks. Although they did find that children with developmental dyscalculia showed longer response times than typically developing controls in *symbolic* (i.e., Arabic numbers) magnitude comparison tasks.

An alternative view of MLD

The second hypothesis for mathematical learning disability is known as the 'domain-general hypothesis'. According to this view, general cognitive impairments in several basic cognitive processes, such as attention, short-term memory, working memory, or executive functions could contribute to explaining the mathematical difficulties of children.

In short, these two parallel research lines have used different terms to refer to children with math problems. On the one hand, some researchers assumed the existence of *pure* developmental dyscalculia on the grounds of specific, endogenous impairments in basic number processing. On the other hand, the 'mathematical learning disability' term has been used for children with impairments in mathematics ability assumed to arise from *general* cognitive deficits. In relation to the domain general hypothesis, a second meta-analysis has now suggested that individuals with MLD do show varying degrees of impairments in certain general domain cognitive skills. Although deficits in processing speed and working memory seem to be the most stable and salient cognitive markers. In their meta-analysis, these authors also considered how these deficits changed according to the influence of other variables (such as for example, comorbidity, severity of the disorder, age, screening methods to select children with those deficits), showing how the observed deficits in the various cognitive domains depended on a range of different research study parameters. The authors also highlighted how in published studies there were strong discrepancies in the criteria used for selecting children with MLD for study.

Our concerns with the status quo

Being concerned by these observations of research findings, we further analyzed the studies included in the two meta-analyses mentioned above, and we noticed that only a few published studies actually tested children with a previous clinical diagnosis (12%). Most studies (88%) involved simply selecting children with a low achievement profile from larger (and typically-developing) samples – by using only psychometric cut-offs. Independently of the way in which children with MLD were selected (i.e., with or without a previous clinical diagnosis), the studies included in the two meta-analyses adopted widely varying criteria for those psychometric cut-offs applied. Considering the above observations, it is unlikely that the available scientific literature yet provides a clear picture of the cognitive profile of children with developmental dyscalculia.

What we did

We, thus, decided to conduct a 'provocative' study by selecting children with a low achievement profile (i.e., without a formal MLD clinical diagnosis) – just as most of the studies published in the literature had done – thereby seeking to determine whether children selected in this way simply reflect the characteristics of the general population. To explore this fully, we also looked for those 'core deficits' in symbolic and non-symbolic magnitude comparison tasks.

In this way, using psychometric cut-offs commonly adopted in the literature, we identified 47 children labelled as an MLD group, and 895 control children – all from a large sample of 1,303 children. We administered to those children a large number of tasks and we used sophisticated statistical methods to simulate a large population that reflected the same set of correlations between all the variables as measured in our sample. We computed standardized differences expressing the difference between our "MLD" and "control" groups for both the observed sample and the simulated population.

Our findings suggested that none of the measures of basic number processing or domain-general abilities could identify "core deficits" in our children with maths deficits. Rather, all differences between the groups were more likely to reflect differences apparent in the global characteristics of the population. Thus, our findings seem to suggest that looking for a "core deficit" in children with MLD is simplistic: these children may have deficits in both basic number processing and in certain domain-general cognitive skills, but neither of these are *necessarily* present.

Some limitations of method

However, it is worth noting that our study only demonstrated that groups of children selected from a large sample (by using psychometric cut-offs only, i.e., without a clinical diagnosis) merely reflected the characteristics of the whole population sampled. In other words, we ideally should have tested a group of children *with a clinical diagnosis* of MLD to conclude with greater certainty whether there is a presence or absence of core deficits in children with persistent mathematical problems. Hence, our study is most "provocative" in terms of it highlighting the importance for future research of carrying out studies that include children with a clinical diagnosis.

Educational and clinical implications

As described above, our study utilised the psychometric cut-off procedure commonly adopted by researchers to identify children with math impairments. It demonstrated that this in principle leads to the same conclusions as those found from just considering the whole population. But, what about children with a *clinical diagnosis* of developmental dyscalculia? In what ways might they differ from children identified with simply a low achievement in math? It is worth noting that obtaining weak math performance in a single assessment does not necessarily mean that a child really shows a specific learning disorder. Children may fail in a single assessment of math achievement tasks for many reasons different from the presence of a specific learning disorder (e.g., low motivation, boredom, worry and anxiety, and many others). This is one of the reasons why, according to the international diagnostic manuals such as the DSM 5, deficits should be *persistent* (at least 6-month long) and should interfere with both academic and daily-life activities. This means that someone (e.g., teachers, parents, children themselves) have to report the presence of these problems interfering with their activities.

In conclusion, our study recommends that future studies focus either on typical populations or on samples of children with a more comprehensive clinical diagnosis of MLD. Such diagnosis should follow shared and recognized criteria, such those reported by the international diagnostic manuals. Our findings may be also useful to teachers who, every day may observe their students' achievement, and that carefully may report the presence of persistent deficits in mathematics that interfere with academic performances.

Source

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