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The paradoxes of inclusion: cognitive and socio-emotional developmental trajectories of deaf and blind primary education students in mainstream and special schools

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Introduction: Students with special educational needs (SEN) have historically found participating in the regular education system challenging. Since the 1990s, inclusion has been considered the optimal strategy for their development. However, the effects of inclusive education on deaf and blind students are still little studied.

Methods: In the present article, we report the results of a longitudinal study on the cognitive and socioemotional developmental trajectories of 23 deaf and 29 blind primary education students attending mainstream (8 deaf and 10 blind) and special schools (15 deaf and 19 blind). The study was conducted in Santiago de Chile between 2018 and 2019.

Results: Our descriptive results suggest that deaf students attending special schools perform better on most of the variables studied. For blind students, those attending traditional schools generally perform better than those attending special schools. However, in the case of socio-emotional variables, blind students attending special schools tend to show fewer problems. However, almost all of the indicated differences are not statistically significantly different.

Discussion: We then discuss the need to consider the characteristics of each group of students with SEN when defining an adequate educational system for their optimal development.

KEYWORDS

cognitive development, socio-emotional development, inclusion, inclusive education, sensory impairment

1 Introduction

Special education has historically been the solution to provide learning opportunities for students with disabilities. However, in recent decades there has been a global trend to migrate from a special education system to an inclusive one (Warnock and Norwich, 2010; Biermann and Powell, 2016). Many countries in the West, starting with the publication of the Warnock Report in 1978, began efforts to modify their public policies to move progressively from segregated to integrated education and then, with the Salamanca Statement (UNESCO, 1994) to inclusive education (see for example Biermann and Powell, 2014, comparing Iceland, Norway and Germany; Rosas et al., 2019, comparing Chile, Spain and Finland). These modifications have meant, in many cases, as in Chile, the dissolution of the special education system (Escudero, 2023). However, in countries such as Chile, not only has a mixed system been maintained, but between 2010 and 2020, the number of students enrolled in special education increased (40,000 more students in 2020 compared to 2010; Ministry of Eduction, 2010/2020).

According to Articles 22 and 23 of the General Education Law, there are two alternatives in the special education system to cater for students with special needs (Ministry of Education of Chile, 2009b). Firstly, special schools are specialised centres for students with special educational needs (SEN) who generally require permanent support in specific areas due to their condition. On the other hand, students with SEN can attend regular schools as part of the School Integration Programme (PIE, Spanish acronym). Through the PIE, the State provides financial resources for each school to hire staff and purchase additional materials so that students receive the specialised support they require, according to their SEN (Ministry of Education of Chile, 2009a). The educational system the student enters will be determined by the family's decision, or the student's own decision, when this is possible given the supply of establishments (Rosas et al., 2018).

Despite global efforts to implement inclusive education policies, the motivation seems both value-driven as scientifically based. Inclusion is seen as a value in itself, as a way to ensure more equitable access to quality education for the population of students with disabilities. This generates a moral paradox about the aims of inclusive education, which is represented in the question of for whom and why educational inclusion is best (Santa-Cruz and Rosas, 2020). The results of the limited research conducted to assess whether students with SEN benefit from educational inclusion are inconclusive and depend on multiple variables of the study population, including the type and degree of SEN investigated, the educational setting (special education, integration at different levels, full inclusion, pedagogical support received), as well as demographic variables such as the age and gender of students with SEN (Lindsay, 2007; Hehir et al., 2016; Pocock and Miyahara, 2018). Furthermore, from the point of view of the analyses conducted for the studies, the results can be affected by the type of dependent variable used and the instruments used to assess it (socio-emotional, academic, cognitive, and social; Loreman et al., 2014). According to the review by Ruijs and Peetsma (2009), in the case of students with SEN, such as learning difficulties, intellectual disabilities, behavioural conditions and mild to moderate psychosocial problems, positive or neutral results were found regarding academic performance. However, the authors advice to consider these results with caution due to the lack of comparison groups in the reported studies. According to Lindsay's (2007) meta-analysis, only one study longitudinally compares the academic and psychosocial outcomes of students with SEN attending special schools or regular schools. This study, carried out by Peetsma et al. (2001), reports that, in the case of students with behavioural and learning difficulties and students with moderate intellectual disabilities, significantly higher performance is observed in students attending regular schools in language and mathematics after 4 years of follow-up. Regarding psychosocial development, no differences were reported between the two types of education systems. According to the description in the meta-analysis conducted by Dalgaard et al. (2022), no other longitudinal studies compare the long-term effects of inclusion due to the costs and difficulties associated with such processes.

On the other hand, some studies refer to the benefits of inclusive education not only for students with SEN, highlighting the collaborative work between students with and without SEN and the benefit of the different educational strategies implemented for all students (Hehir et al., 2016; Pocock and Miyahara, 2018; Palacios et al., 2020).

In Chile, a study by Contreras et al. (2020) addressed the effects of inclusive education policies on students' academic performance in mainstream schools and their peers. The results indicate that before implementing an education reform that provides schools with more resources to support the inclusion of students with SEN, the integration of these students had a negative effect on their peers. Namely, although with small size effects, typically developing children scores in standardized tests dropped after the inclusion of children with SEN in their classrooms. However, the negative effect was neutralised after the reform, possibly due to greater recognition of SEN and increased resources for inclusion.

Concerning students with SEN, Rosas et al. (2021) showed that deaf and blind students present differences in performance in different tests, according to the educational system they attend. The results indicate that students who are blind or have low vision and are integrated into regular schools have better results in mathematics than their peers who attend special schools. However, socioemotional results are better in students who attend SE compared to integrated students. With respect to deaf students, the results suggest that students' performance is highly dependent on their form of communication and the educational system they attend. The results indicate that students attending special schools, and who communicate with Chilean Sign Language (ChSL), have the best results in cognitive skills, language precursors and mathematical skills. In addition, the same study indicates that the included students who communicate with ChSL are those who present the most diminished results. The following will briefly present the international state of the art on the inclusion of students with disabilities and the development of early skills in this population, with a special interest in deaf and blind students.

1.1 Deaf students

Diverse factors influence the needs of deaf children, encompassing variations in their degree of hearing loss, the type of hearing assistance used, the permanence of their condition, their preferred mode of communication, and the age at which they were diagnosed (Terlektsi et al., 2019). Other variables that may be taken into account are cognitive ability, socio-economic status and parental support. In the case of deaf children, it is also crucial to know whether their parents are deaf or hearing, the former being paradoxically a considerable advantage, as this allows them to develop sign language as their mother tongue early on. This ensures adequate vocabulary development, a central variable for cognitive and social development (Powers, 2003).

On the other hand, using cochlear implants has added more variables to consider, such as age at implantation and level of hearing loss before and after implantation, among others (Archbold et al., 2015). The development of language and reading skills in deaf students, whether implanted or hearing impaired, appear to be strongly determined by the level of hearing loss, as well as the age of access to amplification technology, parental or caregiver involvement, and access to educational resources that allow for adequate language development (Moeller et al., 2007; Nelson and Bruce, 2019). Although there is no consensus, the variables listed above appear to affect the development of phonological awareness and vocabulary breadth in deaf students (Moeller et al., 2007). Although differences in performance or developmental timing have been described, the difficulties mentioned above do not necessarily have a negative impact on the reading learning of deaf students (Moeller et al., 2007; Tomblin et al., 2020). In addition to the aforementioned variables, communication variables such as language preference and the ability to understand peers are of great importance in the academic performance of deaf students attending secondary school (Marschark et al., 2015).

Regarding mathematical skills, there is evidence of difficulty in deaf students performing at the level of their hearing peers (Blackorby and Knokey, 2006; Noorian et al., 2013). One of the possible reasons for difficulties in the development of mathematical skills in deaf students is related to difficulties in language development, such as vocabulary and structure of oral and written language (Noorian et al., 2013; Shelton and Parlin, 2016).

As with mathematical skills, deaf students seem to see the development of their executive functions affected due to the language difficulties derived from their condition. Although there is no consensus on the cause-effect relationship between language and executive functions, several studies have provided evidence supporting language as an essential developmental factor (Daneri and Blair, 2017; Santa-Cruz and Rosas, 2017). Botting et al. (2017) conducted a study comparing executive functions in deaf students and typical development. Executive functions were assessed with standardised tests with low verbal load to reduce the burden of oral language on the results. The researchers found that, despite being 'non-verbal' tests, deaf students showed diminished scores relative to their hearing peers and that the participants' language skills mediated this effect. In addition, a study that used the BRIEF-EF parent report to assess problem behaviours associated with different dimensions of executive functions in typically developing children, showed that deaf children who were native sign language speakers had age-appropriate scores similar to those of their hearing peers (Hall et al., 2017).

In the school system, there is evidence that students with hearing impairment have problems in school adjustment, even if the hearing impairment presented is minimal. Among the problems described are attentional problems, impaired language development and difficulties acquiring reading skills (Goldberg and Richburg, 2004; Moeller et al., 2007). In addition, profoundly deaf students have shown lower performance than students with mild to moderate hearing loss on standardised tests (Mitchell and Karchmer, 2012).

Regarding socioemotional adjustment, the research conducted by Santa Cruz et al. (2021), which focused on Chilean deaf students during their early years of primary education, indicates that they exhibit higher instances of emotional problems overall, particularly in terms of behavioral issues when compared to their typically developing peers. The same study compares socioemotional problems to the type of communication used by deaf students, showing no significant differences in whether they used oral or sign language. Specifically, when deaf students attend regular schools, it has been found that, with specialised professional support, in addition to communication support and integration in group activities, deaf-included students show social skills equivalent to their peers (Antia et al., 2011). Along these lines, deaf students with an appropriate level of oral language presented psychosocial problems if they attended SE (predominantly sign language). In contrast, they had psychological well-being when they attended regular schools with a predominance of oral language. In addition, students who communicate predominantly with sign language showed greater well-being when attending special schools than when attending regular schools (Fellinger et al., 2009).

1.2 Visually impaired students

A wide range of different visual impairment conditions are defined by the degree of vision loss. There are children with severe sight impaired or blind, children sight impaired or partially sighted, and children with low vision (Douglas et al., 2019).

Unlike those with hearing impairment, students with visual impairment do not have the difficulty of being educated in a language to which access is limited. However, the education of blind students requires specific accommodations for the mastery of Braille and the use of technological accessibility devices. This led to greater numbers of blind students in regular schools. For example, in the case of the UK, around 70% of blind students attend regular schools (Morris and Smith, 2008).

Despite greater ease in acquiring decoding skills than their deaf peers, many blind students have reading difficulties (Steinman et al., 2006; Stanfa and Johnson, 2015). Despite not having hearing difficulties, in the early pre-reading stages, blind students require a great deal of support from their caregivers or teachers to expand their experience of the world, which is restricted by a lack of vision (Steinman et al., 2006). Similarly, they rely on their caregivers and parents for early tactile experiences that bring them closer to the Braille reading experience, in a similar way that typically developing students are exposed, sometimes unintentionally, to written material (Steinman et al., 2006; Savaiano et al., 2014). All of these elements will subsequently affect students' reading fluency.

As with reading skills, blind students have presented various difficulties in developing mathematical skills. However, similar to what was presented above, many of these difficulties seem to be related to difficulties in the teaching process and not a consequence of the disability condition (Gulley et al., 2017; Healy and Fernandes, 2020). Thus, the proper use of Braille and diverse technology and teaching techniques can promote the proper development of mathematical skills, reaching high levels of abstraction and complexity (Gulley et al., 2017). In this line, a neuroimaging study conducted on blind professional mathematicians showed that mathematical information processing in blind people does not differ from the mathematical processing of typically developing people (Amalric et al., 2018).

Concerning the development of executive functions in blind children and adolescents, there is no evidence of differences in their development concerning typically developing children and adolescents (Greenaway et al., 2017; Bathelt et al., 2018). Moreover, in some cases, the performance of blind students exceeds that of typically developing participants on standardised tests (Greenaway et al., 2017). However, good results on standardised tests contrast with reports from parents and caregivers about participants' performance in everyday activities involving executive functions (Greenaway et al., 2017; Bathelt et al., 2018).

To our knowledge, few studies have explored cognitive learning differences in blind students integrated into regular schools and students educated in special schools. The only study we had access to, Heyl and Hintermair (2015), showed differences in all domains of executive functions assessed. Blind students scored lower than their sighted peers in the normative sample. In addition, the results show that blind students were underdeveloped in executive function domains of importance for social–emotional development. Underdevelopment appears to be especially true for blind students who attend special schools.

Regarding mental health and socio-emotional problems in general, blind students show lower development than their typically developing peers (Santa Cruz et al., 2021). About socioemotional development, it has been shown that, given the difficulty of monitoring their environment, blind students are affected in their interactions and social skills (Alabdulkader and Leat, 2010; Celeste and Grum, 2010). Despite being able to recognise emotions from a self and peer perspective, blind students are less proficient than their typically developing peers in recognising more complex mental states (Dyck et al., 2004; Tadić et al., 2010). In a study by De Verdier (2016), results show great difficulties related to the social inclusion of blind students that increase throughout the school years. Moreover, although the psychosocial well-being of blind students is equivalent to their peers, in-depth interviews showed that blind students were more stressed, experienced difficulties and expressed greater feelings of loneliness compared to their typically developing peers.

In summary, there is no conclusive evidence regarding the outcomes of segregated versus inclusive education in the case of blind and deaf students. The present study aims to provide longitudinal evidence in this direction, showing the case of deaf and blind students attending both inclusive or segregated education. Specifically, we seek to answer the following questions: (1) What is the performance trajectory of blind and deaf students in segregated versus inclusive contexts in cognitive, linguistic, mathematical and emotional performance? (2) Are differences in subgroups observed within each disability category?

2 Materials and method

This study used the quantitative paradigm, with a non-experimental, longitudinal design with three evaluation periods every 6 months from time 1. Descriptive and correlational analyses allow us to answer the research questions.

2.1 Sample

The sampling process of this study is purposive and non-probabilistic, given the specific characteristics of the variables to be studied. This longitudinal study was framed within the process of acquiring reading and mathematical skills in students with sensory disabilities, which was an inclusion criterion for participation in the research. The consequence of this is that, in many cases, students with sensory impairment have a wide variance in age and educational level. This variance depends on the age of entry into formal education, forms of communication, degree of disability and type of school attended. On the other hand, it was considered as an exclusion criterion that the students had some co-morbidity associated with a particular educational need. All students, whether they used oral language or Chilean Sign Language, were in the process of acquiring written language.

2.1.1 Deaf students

The sample included 23 deaf students ages ranging from 5.42 to 11 years, with an average of 7.39 years. Seventeen of the participants were male, and six were female. Fifteen students were studying in the special education system, and eight were included in regular schools. Only one student attending special schools communicated using oral language. All the others, 14 students, were ChSL users. As for the students integrated in regular schools, four were cochlear implant users and used oral language as the primary means of communication, while four used Chilean Sign Language as a means of communication.

2.1.2 Students with visual impairment

At the beginning of the research, the sample consisted of 29 blind students, ranging in age from 4 to 9.08 years, with an average age of 6.85 years. Fifteen of the participants were male, and 14 were female. Nineteen students studied in special schools, and 10 were integrated in regular schools. Of the total number of students attending special school, 7 had low vision, and 12 were blind, and of the integrated students, attending regular schools, 5 were blind and 5 had low vision.

2.2 Procedure

Cognitive skill development, precursors to reading, early mathematical skills, and emotional and behavioural problems were assessed. The first three variables were measured at three points along the initial educational trajectory. The first measure was taken during the first semester of 2018, when the children were beginning the reading process, and then followed up at 6 months and 12 months after the first assessment. The measurement of emotional and behavioural problems was carried out at two points, at the beginning and end of the research. Previously trained professionals conducted the assessments. They took place in the educational centres or in the participants' homes in two individual sessions of about 45 min. Children were invited to participate through their schools or their families, and only children who were authorised by their parents through informed consent and who demonstrated their voluntary interest in participating through informed assent were included in the study. This research was approved by the Ethics Committee of Social Sciences and Humanities of the Pontificia Universidad Católica de Chile.

2.3 Instruments

The following tools were used to perform the cognitive skills composite score.

2.3.1 Analogies subtest of the WISC-V test

This test assesses abstract logical reasoning and verbal reasoning. Students are asked to say how two concepts are similar and, according to a correction scale, are awarded between 0 and 2 points. The original test has a Cronbach's alpha = 0.89 (Rosas and Pizarro, 2018).

2.3.2 Cat-Dog subtest of the Yellow Red executive functions assessment battery

This test is an adaptation of the Hearts & Flowers test (Davidson et al., 2006; Diamond et al., 2007) used to assess the general development of executive functions. The test is administered on a Tablet and has three stages; the first asks students to press on the same side of the figure each time a cat appears, the second asks them to press on the opposite side each time a dog appears, and the third stage is mixed. One point is awarded for each correct answer, and 0 points for each error. The Cronbach's alpha of the original test is 0.83. This test was administered in its original version to students with AD and in an auditory version to students with DV (Rosas et al., 2022).

2.3.3 Digit Retention subtest of the WISC-V test

This test assesses short-term auditory memory and working memory, among other cognitive skills. It has 3 subtests: in direct digits, children are asked to repeat a sequence of numbers in the same order in which they heard it. In sequenced digits, children are asked to listen to a sequence of numbers and to say it in increasing order. And in inverse digits, children are asked to repeat a sequence of numbers after hearing it, but in reverse order. A score of one is given for each correct answer and zero for each error. The total score was made by calculating a composite score of the three tasks. The Cronbach's alpha of the original test is 0.89. It was used for children with DV, and a linguistic adaptation was made for LS-using children (Rosas and Pizarro, 2018).

The following instruments were used to assess the development of reading precursors.

2.3.4 PEFCO phonological awareness assessment

An adaptation of 2 subtests of the Phonological Awareness Assessment test (Varela and Barbieri, 2015) was used. Initial sound identification and phonemic synthesis were assessed. Initial sound identification is assessed by presenting a stimulus word and then asking the child to identify which of two alternatives begins with the same sound as the stimulus. Phonemic synthesis was assessed by telling children all the sounds in a word and then asking them to identify from two alternatives the word corresponding to the synthesis of the above sounds. 1 point was awarded for each correct answer and 0 points for errors. The original test has good reliability indicators (Cronbach's $\alpha = 0.89$).

2.3.5 Vocabulary breadth test

Vocabulary breadth was assessed with an adaptation of the TEVI-R test (Echeverría et al., 2002). In this test, children are asked to choose from four images the one that best represents a given word. One point is awarded for a correct answer and 0 points for errors. It was applied only to students with AD.

The following instrument was used for the assessment of initial mathematical skills.

2.3.6 MARKO-D assessment battery

This test was applied for the assessment of mathematical precursors. In this test, children are asked questions related to various mathematical skills. The questions are aimed at assessing different levels of development. One point is awarded for correct answers, and zero points for errors. The Cronbach's alpha of the Chilean version of the test is 0.95. The instrument has been adapted for both children with both DV and AD (Ricken et al., 2011).

Finally, the following instrument was used to assess emotional problems.

2.3.7 Child behaviour checklist 6–18

This test assesses the presence of emotional and behavioural problems. It yields both a total score and a scale of internalising and externalising problems. The original test has a Cronbach's alpha of 0.74. This instrument was answered by parents and guardians of children with AD and DV (Achenbach and Ruffle, 2000; Achenbach and Rescorla, 2001).

2.4 Data analysis model

To assess differences between students attending special or regular schools, Two-Way Mixed ANOVA was used considering one between-subjects factor (special school or regular school) and one within-subjects factor (Time 1, 2 and 3). For the analyses of each of the tests by disability condition, the following assumptions were tested: (1) outliers in any of the cells of the design, (2) residuals are normally distributed in each cell of the design, (3) the variance of the dependent variable is equal between the groups of the between-subjects factor, (4) homogeneity of covariances, (5) the variance of the between-group differences is equivalent. However, as reported in the text, it was only considered problematic when there was more than one test violation because, as explained by Hox (2020), the assumptions of a test are derived from characteristics of the data in the population, so in small samples deviations from these characteristics are expected. Following his recommendations, the Verbal Reasoning variable was transformed, resulting from violations in assumptions 1, 2, and 3. Verbal Reasoning was transformed to a three-valued ordinal variable, considering low, medium or high performance on the test. In all cases, the main effect of time was analysed to determine whether group progress was significant. The main effect of the group was also analysed to determine the differences between students attending special or regular schools, with specific differences between times being reported only in the case where the main effect of time is statistically significant. When making pairwise comparisons, the Bonferroni method for multiple comparisons was used. For this section of the analysis there are no specific comparisons as there are only two groups. And finally the interaction effect was analysed, to define whether differences between groups could be observed over time, for which the epsilon correction (ε), specifically Greenhouse–Geisser, was applied when the assumption of sphericity is violated, according to the Mauchly's test. The value of partial eta squared (η^2) is included as an indicator of effect size. According to Cohen (1988), a value of $\eta^2 \leq 0.06$ represents a low effect, a value of $0.07 \leq \eta^2 \leq 0.14$ represents a medium effect size and a value >0.14 is high.

Data analyses were performed using the statistical package SPSS (version 27), and all analyses were performed separately for the group of blind and deaf students.

Due to the loss of sample data, missing values were imputed using the Mice package in the statistical program R. This package completes incomplete multivariate data using linked equations. The missing data assignment is based on values observed in an individual's data and relationships observed in other participants' data.

3 Results

3.1 Deaf students

According to the assumptions for the analysis, these are mostly met for all variables except for Verbal Reasoning, as mentioned above.

Comparing the results we can see that there is a main effect of time for vocabulary ($F = 19.12$, $p < 0.001$, $\eta^2 = 0.477$), with a statistically significant difference between T1 and T2 ($M = -4.63$, $SE = 0.67$, $p < 0.001$, 95% CIs [−6.36, −2.90]) and, T1 and T3 ($M = -5.77$, $SE = 1.24$, $p < 0.001$, 95% CIs [−8.99, −2.55]), Mathematics ($F = 18.51$, $p < 0.001$, $\eta^2 = 0.468$), specifically between T1 and T2 ($M = -3.45$, $SE = 1.01$, $p = 0.008$, 95% CIs [−6.08, −0.83], T1 and T3 ($M = -6.91$, $SE = 1.21$, $p < 0.001$, 95% CIs [−10.05, −3.77]) and T2 and T3 ($M = -3.46$, $SE = 1.18$, $p = 0.024$, 95% CIs [−6.53, −0.38]), as well as for externalising problems ($F = 6.82$, $p = 0.016$, $\eta^2 = 0.245$), indicating fewer problems at T3 than at T1 (only two assessments were made). This indicates that across the different measurements there were significant changes in these areas. This is to be expected, given the known effect of schooling and time on these variables. It is striking that there was no improvement in Verbal Reasoning ($F = 2.36$, $p = 0.107$, $\eta^2 = 0.101$), Working Memory ($F = 2.52$, $p = 0.093$, $\eta^2 = 0.107$) and Executive Functions ($F = 2.33$, $p = 0.110$, $\eta^2 = 0.100$).

When analysing the group effect, understood as the type of school attended by deaf students, we only found a significant effect with respect to Verbal Reasoning scores ($F = 4.72$, $p = 0.041$, $\eta^2 = 0.184$). This main effect of group is present in favour of students attending regular schools.

Finally, it is necessary to report that for none of the tests analysed there was a statistically significant interaction.

Although most of the results do not show statistically significant differences when analysing the differences between deaf students who attend regular or special schools, it is important to note that this may be due to the low number of participants in each group, which decreases the power of the study. Therefore, it is relevant to observe the trends in the results, as can be seen in Figure 1. In this, we can see that, both in Vocabulary and in Mathematics and Executive Functions, the performance of students in the special schools is superior to that of those belonging to the ER, demonstrating a statistical trend in this sense. As for Working Memory, the results at time 1 are in favour of the students who attend the special schools, but this trend is reversed at time 3, in which the students who attend the regular schools show better performance, indicating a tendency towards interaction between the type of school the student attends and time. Only in the case of Verbal Reasoning, the performance of students who attend ER is consistently higher than those who attend special schools. And in the case of emotional and behavioural problems, special schools students show a lower presence of problems, both at the general level and with respect to the scale of externalising and internalising problems.

3.2 Students with visual impairment

According to the assumptions for the analysis, these are mostly met for all variables, which is tolerable for the analysis, as ANOVA is a sufficiently robust test.

In the case of students with visual impairment, there is a main effect of time for Phonological Awareness ($F = 4.19$, $p = 0.027$, $\eta^2 = 0.134$), specifically between T2 and T3 ($M = -8.89$, $SE = 0.341$, $p = 0.044$, 95% CIs [−1.76, −0.02]), Mathematics ($F = 19.97$, $p < 0.001$, $\eta^2 = 0.400$), between T1 and T3 ($M = -6.12$, $SE = 0.98$, $p < 0.000$, 95% CIs [−8.63, −3.61]) and T2 and T3 ($M = -3.64$, $SE = 0.98$, $p = 0.003$, 95% CIs [−6.13, −1.15]), Verbal Reasoning ($F = 6.14$, $p = 0.004$, $\eta^2 = 0.183$), only between T1 and T3 ($M = -4.02$, $SE = 1.23$, $p = 0.009$, 95% CIs [−7.16, 5.70]), Working Memory ($F = 8.13$, $p < 0.001$, $\eta^2 = 0.231$), between T1 and T3 ($M = -2.93$, $SE = 061$, $p < 0.000$, 95% CIs [−4.50, −1.36]), and Executive Functions ($F = 4.50$, $p = 0.037$, $\eta^2 = 0.115$), between T1 and T3 ($M = -5.19$, $SE = 1.94$, $p = 0.038$, 95% CIs [−10.16, −0.23]).

On the other hand, a main effect of group, corresponding to the type of school students attend, is observed exclusively in the case of Mathematics ($F = 6.30$, $p < 0.018$, $\eta^2 = 0.189$), in which students attending regular schools average 11.62 points higher in this test than students attending special schools ($SE = 4.63$).

The analysis between time and type of school attended by blind students reveals that there are no statistically significant interactions for any of the tests.

As in the case of deaf students, even though there are no significant differences between the types of schools, there are certain trends that are repeated between instruments: we can observe that in most cases the performance of students with low vision who study in regular schools is better than that of those who study in special schools, although the former also present a greater number of emotional and behavioural problems, both at a general level and with respect to externalising and internalising problems (see Figure 2).

4 Discussion

The aim of this study was to evaluate possible differences between students with disabilities, those attending special schools or regular schools with School Integration Programme (PIE). To this end, the cognitive, linguistic, mathematical and emotional performance of blind and deaf students attending each of the aforementioned educational systems was evaluated.

In the case of deaf students, only a significant effect of time can be observed for instructional skills, indicating that, in the case of Vocabulary and Mathematics, all students showed progress, regardless of the group they were in. However, for most skills the results suggest that the performance of the students attending special schools is slightly superior to that of those attending regular schools. This result replicates the result reported by Rosas et al. (2021) who report that the results obtained by students attending special schools are superior to those attending regular schools. Similarly, the difficulties that deaf students face in the mainstream education system, including regular

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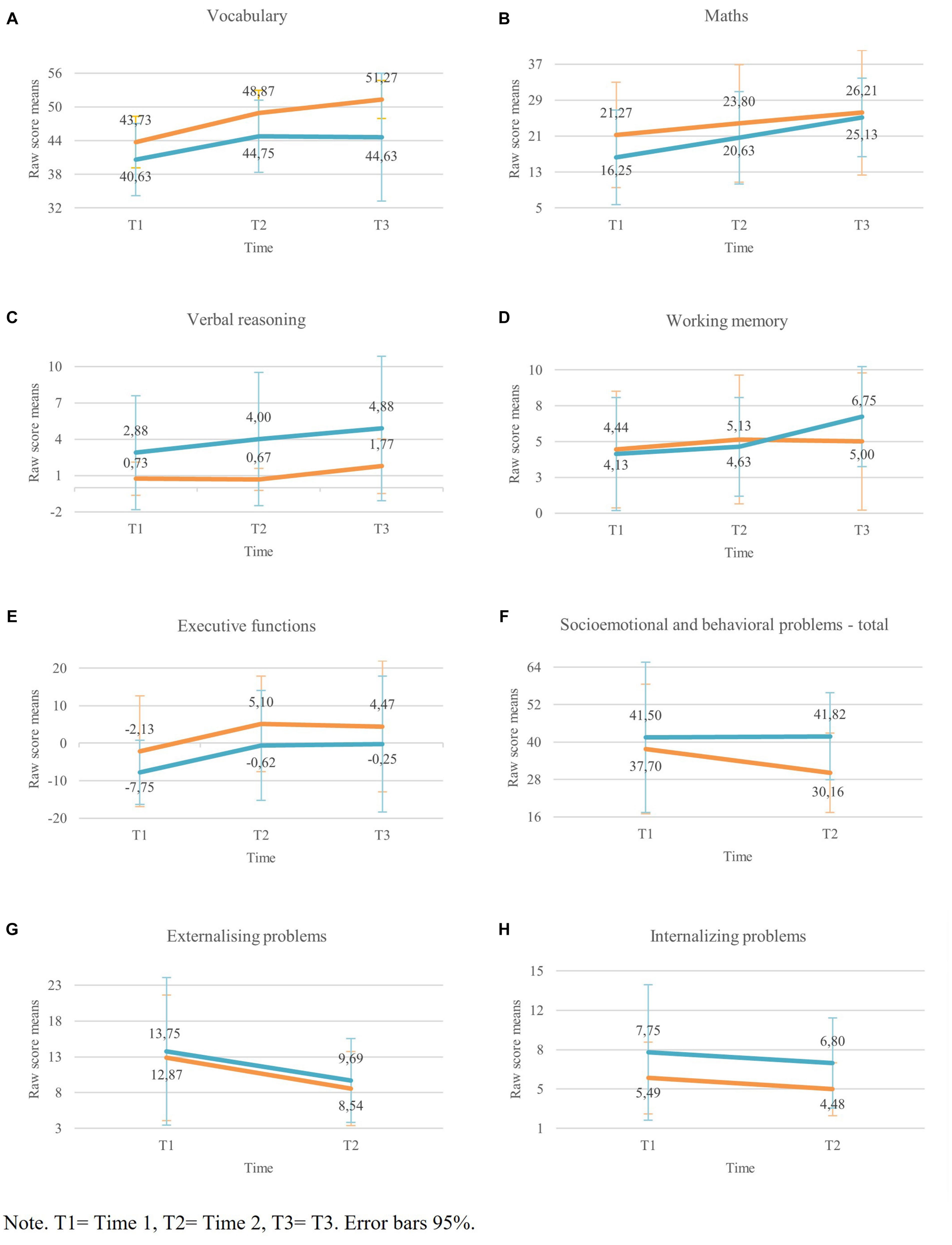

FIGURE 1
(A–H) Performance of deaf students. T1 = Time 1, T2 = Time 2, T3 = T3. Error bars 95%.

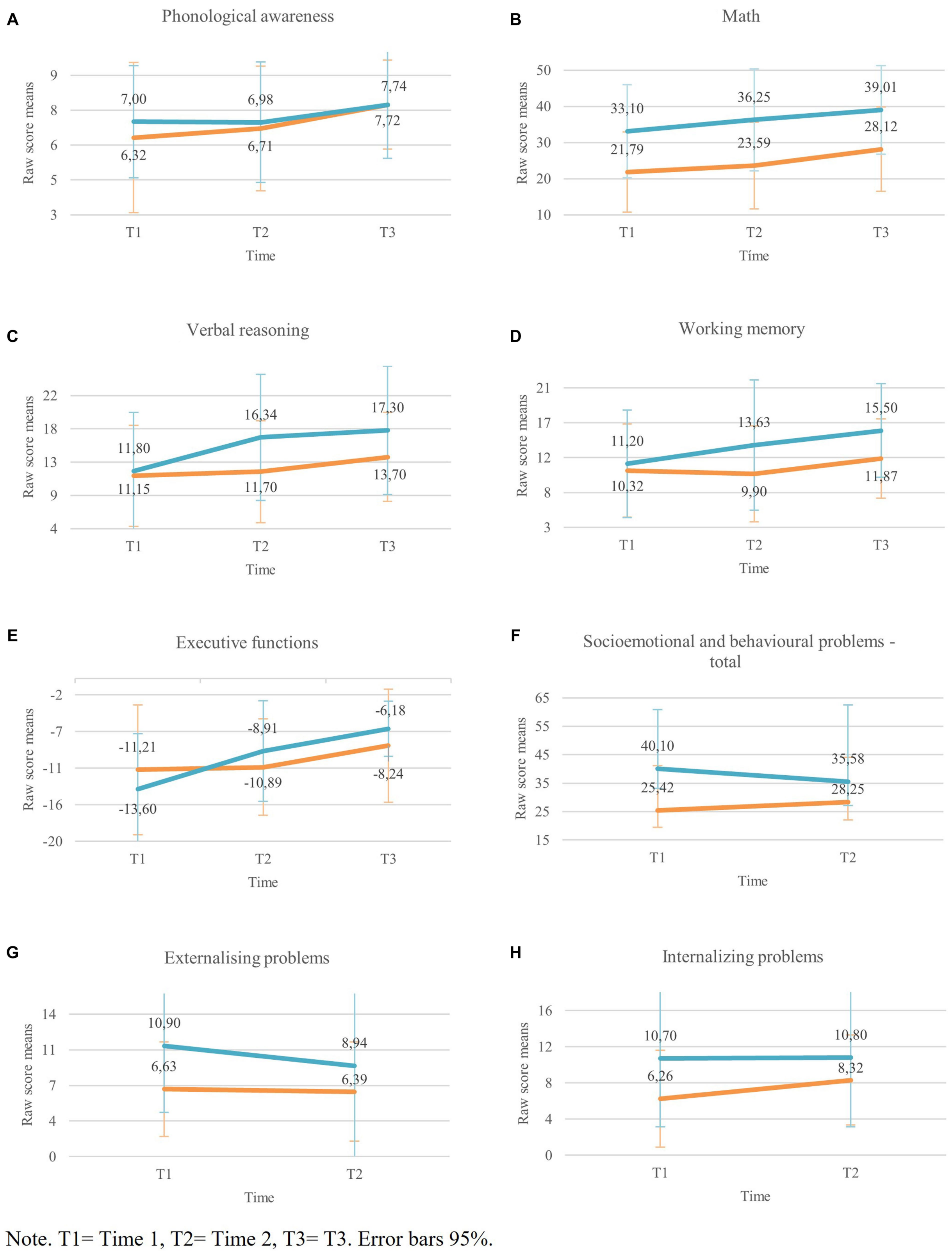

FIGURE 2
(A–H) Performance of blind students. T1 = Time 1, T2 = Time 2, T3 = T3. Error bars 95%.

classrooms, and their negative impact on the learning of deaf students have been described (Goldberg and Richburg, 2004; Moeller et al., 2007). Furthermore, as has been discussed in previous studies, the improved performance of deaf students can be explained by specially adapted educational methods, and instruction in the students' native language, for sign language communication learners (Moeller et al., 2007; Marschark et al., 2015; Nelson and Bruce, 2019).

Regarding the cognitive variables, only in the case of analogies did we observe a significant effect of both time and group. This means that, in addition to showing significant progress between time measures, the students showed significant differences according to the type of school they attend, with these differences being in favour of the students attending regular schools. This effect could be explained by the verbal nature of the task and the difficulty in adapting it to ChSL. In this sense, it is important to mention that in the regular schools, there was a greater presence of oralised students, and cochlear implant users. For both Working Memory and Executive Function assessment, no significant effects of time or group were observed. Although at a descriptive level, it can be seen that while special schools students show a greater increase in Working Memory performance, special schools students show a sustained higher performance in Executive Functions. As mentioned above, these results align with those reported by Rosas et al. (2021), who showed a trend towards better performance of students attending special schools compared to integrated students, both those who communicate mainly through ChSL and those who communicate mainly orally. Interestingly, these differences are maintained over time and are not limited to a point in the early learning process. However, this result should be taken with caution, as this study reports the results of the first evaluation of this longitudinal study, which makes it a related study.

Regarding the presence of emotional and behavioural problems, a significant effect of time is only observed for externalising problems, indicating that both groups reduced their externalising problems over time. In none of the variables related to emotional and behavioural problems are significant differences observed at the group level. However, at the descriptive level we can see that the SE students show a lower presence of internalising, externalising and global problems, results similar to those reported in Rosas et al. (2021). In that article, they reported that integrated students who communicate orally preferentially show a tendency to present greater emotional problems than their integrated peers who communicate through ChSL and, than students attending EE. In turn, integrated students who communicate preferentially through ChSL tend to present more emotional problems than students attending EE. Similar results have been reported internationally, where students' well-being depends on the school they attend and their preferred communication (Fellinger et al., 2009; Antia et al., 2011).

In the case of blind children, it can be said that time affects all the instructional and cognitive variables, which shows that, regardless of the group, the students progress in their learning. Only in the case of Mathematics can we observe a significant effect of the group, which indicates that there are important differences throughout the entire evaluation period between the members of both groups, these being favourable to the students integrated in regular schools. This result replicates that Rosas et al. (2021) presented, who showed that blind or low vision students who attend regular schools perform better than students who attend special schools. The results of this article show at a descriptive level that, with respect to all the learning variables, blind students who attend regular schools perform better than those who attend special schools, only in the case of Phonological Awareness is a compensatory effect observed, where the initial differences disappear in the last measure. The statistically significant differences, in mathematics, in favour of students attending regular schools could be an indicator of good teaching practices in the teaching of mathematics to blind students attending regular schools. However, it is not entirely excluded that, in the case of blind children, there is a process of self-selection, causing children with greater cognitive development to attend regular schools more frequently than those with more diminished development. Previous studies have shown that deaf students show mathematical difficulties, most likely due to the teaching format and the lack of tools for adequate instruction (Gulley et al., 2017; Healy and Fernandes, 2020).

In the case of Executive Functions, although students attending regular schools start with a lower performance than students attending special schools, their more pronounced progress makes them finish with an advantage over their peers. The results reported in Rosas et al. (2021) showed that blind students attending regular schools performed better on all assessments. This replicates the results presented here, as these are the measurements corresponding to the first assessment time of the first study. It is interesting, then, to know the development of these skills in the two educational contexts, which show a greater increase in the performance of students attending RE compared to students attending special schools.

Regarding the presence of emotional and behavioural problems, no significant changes are observed in the period between the evaluations for any of the groups. However, it is important to highlight that, although the differences are not significant between the groups, in this case the advantage is for the students attending regular schools, who present a lower presence of emotional and behavioural problems, although they present a slight tendency to increase problems at an internalising and general level. This has an impact on closing the initial gap between students attending regular and special schools, where the differences are significant on the former measure and non-significant on the latter. Similarly, the study by Rosas et al. (2021) shows an advantage for students attending special schools, who present fewer problems than their peers attending regular schools. Likewise, other studies have shown the difficulties presented by the inclusive education system for blind students, and its impact on socioemotional well-being (De Verdier, 2016; Santa Cruz et al., 2021).

In the case of students with disabilities, it is very common to find studies conducted with small samples, which directly impacts the possibility of obtaining statistically significant results. Consequently, if these results are statistically significant, they are only found when the difference is very large or, in statistical terms, the effect size is very large (Cohen, 1988). Thus, the results in this study are especially noteworthy, particularly regarding the effect of time on the variables of Vocabulary, Mathematics and Total Socioemotional and Behavioural, in the case of deaf students. Similarly, the differences found in Phonological Awareness, Mathematics, Verbal Reasoning, Working Memory and Executive Functions, in the case of blind pupils, are noteworthy. In addition, along the same lines, we should highlight the effect of the type of school in the case of Verbal Reasoning for deaf students and Mathematics for blind students.

When analysing the results of studies with small samples, especially when they are exploratory, Hox (2020) recommends considering an alpha level of around 1.0, instead of the usually used 0.05, assuming the greater possibility of committing a type I error. If we review our results under this criterion, we can observe that there are differences between students with DA in the performance of the Vocabulary test, being higher for students attending special schools ($F = 4.05$, $p = 0.057$, $\eta^2 = 0.162$). In the case of blind students, students who attend regular schools present a greater number of internalising problems ($F = 2.81$, $p = 0.105$, $\eta^2 = 0.094$). Likewise, for blind students there is an interaction effect for the Working Memory test ($F = 2.39$, $p = 0.101$, $\eta^2 = 0.081$), resulting in both groups starting with the same score at T1, clearly distinguishing a faster progress for those who attend regular schools.

4.1 Conclusion

This article is an important resource to assist in the understanding of the learning process of students with SEN, in particular deaf and blind, in the context of regular schools with PIE and special schools. The results presented show that, at the level of instructional performance, in the case of deaf students, attendance at special schools leads to better results, while the opposite is true for blind students.

In the case of cognitive assessments, the results of these study are less consistent. While blind students attending regular schools maintain superior performance in the different tests, deaf students show differences between the assessments. In the case of Verbal Reasoning and Working Memory, the overall performance or increase in performance is higher in students who attend regular schools, while Executive Functions are more developed in students with special schools. This could be related to the level of linguistic intervention that the different tests required for their execution.

And finally, at the Socio-Emotional and Behavioural level, the results indicatedthat, both for deaf and blind students, there is a lower presence of problems in the group of students attending regular schools. However, it is important to note that, in many cases, the differences are not significant and decrease over time for both blind and deaf students.

Although the results of these study are inconclusive, this article shows that students' performance depends both on the disability they have and the educational system they attend. These differences may be due to the educational tools that teachers have when educating students with diverse needs.

What the results of the present study show quite conclusively, however, is that inclusion at all events must be critically evaluated with regard to individual characteristics and the particular conditions of certain groups of students.

4.2 Limitations

The present study is a great contribution to the understanding of the development of academic skills in deaf and blind students integrated in regular schools, in comparison with students attending special schools. However, the sample is still too small to obtain generalisable conclusions. In addition and considering the importance of language in the development of reading skills, mathematics and executive functions, for future studies, it is important to consider the age of language acquisition and oral expression or through ChSL. Additionally, considering different approaches to inclusive education in this kind of studies, would also improve the chances for generalisation of the results.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Scientific Ethical Committee of Social Sciences, Arts and Humanities of the Pontifical Catholic University of Chile. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

RR and VE: conceptualization, writing-review and editing. CS-C, VE, and CM: methodology. CM, VE, and RR: validation. CS-C and CM: formal analysis, resources, and project administration. CS-C, RR, and VE: investigation. CS-C, and CM: resources. VE and CS-C: data curation. RR, VE, CS-C, and CM: writing-original draft preparation. CM: visualization. RR: supervision and funding acquisition. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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