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| Table S1. Overview of the evidence about the performance of deaf children in behavioural regulation and meta-cognition measures along infancy, childhood and adolescence. |
| Study | Target group | Domains of EF | Type of measures | EF measures | Summary of findings |
| Beer et al. (2011) | Deaf cochlear implanted sample (N = 45)Age: 5-18 years | Both | Inventories | BRIEF | Deaf children scored significantly higher than age norms on the behavioural regulation index, but not in the meta-cognition index |
| Beer et al. (2014) | Hearing children (N = 21)Deaf cochlear implanted children (N = 24)Age: 3-6 years | Both | Both | BRIEF and BRIEF-Preschool: Inhibition, working memory and plan/organiseMemory for Designs subtest of the NEPSY–II (visual memory)Attention sustained subtest of Leiter (inhibition-concentration)The Beery Developmental Test of Visual-Motor Integration (organisation-integration) | Deaf children displayed more difficulties on meta-cognition measures (the inhibition-concentration measure, BRIEF working memory, visual memory, organisation-integration or plan/organise subscale) compared with hearing children. No significant group differences were also found on the BRIEF Inhibition (behavioural regulation) compared with hearing children |
| Blank and Holt (2022) | Hearing children (N = 29)Deaf children (N = 30)Age: 3-5 years | Both | Inventories | BRIEF-Preschool version | Deaf children only showed more difficulties in working memory (meta-cognition) |
| Botting et al. (2017) | Hearing children (N = 108)Deaf children (N = 108)Age: 6-12 years | Meta-cognition | Experimental tasks | Color trails test (shifting)Tower of London (planning)Simon task (cognitive inhibitory control)Design fluency (visuospatial cognitive fluency)Odd one out and backward spatial span (visuospatial working memory) | Deaf children performed all EF tasks less well than the hearing group |
| Chen et al. (2022) | Hearing children (N = 28)Deaf children (N = 31)Age: 9-13 years | Behavioural regulation | Experimental tasks | Emotional face-word Stroop task during an electroencephalogram technique | Deaf children exhibited lower accuracy compared to hearing children indicating difficulties in attention allocation ability and emotional cognitive monitoring function |
| Chu and Chen (2023) | Hearing children (N = 35)Deaf children (N = 30)Age: 4-6 years | Meta-cognition | Experimental tasks | Fish-shark go/no-go game (inhibition)Flanker task (inhibition)Digit span (working memory)Dimensional Change Card Sort (cognitive flexibility) | Findings revealed a different pattern for deaf children: some meta-cognition tasks indicated difficulties to inhibit prepotent responses (go/no go) or to adapt to new rules (Dimensional Change Card Sort), whereas the performance on the Flanker task or verbal working memory did not indicate difficulties |
| Dye and Hauser (2014) | Hearing children (N = 60)Deaf children born to deaf parents (N = 37)Age: 6-13 years | Meta-cognition | Experimental tasks | A vigilance task (sustained attention)A distractibility test (selective attention) | The deaf and hearing children did not differ on measures of sustained attention. However, younger deaf children were more distracted by task-irrelevant information in their peripheral visual field, and deaf children produced a higher number of commission errors in the selective attention task. |
| Figueras et al. (2008) | Hearing children (N = 22)Deaf cochlear implanted children (N = 22)Nonimplanted deaf children (N = 25)Age: 8-12 years | Meta-cognition | Experimental tasks | NEPSY battery: Tower (working memory, planning or self-monitoring), Visual Attention, Design fluency, Knock and Tap (self-regulation, inhibition of motor responses, working memory)Day-night and One-two (inhibition)D-KEFS Card Sorting Test (concept formation skills, creativity, problem solving, cognitive flexibility and perseveration) | Deaf cochlear implanted and hearing children differed significantly on some meta-cognition tests (the Tower test, the Card Sorting test and Day-Night/One-Two task), but no differences were found in others (Knock Tap).Hearing children and nonimplanted deaf children also significantly differed on most of these meta-cognition variables (the Tower test, the Day–Night/One–Two task, the D-KEFS Card Sorting test) |
| Figueroa et al. (2022) | Hearing adolescents (N = 54)Deaf cochlear implanted adolescents (N = 36)Age: 12-16 years | Meta-cognition | Experimental tasks | Stroop (inhibition-interference suppression)Plus-minus (shifting)Letter memory task (updating) | Deaf cochlear implanted group performed EF tasks with a similar efficiency as the hearing group |
| Goodwin et al. (2022) | Hearing children (N = 46)Early American Sign Language group (N = 26)Later English group (N = 23)Late American Sign Language group (N = 28)Age: 3-7 years | Both | Inventories | BRIEF-Preschool version | Deaf children who used signed language from birth can develop EF skills (behavioural regulation and meta-cognition) on par with their hearing peers |
| Hall et al. (2017)  | Hearing children (N = 45)Deaf native signers (N = 42)Age: 5-13 years | Both | Inventories | BRIEF | Deaf native signers showed similar EF skills (behavioural regulation and meta-cognition) compared to hearing children |
| Hall et al. (2018) | Hearing children (N = 45)Deaf native signers (N = 49)Deaf cochlear implanted children (N = 26)Age: 5-13 years | Both | Both | BRIEFD-KEFS Tower Test (planning, rule learning and inhibition)Attention-Sustained subtest of the LIPS-RGo/no go (inhibitory control) | Deaf cochlear implanted children obtained lower scores on BRIEF (meta-cognition and behavioural regulation) in comparison to hearing children, and also obtained lower scores in behavioural regulation in comparison to deaf native signers.No differences between groups in experimental tasks (meta-cognition) |
| Holt et al. (2020) | Hearing children (N = 10)Deaf cochlear implanted children (N = 10)Deaf children with hearing aids (N = 10)Age: 6-12 years | Both | Both | BRIEF and BRIEF-Preschool version: Inhibition and working memory | Deaf children showed more difficulties on inhibition (subscale of behavioural regulation) than the hearing group, while no differences were found on working memory (subscale of meta-cognition). When subgroups of deaf children were analysed, no differences were found between hearing group and deaf subgroups |
| Jones et al. (2020) | Hearing children (N = 108)Deaf children (N = 108)Age: 6-12 years | Meta-cognition | Experimental tasks | Color trails test (shifting)Tower of London (planning)Simon task (cognitive inhibitory control)Design fluency (visuospatial cognitive fluency)Odd one out and backward spatial span (visuospatial working memory) | Deaf children performed some meta-cognition tasks (Odd one out, Spatial span and Color trails test) less well than the hearing group |
| Kronenberger et al. (2014) | Hearing children (N = 78)Deaf cochlear implanted children (N = 73)Age: preschool age (3-5 years) and school age (7-17 years) | Both | Inventories | BRIEFLEAF (Learning, Executive, and Attention Functioning Scale) | Preschool deaf children were rated as having significantly more problems than hearing children in meta-cognition aspects of LEAF, while no significant group differences were observed on BRIEF preschool-age subscales.For school-aged children, significant differences were found in the same LEAF domains as for preschool-aged children, school-aged children with CIs were rated as having more problems than hearing children on the behaviour regulation and meta-cognition subscales |
| Kronenberger et al. (2020) | Hearing children (N = 40)Deaf cochlear implanted children (N = 41)Age: 3-6 years | Both | Both | BRIEF-Preschool versionDigit span of Weschler battery and Forward memory of Leiter battery (verbal working memory)Attention sustained subtest of Leiter (inhibition-concentration) | Deaf cochlear implanted children showed significantly poorer EF performance on meta-cognition and behavioural regulation measures than hearing children: the Leiter-R Attention Sustained, Leiter-R Forward Memory, BRIEF Inhibit and BRIEF Working memory subtests. Similar scores between groups were found on BRIEF Shifting (behavioural regulation |
| McCreery and Walker (2022) | Hearing children (N = 86)Deaf children (N = 177)Age: 5-10 years | Both | Both | BRIEF: Working memory (meta-cognition), shift and inhibit (behavioural regulation)Auditory Attention (sustained attention) and Response Set (inhibition) subtests of the NEPSY-IIAutomated Working Memory Assessment | Hearing children had better scores than deaf children on meta-cognition and similar scores on behavioural regulation measures. Deaf children obtained lower scores than hearing children on BRIEF Working memory, working memory tasks and inhibition tasks. However, deaf children obtained similar scores on shift and inhibition (behavioural regulation) |
| Merchán et al. (2022) | Hearing children (*N* = 21)Deaf cochlear implanted children (*N* = 35)Age: 7-10 years | Meta-cognition | Experimental tasks | Attentional Network Test (inhibition) | Deaf group showed similar reaction times, but lower accuracy than hearing group |
| Oberg and Lukomski (2011) | Deaf students (*N* = 22)Age: 5-18 years | Both | Both | BRIEFColor trails test (shifting)Wisconsin Card Sorting Test (problem solving, cognitive flexibility)Attention sustained subtest of Leiter (inhibition-concentration) | BRIEF parent and teacher means for meta-cognition and behavioural regulation index fell below the cutoff criterion |
| Remine et al. (2008) | Deaf adolescents (*N* = 37)Age: 12-16 years | Meta-cognition | Both | Delis–Kaplan Executive Function System (D-KEFS): Tower Test (planning, rule learning and inhibition)Delis–Kaplan Executive Function System (D-KEFS): 20 Questions Test (abstract reasoning and concept formation) | Deaf adolescents showed average nonverbal executive functioning ability compared with age norms |
| Xuan et al. (2018) | Deaf adolescents (*N* = 36)Hearing adolescents (*N* = 36)No age range data available. | Behavioural regulation | Experimental tasks | Iowa Gambling task (decision-making task)Game of Dice (decision-making task) | Deaf adolescents exhibited a preference for risky decision-making in both tasks. |

*Note*. Author interpretation was required for what constituted different aspects of EF in some studies

Table S2. Means and standard deviations of BRIEF and LPP-2 in subgroups of deaf children.

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| **Subscale/index** | **BSL/SSE** | **Spoken English** | **Welch’s *t*-test** |
|  | ***M (SD)*** | ***M (SD)*** | ***t (df)*** | ***p*** |
| BRI | 55.8 (13.4) | 57.1 (12.1) | -0.50 (85.4) | .620 |
| MI | 56.5 (14.1) | 56.4 (12.3) | 0.61 (85.8) | .952 |
| GEC | 55.4 (12.3) | 56.8 (11.3) | -0.56 (85.1) | .580 |
| Total LPP-2 | 93.8 (15.9) | 98.5 (12.9) | -1.47 | .145 |

*Note*. BRIEF and LPP-2 variables are expressed in T-scores and raw scores, respectively. Higher T-Scores on BRIEF reflect increased incidence of problematic behaviour, while higher scores on LPP-2 reflect better language skills. BRI (Behavioural Regulation Index), MI (Meta-cognition Index), GEC (Global Executive Composite) and LPP (Language Proficiency Profile).

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| Table S3. Effect of age on BRIEF and LPP-2 scores of deaf and hearing children. |
| **Subscale/index** | **Young group** | **Middle age group** | **Pre-adolescents’ group** | **Welch’s ANOVA** |
|  | ***M (SD)*** | ***M (SD)*** | ***M (SD)*** | ***F*** | ***P*** |
| **Deaf sample** |
| BRI | 50.2 (13.0) | 48.6 (12.7) | 49.7 (14.8) | 0.12 | .88 |
| MI | 75.7 (17.2) | 78.7 (19.3) | 81.7 (20.3) | 0.64 | .53 |
| GEC | 125.7 (27.0) | 126.8 (30.1) | 131.7 (32.1) | 0.27 | .76 |
| Total LPP-2 | 93.7 (13.6) | 95.4 (16.9) | 99.3 (12.7) | 1.20 | .31 |
| **Hearing sample** |
| BRI | 43.3 (11.1) | 42.9 (11.4) | 39.2 (10.9) | 1.63 | .20 |
| MI | 71.2 (16.0) | 68.7 (14.3) | 71.4 (15.3) | 0.44 | .65 |
| GEC | 114.5 (25.5) | 111.5 (24.1) | 110.2 (22.6) | 0.27 | .76 |
| Total LPP-2 | 106.1 (8.6) | 109.3 (4.6) | 109.7 (4.0) | 2.59 | .09 |

*Note*. BRIEF and LPP-2 variables are expressed in raw scores. BRI (Behavioural Regulation Index), MI (Meta-cognition Index), GEC (Global Executive Composite) and LPP (Language Proficiency Profile).

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| Table S4. Bivariate Pearson’s correlations between executive functions and language in the deaf and hearing group. |
| Group | Subscale/Index | Form | Content | Reference | Cohesion | Use | LPP2 |
| Deaf | Behaviour Regulation Index | -.11 | -.11 | -.08 | -.10 | -.13 | -.14 |
| Meta-cognition Index | -.23\* | -.19 | -.14 | -.20 | **-.29\*\*** | **-.27\*** |
| Global Executive Composite | -.20 | -.17 | -.13 | -.18 | **-.25\*** | -.23\* |
| Hearing | Behaviour Regulation Index | -.04 | -.16 | **-.25\*\*** | -.16 | -.04 | -.17 |
| Meta-cognition Index | -.01 | -.13 | -.17 | -.09 | -.01 | -.11 |
| Global Executive Composite | -.03 | -.16 | **-.22\*** | -.11 | -.02 | -.14 |

*Note*. BRI (Behavioural Regulation Index), MI (Metacognition Index), and LPP2 (Language Proficient Profile-2). Bolded values indicate that the correlation remained statistically significant after the Benjamini–Hochberg procedure was applied with a false discovery rate of 0.05. \**p* <.05; \*\**p* <.01

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| Table S5. Structural equation model comparisons |
| Models | χ2 | df | χ2/df | *p* | Bollen-Stine | CFI | TLI | RMSEA | AIC | BIC |
| **EF influences language** |
| Model A1. BRI precedes MI | 3.10 | 2 | 1.55 | .21 | .24 | .99 | .99 | .02 | 19.10 | 58.67 |
| Model A2. MI precedes BRI | 54.55 | 2 | 27.27 | <.001 | <.001 | .95 | .86 | .16 | 70.55 | 110.12 |
| Model A1 controlling for age | 4.03 | 2 | 2.01 | .13 | .16 | .99 | .99 | .03 | 30.03 | 94.34 |
| **Language influences EF** |
| Model B1. BRI precedes MI | 59.56 | 2 | 29.78 | <.001 | <.001 | .95 | .85 | .17 | 75.56 | 115.14 |
| Model B2. MI precedes BRI | 12.92 | 2 | 6.46 | <.01 | <.01 | .99 | .97 | .07 | 28.92 | 68.50 |

*Note*. In model A1, we determined that behavioural regulation EF should precede meta-cognition EF, so the following pathway was estimated: Group → Behavioural regulation EF → Meta-cognition EF → Language. As can be seen in this table, the model showed a reasonably good fit. When meta-cognition acted as the primary mediator and behavioural regulation as the secondary mediator in model A2, the chi-square test and other parameters such as RMSEA or TLI denoted that the goodness of fit was not achieved. In the case of the mediation model B1, the following pathway was estimated: Group → Language → Behavioural regulation EF → Meta-cognition EF. The model fit was inadequate. Compared to the previous model, model B2 retained language as the primary mediator, while meta-cognition was the secondary mediator and behavioural regulation the dependent variable. Although chi-square was significant, all other fit indices were within acceptable parameters. Significant direct and indirect pathways were found (β = -.13, 95%CI = -.17 to -.08; p <.001 and β = -.10, 95%CI = -.12 to -.08; p <.001; respectively).

Finally, comparisons between models were performed using both the AIC and the BIC values. In this case the model with lower AIC and BIC is likely to be correct. The results were consistent showing that model 1 is a better fit to the data compared to the other models. Therefore, we tested again our model 1 controlling for age. The results of this model confirmed that the mediating effect of EF on language is maintained even when controlling for age. The model showed a good fit with a significant direct and indirect effect. Age was significantly related to the variables language (β = .16, 95%CI = .11 to .21; p <.001) and meta-cognition (β = .09, 95%CI = .04 to .13; p <.001), but not to behavioural regulation (β = -.03, 95%CI = -.10 to .03; p =.27).

# SUPPLEMENTARY FIGURE CAPTIONS

Figure S1. Serial mediation model A2 with meta-cognition and behavioural regulation EF as mediators of the relationship between deaf/hearing condition and language. Solid lines represent the direct effects and dashed lines represent the indirect effects.

Figure S2. Serial mediation model B1 with language and behavioural regulation EF as mediators of the relationship between deaf/hearing condition and meta-cognition. Solid lines represent the direct effects and dashed lines represent the indirect effects.

Figure S3. Serial mediation model B2 with language and meta-cognition as mediators of the relationship between deaf/hearing condition and behavioural regulation. Solid lines represent the direct effects and dashed lines represent the indirect effects.

Figure S4. Serial mediation model A1 with age as a covariate. Solid lines represent the direct effects and dashed lines represent the indirect effects.

## Diagrama  Descripción generada automáticamenteFigure S1

 

### Figure S2

Figure S3



Figure S4

#### Supplementary material references

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