Working Memory and Executive Functions in monolingual and bilingual preschoolers: The role of the socio-economic status

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Abstract

Research on bilingualism showed mixed results about performance on cognitive tasks in preschoolers, and only few studies also considered children's socioeconomic status. This study aims at (i) investigating the difference between monolingual and bilingual preschoolers concerning socioeconomic status in the Italian context; (ii) investigating the difference between monolinguals and bilinguals concerning performance on working memory and executive functions tasks, and (iii) verifying the difference between monolinguals and bilinguals on working memory and executive functions tasks, also controlling for socioeconomic status. A large battery of working memory and executive functions tasks was administered to 91 typically developing children (M_{age}= 64 months; 44 monolinguals and 47 bilinguals). Findings reported higher socioeconomic status in monolinguals; furthermore, results showed that the monolingual group outperformed the bilingual group on some cognitive tasks administered. However, when performance of monolinguals and bilinguals was controlled for socioeconomic status, no significant difference emerged, and most effect sizes were indeed negligible.

Keywords: bilingualism; socioeconomic status; working memory; executive function; preschool

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Introduction

Executive function (EF) refers to a family of adaptive, goal-directed, top-down mental control processes that may rely on working memory (e.g., Miyake et al., 2000). Working memory is a system that can hold a limited amount of information in a heightened state of availability for use in ongoing information processing (e.g, Cowan, 2017).

A large body of literature showed that some contextual factors, such as bilingualism (e.g., Foy & Mann, 2014; Martin-Rhee & Bialystok 2008; Morales, Calvo, & Bialystok, 2013) and socioeconomic status (SES; for a review Lawson, Hook, & Farah, 2018) can influence the development of EF and WM.

There is a controversy on the role of WM and EF in children with bilingualism, which in the present study is conceived within a functional perspective referring to the use and need of two or more languages in everyday life (Grosjean, 1992). On the one hand, past literature showed that bilinguals outperform monolinguals in EF and WM tasks (for a review, see Bialystok, Craik, & Luk, 2012). Conversely, a series of recent studies did not find evidence for a bilingual advantage (e.g., Duñabeitia, 2014; Jaekel, Jaekel, Willard, & Leyendecker, 2019; von Bastian, Souza, & Gade, 2016). Notably, some recent systematic reviews and meta-analyses, on both younger and older children and adults, found no evidence of any difference between monolinguals and bilinguals on measures of EF after correcting for publication bias (de Bruin, Treccani, & Della Sala, 2015; Gunnerud, Ten Braak, Reikerås, Donolato, & Melby-Lervåg, 2020; Lowe, Cho, Goldsmith, & Morton, 2021).

A crucial aspect that might influence the results on this topic is SES.

There is abundant evidence indicating that children living in poverty are at increased risk of deficits in WM and EF domains (e.g., Lawson et al., 2018).

In the Italian context, this issue is particularly relevant because bilingualism in childhood is frequently associated with migration and minority language backgrounds. Most children from migrant families are first exposed to their home language (L1) within the family context and subsequently encounter the majority language (L2) primarily at school. Moreover, migrant families often experience socioeconomic disadvantage, resulting in a frequent overlap between bilingualism and lower SES.

Recent Italian studies on language minority bilingual children (LMBC) have consistently highlighted the need to disentangle the role of bilingualism from that of SES. For instance, studies comparing LMBC and monolingual children with different SES levels have shown that, once SES is controlled for, several differences traditionally attributed to bilingualism are reduced or disappear, whereas socioeconomic disadvantage remains a robust predictor of performance, particularly in complex language-related skills (Bonifacci et al., 2019; Bonifacci et al., 2022; Cangelosi et al., 2024).

Although these studies focused primarily on literacy outcomes, their findings are highly relevant to research on EF and WM. EF and WM are known to support language and academic development, including reading comprehension and vocabulary acquisition. Therefore, the documented impact of SES on literacy skills suggests that socioeconomic disadvantage may also play a fundamental role in shaping the cognitive mechanisms that underpin those skills, especially during the early phases of development.

Most of the studies investigating the role of SES in the performance of cognitive tasks in monolinguals and bilinguals are focused on older children or adults (e.g., Donnelly et al., 2019; Giovannoli et al, 2020; Vivas et al., 2020). In fact, only few studies are focused on children in the early years of life (e.g., Carlson & Meltzoff, 2008; Morales et al., 2013),

However, evidence on preschool-aged children in the Italian context is still limited, despite the fact that the impact of SES may be particularly pronounced in the earliest stages of cognitive and language development. Indeed, considering different stages of language development could be relevant.

Based on these premises, we decided to examine the performance of monolingual and bilingual preschool children on a series of WM and EF tasks. We also decided to take SES into account, since past literature showed that this might be crucially important (e.g., Lawson et al., 2008).

Given the sociolinguistic characteristics of the Italian context, where many bilingual preschoolers come from lower-SES backgrounds, disentangling the respective contributions of bilingualism and SES to early EF and WM development appears essential.

The current study

The current study was performed in Italy, in an area in which bilingual children are typically from a lower SES background.

The main goal is to examine differences between monolinguals and bilinguals, controlling for SES, in WM and EF tasks, during the pre-school years.

Starting from this main goal, our research questions are as follows:

Research Question (RQ1): *Is there a difference between monolinguals and bilinguals concerning SES?*

Research Question 2 (RQ2): *Are there some differences in monolinguals and bilinguals concerning performance in WM and EF tasks?*

Research Question 3 (RQ3): *Does SES play an important role in performance in WM and EF tasks in monolinguals and bilinguals?*

Concerning *RQ1*, we expect to find a difference between monolinguals and bilinguals concerning SES. This is because in the Italian context a large number of bilinguals come from a low-income background (INVALSI, 2018). Therefore, we expect that, on average, monolingual children will probably have a higher SES than bilinguals. It is, in fact, very hard to match monolingual children for SES in Italy, since many bilingual families typically have lower resources as compared to average families.

Concerning *RQ2*, as for differences between monolingual and bilingual children in cognitive performance, we did not have strong predictions, since the literature is mixed (e.g., Byalistok et al., 2012; Jaekel et al., 2019)

Finally, concerning RQ3, we expect to find (i) a relation between SES and performance in WM and EF tasks in preschoolers and (ii) SES influences performance in WM and EF tasks, in line with the literature (e.g., Lawson et al., 2008) and that its influence is more relevant than bilingualism in the specific Italian context.

Methods

Participants and procedure

91 typically developing children, M_{age} = 64.20 months (5.08), range = 53-74, 52% female, participated in the study. 44 children were monolingual, M_{age} = 63.77, SD = 5.95), and 47 were bilingual (M_{age} = 64.60, SD = 4.12). Two groups did not statistically differ for age, $F(1, 89) = 0.201$, $p = .655$, $\eta^2 = .002$.

The children were recruited in two public preschools in the main town of a northwestern region of Italy. Concerning monolinguals, we included typically developing children (without ascertained diagnosis) that speak only Italian with both Italian parents. Regarding bilinguals, we considered typically developing children that speak Italian at school and in the community and a different language at home. Specifically, the bilingual group included children whose parents, in 85.1% of cases, both had the same non-Italian nationality. The languages spoken at home were: Spanish (n = 19; 40%); Albanian (n = 14; 29.8%); Arabic (n = 5; 10.6%); French (n = 2; 4.3%); English (n = 2; 4.3%); Chinese (n = 1; 2-1%); Sinhala (n = 1; 2.1%); Polish (n = 1; 2.1%); Tagalog (n = 1; 2.1%); Urdu (n = 1; 2.1%). The school did not inform the research team of the need for a mediator to inform the parents of bilingual children about the research. The Peabody Picture Vocabulary Test was administered to the bilingual children group to assess Italian comprehension; the mean raw score was 48.38. Each child was tested by a trained graduate student in a quiet room during school day. The tasks were administered during two sessions lasting approximately 20-30 minutes each.

Materials

Parents' questionnaire

Parents provided both bilingualism and SES information filling in a questionnaire. Parents were asked about their nationality, as well as the language spoken at home. Concerning SES, each parent's educational level was classified on a 7-point scale: 0 = no educational title; 1 = primary education, 2 = secondary school; 3 = professional education; 4 = high school; 5 = degree; and 6 = post graduate education. Each parent's occupation was classified on an 8-point scale. The levels of this scale were: 1 = housewife, unemployed, student; 2 = unskilled professions; 3 = craftsmen and skilled workers, drivers of vehicles or machinery; 4 = qualified commercial and service jobs; 5= clerical work; 6 = technical professions; 7 = highly specialized intellectual and scientific professions; and 8 = entrepreneurs and high executives.

Working memory tasks

Mr. Cucumber Test (Case, 1985). The outline of an extra-terrestrial figure, to which colored stickers were attached, was displayed for 5s per item. The child was then required to show the positions of the stickers. There were three items at each level (from one to eight stickers). The test was discontinued after failing three items at a level. One point was awarded for each consecutive level on which at least two items were correctly solved, and one-third of a point for each item above that level

Backward Word Span (BWS; Morra, 1994). The child had to repeat lists of words in backward order. Each level (from two to seven words) had three lists. The test was discontinued when the child failed all three lists at one level. One point was awarded for each consecutive level on which a subject had at least two lists correct and one-third of a point for each list above that level.

Executive function tasks

Day/Night Stroop Task (Gerstadt, Hong, & Diamond, 1994). This is an inhibition task. The task consists of two phases. In the first phase (control phase), the child is shown cards depicting either a "moon" or a "sun." The child is required to say "night" when seeing the moon and "day" when seeing the sun. In the second phase (Stroop phase), the child must say "day" when seeing the moon and "night" when seeing the sun. Each phase includes 16 items. The final score is calculated as the difference between the Stroop phase and the control phase (Stroop-control).

Simon Says Task (Strommen, 1973). This task was used to assess response inhibition. The child was required to do certain actions (e.g., touch his head) only if the experiment said "Simon says". If not, the child must not move. The task includes twenty items (10 go/Simon says items in which the child has to perform the action required and ten no-go items in which the child should not move). The score is the sum of the correct responses to the no-go items

Dimensional Change Card Sort (DCCS; Zelazo, 2006). This is a shifting task: the child is shown a deck of cards, each of which displays a figure with three variables: shape (rabbit, boat), color (red, blue), and the presence or absence of a black border. During the pre-switch phase the child was required to sort the cards according to color, during the post-switch phase the child was required to sort the cards according to shape, and in the third phase, the child had to sort cards with a black border according to shape, and those without border according to color. There were six trials in the pre-switch phase, six in the post-switch phase, and 12 in the border phase. During the pre-switch phase, the DCCS creates a predominant response that must later be inhibited in the post-switch phase. Subsequently, the third phase introduces an additional, second level variable. The score was the sum of the child's correct responses.

Magic House (Panesi & Morra, 2017). This task assesses monitoring, addition and deletion of working memory contents. On each item, three to five toy animals were placed sequentially in a cardboard house. The child was instructed to recall which animal entered the house last, and which one entered just before it. There were nine items, each of which was scored zero, one, or two points (i.e., the number of correct responses).

Italian comprehension

Peabody picture vocabulary task. The Italian version of the PPVT (Stella, Pizzoli & Tressoldi, 2000) was administered only to bilingual children group to assess receptive vocabulary (Hoffman, Templin & Rice, 2012). In this task, the experimenter reads a word aloud and the child selects the corresponding picture from four options. The starting item is determined by the child's PPVT age. A basal is established after eight consecutive correct responses; otherwise, testing proceeds backward until this criterion is met. The task continues until the child makes six errors within eight items. The score corresponds to the total number of correct responses, with items preceding the basal counted as correct (range: 0-175).

Data analytic approach

A composite SES score was used. To create the SES composite score, all four SES variables (each parent's education level and occupation) were transformed in z-scores considering the whole sample and then the mean was computed (if there were not at least 2 out of 4 indices of SES, the SES composite score was not computed, and it was considered as a missing value; this caused the exclusion of 8 participants from some analyses).

Descriptive analyses considering SES and cognitive task scores were calculated for the monolingual and bilingual groups. Concerning SES and cognitive measures, the differences between the two groups were investigated performing independent sample t-tests and examining the effect size. Subsequently, Pearsons correlations among variables of interest were calculated. Then, we used ANCOVAs to examine the difference in cognitive performance between bilingual and monolingual groups adjusting for SES. Effect sizes were calculated using eta squares (η^2), for the ANCOVA. The results were interpreted using Cohen's (1988) traditional criteria. Analyses were performed using SPSS (IBM Corp. Released 2019).

Results

Descriptive statistics of WM, EF task scores and SES variables, and differences between monolingual and bilingual groups performing independent sample t-tests (also examining the effect size) are reported in Table 1.

The results suggest a significant difference in SES between groups, with a high effect size of the difference in favor of monolingual children.

Concerning performance in cognitive tasks, monolingual children outperformed bilingual children in the Simon Says and Magic House tasks, with a medium effect size of the difference, while the group difference on the other tasks was nonsignificant.

Tab. 1 - *Descriptive statistics on cognitive task scores and SES variables (for the monolingual and bilingual groups), results of the independent sample t-tests performed to compare performance on cognitive tasks and SES of monolingual and bilingual groups and standardized differences and 95% CIs expressed in terms of Cohen's d between the two groups*

	Monolingual				Bilingual									
Tasks	Min	Max	Mean	SD	Min	Max	Mean	SD	*t*	*d.f.*	*p*	Cohen's *d*	LL	UL
BWS	0.33	5.00	2.40	0.87	1.00	3.33	2.20	0.75	1.15	89	.25	0.25	-0.17	0.66
Mr. Cuc.	0.00	3.66	1.73	0.85	0.00	3.33	1.61	0.74	0.67	88	.50	0.15	-0.26	0.56
Day/Night Stroop	-6.00	1.00	-1.24	1.78	-11.00	3.00	-1.78	2.80	1.08	86	.28	0.23	-0.19	0.65
Simon Says	0.0	19.0	7.59	6.68	0.0	20.0	4.57	6.32	2.21	89	.03	0.46	0.04	0.88
DCCS	17.0	24.0	19.12	1.69	12.0	24.0	18.41	2.34	1.61	87	.11	0.35	-0.08	0.76
Magic House	2.0	18.0	11.82	3.66	2.0	17.0	9.83	3.95	2.49	89	.02	0.52	0.10	0.94
SES	-1.08	1.60	0.52	0.74	-1.40	1.60	-0.40	0.69	5.51	71	<.001	1.295	0.78	1.80

Note. LL = Lower Level, UL = Upper Level. Differences are statistically significant when zero is not included in the interval (95% confidence interval).

Table 2 reports zero-order (Pearson) correlations in the whole sample. The two WM measures showed a reasonable correlation. Among EF tasks, the two inhibition tasks showed a reasonable correlation. Moreover, the Simon Says and the DCCS tasks correlated significantly with the Magic House task. Furthermore, WM tasks correlated significantly with EF tasks except for two correlations. Finally, cognitive tasks were significantly correlated with the SES composite score, except for Mr. Cucumber and DCCS.

Finally, we ran a series of analyses ANCOVAs using SES as covariate, and linguistic status (monolingual vs. bilingual) as the independent variable. The ANCOVA results are reported in Table 3.

Tab. 2 - *Correlations among cognitive task scores and SES*

		1	2	3	4	5	6	8
1	BWS	—						
2	Mr. Cucumber	.358**	—					
3	Day/Night Stroop	.262*	.088	—				
4	Simon Says	.375**	.344**	.265*	—			
5	DCCS	.299**	.206	.088	.162	—		
6	Magic House	.421**	.298**	.162	.450**	.263*	—	
8	SES	.376**	.103	.265*	.494**	.121	.459**	—

Note.
$^{*}p < .05$
$^{**}p < .01$

As we can observe, results showed the absence of a statistically significant effect of bilingualism in all the tasks. Moreover, the effect of SES was statistically significant in BWS, Simon Says and Magic House.

In particular, in the BWS task the effect of bilingualism was not statistically significant; instead, the effect of the covariate SES was statistically significant and the effect size was large. As for the Simon Says, the effect of bilingualism was not statistically significant; concerning the effect of the covariate SES, it was statistically significant and the effect size was large. Finally, the results of the Magic House showed that the effect of bilingualism was not statistically significant; instead, the effects of the covariate SES was statistically significant and the effect of size was large (for details, see table 3).

Tab. 3 - *Results of the ANCOVAs using SES as covariate, and linguistic status (monolingual vs. bilingual) as the independent variable*

	Source of variance	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**	**η²**
BWS	SES	7.549	1	7.549	14.001	< .001	0.166
	Linguistic status	1.313	1	1.313	2.435	0.123	0.029
	Residuals	37.744	70	0.539			
Mr.Cuc.	SES	0.317	1	0.317	0.496	0.483	0.007
	Linguistic status	8.190×10^{-4}	1	8.190×10^{-4}	0.001	0.972	0.00002
	Residuals	44.060	69	0.639			
Day/Night	SES	21.184	1	21.184	3.525	0.065	0.048
	Linguistic status	0.008	1	0.008	0.001	0.970	1.903×10^{-5}
	Residuals	408.624	68	6.009			
Simon Says	SES	633.290	1	633.290	17.914	< .001	0.193
	Linguistic status	7.072	1	7.072	0.200	0.656	0.002
	Residuals	2.474.667	70	35.352			
DCCS	SES	0.623	1	0.623	0.125	0.724	0.002
	Linguistic statusl	4.251	1	4.251	0.856	0.358	0.012
	Residuals	342.636	69	4.966			
Magic House	SES	199.850	1	199.850	15.622	< .001	0.175
	Linguistic status	4.571	1	4.571	0.357	0.552	0.004
	Residuals	895.494	70	12.793			

Discussion

The relationships between SES, WM and EF (e.g., Lawson et al., 2018), and between bilingualism and WM and EF (e.g., Foy & Mann, 2014; Martin-Rhee & Bialystok, 2008; Morales et al., 2013) have been repeatedly investigated in the current literature. However, studies that considered the joint effects of bilingualism and SES on WM and EF found mixed results (e.g., Gunnerud, 2020; Vivas et al., 2017), and only a few studies jointly investigated these variables in preschoolers (e.g., Carlson & Meltzoff, 2008). It is also worth mentioning that the Italian context is quite different from other international environments. In fact, bilingual children in Italy typically come from a lower SES background and this makes it very interesting to evaluate the current issue in this context.

Concerning RQ1, the findings highlighted a difference between monolinguals and bilinguals concerning SES, in favor of monolinguals. This is in line with our hypothesis that monolingual children have a higher SES than bilinguals, as in the Italian context a large number of bilinguals come from a low-income background (INVALSI, 2018).

Concerning RQ2, our findings suggest that in the preschool years there are some differences in monolinguals and bilinguals, in favor of monolinguals. Specifically, we found that monolinguals outperformed in two tasks: an inhibitory control task (Simon Says) and an updating task (Magic House). Our results are in line with a series of recent studies that did not find evidence for a bilingual advantage in preschoolers and even in older children (e.g., Lowe et al., 2021; Duñabeitia et al., 2014; Jaekel, Jaekel, Willard, & Leyendecker, 2019).

Finally, concerning RQ3, the results confirmed our hypothesis that SES plays an important role in performance in WM and EF tasks in monolinguals and bilinguals, in line with the literature (e.g., Lawson et al., 2008). Specifically, we did not find differences between monolinguals and bilinguals in cognitive tasks performance, except for Simon Says and Magic House, but those differences became not statistically significant when SES was controlled for.

Also concerning RQ3, our results showed that SES was positively associated with WM and EF. This is not particularly surprising, being in line with our hypothesis and with Lawson and colleagues (2018), who found a correlation between SES and EF.

A possible explanation for this association may be found in the proximal mechanisms through which SES operates on children's cognitive development. According to the family stress model, children growing up in socioeconomically disadvantaged contexts are more likely to be exposed to higher levels of parental psychological distress and environmental stressors, which in turn may negatively affect the quality of parent–child interactions and the development of self-regulatory skills. In addition, the family investment model suggests that families with higher SES may have greater access to cognitively stimulating materials and experiences (e.g., books, structured games, rule-based activities) that resemble the cognitive demands of EF tasks. Therefore, children from lower SES backgrounds may have fewer opportunities to engage in activities that train WM and EF. Differences in parenting styles, scaffolding practices, and exposure to structured rule-based play may also contribute to disparities in EF development. These mechanisms are consistent with previous research showing that parental education and psychological well-being can influence children's executive functioning through variations in environmental stimulation and family functioning (e.g., Vrantsidis et al., 2020).

However, not all cognitive tasks were equally influenced by SES. In particular, the Mr. Cucumber and the DCCS were not statically correlated with SES. Regarding the Mr. Cucumber test (Case, 1985), it is essentially a refinement of the older Mr. Cucui, designed by De Avila, Havassy and Pascual-Leone (1976) as a culture-fair test for a study of Mexican-American schoolchildren, most of whom had a low-income family background and only had a lower proficiency in English.

Regarding the DCCS, our results did not replicate findings in the literature that found a relation between DCCS and SES (Hartanto and colleagues, 2019). We can explain the lack of replication analyzing the difference in the definition of SES. In fact, differently from our study, Hartanto and colleagues (2019) considered also household income in the SES component. A limitation of our study is that we only considered four indices for SES and did not include household income.

To conclude, this study brings some elements of novelty in the field of bilingualism. First, the results of our study provide support in favor of the null hypothesis, against the prediction of a bilingual advantage in cognitive tasks (i.e., in EF measures and in a sample of preschoolers). Furthermore, our results showed a significant effect of SES (although not on all tasks), whereas the effect of bilingualism was not statistically significant (or in some cases, without SES as covariate, in favor of monolinguals), and was negligible in terms of magnitude.

It is worth noting that our results might be related to the Italian context that has specific socioeconomic and sociolinguistic features. These results are very important also because there is a paucity of studies carried out in Italy on the cognitive effects of bilingualism. Finally, in this study we used six different cognitive tasks to investigate WM and EF thus adding significantly to the literature on bilingual preschoolers, which remains an under-investigated area of research. Moreover, to the best of our knowledge, this is the first research using an updating task for preschoolers (the Magic House task) in a study on bilingualism, thus adding new information to the literature.

Despite these positive aspects, this paper presents some limitations. First, bilinguals were speaking several different mother languages. Therefore, we cannot exclude the possibility that a bilingual advantage may occur for some specific L1 languages (e.g., Prior & Gollan, 2011). Additionally, the description of participants' bilingual status could be more detailed. Future studies should incorporate a more comprehensive assessment of specific bilingual profiles and linguistic experiences in a larger sample, including aspects such as children's language exposure history (e.g., attendance in Italian nurseries) and parental language use patterns. Finally, future research should also take a longitudinal approach, analyzing the relationships between WM and EF and their changes over time.

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