SCIENTIFIC CULTURE

www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 2.1, (2026), pp. 10034-10045
Open Access. Online & Print

DOI: 10.5281/zenodo.20008456

THE RELATIONSHIP BETWEEN BILINGUALISM AND THREE COMPONENTS OF EXECUTIVE FUNCTIONING

Hussien Tash Niyazi[1*]

[1]*Department of Psychology, College of Social Sciences, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia. Email: htneyazi@imamu.edu.sa*

Received: 02/04/2026
Accepted: 23/04/2026

Corresponding Author: Hussien Tash Niyazi (htneyazi@imamu.edu.sa)

ABSTRACT

The issue of whether, and how, using multiple languages is cognitively beneficial to the young child, or disadvantageous, continues to attract attention for both theoretical and practical reasons. Currently, clear answers are scarce. This study offers a contribution to the field, in multiple areas of current concern: differential contribution of multilingualism to three core dimensions of executive function (EF), role of language proficiency and of birth primacy of a language, strength of language-based prediction relative to parental factors affecting EF, and possibility of results differing by age groups. Data was gathered concerning 121 children, using a parental questionnaire. Multiple regression analyses showed that only inhibitive control was significantly predicted by number of languages known (not working memory or cognitive flexibility), and that was only found where age was the sole other variable in the model, and arose particularly in the 8-14 age group. No significant effects were found for language proficiency or birth primacy of language. A seemingly novel finding was that the parental variable of mother being a housewife rather than employed proved to predict inhibitory control only below age 8, while being bilingual predicted it only age 8+. Implications are drawn for parents and the research field.

KEYWORDS: Executive Function, Inhibitory Control, Bilingualism, Parental Variables, SES, Child Development.

1. INTRODUCTION

An enduring theme in studies of bilingualism has been whether, especially at a very young age, attempting to learn and use two languages rather than one is problematic for speakers, and has harmful effects on their cognitive functioning and performance in school. Although often popular opinion has held that it is harmful, some psychological studies have in fact shown benefits, including for executive functioning (EF), which is a core cognitive ability that humans develop (Bialystok, 2001).

According to the Cognitive Complexity and Control (CCC) theory (Zelazo et al., 2003), the development of EF can be understood in terms of age-related increases in the maximum complexity of the rules children can formulate and use when solving problems. That however does not take into account other factors that may speed or slow EF development. The main aim of this study is to assess whether children who know and use two (or more) languages improve at a faster rate than monolingual ones, so at a given age have better executive function abilities (in three areas: working memory (WM), inhibitory control (IC), cognitive flexibility (CF)) than monolingual children.

The present study contributes to the cutting edge of this research area by separately measuring three key aspects of EF, following the influential differentiation between IC, CF and WM within EF (Diamond, 2013). I.e. it does not just measure some undifferentiated construct of EF, which may often be biased in favour of some EF component abilities by the instruments chosen, without that bias being recognised. It also takes account of a number of finer points that emerge from the substantial literature concerning language effects on EF, as the literature review that follows will reveal. They concern consideration of language proficiency as well as number of languages, possible differences between age bands of children, and control of some other factors known to affect EF development. This is all pursued in a relatively less often researched context: Saudi Arabia.

This whole topic continues to have practical importance as well as theoretical interest. Parents, educators, and indeed society as a whole need to know the cognitive effects of multiple language learning so as to provide well informed interventions and policies and ensure the best possible development of children.

2. AIMS

The research questions, details of which will be justified from the literature review, are as follows:

1. Which of the three EF component abilities is more closely related to the monolingual - multilingual distinction, when age is controlled? Hs: WM will be related to bilingualism (Adesope et al., 2010) but will be the least related of the three (Beaudin and Poulin-Dubois, 2022); performance of conflict tasks (measuring IC or CF) will be advantaged by being bilingual (Carlson and Meltzoff, 2008).
2. Does it make a difference to that relationship if proficiency in the two languages of a bilingual is unequal or if only one of the two languages was encountered right from birth? H: Greater degree of non-dominant language exposure yields greater IC (Beaudin and Poulin-Dubois, 2022).
3. Do the relationships in 1 or 2 differ for children in different age ranges (e.g. 3-4 years versus 6-7 years)?
4. Is the relationship of bilingualism with IC more or less substantial than that of parental variables (specifically educational level and occupation) with EF? H: Higher parental educational level yields greater IC (Lawson et al., 2017).

3. LITERATURE REVIEW

3.1. EF And Its Importance

Executive functions (EFs) are central control processes that enable goal-directed behaviour across cognition, emotion and social interaction. Research continues to emphasize how they underpin reasoning, planning, self-regulation and key cognitive abilities like theory of mind (Benson et al., 2013). Consequently, they affect real-world outcomes such as academic achievement, mental-health trajectories and occupational success. Recent reviews emphasise that EF deficits are transdiagnostic risk factors across psychopathology and also have population-level public-health implications, linking EF to schooling, wellbeing and life-course outcomes (Doebel and Mueller, 2023).

Contemporary models treat EF as a small set of partly separable but interacting components, particularly working memory (WM, holding and manipulating information during a task), inhibitory control (IC, suppressing prepotent responses or distractions), and cognitive flexibility / set-shifting (CF, switching between tasks, rules or perspectives) (Steinbeis and Smid, 2022). Empirical studies and

reviews continue to show both shared and distinct neural and behavioural signatures for these components and document how they jointly support complex tasks (e.g., problem solving, reasoning, classroom learning) (Kofler et al, 2024).

Understanding how these EFs develop in childhood is crucial because early individual differences predict later academic, social and mental-health outcomes and because EF is malleable. It does not just automatically improve with age but is sensitive in some degree to a whole range of factors, many of which are contextual. Some can be addressed by interventions which can produce meaningful gains. Cross-sectional, longitudinal and intervention studies therefore prioritize measuring WM, IC and CF across preschool and early school years in conjunction with measuring factors that may affect EF. In this way they hope to identify sensitive windows and scalable treatments that can improve both cognitive and life outcomes (Ibbotson, 2023). The present study is a contribution to this enterprise.

3.2. Factors Affecting EF Development

The following is designed to locate the present study, with its interest in the effect of multilingualism on EF development, in the context of wider research on the main factors that affect, or at least predict, EF development. It will be noted from the start that many of these factors overlap in their nature. For example, many of them involve some kind of stress, many involve parents, etc. They may broadly be divided into predictors in the form of contextual influences (especially within the family), and predictors consisting of non-EF variables located more within the child and which correlate with EF.

3.2.1. Contextual Factors

At the earliest stage, including prenatal, exposures to smoking, alcohol, and maternal stress, as well as malnutrition, have been found to relate to poorer EF. A manifestation of this is that micronutrient deficits and low birth weight are risk factors (Hook et al., 2013). These factors are largely but not exclusively in the hands of the parents.

Socioeconomic status (SES) of parents has a wider effect associated with the cognitive stimulation at home which has been found to be related to EF. Children from lower-SES homes tend to show weaker EF on average; much of this is mediated by differences in cognitive stimulation, language exposure, material resources, and stress in the home (see further below). Improving the home learning environment therefore reduces the gap (Rakesh et al., 2024; Hook et al, 2013).

Lawson et al. (2017) is typical of recent studies in treating educational level of parents as a key SES indicator. In a large review/meta-analysis they found a robust positive relationship between SES and children's EF performance, especially for IC. The present study therefore includes parental education as a core variable whose effects can be assessed in comparison with those of language use.

Occupation, especially of the mother, is another parental variable likely to be relevant to EF development. It is often seen as demographic rather than SES related but would be expected to influence EF due to its connection with how much time the mother spends in the home. It is found treated as a predictor less often in the literature, perhaps because it is less straightforward to handle in multiple regression. However, recently it was considered as a predictor of IC task performance by Ji and Wang (2018) for example, and statistical differences in IC performance across groups defined by mother's occupation have been uncovered. The present study therefore includes mother's occupation in a simple form (housewife vs employed).

Parenting quality/style and parental mental health also have an influence in the affective domain. Sensitive, structured, and responsive parenting (scaffolding, warm but firm discipline) supports EF development. Parental depression, high stress, or low sensitivity are risk factors for poorer EF (Hendry et al., 2022).

Adverse childhood experiences, institutionalisation and associated stress more widely have also been identified as relevant. Early adversity (maltreatment, neglect, institutional care) and chronic stress impair inhibitory control and working memory. However, the timing and duration matter. Institutionalised children often show deficits unless caregiving improves (Dydenkova et al, 2024).

Quality of early education, enrichment and parent–child educational activities are also influential. High-quality preschool, parent–child shared activities, and play that challenges self-control (e.g., games with rules) reliably boost EF. Intervention studies show EF improvements from targeted curricula and enrichment (Steinbeis and Smid, 2022). On the other hand, excessive screen time and media exposure in early childhood, especially passive viewing, has been associated with slower EF development in some longitudinal studies (effects vary by content and context) (McHarg et al, 2020).

3.2.2. Factors More Within the Child

ADHD, ASD, and other neurodevelopmental disorders show characteristic EF profiles (e.g., IC

deficits). Genetic factors contribute to individual differences and interact with environment (Lee et al., 2025).

Something as simple as sleep also has an effect. Short or poor-quality sleep undermines attention and EF (working memory and inhibitory control); chronic sleep problems predict weaker EF (Diamond, 2013). Regular physical activity and better aerobic fitness are associated with stronger EF, especially inhibitory control and cognitive flexibility. Exercise interventions often show EF gains (Steinbeis and Smid, 2022).

Finally, the language ability and bilingualism or multilingualism of the child may be related to EF. Language skills certainly would by their nature be expected to exploit EF capabilities: e.g. any language use requires verbal working memory, and users of more than one language need to be able to inhibit one language while using another. As elaborated in the next section, evidence on bilingualism is however mixed: some studies report small advantages in cognitive flexibility/inhibition, others find no effect - context and proficiency matter (Filipe et al., 2023).

The main point that emerges from this is that how many languages the child encounters and has to start learning is far from being the only or main factor affecting EF development. Indeed, it is in some studies rather borderline in having any effect at all. It is noticeable however that family-related variables are represented directly or indirectly quite widely among the contextual factors affecting EF and could even have an influence over some that we listed as within the child (e.g. opportunities for sleep and for physical activity of a young child are heavily influenced by the parental context in the home). Therefore, it was decided to include some key parental indicators in the present study, so as to allow for some comparison between the strength of prediction of EF afforded by number of languages and that by SES of family.

3.3. Knowledge Of Languages And EF

There used to be popular belief that being exposed to multiple languages at a young age confused the child and had negative effects on their development (Bialystok, 2001). However, research shows that bilingualism and multilingualism are not associated with widespread harms to child development, despite involving the development of radically more capability than monolinguals need. If anything, most recent reviews find neutral-to-positive outcomes for language, academic and social domains (Bialystok and Werker, 2017). Large-scale and recent syntheses emphasise that multilingual children often achieve similar or better outcomes in areas such as metalinguistic awareness, pragmatic skills and later language learning, while any early delays in single-language measures typically reflect divided exposure rather than a pathological disorder. Recent cohort and review papers reiterate that multilingual upbringing can be part of healthy cognitive and social development, though effects vary with proficiency, exposure, socio-economic context and educational support. This even applies to people in old age as well as children (Menon et al., 2024).

When it comes to executive functions (EF: WM, IC, CF), the literature remains mixed although converging on the view that if there is a bilingual "advantage" it is small, task-dependent and sensitive to sampling and methodological choices (Ware et al., 2020). Several meta-analyses and systematic reviews report small overall effects or effects confined to particular EF tasks and age ranges, and they highlight publication bias and heterogeneity across studies. Conversely, large-sample and multi-site studies (and some other meta-analyses) have failed to find a reliable bilingual advantage once confounds (SES, immigration status, language proficiency, task differences) and analytic choices are controlled (Dick et al., 2019). Language status was also not found to have an effect (Lowe et al., 2021). The best summary for now is that bilingualism can be associated with modest improvements on some EF measures in some contexts, but there is no robust, universal EF benefit that applies across all children, tasks and settings.

The message from this for the present study is that single causes such as the ones we are concerned with rarely explain much variance (Lynch et al., 2023). Nevertheless, the present study has adopted a few hypotheses from the recent literature, along with the research questions as cited in the Aims section above. RQ1 addresses whether indeed language variables predict ability in the three components of EF differentially, favouring IC (Adesope et al., 2010). RQ2 addresses whether different language measures of the children have different predictive powers compared with the default measure of simply how many languages a child knows in some degree (bilingualism). In particular it considers possible predictive power of two less often considered capabilities: the relative proficiency that the child possesses in the multiple languages involved (equal or one much better than another), and the possible influence of the primacy of the current main language (i.e. whether the latter is the one they learnt from (before) birth or one that they picked up later) (Beaudin and Poulin-Dubois, 2022).

RQ3 takes up the finding in some studies that

language influence on EF is not the same at all age levels (Ware et al, 2020). However, what the relevant age bands are is as yet not clear. RQ4 addresses the characterisation of the strength of the predictive effect of language measures of children by contrasting that strength with that of a few leading contextual variables (parental educational level and occupation) (Lawson et al., 2017).

4. METHOD

4.1. Design

The design is correlation/regression, with attention to the strengths of various predictors of different dependents which are considered one at a time. The predictors are of three types as suggested above from discussion of the literature: three language measures (of focal interest), two child demographic measures (internal controls), and three indicators of parental context (external controls). The study considers those in relation to three dependents – measures of the three EF components - for the whole sample and for the sample divided into two age groups (Figure 1).

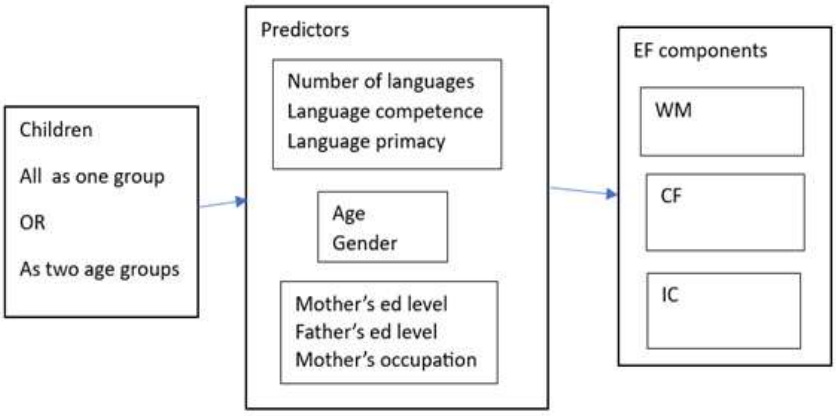

Figure 1: Design Of the Study.

4.2. Participants

121 parents responded with respect to one of their children. 50% were from Riyadh, the remainder mostly from other cities and areas in the Kingdom (e.g. Jeddah, Hafar Al-Batin, Najran). Just a few gave their homes as Canada, Istanbul or UK. The children were aged between 3 and 14 years; male 72, female 49. The great majority lived with both parents and siblings. Children predominantly but not exclusively had Arabic as first language and English as second language. The numbers of languages that parents named as known, at least minimally, by their children, were distributed as in Figure 2. Arabic accounted for 100% of the children who spoke only one language and was the first language named by 82% of those who spoke two, where English accounted for the other 18%. The second language of those that spoke two languages was 79% English (Arabic 18%). Other languages named by small numbers were Turkish, Russian, French, Spanish, German.

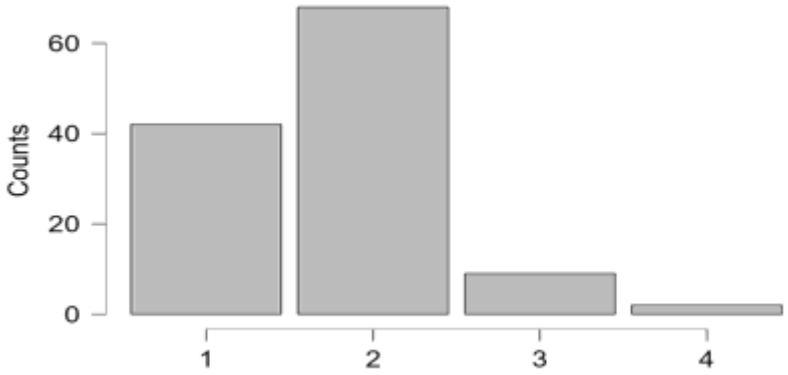

Figure 2: Numbers Of Languages Known At Least Minimally.

Parents were from a range of age groups from 20s to 60s, modal band age 35-44. They were from the

well-educated class: fathers' modal educational level was PhD, mothers were Bachelor's. Their occupations were predominantly: male - government, military, business, or education; female - housewife or education.

4.3. Instrument

All data was gathered via parent report in a questionnaire which contained demographic items, language related items, and three sets of five rating items (each responded to on 0-4 scale) designed to measure the three EF components (WM, CF, IC). The demographic and language parts of the questionnaire were based on the LEAP-Q of Marian et al. (2007). The EF parts exploited the three relevant sections of the EPYFEI (Romero-Ayuso et al., 2018).

4.4. Procedure

The questionnaire was administered in Arabic online to those parents who agreed to participate. Responses were downloaded as an Excel file.

4.5. Data Analysis

Reliability within each of the EF subsets of 5 items was very good. For the five WM items, Cronbach alpha =.89; for the five CF items alpha=.77; for the five IC items alpha = .72. This supports the assumption that each subset measures a unitary construct. EF scores were reversed where necessary so that higher scores reported below all represent higher degrees of EF and its components.

The data involves multiple outcomes (aspects of EF) and multiple predictors (types of language knowledge, gender and age, parental variables). The relationships in the data were therefore analysed with a number of multiple regression analyses conducted in JASP to answer the research questions.

4. RESULTS AND INTERPRETATION

These are considered for each RQ in turn.

5.1. RQ1 And 3

RQ1. Which of the three EF component abilities is more closely related to the monolingual - bilingual distinction, when age is controlled? Hs: WM will be related to bilingualism (Adesope et al., 2010) but will be the least related of the three (Beaudin and Poulin-Dubois, 2022); performance of conflict tasks (measuring IC or CF) has been found to be advantaged by being bilingual (Carlson and Meltzoff, 2008). RQ3 (part). Do the relationships in RQ1 differ for children in different age ranges (e.g. 3-4 years versus 6-7 years)?

The multiple regression findings in Table 1 show that, when all children are included as one group, and only age is considered alongside number of languages known, then number of languages known significantly positively predicts IC (p=.048) but not CF or WM. This then is consistent with the hypothesis that IC is advantaged by being bilingual (Carlson and Meltzoff, 2008). However, it is not consistent with the prediction that the relationship for CF will be similar to that for IC. The relationship of number of languages with CF has a beta only about half the size of that with IC and the relationship is not significant.

Indeed, the relationship of number of languages with CF resembles that with WM which is also nonsignificant, and therefore does not support the hypothesis that WM will be related (significantly) to bilingualism (Adesope et al., 2010). However, it does (though only by a small margin) support the hypothesis that WM will be the least related of the three (Beaudin and Poulin-Dubois, 2022): the beta is .079, smaller than .097 or .183.

It should also be noted that when a wider range of predictors is included in the multiple regression, IC loses the significance of its association (p=.077). This testifies to the observation in the literature that, with so many variables influencing IC, it is not to be expected that any one will have a very strong connection. In fact, the other variable with the strongest connection (though not significant) was gender (beta=.160, p=.083): for female children, IC was slightly higher.

The analysis also considered if splitting the sample by age produced any effects. In fact, selecting age 3-4 years versus 6-7 years yielded no significant effect of number of languages. However, splitting the whole sample into 3-7:11 versus 8-14 produced a remarkable result. The relationship of number of languages with IC totally disappeared in the lower age group but soared to beta=.398, p=.003 in the older age group (with only age controlled; with the wider range of predictors taken into account beta=- .416, p=.004).

Table 1: Predictive Power of the Number of Languages Used by the Child.

Predictor: Number of languages the child speaks/understands		WM		CF		IC	
Other predictors considered alongside	Children included (n)	beta	p	beta	p	beta	p

age, gender (M=1, F=2), mother's and father's educational levels	All (121)	.088	.343	.089	.352	.165	.077
age	All (121)	.079	.393	.097	.299	.183	.048
age	Aged 3-7 (66)	.016	.903	.053	.677	.039	.756
age	Aged 8-14 (55)	.128	.349	.117	.395	.398	.003

5.2. RQ2 and 3

RQ2. Does it make a difference to that relationship if proficiency in the two languages of a bilingual is unequal or if only one of the two languages was encountered right from birth? H: Greater degree of non-dominant language exposure yields greater IC (Beaudin and Poulin-Dubois, 2022). RQ3 (part). Do the relationships in RQ2 differ for children in different age ranges (e.g. 3-4 years versus 6-7 years)?

The same analyses were conducted as above, except that in each case different language variables were used (Tables 2 and 3). It can be seen in Table 2 that in none of the analyses is there any remotely significant relationship involving difference or similarity of proficiency of the strictly bilingual children in the two languages (as rated by parent). At best we can say is that descriptively, from the betas, CF and IC are more similar to each other in their relationship to the language variable than either are to WM, where the relationship is mostly negative (i.e. difference rather than similarity of proficiency weakly predicts higher WM). Similarity between CF and IC is perhaps explicable since their definitions are more similar than that of either with WM.

Table 2: Predictive Power of the Proficiency Level of the Child in Their Two Best Known Languages.

Predictor: Child has same (1) or different (0) prof level in the two best known languages		WM		CF		IC	
Other predictors considered alongside	Children included (n)	beta	p	beta	p	beta	p
age, gender (M=1, F=2), mother's and father's educational levels	All bilingual (68)	-.066	.585	.080	.512	.065	.601
age	All bilingual (68)	-.054	.663	.093	.453	.080	.516
age	Aged 3-7 (34)	.081	.674	.180	.351	.011	.956
age	Aged 8-14 (34)	-.089	.617	.056	.756	.025	.888

In Table 3 we see the results where the language variable distinguishes between children whose birth language is still their most used language (monolinguals and some bilinguals) and those where that is not the case. Again, no relationships are significant. Tantalizingly, however, the result for age 8+ is the closest to significance (p=.098). This therefore is closest to confirming the expectation that the older age range of children exhibit a language effect on IC, seen more convincingly above (Table 1) and below (Table 4). The effect is the one hypothesised by Beaudin and Poulin-Dubois (2022): Greater degree of non-dominant language exposure yields greater IC.

Table 3: Predictive Power of the Continued Primacy of the Language Most Used by the Child.

Predictor: Current most used language is same as (0) or different from (1) the language heard at birth		WM		CF		IC	
Other predictors considered alongside	Children included (n)	beta	p	beta	p	beta	p
age, gender (M=1, F=2), mother's and father's educational levels	All (121)	.086	.357	.150	.114	.092	.325
age	All (121)	.041	.664	.130	.165	.077	.413
age	Aged 3-7 (66)	-.042	.739	.053	.676	-.096	.438
age	Aged 8-14 (55)	.115	.402	.195	.154	.228	.098

5.3. Rq4

RQ4. Is the relationship of bilingualism with IC more or less substantial than that of parental variables (specifically educational level and occupation) with EF? H: Higher parental educational level yields greater IC (Lawson et al., 2017).

Above we saw that including parental educational level in the model had some impact on the predictive power of number of languages known (Table 1). In particular the relationship of number of languages with IC weakened in the presence of parental educational level. However, the parental educational level variables themselves did not predict IC significantly, in the presence of the number of languages variable. That is true also where the sample is split and the older and younger

children considered separately (Table 4). Thus, the hypothesis based on Lawson et al (2017) is not supported.

However, when we turn attention to the less often studied variable of the mother's occupation, specifically with respect to her being a housewife or not, an interesting picture emerges (Table 4). In the older child age band, number of languages continues to have a significant relationship with IC (as in Table 1), with mother's occupation as housewife having no significant relationship. However, in the lower age group, where the impact of number of languages is small, the predictive power of mother's occupation as housewife is high (beta=.368, *p*=.006).

Here then the findings support a conclusion that makes sense, at least in the Saudi context, and is consistent with Ji and Wang (2018), but which I have not found clearly emerging in previous studies. At preschool and early primary level children's IC is boosted by the presence of the mother as a full-time care giver in the home, rather than being out at work. At a later age, however, the impact of the mother in the home weakens (naturally, since the child is at school more of the time) and the impact on IC of bi- or multilingualism shows itself more clearly.

Table 4: Predictive Power of the Number of Languages Used by the Child Compared with That of Mother's Occupation as Housewife.

Other predictors considered alongside: age, gender		IC	
Children included (n)	Predictor:	beta	p
Aged 3-7 (66)	Father's ed level	0.174	0.176
	Mother's ed level	-0.001	0.998
	Mother's occupation housewife	0.368	0.006
	Number of languages	-0.048	0.689
Aged 8-14 (55)	Father's ed level	0.036	0.794
	Mother's ed level	-0.055	0.708
	Mother's occupation housewife	0.227	0.114
	Number of languages	0.438	0.002

5. OVERALL DISCUSSION

In some key respects the study supports modern extensive reviews like Ware et al. (2020) which suggest that any language predictive effect on EF that is found depends on task (which in turn reflects what exact EF component(s) are involved, and favours IC), and on age. To that we would add dependence on what and how many other potential factors affecting EF development are included in the model. Ware et al. also suggest that effect sizes of mono-/bilingualism differences can be quite small, consistent with Lynch et al. (2023) who say that single predictors rarely explain much variance on their own. That is consistent with the betas in the present study.

Not supported so clearly by the present study is the impact of language variables on CF and WM, at a lower level than on IC. That only appeared weakly descriptively (cf. Adesope et al., 2010). A predictive effect on EF of language variables other than simply the number of languages used (bilingualism/multilingualism) also was only weakly supported, for primacy (Cf. Beaudin and Poulin-Dubois, 2022).

Two connected results however emerged that we feel have some novelty: the age band of greatest effect and the influential role of mother' occupation as housewife. The age group effect took the form of the band 8-14 showing clearest influence on EF (IC) of number of languages spoken. Other studies have tended to highlight a lower or higher age band, although there is no established agreement on this issue. For example, Planckaert et al (2023) refer to a bilingual advantage as found in studies either targeting very young children or aging adults. That would suggest that bilingualism mainly impacts the sensitive periods of cognitive development and cognitive decline. De Cat et al. (2018) also found 5-7 years as the age band of greatest impact.

The present study directly contradicts those findings and requires further research, albeit all sources admit that the age of greatest impact is by no means a settled issue and is sensitive to many factors such as the context and the other variables included in the analyses. Possibly the present study differs due to the Saudi social context or the inclusion of mother's occupation as housewife rather than employed in an outside job as a key variable. That specifically has not been widely highlighted in the literature on effects of bilingualism although intuitively one can see why the full presence of the mother in the home in the age group 3-7 might overshadow the effect of multiple languages on EF development in that period. Certainly, this maternal benefit is recognised in general studies of factors affecting IC development (e.g. Swingler et al., 2018).

Another consideration that possibly could lead to

the Saudi context being different and involving a later apparent impact of bilingualism on EF is the nature of the learning of the usual L1, Arabic. In the study we treated Arabic as a unitary language. However, it is possible to argue that it is two languages or at least, in linguistic terminology, two very different dialects (referred to technically as 'diglossia'): the everyday spoken variety learned from birth and the formal written variety (Modern Standard Arabic) heard spoken on children's TV etc, learned a little later from the media and school (plus of course Quranic Arabic encountered in the mosque). That is, Arabic is bordering on being two languages rather than just possessing formal and informal varieties such as those that English speakers encounter in English (Ibrahim, 2009). Hence it could be argued that all Arabic-acquiring children, monolingual or otherwise, experience a kind of bilingualism within Arabic especially acquired in the age band 3-7, and that drowns out any Arabic-only versus Arabic-English bilingualism effect in that age band.

6. CONCLUSION

The implications for research are clear. Continued work is needed to clarify further the details of the bilingualism 'advantage' to learners, especially in Arabic speaking contexts. The precise age group and extent of effect across components of EF remain unclear, as well as the full effects of parental involvement.

For parents the practical implications are hard to state categorically while so many details of the research remain contested. However, it certainly seems to be that bilingualism or multilingualism is not harmful and indeed is in certain circumstances beneficial at least for IC development. Hence there does not seem to be a need to limit exposure to multiple languages at a young age. However, in the context of the present study the mother's presence in the home also emerged as important, while the child is still young (3-7), and that factor eclipsed any impact of bilingualism on IC in that age band. If that is supported by further studies, then in Saudi Arabia it could represent a proviso to modify the ideas prompted by the Saudi Vision 2030 goal of increasing female involvement in workplaces and a reason for continuing the traditional role of women in the home, at least while children are still young (Arab News, 2024).

FUNDING STATEMENT: THIS WORK WAS SUPPORTED AND FUNDED BY THE DEANSHIP OF SCIENTIFIC RESEARCH AT IMAM MOHAMMAD IBN SAUD ISLAMIC UNIVERSITY (IMSIU) (GRANT NUMBER IMSIU-DDRSP2601).

REFERENCES

Adesope, O., Lavin, T., Thompson, T. and Ungerleider, C. (2010) A systemic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research,* Vol. 80, 207–45.

Arab News (2024) Saudi Arabia targeting 40% female workforce participation by 2030: Al-Jadaan. *Arab News*, Oct. 30. https://www.arabnews.com/node/2577394/business-economy

Beaudin, K., and Poulin-Dubois, D. (2022) Testing the bilingual cognitive advantage in toddlers using the early executive functions questionnaire. *Languages*, Vol. 7, No. 2, 122. https://doi.org/10.3390/languages7020122

Benson, J. E., Sabbagh, M. A., Carlson, S. M., and Zelazo, P. D. (2013) Individual differences in executive functioning predict preschoolers' improvement from theory-of-mind training. *Developmental Psychology,* Vol. 49, No. 9, 1615. doi:10.1037/a0031056

Bialystok, E. (2001) *Bilingualism in development: Language, literacy, and cognition*. Cambridge University Press. Doi: 10.1017/CBO9780511605963.

Bialystok, E. and Werker, J. (2017) The systematic effects of bilingualism on children's development. *Developmental Science,* Vol. 20, No. 1. DOI:10.1111/desc.12535.

Carlson, S. and Meltzoff, A. (2008) Bilingual experience and executive functioning in young children. *Developmental Science,* Vol. 11, No. 2, 282-298.

Cook, C. J., Howard, S.J., Makaula, H., Merkley, R., Mshudulu, M. et al. (2024) Risk and protective factors for executive function in vulnerable South African preschool-age children. *Journal of Cognition*, pmc.ncbi.nlm.nih.gov

De Cat, C., Gusnanto, A. and Serratrice, L. (2018) Identifying a threshold for the executive function advantage in bilingual children. *Studies in Second Language Acquisition,* Vol. 40, No. 1, 119-151. doi: 10.1017/S0272263116000486 Available at https://centaur.reading.ac.uk/69130/

Diamond A. (2013) Executive functions. *Annual Review of Psychology*, Vol. 64, 135-168. doi: 10.1146/annurev-psych-113011143750

Dick, A.S., Garcia, N.L., Pruden, S.M. et al. (2019) No evidence for a bilingual executive function advantage in the ABCD study. *Nature Human Behavior,* Vol. 3, 692–701. https://doi.org/10.1038/s41562-019-0609-3

Doebel, S., and Müller, U. (2023) The future of research on executive function and its development: An introduction to the special issue. *Journal of Cognition and Development,* Vol. 24, No. 2, 161–171. https://doi.org/10.1080/15248372.2023.2188946

Dydenkova, E., McGlone, F., Mayorova, L. and Nikolaeva, E. (2024) The impact of early life experiences on inhibitory control and working memory. *Frontiers in Psychology (Sec. Human Developmental Psychology),* Vol. 15. https://doi.org/10.3389/fpsyg.2024.1484424

Filipe, M., Veloso, A. and Frota, S. (2023) Executive functions and language skills in preschool children: The unique contribution of verbal working memory and cognitive flexibility. *Brain Sciences,* Vol. 13, No. 3. DOI:10.3390/brainsci13030470

Hendry, A., Gibson, S., Davies, C. McGillion, M. and Gonzalez-Gomez, N. (2022) Toward a dimensional model of risk and protective factors influencing children's early cognitive, social, and emotional development during the COVID-19 pandemic. *Infancy,* 2022, 1–29. DOI: 10.1111/infa.12495

Hook, C., Lawson, G. and Farah, M. (2013) Socioeconomic status and the development of executive function. *Encyclopedia on early childhood development*. Abilio Université de Montréal.

Ibbotson, P. (2023) The development of executive function: Mechanisms of change and functional pressures. *Journal of Cognition and Development,* Vol. 24, No.2, 172–190. https://doi.org/10.1080/15248372.2022.2160719

Ibrahim, R. (2009) The cognitive basis of diglossia in Arabic: Evidence from a repetition priming study within and between languages. *Psychology Research and Behavior Management*, Vol. 2, 93-105. doi: 10.2147/prbm.s5138.

Ji, S. and Wang, H. (2018) A study of the relationship between adverse childhood experiences, life events, and executive function among college students in China. *Psicologia: Reflexão e Crítica,* Vol. 31, 28. doi: 10.1186/s41155-018-0107-y

Kofler, M., Groves, N., Chan, E. Marsh C., Cole, A. et al. (2024) Working memory and inhibitory control deficits in children with ADHD: An experimental evaluation of competing model predictions. *Frontiers in Psychiatry,* Vol. 8, No. 15, 1277583. doi: 10.3389/fpsyt.2024.1277583

Lawson, G. Hook, C., and Farah, M. (2017) A meta-analysis of the relationship between socioeconomic status and executive function performance among children. *Developmental Science*, Vol. 21, No. 2, 10.1111/desc.12529. doi: 10.1111/desc.12529

Lee, D., Boulton, K.A., Sun, C. et al. (2025) Attention and executive delays in early childhood: A meta-analysis of neurodevelopmental conditions. *Molecular Psychiatry,* Vol. 30, 1906–1914. https://doi.org/10.1038/s41380-024-02802-3

Lowe C.J., Cho I., Goldsmith S.F., and Morton J.B. (2021) The bilingual advantage in children's executive functioning is not related to language status: A meta-analytic review. *Psychology of Science*, Vol. 32, No. 7, 1115-1146. doi: 10.1177/0956797621993108

Lynch, J.D., Xu, Y., Yolton, K., Khoury, J., Chen, A. et al. (2023) Environmental predictors of children's executive functioning development. *Child Neuropsychology*, Vol. 30, No. 4, 615–635. doi: 10.1080/09297049.2023.2247603

Marian, V., Blumenfeld, H. and Kaushanskaya, M. (2007) The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech, Language, and Hearing Research,* Vol. 50,940–967.https://bilingualism.northwestern.edu/wp-content/uploads/2012/02/ MarianBlumenfeldKaushanskaya.pdf

McHarg, G., Ribner, A., Devine, R. and Hughes, C. (2020) Screen time and executive function in toddlerhood: A longitudinal study. *Frontiers in Psychology (Sec. Human Developmental Psychology),* Vol. 11. https://doi.org/10.3389/fpsyg.2020.570392

Menon, A., Malo, P., Jain, S., Gandhi, S., Sundarakumar, J. et al. (2024) Association between multilingualism and cognitive performance among older adults in rural southern India. *Neurosciences in Rural Practice,* Vol. 15, No. 1, 81–85. doi: 10.25259/JNRP_376_2023

Planckaert, N., Duyck,W., and Woumans, E. (2023) Is there a cognitive advantage in inhibition and switching for bilingual children? A systematic review. *Frontiers of Psychology (Sec. Psychology of Language),* Vol.

14. https://doi.org/10.3389/fpsyg.2023.1191816
Rakesh, D., Lee, P., Gaikwad, A. and McLaughlin, K. (2024) Annual Research Review: Associations of socioeconomic status with cognitive function, language ability, and academic achievement in youth: a systematic review of mechanisms and protective factors. *Journal of Child Psychology and Psychiatry,* Vol. 66, No. 4, 417–439. doi: 10.1111/jcpp.14082
Romero-Ayuso, D., Jorquera-Cabrera, S., Segura-Fragoso, A., Toledano-González, A. et al. (2018) Assessment of sensory processing and executive functions in childhood: Development, reliability, and validity of the EPYFEI. *Frontiers in Pediatrics*, Vol. 6. DOI https://doi.org/10.3389/fped.2018.00071
Steinbeis, N. and Smid, C. (2022) Interventions for improving executive functions during development: working memory, cognitive flexibility, and inhibition. In *Cambridge handbook of cognitive development Part III - Education and school-learning domains,* O. Houdé and G. Borst (eds.), Cambridge University Press.
Swingler, M., Isbell, E., Zeytinoglu, S., Calkins, S.D., and Leerkes, E. (2018) Maternal behavior predicts neural underpinnings of inhibitory control in preschoolers. *Developmental Psychobiology,* Vol. 60, No. 6, 692-706. doi: 10.1002/dev.21742.
Ware, A., Kirkovski, M., and Lum, J. (2020). Meta-analysis reveals a bilingual advantage that is dependent on task and age. *Frontiers in Psychology (sec. Psychology of Language),* Vol. 11. https://doi.org/10.3389/fpsyg.2020.01458

APPENDIX: QUESTIONNAIRE ABOUT YOUR CHILD (AGE 3-14 YEARS)

If you have more than one child between age 3 and 11, do please complete this questionnaire more than once: one time for each child.

This questionnaire is for research only. It is not meant to evaluate your child. Typical children vary widely in language skills and in how they think and behave. This research aims to help us understand better how those things may be connected. Do children who know more languages think in some ways differently from others?

There is no correct or incorrect answer to the questions below. Please just try to reply as accurately as possible. No names are asked for, so nobody will know who said what. We are interested only in any overall patterns that emerge.

Thank you in advance for helping us!

About the child that you are telling us about

1.Age of child: Years…. Months .....

2.Gender M F ….

3.City, town or village where child lives …….

The following questions in this section are optional. It would be useful for us to know the answers but if you prefer not to answer any of them, please skip those items.

4.Was the birth normal? Yes No

5.Does the child have any diagnosed learning difficulties or health problems? Yes/No

6.Please say what ……..

7.Does the child live with: Both mother and father? Mother? Father? Someone else?

8.Father's occupation:_____ Father's age:_____

9.Father's educational level: Grade 9 High school University MA or PhD

10. Mother's occupation:_____ Mother's age:_____

11. Mother's educational level: Grade 9 High school University MA or PhD

Now the languages / dialects that your child understands or uses

1.Please list the names of all the languages or major dialects that the child knows even a little. Please put them in order, starting with the one he/she knows best. Up to five can be entered (You need not include any beyond five)

		How well do they speak and understand it. Please tick one choice for each language/dialect			
		4	3	2	1
Order	Name of language / dialect	just like any native speaker child of the same age	not quite as well as a native speaker of the same age	adequately for commun-ication at that age but with some mistakes or limitations	little for his/her age. E.g. can only understand or say common phrases
The best					
Second					

Third					
Fourth					
Fifth					

2.Which language / dialect did the child hear and start learning first after birth? .....

3.Please list which language / dialect the child currently on average uses or is exposed to most of the time? .....

4.Has the child received instruction from a tutor or in a kindergarten or school for any of those languages/dialects? Please say which

.....

5.When choosing a language to speak with a person who is equally fluent in all the languages/dialects, which would the child usually choose? .....

Now about how your child thinks and behaves

Compared with other children of the same age, my child…..	4 = Always responds this way	3 = Frequently responds this way	2 = Half the time responds this way	1 = Occasion-ally responds this way	0 = Never responds this way
1. Has difficulty keeping in mind the instructions necessary to complete tasks					
2. Has difficulty following a conversation					
3. Has difficulty performing activities that require thinking					
4. Has difficulty performing tasks that require more than one step					
5. Takes a lot of time to complete activities					
6. Is able to change how they perform an activity when given a new instruction					
7. Reviews and corrects activities					
8. Knows how to organize free time and play independently					
9. Solves problems that arise during activities					
10. Performs daily activities such as dressing, washing, eating, etc., without assistance					
11. Habitually hums or makes noises while performing tasks when they should remain silent					
12. Seeks to engage in activities that include jumping, crawling, squeezing, pushing, or pulling					
13. Has difficulty remaining still when required					
14. Acts impulsively, without planning what to do					
15. Changes activities without finishing the one they were doing					