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Similarities and differences across countries in the development of executive functions in children: A systematic review

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Abstract

A systematic review was conducted to gain a more nuanced understanding of similarities and distinctions across countries in the development of executive functions (EF). The review includes 26 studies, with child and adolescent participants, that were published between 2006 and 2018. Both similarities and differences within developmental patterns of EF are identified across different countries. Across countries, bilingual children are shown to outperform their monolingual peers. Task improvement with age is not consistently reported in all studies, with no linear effects apparent in children from developing countries or regions. Gender differences on EF measures also vary between countries. Girls perform better than boys on EF tasks and parent and teacher ratings of EF in both Western and East Asian samples. Yet, in Iran and Tanzania, boys receive higher EF scores. From preschool age through adolescence, East Asians outperform Western counterparts on direct assessment measures of EF. However, strong discrepancies can be found between measures of direct EF assessment and parent and teacher ratings of children's EF. Chinese parents rate their children's EF as lower compared with parents from other countries. The role of contextual factors explaining differences in EF development is discussed.

Highlights

- This paper presents the first systematic review on the topic of cross-national variation in children's EF development.
- A clearly defined conceptual framework regarding EF facets and analysis of a wide age span underpin this review.
- From preschool age through adolescence, East-Asian children outperform their Western counterparts on direct assessment measures of EF.

KEYWORDS

childhood, cross-national comparison, executive functions, systematic review

1 | INTRODUCTION

Executive functions (EF) are of great relevance to many developmental outcomes. A large number of studies have identified EF as a significant predictor of academic achievement as well as socio-emotional competence across childhood (Baumeister & Vohs, 2004; Best, Miller, & Jones, 2009; Gestsdottir et al., 2014). EF enable individuals to plan and anticipate possible courses of action, to stay focused and on task, to avoid temptations, and to adapt flexibly to changes in the environment (Diamond, 2013). EF are suitably described as "the brain's air traffic control system" (Center on the Developing Child at Harvard University, 2011). Although theorists have varied views regarding the constituents of EF (Ackerman & Friedman-Krauss, 2017), there is a broad consensus that there are three key components: inhibition, updating (working memory), and shifting (cognitive flexibility; Blair & Razza, 2007; Diamond, 2000; Kamijo et al., 2012; McClelland et al., 2007).

Previous research has demonstrated that contextual factors affect basic cognitive processes (Nisbett, Peng, Choi, & Norenzayan, 2001). On that basis, scholars are seeking to identify distinct contextual factors that influence children's EF development. Socio-economic status, bilingualism, and parental scaffolding have been identified as significant contextual factors impacting EF (Hartanto, Toh, & Yang, 2019; Hughes, Roman, & Ensor, 2014). Recent research specifically considers if and how cultural contexts affect EF and whether developmental trajectories of EF are universal for children growing up in different parts of the world. Chasiotis, Kiessling, Hofer, and Campos (2006) and Sabbagh, Xu, Carlson, Moses, and Lee (2006) were among the first researchers to examine cross-national differences in EF development. Chasiotis, Kiessling, Hofer, and Campos (2006) reported that children from Germany and Costa Rica performed better than children growing up in Cameroon on conflict inhibition measures. Sabbagh, Xu, Carlson, Moses, and Lee (2006) found that preschoolers from China significantly outperformed their age-matched U.S. American counterparts on several EF tasks, and these findings sparked further studies that have also found similar developmental advantages in EF domains for East Asian children (Ellefson, Ng, Wang, & Hughes, 2017; Oh & Lewis, 2008; Schmitt et al., 2018; Wang, Devine, Wong, & Hughes, 2016).

Different hypotheses have been put forward regarding the pathways through which cultural contexts influence EF. For instance, some scholars have ascribed EF differences between Euro-American and East Asian children to cultural values. Historically, Confucian teachings and values have had a strong influence on East Asian cultures (Chao & Tseng, 2002). Confucian philosophy considers "proper human relationships to be the basis of society" (Yum, 1988, p. 374) and emphasizes self-control in order to ensure harmonious interpersonal relationships. One particular area of

interest with regard to socialization influences is that of cultural differences in parenting styles. For example, East Asian parents have been described as emphasizing the "centrality of the family and family interdependence, the use of parental control and strictness, and fostering educational achievement in children" (Chao & Tseng, 2002, p. 60). It has been argued that these social norms and cultural values affect children's upbringing and consequently their cognitive development (Ellefson, Ng, Wang, & Hughes, 2017; Moriguchi, Evans, Hiraki, Itakura, & Lee, 2012; Oh & Lewis, 2008).

In addition to the influence of broader cultural values, it has been suggested that cross-national differences in pedagogic approaches and educational settings underlie variations in children's EF development (Wang, Devine, Wong, & Hughes, 2016). Cultural heritage has been shown to influence national curriculum (Wang & Mao, 1996), and variations in priorities regarding educational policy and practice exist between countries. For example, some qualitative educational research has described Chinese preschools as being more controlling and teacher-centred as well as emphasizing obedience more strongly than U.S. American preschools (Tobin, Hsueh, & Karasawa, 2009; Tobin, Wu, & Davidson, 1989). Cultural beliefs also influence teachers' views and beliefs. To illustrate, variations in kindergarten teachers' beliefs about the importance of play and learning objectives were shown to translate into differences in the structuring of play and learning in Germany and Hong Kong (Wu & Rao, 2011). These differences might, in turn, influence children's cognitive development. East Asian educators' emphases on obedience and self-control within the classroom may underlie higher performance scores on inhibitory control tasks in children in these countries (Oh & Lewis, 2008).

Moreover, it seems plausible that contextual factors, such as socio-economic status or bilingual teaching practices, vary systematically between different countries and therefore foster cross-national differences in EF development. With this in mind, Legare, Dale, Kim, and Deak (2018) stress that it is often difficult to attribute cross-national differences to a single factor as multiple explanatory factors are often confounded. In a comparative study of children growing up in Cameroon, Germany, and Costa Rica, Chasiotis et al. (2006) argued that both parental expectations and differences in maturation, possibly related to socio-economic status, were linked to the reported differences in EF development.

When trying to disentangle the influence of multiple contextual factors underlying cross-cultural differences in children's development, the definition of culture is of the upmost importance. Traditionally, the most prevalent proxy for culture has been country of residence. Political boundaries also constitute the most commonly applied operationalization of culture in much of the literature reviewed in the current study. However, findings from a meta-analysis by Taras, Steel, and Kirkman (2016) offered new perspectives on the conceptualization of culture and cultural entities. These results indicated that the majority of the variations in cultural values arise within and a smaller percentage between countries. These findings highlight the importance of distinguishing carefully between the terms "culture" and "country," as the two must not be used interchangeably. Thus, we have conceptualized our review as a cross-national research approach.

Against this backdrop, we aimed to integrate current findings investigating variations in EF development in children growing up in different countries. We reviewed findings from cross-national studies that examined EF developmental patterns in children from preschool age up to adolescence and built upon the concept of separable, yet closely linked, facets (Miyake et al., 2000). In addition, the current study followed the Evidence for Policy and Practice Information and Co-ordinating (EPPI)-Centre's (2007, updated 2010) guidelines for conducting systematic reviews, as distinguished from a narrative synthesis on the topic by Roos, Beauchamp, Flannery and Fisher (2017).

Two specific research questions guided our systematic review. First, the results of previous studies suggest specific developmental patterns and systematic influences of contextual factors on children's EF development, such as increased task performance with age (Carlson, 2005), positive effect of bilingual upbringing (Hartanto et al., 2019), and gender differences favouring girls (Wanless et al., 2013). Consequently, the first research question addressed the generalizability of such findings: (a) What are the commonalities and differences in EF development across countries? The second question was derived from indications in the literature that differences in EF development arise

between countries due to variations in cultural contexts. In particular, we were interested in evidence that children from East Asian countries are developmentally ahead of others (Ellefson et al., 2017). Therefore, the second goal of the current study was to systematically review empirical results regarding the second research question: (b) Which cross-national differences in EF development are apparent during childhood?

2 | METHOD

2.1 | Search strategy

For this systematic review, we sought to identify studies reflecting our two variables of interest: (a) Assessment of at least one facet of EF (inhibition, updating, shifting) in populations of children or adolescents and (b) a comparison across cultures—to be precise, a comparison between two or more countries within one study. The search strategy was developed primarily using the EPPI-Centre's (2007, updated 2010) guidelines for conducting systematic reviews, consisting of electronic database searching, hand searching of key journals, and searching of specialist websites.

2.2 | Database analysis

The bibliographic databases Web of Science, PsycINFO, and PSYNDEX were searched between October and November 2018, using search terms mirroring the variables of interest. For some of the initial search terms, the numbers of publications listed appeared too large for the majority of results to realistically be relevant to the given topic. Therefore, the keyword *child* was added to these search terms, aiming to achieve better concordance. The following combinations of topic–keywords were chosen:

[Executiv* NEAR/3 function* AND *cultur*];
[inhibit* AND *child* AND *cultur*];
[shifting AND *child* AND *cultur*];
[cognitiv* NEAR/3 flexibi* AND *cultur*];
[updating AND *child* AND *cultur*]; and
[working* NEAR/3 memory* AND *child* AND *cultur*].

2.3 | Study selection

The screening was conducted in three steps, following a predetermined protocol and the aforementioned inclusion criteria. The first author carried out the screening process in frequent consultation with the second and third authors. Ambiguities were discussed by the authors until a consensus was reached. During the first step, the titles of the identified publications were checked to see if they corresponded with the two variables of interest. This was determined by indicating in the title (a) an assessment of at least one facet of EF and (b) a cross-national perspective (mentioning a cross-cultural comparison or naming one or more countries where testing took place). The publications' abstracts were screened during the second step. In the third step, the full texts of the studies were assessed to determine inclusion for the systematic review. The same set of predetermined inclusion criteria was implemented in the second and third steps. The abstracts and full texts had to meet all of the following criteria in order to be included in the next phase of the screening process: (a) one or more subcomponents of EF (shifting, updating, inhibition) had been measured, either by direct assessment or questionnaire/ratings; (b) the study sample consisted of children and/or adolescents; (c) the sample was drawn from at least two different countries, and the results of the comparison were reported; (d) the study did not assess a clinical sample (including developmental disorders and mental or physical impairment); and (e) the publication was available in English.

TABLE 1 Study characteristics and main results of included publications

Authors	Sample	Sample characteristics	Measures Shifting	Measures Updating
Alansari & Soliman, 2012	Kuwait *n* = 192; Egypt *n* = 192	Mean age of 10 years; middle-class families; matched for age, sex, and parental education		Digit span backward
Bialystok & Viswanathan, 2009	Canada *n* = 30 ml. children & *n* = 30 bl. children; India *n* = 30 b. children	8-year-old children, monolingual and bilingual all attending private schools	Faces task (difference between mixed and single block presentations)	

Chasiotis, Kiessling, Hofer, & Campos, 2006	Germany
	n = 116;
	Costa Rica
	n = 82;
	Cameroon
	n = 116
		3- to 5-year-old children (mixed levels of SES)		

Cheie, Veraksa, Zinchenko, Gorovaya, & Visu-Petra, 2015	Romania *n* = 67; Russia *n* = 64	5- to 7-year-old children recruited from public kindergartens in metropolitan areas; sample matched for age, nonverbal intelligence scores, and sex distribution		
Ellefson, Fei-Yin Ng, Wang, & Hughes, 2017	Hong Kong *n* = 371; United Kingdom *n* = 516	9- to 16-year old children, recruited from state (Hong Kong & United Kingdom) and private schools (only Hong Kong)	Figure matching Task	Corsi block tasks (forward and backward)
Engel de Abreu, Baldassi, Puglisi, & Befi-Lopes, 2013	Luxembourg *n* = 20 (Portuguese language minority children) and *n* = 20 (Luxembourgish language majority children); Brazil *n* = 20 (monolingual children)	7-year-old children; sample matched for gender, age, nonverbal reasoning, and socio-economic status		Counting recall and backward digit recall tasks from Luxembourgish and Portuguese versions of AWMA

TABLE 1 (Continued)

Authors	Sample	Sample characteristics	Measures Shifting	Measures Updating
Gestsdottir et al., 2014	France *n* = 79; Germany *n* = 70; Iceland *n* = 111	Longitudinal assessment over 1 or 2 years (average age at Time 1: six and a half years); Majority of children from upper middle-class backgrounds		
Grabell et al., 2015	United States *n* = 57; China *n* = 60	3- to 5-year-old children, living in a small city (United States) or large urban center (China); different socio-economic backgrounds		
Holding et al., 2018	Tanzania *n* = 323; Ghana *n* = 166; Bangladesh *n* = 297	7- to 18-year-old children, recruited at sites of rural ambience, relative poverty, limited health care access and low adult literacy	Shift task	Rey Osterrieth complex figure task
Imada, Carlson, & Itakura, 2013	United States *n* = 89; Japan *n* = 86	4- to 9-year-old children; both samples from metropolitan areas	DCCS	
Lan, Legare, Ponitz, Li, & Morrison, 2011	China *n* = 119; United States *n* = 139	3- to 5-year-old children from urban public schools (China) and rural and suburban schools (United States)		Sentence completion task
Legare, Dale, Kim, & Deák, 2018	United States *n* = 60; South African *n* = 60	3- to 5-year-old children from majority English-speaking, middle SES communities (United States) and multilingual, low-SES community in peri-urban informal settlement (South Africa)	3DCCS; FIM-An	
Moriguchi, Evans, Hiraki, Itakura, & Lee, 2012	Canada *n* = 70; Japan *n* = 61	3- and 4-year-old children from predominantly middle-class communities	Standard DCCS; social DCCS	

TABLE 1 (Continued)

Authors	Sample	Sample characteristics	Measures Shifting	Measures Updating
Oh & Lewis, 2008	Korea *n* = 76; United Kingdom *n* = 64	3- and 4-year-old children from predominantly professional families	DCCS, fruit animal alternation	Eight boxes, word span backward
Rato, Ribeiro, & Castro-Caldas, 2018	Portugal *n* = 233; U.S. normative sample (Isquith, Crawford, Espy, & Gioia, 2005)	3- to 5-year-old children; Portuguese sample from (sub-) urban areas	Shape school test (Condition C)	
Sabbagh, Xu, Carlson, Moses, & Lee, 2006	China *n* = 109; United States *n* = 107	3- and 4-year-old children; middle-class urban neighbourhoods	DCCS	KRISP
Schmitt, Korucu, Purpura, Whiteman, Zhang, & Yang, 2018	United States *n* = 125; China *n* = 91	Longitudinal assessment (mean age: time 1 = 4.20 years, time 2 = 4.74 years)	DCCS	
Song & Jinyu, 2017	Korea *n* = 43; China *n* = 56	Mean age of 10 years; children from lower-to-middle class (Korea) and upper-class or middle-class (China) communities		

Thorell, Veleiro, Siu, & Mohammadi, 2013	Sweden
	n = 141;
	Spain
	n = 219;
	Iran
	n = 49;
	China
	n = 72
		6- to 11-year-old children primarily from urban areas; Samples were representative regarding SES distribution in each country		Childhood executive functioning inventory (teacher and parent ratings)

TABLE 1 (Continued)

Authors	Sample	Sample characteristics	Measures Shifting	Measures Updating
Thorell et al., 2018	Sweden *n* = 3496 (Parents', teachers', and self-reports); comparison with U.S. American and German norms	6- to 18-year-old children and adolescents from population-based samples	Conners Rating Scales	Conners Rating Scales

Tran, Arredondo, & Yoshida, 2018	United States
	n = 13 (English ml.),
	n = 13 (Spanish-English bl.),
	n = 15 (Vietnamese-English bl.);
	Argentina
	n = 19 (ml.);
	Vietnam
	n = 20 (ml.),
	n = 16
	(Vietnamese-Cantonese bl.)
		Longitudinal assessment over a one year time span of 3-year-old (Time 1) monolingual and bilingual children from middle-class backgrounds	DCCS	

Wang, Devine, Wong, & Hughes, 2016	Sample 1: Hong Kong & United Kingdom *n* = 118; Sample 2: United Kingdom *n* = 108, Hong Kong *n* = 108	Sample 1: 9- to 16-year-old pupils of English-speaking international schools (Hong Kong) and state schools (United Kingdom); Sample 2: 10- to 12-year-olds from state schools (Hong Kong & United Kingdom)	Smiling faces task; trail making Test	Digit span backward

Wanless, McClelland, Acock et al., 2011	United States
	n = 310;
	Taiwan
	n = 158;
	South Korea
	n = 227;
	China
	n = 119
		Age range: 3 to 6 years; majority 4 or 5 years old		

TABLE 1 (Continued)

Authors	Sample	Sample characteristics	Measures	Measures
			Shifting	Updating

Wanless, McClelland, Lan, Son, Cameron, Morrison, Chen, Chen, Li, Lee, & Sung, 2013	United States
	n = 310;
	Taiwan
	n = 158;
	South Korea
	n = 227;
	China
	n = 119
		Children ranged in age from 3.12 to 6.50 years old; however, the majority of children (91%) were either 4 or 5 years old.		

Weixler, 2012	China *n* = 196; United States *n* = 198	Longitudinal assessment at the beginning (5-year olds) and end of kindergarten year (time span of roughly 1 year); different SES backgrounds (results controlled for SES)	DCCS	Auditory working memory task (Woodcock & Mather, 2000); self-administered teacher questionnaire
Yang, Yang, & Lust, 2011	United States *n* = 15 (English ml.), *n* = 13 (Korean ml.), *n* = 15 (Korean-English bl.); Korea *n* = 13 (Korean ml.)	4-year-old children from middle-class urban areas	Attention Network Test (congruent and incongruent flanker conditions)	

TABLE 1 Study characteristics and main results of included publications

	Measures	Main results	Main results	Main results
Authors	**Inhibition**	**Shifting**	**Updating**	**Inhibition**
Alansari & Soliman, 2012			Children from Egypt scored higher than children from Kuwait (sig. effect but very small effect size)	
Bialystok & Viswanathan, 2009	Faces task (difference between gaze shift and straight eye trials & difference between red and green eye trials)	Bilinguals in Canada and India performed similarly to each other and better than monolinguals in Canada		Bilinguals in Canada and India performed similarly to each other and better than monolinguals in Canada
Chasiotis, Kiessling, Hofer, & Campos, 2006	Bear & dragon; Luria's hand game; day and night task			German and Costa Rican children scored sig. better than Cameroonian children
Cheie, Veraksa, Zinchenko, Gorovaya, & Visu-Petra, 2015	Statue test; knock and tap; auditory attention subtest, response set subtest and visual attention subtest of NEPSY; inhibition subtest of NEPSY-II			No differences in response suppression; on measures of attention control Russian children outperformed Romanian children with regard to response accuracy but, regarding efficiency Romanian children performed better than Russian children
Ellefson, Fei-Yin Ng, Wang, & Hughes, 2017	Child-friendly version of stop signal task	Children in Hong Kong outperformed U.K. peers: 2-year advantage across the studied age-span with small to medium effect sizes	Children in Hong Kong outperformed U.K. peers: 2-year advantage across the studied age-span with small to medium effect sizes	Children in Hong Kong outperformed U.K. peers: 2-year advantage across the studied age-span with small to medium effect sizes
Engel de Abreu, Baldassi, Puglisi, & Befi-Lopes, 2013			No sig. group difference between any groups (neither between the different language status groups nor between the cultural groups)	

TABLE 1 (Continued)

Authors	Measures Inhibition	Main results Shifting	Main results Updating	Main results Inhibition
Gestsdottir et al., 2014	Direct assessment: HTKS; teachers' questionnaires: CBRS and Q-EM			In all three countries HTKS scores predicted increase in academic achievement; teacher ratings predicted growth in all areas of academic achievement among French and Icelandic children, in German sample only vocabulary
Grabell et al., 2015	Grass/Snow task; Luria's hand game; day/night stroop task; CBQ (inhibitory control scale)			Chinese preschoolers performed sig. Better on behavioural tasks with small effect sizes; Chinese mothers rated their children sig. lower on inhibitory control than U.S. mothers
Holding et al., 2018	Go/NoGo task	In the Bangladesh and Tanzanian samples age had a sig. linear effect on task results	In all three countries younger children performed above the level of older children; in the Tanzanian sample boys scored sig. better than girls	Improved performance with age in Ghana and Tanzania; in Bangladesh younger children scored above the level of older children
Imada, Carlson, & Itakura, 2013		Japanese children outperformed American children (in terms of both, accuracy and response time) with small effect sizes		
Lan, Legare, Ponitz, Li, & Morrison, 2011	HTKS		No difference between the two countries	Chinese preschoolers sig. outperformed American counterparts with large effect sizes
Legare, Dale, Kim, & Deák, 2018		Sig. effect of country for 3DCCS (U.S. children outperformed South African children and only U.S. children showed increase in task performance with age); no sig. difference between cultural groups for FIM-An test		

TABLE 1 (Continued)

Authors	Measures Inhibition	Main results Shifting	Main results Updating	Main results Inhibition
Moriguchi, Evans, Hiraki, Itakura, & Lee, 2012		No sig. differences based on country in the standard DCCS; however, 72% of Canadian children and only 57% of Japanese children passed the social DCCS		
Oh & Lewis, 2008	Day/night task; Luria's hand game; blue/red test; Luria's tapping test	No sig. Difference for DCCS; Sig. (but small) advantage for the Korean children on fruit animal alternation	Sig. and strong (Eight boxes) as well as a sig. But small (word span backwards) advantage of Korean children over U.K. peers	Sig. differences: On 3 of 4 measures Korean 3-year-olds performed above the level of the almost 5 years old English children
Rato, Ribeiro, & Castro-Caldas, 2018	Shape School test (Condition B)	Similar performance of Portuguese and U.S. children; exception of 3 year-old Portuguese children needing more time than American counterparts (however, Portuguese sample smaller and younger)		Similar performance of Portuguese and U.S. children
Sabbagh, Xu, Carlson, Moses, & Lee, 2006	Whisper task; day/night Task; grass/Snow task; bear/dragon task	Chinese children sig. outperformed U.S. children	Chinese children sig. outperformed U.S. children	Chinese children sig. outperformed U.S. children
Schmitt, Korucu, Purpura, Whiteman, Zhang, & Yang, 2018	Sun/Moon task; HTKS	Chinese children experienced greater growth than U.S. children; no sig. three-way interaction (Time x Country x SES)		Chinese children experienced greater growth in HTKS scores than U.S. children; no sig. three-way interactions (time × countr × SES); no differences on Sun/Moon task

TABLE 1 (Continued)

Authors	Measures Inhibition	Main results Shifting	Main results Updating	Main results Inhibition
Song & Jinyu, 2017	Executive Function Difficulty Questionnaire (emotional control difficulty & behaviour control difficulty subscales)			Cultural difference in reported emotional control difficulty: Korean children expressed more emotional control difficulty than Chinese children; no differences in reported behaviour control difficulty
Thorell, Veleiro, Siu, & Mohammadi, 2013	Childhood executive functioning inventory (teacher and parent ratings)		Sig. effects of country: Overall, Chinese sample rated as having more EF deficits compared with other samples; boys rated as poorer on EF than girls, except in Iran where parents, but not teachers, rated girls as having poorer EF compared with boys	Sig. effects of country: Overall, Chinese sample rated as having more EF deficits compared with other samples; boys rated as poorer on EF than girls, except in Iran where parents, but not teachers, rated girls as having poorer EF compared with boys
Thorell et al., 2018	Conners Rating Scales	Comparison of raw scores for EF subscale: Teacher ratings of EF problem levels increased during age period 6–9 years in Sweden and Germany, and decreased in United States	Comparison of raw scores for EF subscale: Teacher ratings of EF problem levels increased during age period 6–9 years in Sweden and Germany, and decreased in United States	Comparison of raw scores for EF subscale: Teacher ratings of EF problem levels increased during age period 6–9 years in Sweden and German and decreased in United States
Tran, Arredondo, & Yoshida, 2018	Day/night task; bear/dragon task;	No sig. Differences between cultures; across cultural groups bilingual children scored above the level of monolingual children		Day/Night: Vietnamese children (ml. & bl.) outperformed Western counterparts (ml. & bl.), Western and Latin American children caught up over time; sig. advantage for bilinguals across cultural groups (small effect size); bear/dragon: no sig. differences between cultures or language status groups

TABLE 1 (Continued)

Authors	Measures Inhibition	Main results Shifting	Main results Updating	Main results Inhibition
Wang, Devine, Wong, & Hughes, 2016	Arrows task; bead memory task	In both samples, Hong Kong children (both attending local and international schools) outperformed British counterparts on latent EF factor with small effect sizes	In both samples, Hong Kong children (both attending local and international schools) outperformed British counterparts on latent EF factor with small effect sizes	In both samples, Hong Kong children (both attending local and international schools) outperformed British counterparts on latent EF factor with small effect sizes
Wanless, McClelland, Acock et al., 2011	HTKS; CBRS			Differences regarding relation between HTKS scores and teachers' perception of classroom behavioural regulation: sig. positively related in United States and South Korea, not sig. related in Taiwan or China
Wanless, McClelland, Lan, Son, Cameron, Morrison, Chen, Chen, Li, Lee, & Sung, 2013	HTKS; CBRS			HTKS: sig. gender differences only in U.S. sample (girls scoring higher than boys); CBRS: Taiwanese, South Korean & U.S. (not Chinese) teachers rated girls' classroom behavioural regulation higher compared with boys
Weixler, 2012		Chinese children showed an advantage of 0.47 *SD* (approx. equivalent to 6 months of development) compared with U.S. peers; gap grows by 0.33 *SD* by the end of kindergarten year; in both samples girls scored higher than boys at Time 1	Chinese children outperformed U.S. children (advantage of 0.62 *SD*); Faster rate of development in Chinese children during kindergarten year (gap grows by 0.24 *SD*); advantage for girls only in U.S. sample	

TABLE 1 (Continued)

	Measures	Main results	Main results	Main results
Authors	**Inhibition**	**Shifting**	**Updating**	**Inhibition**
Yang, Yang, & Lust, 2011		Advantage of bilingual children compared with the monolingual groups; only sig. cultural difference regarding overall accuracy scores, with children from Korea working more accurately but slower (medium effect size)		

Abbreviations: 3DCCS, Three Dimensional Change Card Sort task; AWMA, Automated Working Memory Assessment; bl., bilingual; CBQ , Child Behavior Questionaire; CBRS, Child Behavior Rating Scale; DCCS, Dimensional Change Card Sort task; EF, Executive Functions; FIM-An, Flexible Induction of Meaning - Animates Test; HTKS, Head-Toes-Knees-Shoulders task; ml., monolingual; NEPSY, A Developmental NEuroPSYchological Assessment; NEPSY II, A Developmental NEuroPSYchological Assessment—Second Edition; Q-EM, Questionnaire pour les éleves de Maternelle; *SD*, standard deviation; SES, socio-economic status; sig., significant.

2.4 | Documentation of results

Summaries of all included publications were tabulated (Table 1). Information regarding the samples (children's countries of residence and sample size) as well as sample characteristics (e.g., children's ages, socio-economic backgrounds, social milieu, and language status) were documented, if available. In addition, each publication's measures and results were recorded separately for the three EF subdomains (shifting, updating, and inhibition). Regarding the administered measures, both the format of assessment (direct assessment or questionnaire/rating) and the specific tasks were noted. Effect sizes of the results were listed, when available.

3 | RESULTS

Our search strategy identified 4,418 unique publications. The titles of the identified publications were screened according to the aforementioned criteria. A total of 4,210 titles did not meet these specifications and were excluded from further investigation. Correspondingly, 208 publications were included in the next phase of the screening. Of these, 149 did not meet the inclusion criteria (see Figure 1). In the third step, full texts of the remaining

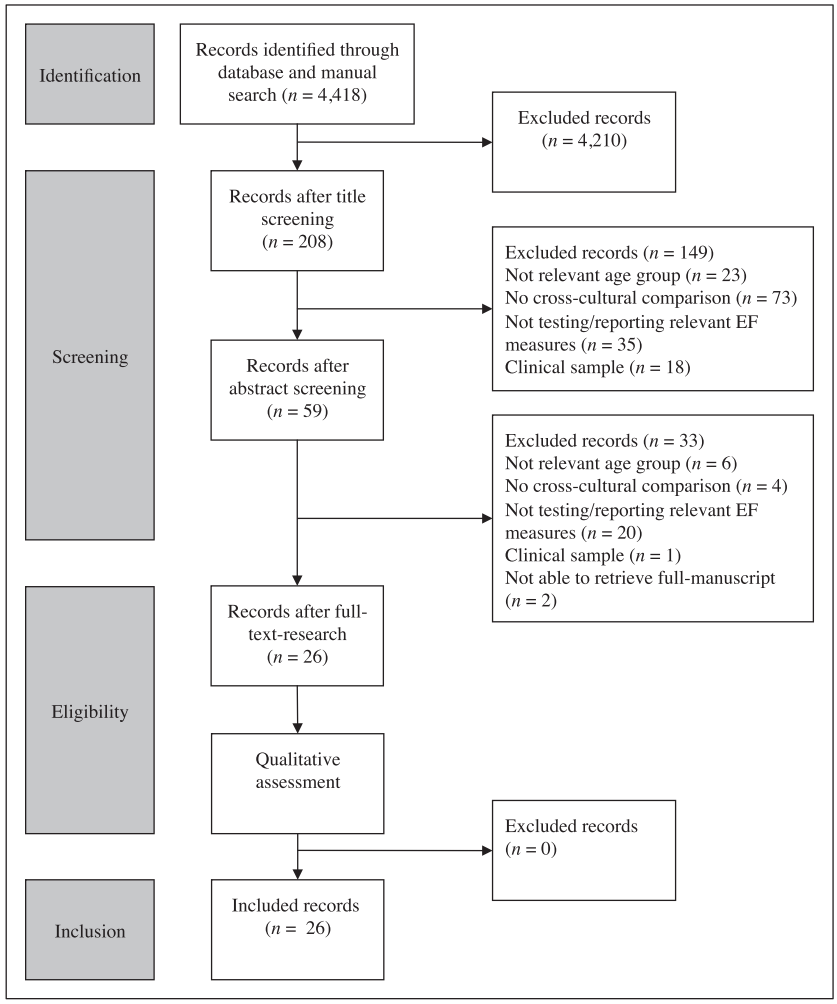

FIGURE 1 Process of study selection

59 publications were assessed thoroughly against the set inclusion criteria, and 26 of these were included for the systematic review.

All 26 texts were published between 2006 and 2018. As we did not place any restrictions regarding the date of publication, this time frame clearly highlights the current relevance of the topic. Taken together, the included studies assessed samples from 28 countries. Thirteen studies reported cross-cultural comparisons of children from Western and East Asian countries, and an additional two studies compared children from Western, East Asian, South American (Argentina) and Persian (Iran) samples, respectively. Four studies reported findings from studies comparing EF performances of children from Western countries with children growing up in South America, Central America, South Asia, and Africa. Three publications offered information on studies comparing participants from different Western countries. One paper assessed differences between children from two East Asian countries and another between children from two Arab countries. One publication compared children from Russia with children growing up in other Eastern European countries. Another one provided findings from African and South Asian samples. A detailed overview of the publications and their respective results are presented in Table 1.

3.1 | Advantage of bilingual children

Cross-national similarities in EF development were identified with regard to beneficial contributions of bilingualism to EF. Across different countries, bilingual children were shown to perform above the levels of monolingual peers. This pattern of results was examined in three studies and found for East Asian, Indian, South American, and Western children alike (Bialystok & Viswanathan, 2009; Tran, Arredondo, & Yoshida, 2018; Yang, Yang, & Lust, 2011). The bilingual advantage was demonstrated most clearly with regard to the subcomponents of shifting and inhibition, for which all three studies identified significant findings. Two of the three studies reported effect sizes, one small (Tran, Arredondo, & Yoshida, 2018) and the other medium to large (Yang, Yang, & Lust, 2011). The extant literature did not compare the updating capacities of bilingual and monolingual children. Hence, it was not possible to draw any conclusions about the relation between bilingualism and updating.

3.2 | Gender differences

Concerning cross-national differences in EF development, the reviewed studies indicated that gender differences in EF measures vary across different countries. Four of the studies analysed this particular issue. In samples from Euro-American countries, girls scored better than boys on measures of direct EF assessment, with small effect sizes. Similar patterns were also found for East Asian samples (Wanless et al., 2013; Weixler, 2012). In contrast, in Tanzania, boys performed above the levels of their female counterparts on direct EF tasks, with small effect sizes (Holding et al., 2018). Moreover, in Iran, parents rated boys as having higher EF performance levels, whereas girls received higher rating scores on the same parent questionnaire in the samples from Sweden, Spain, and China (Thorell, Veleiro, Siu, & Mohammadi, 2013).

3.3 | Increased task performance with age

Another interesting pattern was that EF performance was shown to increase with age in almost all samples analysed in the review, with large effect sizes. However, two of the studies investigated cross-national age differences in EF tasks with samples recruited in developing countries and/or communities classified as severely underprivileged economically (Holding et al., 2018; Legare, Dale, Kim, & Deak, 2018). In such samples, older children were not shown

consistently to score above the levels of their younger counterparts; in some cases, there were no significant effects of age at all (Holding et al., 2018; Legare et al., 2018).

3.4 | Advantage of children from East Asian countries

Another specific cross-national difference in EF development was evidence of a developmental advantage for children from East Asian countries over their Western counterparts on measures that involved direct assessment of EF. Preschool aged children from Asian countries showed an advantage equivalent to around 6 months of development (Oh & Lewis, 2008; Sabbagh et al., 2006; Weixler, 2012). This developmental advantage appears to increase in adolescence. For example, Hong Kong–Chinese adolescents were found to be 2 years ahead of their British counterparts on EF development (Ellefson et al., 2017).

This effect was identified most consistently with regard to the EF facet of inhibition. All eight studies that reported cross-national comparisons between East Asian and Euro-American children for inhibition measures reported significant findings for at least one inhibition subtest (Ellefson et al., 2017; Grabell et al., 2015; Lan, Legare, Ponitz, Li, & Morrison, 2011; Oh & Lewis, 2008; Sabbagh et al., 2006; Schmitt et al., 2018; Tran et al., 2018; Wang et al., 2016). Out of these eight studies, seven reported effect sizes. Three studies detected small-to-medium effect sizes, whereas four found large effect sizes.

Ten publications administered shifting tasks in East Asian and Western samples, the most common being the Dimension Change Card Sort (DCCS; Zelazo, 2006). One of these studies did not find any cross-national differences in shifting (Tran et al., 2018), three found effects on only one out of two subtests (Moriguchi, Evans, Hiraki, Itakura, & Lee, 2012; Oh & Lewis, 2008; Yang et al., 2011), and the remaining six found solely significant effects (Ellefson et al., 2017; Imada, Carlson, & Itakura, 2013; Sabbagh et al., 2006; Schmitt et al., 2018; Wang et al., 2016; Weixler, 2012). The effect sizes varied between small to medium (three studies) and medium to large (four studies).

The results are less conclusive regarding the updating subcomponent. Six studies reported findings on updating measures from East Asian and Euro-American samples. Five of these ascertained significant findings (Ellefson et al., 2017; Oh & Lewis, 2008; Sabbagh et al., 2006; Wang et al., 2016; Weixler, 2012) and one reported no cross-cultural differences (Lan, Legare, Ponitz, Li, & Morrison, 2011). The effect sizes fluctuated from small to large.

Two studies examined cross-national differences between East Asian (Chinese) and North American (Euro-American) samples in directly assessed EF tasks using a longitudinal design. These studies reported that the gap between Western children and their East Asian counterparts widens as children mature (Schmitt et al., 2018; Weixler, 2012).

Notably, the results from two studies that assessed EF by means of parent and teacher ratings suggested that Chinese parents rate their children's EF as significantly lower than parents from other countries (Grabell et al., 2015; Thorell, Veleiro, Siu, & Mohammadi, 2013).

4 | DISCUSSION

This paper has reviewed current research on EF development in children from different countries, following the EPPI-Centre's (2007, updated 2010) guidelines for systematic reviews. Similarities and differences in EF development were identified for children growing up in various parts of the globe. First, across countries, bilingual children were shown to outperform their monolingual peers. However, task improvement with age was not reported consistently, with no linear effects apparent in children from developing countries or regions. Gender differences on EF measures also varied between countries. Girls were found to perform better than boys on tasks assessing EF, and parents and teachers rated them higher than boys on EF development in both Western and East Asian samples. Yet, in Iran and Tanzania, boys received higher EF scores. A specific pattern of results was evident with regard to children growing up in East Asian countries. From preschool age to adolescence, East Asians outperformed their Western

counterparts on direct assessment measures of EF. Interestingly, the opposite pattern of results was portrayed by studies in which children's EF were rated by parents and teachers. Chinese parents rated their children's EF significantly lower compared with parents from other countries.

4.1 | Contextual factors underlying cross-national differences

Although the reviewed studies clearly displayed cross-national variations in EF development, the nature of specific influences linked to these differences was understood less clearly. Different working hypotheses have been formulated within the scientific discourse regarding the impact of contextual factors on EF. Cross-national differences have been ascribed to differences in pedagogic approaches and educational settings, parental upbringing and expectations, and to social norms and value systems.

It has been argued that cultural differences in pedagogic approaches and educational settings influence children's EF development. Teacher's beliefs about the importance of play and learning objectives translate into differences in the structuring of play and learning in kindergarten (Wu & Rao, 2011). Likewise, classroom practices in primary school differ across cultures (Lan et al., 2009). Teachers' classroom management is, in turn, linked to children's cognitive and behavioural self-regulation (Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009). This assumption offers one specific possible explanation of the advantage of East Asian children over their Western counterparts on measures of direct EF assessment (Wang et al., 2016). To illustrate, behavioural engagement has been shown to decline considerably faster in U.S. American classrooms than in Chinese classrooms (Lan et al., 2009). Increased exertion of self-control required during inhibitory processes of EF (Diamond, 2012) could, therefore, underlie differences in on-task behaviour in classroom settings.

Wang et al. (2016) systematically tested the hypothesis that educational setting influences EF development. They compared Hong Kong–Chinese children attending public schools and ethnically diverse children attending English-speaking private schools in Hong Kong with children from the United Kingdom on EF measures. They found that the children in Hong Kong, regardless of type of school, outperformed their U.K. counterparts on the EF tasks (Wang et al., 2016). Following up on these findings, future research would benefit from implementing classroom observations alongside EF testing in order to assess cross-cultural differences in teachers' interactions with their students and their relationships to EF development. This methodology potentially offers new insights into the pathways through which cross-cultural differences are shaped. In addition, the to-date inconclusive findings highlight the importance of distinguishing between socialization influences at school and at home.

Indeed, differences in parenting styles present an additional promising approach in understanding cross-cultural as well as cross-national differences in EF development (Chasiotis et al., 2006; Oh & Lewis, 2008). Different aspects of parenting, such as maternal sensitivity, mind-mindedness, scaffolding, and autonomy support, have been shown to have an influence (Bernier, Carlson, & Whipple, 2010; Carlson, 2003) and culturally specific emphases of parenting have been formulated (Chao & Tseng, 2002). Examining systematic variations across countries within constructs such as scaffolding and autonomy support and their link to EF, therefore, pose a promising path for future research.

One of the most striking findings of the current review is the discrepancy between the results of direct assessment of EF and parents' ratings of their children. Studies reporting the results of direct assessment have demonstrated higher levels of EF in children from East Asian countries, although Chinese parents rated their children as poor, compared with parental ratings of Western children (Grabell et al., 2015; Thorell et al., 2013). One possible explanation of this non-conformance of results is that parents' expectations of their children's cognitive and behavioural self-regulation differ between countries. Higher expectations might lead to increased behaviour fostering these skills in parents, which in turn might result in more advanced EF skills of the children, but further research is needed in order to test the causality of such pathways.

In addition, most studies assessing gender differences in EF development in Western and East Asian countries reported advantages for girls over boys, both on measures of direct assessment and parents' ratings (Thorell et al., 2013; Wanless et al., 2013; Weixler, 2012). However, the results for a sample from Tanzania demonstrated male

participants having the advantage on updating measures (Holding et al., 2018). Furthermore, Iranian parents rated girls' EF as lower than their male peers—a finding directly opposite to the results from Sweden, Spain, and China (Thorell et al., 2013). Thorell et al. (2013) argued that these differences are most likely to be the result of parental cultural biases, as patriarchal views are still widespread in Iranian society.

Taken together, these findings offer preliminary support to the notion that parental expectations of their children's behaviour vary as a function of cultural influences and, in turn, affect children's cognitive development of EF. In future research, it will be particularly important to apply both measures of direct assessment and parents' ratings of children's EF, within one cross-cultural research design. This approach will enable scholars to disentangle effects of culturally biased ratings and cross-cultural differences in children's performances on cognitive tasks. In addition, there is a need to assess parents' and teachers' beliefs and expectations simultaneously with children's EF performances in longitudinal designs to be able to test the causality of such links.

Other scholars have argued in favour of more general cultural influences underlying differences in children's EF development, such as social norms and cultural values. In line with this hypothesis, Moriguchi et al. (2012) reported that social aspects of task introduction influenced performance on the DCCS (Zelazo, 2006). In particular, it was more difficult for Japanese children than for Canadian children to shift to a new sorting rule after having seen a test instructor sorting only according to the first rule. This social transmission of disinhibition was apparent for both Canadian and Japanese children, but with a much smaller effect in the Canadian sample. In addition, different cognitive processing styles of Western and Asians children have also been discussed (Imada, Carlson, & Itakura, 2013). Their findings showed that Japanese children focused more than American children on contextual information in visually presented material. These distinctions in levels of context sensitivity mediated the differences between the two cultural groups on the EF shifting task (Imada et al., 2013). These findings highlight the influence of Confucian traditions, such as prioritizing collectivistic and interpersonal connections on cognitive processes. However, further research is urgently needed to differentiate reliably the effects of global cultural factors from more specific contextual influences such as educational settings.

At the same time, similarities can be identified across countries with regard to the advantages of bilingual children over their monolingual peers (Bialystok & Viswanathan, 2009; Tran et al., 2018; Yang et al., 2011). This finding holds promise with regard to future research as it offers the opportunity to assess shared influences and gives ground to cross-national intervention programs.

Notably, examining cultural influences requires diligent consideration of guiding frameworks characterizing and conceptualizing culture and cultural influences. Velez-Agosto, Soto-Crespo, Vizcarrondo-Oppenheimer, Vega-Molina, and Coll (2017) postulated that differences between cultures are in fact evinced at a micro level. They argued "that culture is not a separate system operating from a macro level, but is within everyday action" (Velez-Agosto, Soto-Crespo, Vizcarrondo-Oppenheimer, Vega-Molina, & Coll, 2017, p. 900). According to this definition, culture manifests itself within everyday practices of social groups, such as families or classes (Velez-Agosto et al., 2017). This paradigm shift has strong implications for research focusing on child development. It highlights the relevance of taking into account specific daily practices within communities or institutions, like families, kindergartens, and schools, as opposed to more global cultural influences, such as individualism versus collectivism. Having said that, global cultural dimensions can by no means be considered irrelevant in understanding the pathways of cultural influences. Instead, it implies that exploration of such factors in future research needs to be guided by questions focusing on the micro level. To illustrate by example, how do parental expectations differ between individualistic versus collectivistic cultures, and how are these expectations manifested?

Taras, Steel, and Kirkman (2016) offered new perspectives on the conceptualization of cultural entities. They argued that country of residence should not be equated with culture, even though it is one of the most commonly implemented proxies for culture, as cross-cultural variations in cultural values also occur within countries (Taras et al., 2016). Implementing this conceptual approach into the field of EF research offers interesting new outlooks. To illustrate, one might ask if the operationalization of socio-economic-status in the different countries can be considered as equivalent. Concerning this, future research should extend the finding that EF performance does not improve

with age in some samples from economically disadvantaged communities (Holding et al., 2018) by assessing samples from different socio-economic backgrounds within multiple countries. Combining this approach with longitudinal designs seems particularly promising.

4.2 | Longitudinal development of EF

The reviewed studies demonstrated that strong discrepancies in EF development exist between children from East Asian and, in particular, Western countries. However, it remains less clear how trajectories of EF development from preschool until adolescence vary across cultures. Do children from East Asian countries develop EF competencies earlier and at a faster rate than Western children, or are there substantial cultural differences in patterns of EF development? Are there cultural differences in developmental trajectories of the different components of EF? In short, it is not merely a question of when and if Western children catch up to their East Asian peers, but it is also a matter of patterns of development. The studies to date reporting results from longitudinal studies differ with regard to the samples tested. Tran et al. (2018) illustrated that 3-year olds from the United States and Argentina initially performed below the level of their Vietnamese counterparts but caught up by the age of four. In contrast, other results have suggested that the developmental gap between Chinese and American children widens during the preschool years (Schmitt et al., 2018; Weixler, 2012). To our knowledge, there have been no studies to date that have analysed the different components of EF development longitudinally in different cultures during the primary school years or adolescence.

At the same time, not all of the reviewed studies found task improvement with age in samples of children from developing countries or severely disadvantaged communities, these generally being reported for children from developed countries (Roethlisberger, Neuenschwander, Cimeli, & Roebers, 2013). Results reported by Legare et al. (2018) showed that linear improvements with age on a three-dimensional DCCS task were only apparent in the U.S. American sample but not in the sample of children from economically disadvantaged communities in South Africa. Holding et al. (2018) assessed shifting, updating, and inhibition performances of children growing up in areas of relative poverty and limited health care access in Tanzania, Ghana, and Bangladesh. They reported that, on multiple tasks and in all three samples, the older children did not score any better than their younger counterparts (Holding et al., 2018). These findings question the presumption of a universal processes of maturation (Holding et al., 2018; Legare et al., 2018).

Additional research is required to find conclusive answers to the intriguing research question of how EF development trajectories compare across different cultural contexts. Ultimately, longitudinal research designs covering wider age spans are needed.

4.3 | Methodological considerations

From a methodological standpoint, it remains a challenge to ensure that applied EF measures are not culturally biased. For example, children from many East Asian countries have been shown to outperform their Western counterparts with regard to numerical and mathematical competencies (Brenner, Herman, Ho, & Zimmer, 1999; Geary, Bowthomas, Fan, & Siegler, 1993; Miller & Stigler, 1987). This increased familiarity with numbers might result in an advantage for Asian children compared with Western children in EF tasks involving numbers, for example, backward digit span. In this case, scholars have not been able to determine conclusively whether such effects truly measure higher levels of EF, or if they are primarily apparent due to higher mathematical competence.

In addition, many of the reviewed studies administer very different tasks in order to assess the EF subcomponents. This inconsistency in measurement formats increases the difficulty in summarizing findings conclusively across

individual studies. The administration of standardized computer-based tasks constitutes one possible approach to limiting effects of methodological thresholds. Studies assessing reliability and validity of cognitive tasks, such as visual attention and short-term memory, offer support for the notion that this form of assessment presents a promising approach to cross-cultural assessment (Pitchford & Outhwaite, 2016).

4.4 | Limitations

A number of specific search terms was applied during the systematic literature search of bibliographic databases. The combinations of topic–keywords were chosen with the aim to represent the contextual framework of EF underpinning this review. However, the possibility cannot be excluded that potentially eligible studies assessing similar constructs but using different terms (e.g., effortful control) might therefore have been missed.

The first author carried out the screening process in frequent consultations with the second and third authors. The format of a systematic review was chosen to avoid effects of biases during the process of study selection. Due to time and budgetary limitations, it was not feasible for the screening process to be conducted jointly by multiple scholars. Notwithstanding, having a team of scholars each rate the eligible studies would have possibly enhanced objectivity further during the screening process.

Lastly, this review has not offered any quantitative assessment of the reported results. To draw conclusions regarding effect sizes, an additional meta-analysis would have been required. Having said that, the format of a systematic review was chosen in the current study, with a predominant aim to summarize patterns of findings and to offer considerations for future research. In addition, the rather small number of eligible studies and the heterogeneity of applied measurement formats and tasks were counterarguments for conducting a meta-analysis.

5 | CONCLUSION

In summary, the reviewed studies clearly demonstrated that cultural context factors influence EF development. Both similarities and differences in developmental patterns of EF were identified across different countries. In addition, strong discrepancies were found between measures of direct EF assessment and parent and teacher ratings of children's EF. Therefore, future research will need to apply both formats simultaneously within cross-national studies in order to understand the underlying influences better. In addition, longitudinal research covering wider age spans is needed to assess trajectories of EF development in different countries.

CONFLICT OF INTEREST

The authors of this paper declare that they have no affiliations with or involvement in any organization or entity with any financial or nonfinancial interest in the subject matter or materials discussed in this manuscript.

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