The Relationship between Bilingual Cognitive Flexibility and Mental Executive Functions among Primary School Pupils[1]

A Research Paper Prepared and Proposed by:

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Abstract

The present study aims to investigate differences between a sample of bilingual primary school pupils according to their gender and socioeconomic and cultural level, based on their mental executive functions (EFs) abilities on one hand, and bilingual cognitive flexibility (BCF) on the other among a sample of bilingual primary school pupils, aged between (9-12) representing the late childhood phase, who speak both Arabic and English. Furthermore, the study target shedding light on the relationship between bilingual cognitive flexibility and mental executive functions among primary school pupils (9-12) years old.

The study followed the descriptive approach. The descriptive diagnostic sample was randomly chosen. The final N=(136)of primary middle school pupils.

The measurements to diagnose the dynamic variables were: The Executive Skills Questionnaire (ESQ) - Dawson and Guaref, for children (36 items), translated by the researcher, for Bilingual Cognitive Flexibility, the

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researcher prepared a scale. As for the socioeconomic and cultural level, the researcher presented a form.

Dealing with the statistical methods, the researcher used T-test for independent variables, one-way ANOVA, Tukey's test, and the Pearson correlation coefficient method.

The results of the study revealed statistically significant differences between the demographic variables (gender-socioeconomic and cultural level), and the dynamic variable (Cognitive Bilingual Flexibility). There were no statistically significant differences between the demographic variables (gender), and the dynamic variable Mental Executive Function, whereas there were statistically significant differences regarding the demographic variables (socioeconomic and cultural level), The result also showed a positive relationship between bilingual cognitive flexibility and mental executive functions in primary school.

(**Key Words:** Interdisciplinary research in Humanities, Bilingual Cognitive Flexibility, Mental Executive Functions, Primary School pupils).

Introduction:

A child, who is going to primary school, is an active, creative young person, hence, teaching him/her must be combined with the characteristics of a primary school pupil and his/her social, emotional, physical activity, and linguistic growth. Since birth, a child learns the mother tongue developing it from distinguishing simple sounds to developing morphology, syntax, and semantics. By the age of 5-6, the child completes the greater part of the basic language acquisition process, and this time is in a good position to start to learn a second (foreign)language. He/she at the age of 7-12 is adroit to acquire the knowledge of the language quickly enough and a wholesome development as he/she is surrounded by language which is made worthwhile because of context and how teachers speak to them. (Bialystok, E. and Martin, M.M.2004).

Language is associated with cognitive processing. The ongoing activities associated with languages, listening to a certain topic, articulating a thought, and shifting attention from one topic to another, are mentally demanding when a person exercises a language. When a person speaks two languages it becomes more complicated and there is more cognitive processing involved. Bilinguals are forced into a cognitive flexible behavior when they shift from

one language to another. This shifting behavior has led to a hypothesis that bilinguals have their cognitive abilities shaped, which results in having a special mental advantage compared to monolinguals who do not experience shifting languages (Bialystok. E, et al.2010).

Bilingual cognitive flexibility is a critical skill that enables individuals to respond in the face of changing environments accurately and efficiently. The specific interactions among mental executive functions required to successfully implement bilingual cognitive flexibility continue to be characterized. Important considerations need to be accounted for as researchers examine cognitive flexibility development considering developmental differences.

Mental executive functions can be changed and developed over time and age and influenced by the educational context-where it can be targeted and heightened- and students can effectively regulate themselves in demanding bilingual cognitive flexibility and can enhance their academic performance through mental executive functions (Zelazo, P. D.2006).

Issue of the Current Study:

According to research, bilinguals have higher cognitive abilities than monolinguals (Prior, A., and MacWhinney, B.2010). Mental executive functions are a set of cognitive processes that help people regulate their thoughts and engage in goal-directed actions (Shao, Z.2014). Even though there are several conceptualizations of EFs components, there is universal agreement that EFs are made up of the following major components: Working memory (a mental workspace in which knowledge is temporally and mentally modified), attention and inhibition (the capacity to manage attention, behavior, and ideas), and cognitive flexibility (allows us to think divergently, change perspective and adapt to a constantly changing environment). Bilingual advantages and connections have been discovered in all three components of EFs: inhibition, shifting, and working memory. Bilinguals get more practice in inhibitory processes and attentional controlin processing their language(s), such as inhibiting the non-target language or actively attending to the target language (Wiseheart, M. et al.2016).

However, several studies have failed to find a bilingual advantage in cognitive measures (Dick, A.S, et al.2019). The lack of bilingual advantage has also been found in all three domains of EFs:inhabitation (Arizmendi, G.D, et al.2018). shifting, and working memory.Researchers have proposed several

explanations for these discrepant findings, including physical activity and dietary intake (Kim, J. Y., and Kang, S. W.2017), culture (Samuel, S.et al.2018), the age of participants, demographic factors, weak psychometric properties of cognitive tasks (Paap, K. R., and Sawi, O.2016), sample size, and publication bias (De Bruin A, et al.2016).

Because there are some contradicting findings in the field of multilingual flexibility and EFs, one illuminating step is replication (Poarch, G. J.2018). Bialystok and Martin (2004) compared 36 English monolinguals (18 boys and 18 girls, M = 59.1 months) against 31 Chinese-English bilinguals (21 boys and 10 girls, M = 58.9 months) (Bialystok, E. and Martin, M.M.2004). They assessed the children's receptive vocabulary in English (using the Peabody Picture Vocabulary Test) and found no differences in verbal working memory ability (with a forward digit span task). The dimensional change card sort (DCCS) task was used to measure the children's attention and inhibition components of EFs. The DCCS is a commonly used measure of EF in preschool children (Zelazo, P. D.2006).

Students are required to sort cards containing pictures (such as red and blue rabbits and boats) based on one dimension of the photographs (such as color) and then sort the cards based on another dimension of the photographs (such as size) in this task (such as shape). This practice requires students to focus on crucial components of a problem while filtering out irrelevant information and moving between rules. When asked to modify the rules, young children typically persist, which means they continue to apply the previous rule even after the rules have changed (Zelazo, P. D.2006). When it comes to switching rules, Bialystok and Martin (2004) observed that bilinguals outperformed monolinguals. In other words, they identified a linguistic edge (Bialystok, E. and Martin, M.M.2004).

Even when they are just processing one language, bilinguals are thinking in both languages. Bilinguals must constantly manage input from their two competing language systems to select the right language and suppress the one that is not currently in use. Several studies have found that bilinguals' ability to select and suppress languages may be applied to other activities that involve attentional processing and cognitive flexibility (Bialystok, E .2001; Bialystok, E et al., 2005).

Cognitive flexibility is defined as the ability to direct attention to a specific stimulus while disregarding other inputs. Cognitive flexibility and selective attention are higher mental skills responsible for goal-directed behavior, often

known as executive functions (Best, J. R., & Miller, P. H., 2010). Therefore, bilinguals using bilingual cognitive flexibility may outperform monolinguals on non-linguistic tests of EFs if their expertise in selecting and suppressing languages generalizes to other activities involving EFs. This multilingual advantage may be especially noticeable during periods of developmental transition, such as childhood and old age (Bialystok, E. et al., 2006; Craik, F. I., & Bialystok, E., 2006). EFs expand rapidlyduring childhood, thanks in part to the prefrontal cortex's strong plasticity and maturation, which helps youngsters to gain greater control over their behaviors and ideas (Diamond, A. 2009; Conway, A., and Stifter, C. A., 2012). This critical phase of development allows for some beneficial contextual experiences, such as socioeconomic position and parental practices, to increase the development of EFs (Lengua, L. J.et al., 2015).

Some studies have demonstrated that bilingualism has advantages in EFs tasks involving conflict (Bialystok, E 2001, 2011; Bialystok, E and Martin, 2004; Bialystok, E et al., 2010; Poulin-Dubois, D.et al., 2011; Barac, R. and Bialystok, E 2012; Garraffa, M. et al., 2015; Antoniou et al., 2016; Blom, et al., 2017). Conflict is defined in this context as a dispute between two or more objects, and it arises anytime incompatible and conflicting reactions or representations exist (Festman, J., and Münte, T. F., 2012). The dimensional shift card sort task is one example of a task that presents a contradictory scenario (DCCS). This challenge pits two sets of rules against one other and requires youngsters to focus on only one of them at a time 2014). (Craig. I and Bialystok, E 2006; Bialystok et al., 2014). Other research has not discovered a multilingual advantage in those age ranges (Valian, V, 2015).

One reason for these disparities might be that bilinguals have unique traits that determine when an EF advantage is identified (Festman, J. et al., 2010; Valian, V, 2015). Indeed, the previous study has found that bilinguals with more balanced proficiency had greater EF. (Yow, W. Q., & Li, X. 2015).

As a result of presenting the study problem in the previous lines, and the sense of the research issue, the following questions emerged:

Research Questions: This study aims to explore and provide descriptive support for the following research questions:

RQ1: Are There statistically significant differences between the dynamic variable (bilingual cognitive flexibility), and the demographic variables

(gender- the socioeconomic and cultural level) among middle primary school pupils.?

RQ2: Are There statistically significant differences between the dynamic variable (mental executive functions), and the demographic variables (gender- the socioeconomic and cultural level) among middle primary school pupils.?

RQ3: Is there a statistically significant relationship between bilingual cognitive flexibility and mental executive functions among middle primary school pupils?

Study Hypotheses: The study hypotheses are summarized after presenting the questions as follows:

Hypothesis 1: There are statistically significant differences between the dynamic variables (bilingual cognitive flexibility), and demographic variables (gender- the socioeconomic and cultural level) among middle primary school pupils.

Hypothesis 2: There are statistically significant differences between the dynamic variables (mental executive functions), and demographic variables (gender- the socioeconomic and cultural level) among middle primary school pupils.

Hypothesis 3: There is a statistically significant relationship between bilingual cognitive flexibility and mental executive functions among middle primary school pupils.

Aim of the study:

The study goals were to monitor the possibility that there are disparities in the mean of the research sample scores of both genders and differences according to the socioeconomic and cultural level, on measures of bilingual cognitive flexibility and mental executive functions. Also, the study aims at

monitoring whether there is a relationship between bilingual cognitive flexibility and mental executive functions among primary school pupils (9-12) years old.

Importance of the Study: The importance of the study stems from several considerations, the foremost of which are the following:

1-The importance of variables: The importance of this study comes from the scarcity of its variables. Bilingual cognitive flexibility and executive mental functions are two basic concepts in all teaching fields, where the two variables are the main guarantee for the advancement of learners in the educational field, especially the primary stage. Also, this study derives its importance from the positive gains in displaying the components of bilingual cognitive flexibility and executive mental functions. Through this, they can acquire basic skills to improve academic achievement; This is because the executive mental functions include self-development skills, self-efficacy, and academic performance efficiency.

2- Psychometric Importance: The study presents new diagnostic measures for the Library of Arab Studies, including the Bilingual Cognitive Flexibility Scale and a translation of the Executive Mental Functions Scale.

٣- The importance of the research field: The importance of the study is attributed to the fact that its variables place it in more than one research field. In terms of variables: bilingual cognitive flexibility, and executive mental functions, fall in the field of linguistic and cognitive psychology, and in terms of the sample, they fall in the field of educational psychology, and from Where the environment of application of the study is located in the field of educational psychology, and terms of tools and preparation, it falls in the field of psychometrics; There is no doubt that the plurality of these areas in one study gives it special importance.

4- The Practical Importance: This research comes in the context of interest and emphasizes the importance of diving into the psychological and behavioral aspects, especially the positive psychological aspects and dimensions of the workforce, and finding appropriate mechanisms that would provide a fertile ground for unleashing the creative talents and ideas

of human capital in different organizations and not Only primary education environment.

The Study's Spatial and Time Limitations:

The researcher outperformed the study in Egypt, Nile Egyptian Schools, Sheikh Zayed Branch–NES, from April to November 2022.

Idiomatic Definitions:

Bilingual Cognitive Flexibility: The capacity to modify one's behavior (language) correctly and effectively in response to a changing environment and situation (Armbruster, D. J., et al.2012). Such as managing the air traffic control system to make sure the safe arrival and departure of multiple aircraft on multiple runways the brain needs management skills to filter out distractions, set goals, prioritize tasks, achieve them, and control motivation (Center on the Developing Child. 2022).

It is the shift in focus of attention to a task for a specific problem, this navigation is closely related to the dimensions and aspects of this task or problem, and includes switching between skill sets, tasks, and strategies relevant to solving that task, problem, or Start with a new, more appropriate group.(شيماء توفيق، ٢٠٢١، ص ٣٠)

Executive Functions: Working memory, inhibition, and shifting are all mental control mechanisms required to conduct goal-directed activities (Diamond, A.2013).

The executive functions are mental skills that can regulate mental processes; for which their results can be interpreted through human behavior in different situations according to different stimuli. (أشرف لطفي ، ٢٠١٩ص ٣٢)

Procedural Definitions: The researcher could determine the procedural definitions as follows:

Bilingual Cognitive Flexibility (BCF): The ability to adapt to changes in the contextual environment by switching and decoding languages using

skills such as attention flexibility and bilingual fluency shifting, which can be interpreted through the examinee's score.

*The factors of the mental executive functions scale can be defined as follows:

1-Attention flexibility: Is the ability to alternate between narrow attention (focused) and diffused attention (broad) or to apply both at the same time, where (narrowing) makes us specific but requires dividing reality into smaller pieces /objects, (diffusing) allows us to see the big picture and connect /immerse with its elements. Deduced from the work of (Bialystok, E., & Craik, F. I. M. 2022)

2-Bilingual fluency shifting: The ability to use two languages with equal fluency in both skills of reading and writing fluency. Deduced from the work of (Bialystok, E., & Craik, F. I. M. 2022)

Executive Functions (EF): Mental skills that can regulate mental processes for which their results can be interpreted through human behavior in different situations according to different stimuli and can be classified as the following components:(Response Inhibition - Working Memory - Emotional Control- Flexibility -Sustained Attention - Task Initiation - Planning/Prioritization – Organization - Time Management - Goal-Directed Persistence – Metacognition); could be interpreted through the examinee's score.

*The factors of the mental executive functions scale can be defined as follows:

1-Response Inhibition: The capacity to think before you act – this ability to resist the urge to say or do something allows us the time to evaluate a situation and how our behavior might impact it. In the young child, waiting for a short period without being disruptive is an example of response inhibition while in the adolescent it would be demonstrated by accepting a referee's call without an argument.

2- Working Memory: The ability to hold information in memory while performing complex tasks. It incorporates the ability to draw on past learning or experience to apply to the situation at hand or to project into the future. A young child, for example, can hold in mind and follow 1-2 step directions

while the middle school child can remember the expectations of multiple teachers.

3- Emotional Control: The ability to manage emotions to achieve goals, complete tasks, or control and direct behavior. A young child with this skill can recover from disappointment in a short time. A teenager can manage the anxiety of a game or test and still perform.

4- Sustained Attention: The capacity to maintain attention to a situation or task despite distractibility, fatigue, or boredom. Completing a 5-minute chore with occasional supervision is an example of sustained attention in the younger child. The teenager can attend to homework, with short breaks, for one to two hours.

5- Task Initiation: The ability to begin projects without undue procrastination, in an efficient or timely fashion. A young child can start a chore or assignment right after instructions are given. A high school student does not wait until the last minute to begin a project.

6- Planning/Prioritization: The ability to create a roadmap to reach a goal or to complete a task. It also involves being able to make decisions about what's important to focus on and what's not important. A young child, with coaching, can think of options to settle a peer conflict. A teenager can formulate a plan to get a job.

7- Organization: The ability to create and maintain systems to keep track of information or materials. A young child can, with a reminder, put toys in a designated place. An adolescent can organize and locate sports equipment.

8- Time Management: The capacity to estimate how much time one has, how to allocate it, and how to stay within time limits and deadlines. It also involves a sense that time is important. A young child can complete a short job within a time limit set by an adult. A high school student can establish a schedule to meet task deadlines.

9- Goal-directed persistence: The capacity to have a goal, follow through to the completion of the goal, and not be put off by or distracted by

competing interests. A first grader can complete a job to get to recess. A teenager can earn and save money over time to buy something of importance.

10- Flexibility: The ability to revise plans in the face of obstacles, setbacks, new information, or mistakes. It relates to adaptability to changing conditions. A young child can adjust to a change in plans without major distress. A high school student can accept an alternative such as a different job when the first choice is not available.

11- Metacognition: The ability to stand back and take a birds-eye view of oneself in a situation. It is an ability to observe how you solve problems. It also includes self-monitoring and self-evaluative skills (e.g., asking yourself, "How am I doing? or How did I do?"). A young child can change behavior in response to feedback from an adult. A teenager can monitor and critique her performance and improve it by observing others who are more skilled.

(Cipolotti et al., 2020) (Roche et al., 2020)

Theoretical Framework:

Explanatory theories and models of bilingual cognitive flexibility and mental executive functions:

1-Threshold theory: threshold theory is a hypothesis that is related to bilingualism. It is an idea that attempts to explain the cognitive effects of bilingualism. According to Cummins (1979), different types of bilingualism will reflect differences in cognitive development according to the threshold of competence reached. He also stated that in the threshold theory, there are two thresholds of bilingual ability; high and low level. Each threshold is a level of competence that must be achieved to reach the next level. The first threshold is a level that a child must reach to avoid the negative cognitive consequences of bilingualism. To surpass this first threshold, the bilingual child must have reached a high enough proficiency in at least one language to cope with the academic content of the classroom. The second threshold level is when both languages are well developed to the point where a child may succeed in the classroom in either one of the languages. Once past this second level, a bilingual child may have an advantage over a monolingual child in terms of thinking. Cummins claims that high levels of bilingualism still have a positive cognitive effect provided that the child's bilingual competence extends beyond the higher threshold level. Cummins also points out that a child with a high level of bilingualism has an ability of

understanding and excellent communication in both languages, and hereby we can notice bilingual cognitive flexibility.

(Abdulaziz Alshahrani,2017)

2-The theory of cognitive complexity and control: According to the theory of cognitive complexity and control (CCC) proposed by Zelazo &Frye (1997), preschool children lack the necessary conscious representation and executive functioning to solve problems based on conflicting rules.

Related to this, in a later work, Bialystok& Majumder (1998) evaluate the effect of different degrees of bilingualism on the non-verbal problem-solving abilities of children in grade three. In their study, a French-English and a Bengali-English bilingual group are compared with an English monolingual group. The problem-solving task is designed to measure the subject's control of attention and analysis of knowledge. In earlier studies, these capabilities are different for monolingual and bilingual children when it came to solving linguistic problems. Language proficiency tests show the French-English group to be relatively more balanced bilinguals and the Bengali-English group to be partially balanced bilinguals. The results show the balanced French-English group to be better in solving non-linguistic tasks requiring the control of attention. However, there is no difference between the three groups concerning the ability to analyze representational structures. Thus, balanced bilinguals do appear to carry their linguistic advantages to non-linguistic tasks requiring close attention.

Depending upon discourse demands, at some level bilinguals need to control two languages during speech. This affects their attentional networks. Fan, McCandliss, Sommer, Raz, & Posner (2002) discuss three types of attentional networks among bilinguals. These three attentional networks are: becoming alert, orienting, and executive control. Bilinguals are faster in performing tasks and specifically are more efficient at becoming alert and managing executive networks. More content is added by bilinguals on the presentation of an alerting cue, and it is more useful to resolve conflicting information. Their flexible switching cost between trials is less than that of monolinguals. The most efficient attention mechanisms appear to be produced by young adults who are at the peak of their attention capabilities. In another work by Bialystok, Craik, Klein, & Viswanathan (2004), the ability to control processing among bilinguals decreases less with

age than among monolinguals. Thus, bilingualism effectively helps to offset age-related loss of the ability to flexibly control some executive processes.

3- The 'unity and diversity' model: One commonly accepted model of executive functions is the 'unity and diversity' model proposed by Miyake et al. (2000). Miyake et al. tested 137 young adults on multiple measures of three commonly theorized executive functions (prepotent response inhibition, updating of working memory, and task shifting), and extracted latent variables for each of these three constructs by using confirmatory factor analysis (CFA). The resultant model provided evidence of these constructs being related yet distinct from each other, as evidenced by moderately strong inter-factor correlations (range r = .42 to r = .63). This model proposes that there is a general, domain-free ability underlying all executive processes, as well as several independent abilities specific to each single executive function. The general, common ability causes each single executive function to correlate with each other, whereas the specific abilities cause each function to be separable from each other. Although the Miyake et al. (2000) model is generally considered the seminal model of executive functions, attempts to replicate it in children have been mixed. Specifically, the structure of executive functions through early to mid-childhood, up to around the age of 9 years, appears to be unitary (i.e. a one-factor model of executive functioning is the best fit of the data). At some point after the age of 9 years, the individual executive functions differentiate themselves from each other, so that by the age of 10–11 years, the Miyake et al. (2000) model of executive functions is observed (i.e. children display 'unity and diversity'). (Miyake and Friedman, 2012)

4-Luria Model: Alexander Luria developed one of the most interesting models for understanding the human brain's functioning. This theory proposed that three functional units interact between different structures: the first oversees the regulation of wakefulness and tone; the second oversees the reception, process, and storage of information; the last unit oversees the programming, regulation, and verification of behavioral and cognitive activity. The third functional unit is related to the work of the human prefrontal cortex, the structure responsible for the activation of the most developed mental activities of the nervous system, which are the executive functions (Cipolotti et al., 2020). These functions have been classically identified as the following mental abilities: (1) working memory, (2)

inhibitory control, (3) emotional regulation, (4) monitoring, (5) planning, (6) organization, (7) initiative, and (8) cognitive flexibility (Roche et al., 2020)

Effects of bilingual cognitive flexibility on mental executive functions:

More than half of the world's population speaks two languages fluently. The concept of "bilingual advantage" argues that persons who are fluent in two languages may have cognitive advantages, particularly in the domain of executive function. Inhibition and monitoring have been discovered as mechanisms for improved executive control in people with various language experiences, lending credence to the multilingual advantage (Bialystok, E., et al.2012).

According to this approach, both languages in a bilingual individual's repertoire are constantly active to some extent, and selection is continual. Lifelong monitoring and resolution of linguistic rivalry place demand on brain regions that are not typically used for language processing (Meijer, A. et al.2020).

When non-linguistic processing uses the same executive control networks as language processing, the multilingual experience reorganizes brain networks to develop more effective executive control mechanisms. Because language switching involves the same frontal systems that participate in executive control and inhibitory processes, it is thought that bilingualism improves overall brain system function (Costumer, V. et al.2020).

Current bilingualism research yields inconclusive results, and there is no consensus on the relationship between bilingualism and cognitive flexibility in the executive function domain. Some research shows that bilingual persons have cognitive benefits, whereas others fail to replicate comparable findings in properly developing infants and adults. However, the advantage of being bilingual has been established among children from lower socioeconomic families. Similarly, among those undergoing age-related cognitive loss, there is a 'cognitive reserve in which the bilingual brain is more resistant to neurodegeneration and dementia (Stillman, C. M., et al.2020).

Executive functions required for bilingual cognitive flexibility:

To correctly execute bilingual cognitive flexibility, several EF subdomains collaborate. Individuals must first recognize how their surroundings have changed in constantly changing conditions by focusing their attention on the

elements that are changing. After recognizing that a previous approach is no longer acceptable in the current environment, individuals must block earlier reactions and reconfigure a new strategy. Individuals process and adjust information in real-time to switch reactions from one occurrence to the next. Bilingual cognitive flexibility entails more than just using different EFs; it also entails adapting or restructuring one's response set to the new goal. This model is currently theoretical and will need to be validated by more causal modeling research. (Costumero, V. et al.2020).

Development of bilingual cognitive flexibility and associated brain regions:

Bilingual cognitive flexibility skills start to develop in early childhood, with a significant rise in ability between the ages of 7 and 9. Cognitive flexibility overall reaches its optimum between the ages of 21 and 30 (Dick, A.S.2014), although skills continue to grow throughout adolescence and into adulthood (Hunter S.J., and Sparrow, E.P..2012). Different developmental paths are followed by EF components implicated in bilingual cognitive flexibility (Figure 1).

Inhibition develops as early as 12 months of age and is completely formed by 10 to 12 years old. Working memory begins to develop in childhood and continues to improve throughout puberty (Hunter, SJ., and Sparrow, EP.2012). Because the EFs involved in cognitive flexibility do not have identical developmental histories, adults will outperform children on bilingual cognitive flexibility tests if compensatory measures for inhibitory and working memory demands are not included in task design.

According to behavioral studies, children and adults develop flexible cognition in qualitatively distinct ways. Children's control mechanisms transition around the age of 8 to 9 years old, from recovering the task aim by concentrating their attention on the appropriate stimulus parts to cue-stimulus-response links (Lucenet, J et al.2014). Inhibition and working memory, which begin around the age of four, contribute to successful bilingual cognitive flexibility, which is driven by developments in children's goal representation abilities (Chevalier, N. et al.2012). Improvements in perceptual speed, superior working memory, resistance to interference from irrelevant tasks (Cragg L, and Nation K.2009), associative processing use, and task set reconfiguration abilities may be attributed to faster bilingualism

and more accurate cognitive flexibility skills in adulthood (Manzi, A. et al. al.2011).

Executive function development: Most studies of bilingual cognitive flexibility that compare children and adults find higher levels and more specific activation in frontal, parietal, and basal ganglia regions in adults and more dispersed activation in children (Ezekiel, F., et al.2013), whereas others find no difference in brain activation between age groups (Ezekiel, F., et al.2013) (Wendelken, C. et al.2012). One noteworthy finding is that as people age, there is a general increase in activation in right-lateralized areas and a decrease in activation in left-lateralized areas (Taylor, M. J, et al.2012).

It is unclear whether this is due to the functional segregation of EF-specific inter-hemispheric homologs or to the spatial demands of most cognitive flexibility tests, which may preferentially stimulate the right hemisphere as we age. Young children (around the age of 5) have trouble successfully interpreting task signals to determine the applicable task (Chevalier, N. et al.2015). Improvements in cue monitoring, potentially mediated by the maturity of the right ventrolateral prefrontal cortex, may explain some of the developmental brain network variations between children and adults. Rubia et al. (2006) demonstrate a linear increase in activity of the right ventrolateral prefrontal cortex from childhood to adulthood under both inhibition and switching tasks (Chatham, C.H., et al.2012).

Executive dysfunction and cognitive inflexibility:

The rudimentary kinds of EF that emerge in childhood lay the framework for the development of more mature EFs that support self-control. As children enter middle childhood and experience academic and social problems, previously undetected executive dysfunction may emerge (Hunter, SJ., and Sparrow, EP.2012).

Reduced cognitive flexibility and working memory have been related to a wide range of academic shortcomings, from reading to science. In adolescence, intact EF is defined as the ability to consider possibilities before acting, which necessitates the suppression of instinctual impulses, as well as the ability to make effective decisions given the intended aim (Hunter, S.J., and Sparrow, E.2012)

P.2012). As EF abilities improve as adolescents grow into adults, the accumulation of various executive dysfunctions may have the biggest impact. during maturity. Cognitive rigidity in adults relates to clinical

symptoms such as rumination and a longer duration of eating disorder disease (Tchanturia, K, et al.2011).

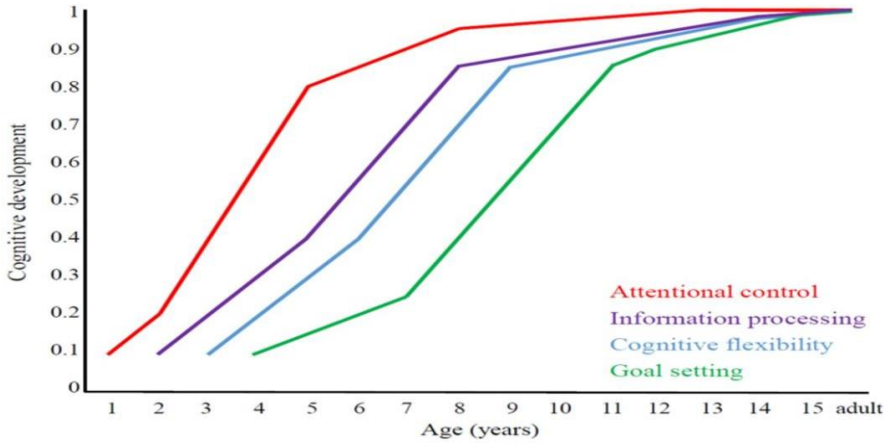

Figure (1): Developmental trajectories of cognitive flexibility and component executivefunctions

Figure (1): Attentional control, information processing, cognitive flexibility, and goal-setting developmental paths hypothesized about mature adult levels of cognitive development (Dajani, D. R., and Uddin, L. Q. Uddin,2015).

Study Approach: The results of any study are determined considering the quality of the methods used. The study has relied on the descriptive approach where the description of the phenomenon and its diagnosis is from the demographic and dynamic perspectives.

Sample: The original community for the study is divided as follows:

1- Diagnostic sample: Participants were N=(230) this sample aims to collect scientific and field material, verify the psychometric characteristics of the study tools, and verify the validity of research hypotheses.

2- Basic sample: Participants were N= (136) primary school pupils (9-12) years, both genders, and were picked randomly fromNile Egyptian Schools Sheikh Zayed Branch–NES) Egyptian International School -Arabic and

English Language Study System. All the participants were bilingual (Arabic – English).

Of the participants recruited from Nile Egyptian Schools Sheikh Zayed Branch–NES, there were 34 children aged 9 years (*M* = 75.94 months, *SD* = 3.47,17 girls, 17 boys); 34 children aged 10 years (*M* = 89.53 months, *SD* = 2.92, 16 girls, 18 boys); 38 children aged 11 years (*M* = 101.53 months, *SD* = 2.59, 19 girls, 19 boys); and 30 children aged 12 years (*M* = 112.67 months, *SD* = 3.52, 15 girls, 15 boys).

As for the socioeconomic and cultural level form, there were 28 children at the (High) level with a rate of (15.56%); 74 children at the (Average) level with a rate of (65.56%);34 children at the (Low) level with a rate of (18.78%).

Study tools and Procedure:

Measurement of Executive Functions: Several measures and tasks for evaluating EFs have been developed. Many of the tasks employed to measure executive functions have an underlying multidimensional structure (e.g., the Wisconsin Card Sorting Test, Greve, et al., 2005; the Trail Making Test, Sanchez-Cubillo et al., 2009), with many different cognitive abilities interacting to explain a given performance (Duggan and Garcia-Barrera, 2015). Executive function tests have a reputation for task faults, whereby many non-executive abilities explain performances on tests purported to measure executive functions (Miyake and Friedman, 2012).

The Behavior Rating Inventory of Executive Function-Adult Version (Roth, R. Metal,2005) and the Barkley Deficits in Executive Functioning Scale are two examples (Barkley, R.A,2018). It should be noted, however, that these measures are often tailored to the clinical population and are expensive. Apart from those mentioned above, there are measurement tools of EFs that cater to other populations. The Adult Executive Functioning Inventory (ADEXI) (Holst, Y. and Thorell, L.B.,2018) and the Executive Function Index (EFI) (Spinella, M.,2005) are two of those. While ADEXI exhibits sufficient psychometric properties, it is unfortunately technically inadequate as a sole measurement tool of EF. This is because the ADEXI requires numerous ratings and is used in conjunction with neuropsychological instruments (Holst, Y. and Thorell, L.B.,2018). On the other hand, the EFI is a 27-item self-reported executive functioning assessment with high internal consistency

(Spinella, M.,2005). Although the EFI has been validated in a variety of situations, it is not designed to be an intervention-focused measure.

Strait et al. (Strait, J.E.et al,2019) indicate that the adult EF rating scales now available are either technically deficient (but very efficient and accessible) or have excellent technical adequacy but require substantial training to administer and are pricey. Most EF assessments are designed and validated for clinical populations suffering from neurodevelopmental or neurodegenerative illnesses. These metrics are usually too pathological to be employed in a nonclinical population (Spinella, M. et al,2005). To address this constraint, (Dawson, P, and Guare, R.,2010,2012,2018) created four versions of the Executive Skills Questionnaire (ESQ) to offer a quick and inexpensive self-assessment of EF for children (36 items), teens (33 items), students (33 items), and adults (36 items). All ESQ versions were created to evaluate the eleven areas of EF skills.

The study relied on a well-designed measurement by outstanding researchers to diagnose the dynamic variable (Mental Executive Functions), which is: The Executive Skills Questionnaire (ESQ) - Dawson and Guare, (Dawson, P.; Guare, R.,2010,2012,2018) for children (36 items) – translated and re-edited on the Arabic culture by the researcher. The researcher did not use (the student version) because it was designed for high school students, and the current study sample is primary school pupils (9-12) late childhood stage, therefore (the children's version) was applicable. All the versions of ESQ were designed to assess the eleven areas of EF skills: (Response Inhibition - Working Memory - EmotionalControl - Flexibility -Sustained Attention - Task Initiation - Planning/Prioritization – Organization - Time Management - Goal-Directed Persistence - Metacognition).

The researcher slightly modified the response alternatives, and they are matched by three options,which are (yes - sometimes - no) of which the positive answers receive degrees (3-2-1), and the negative statements follow the reversed order (1-2-3), and therefore the total score of the scale ranges between (36-99) so that the high degree indicates the high level of the variable and vice versa, there is no specific time for the answer but nearly one hour is sufficient.

Measurement of Bilingual Cognitive Flexibility: the study offered a scale to diagnose Bilingual Cognitive Flexibility for School pupils (9-12) years, which was developed by the researcher and clarified the following: Using

what has been discovered from prior investigations on the variable, the most essential components of the scale as presented in the previous studies:

(Dennis,J.P and Vanderwal,J.S.2010; Manzi,A.et al.2011; Ezekeil,F .et al.2013; Johnco,C.et al.2014; Dick,A.S.2014; Arizmendi,G.D et al.2018; Briceno,E.M. et al .2021).

The (BCF) scale wording for middle primary school pupils was formulated considering several considerations, including:

1-Do not start phrases with negative words.

2-Not being vague or suggestive.

3- Preferably not to use exaggeration formulas (always -all the time…etc).

4-Formulating phrases between the negative and positive meanings of the variable.

5-The formulation of items came in the form of comprehensive information for the areas to be measured, which fall under the umbrella of the variable.

the scale ,In its final version consists of thirty items separated into two sub-components linked to Bilingual Cognitive Flexibility:(Attention Flexibility-Bilingual Fluency Shifting). To examine the verification of the hypotheses, the researcher created compatible forms in terms of the number of elements and sub-components. The Bilingual Cognitive Flexibility Scale for middle Primary School pupils was completed with the help of teachers. They could understand the items better than the middle primary school pupils (9-12), and the class teachers were also the best who could reflect their students' bilingual cognitive flexibility, hence there were only 12 pupils in each class. Positive statements are matched by three possibilities, which are (yes - sometimes - no), and positive replies receive degrees (3-2-1), whereas negative statements follow the reversed pattern (1-2-3), and so the positive answers earn degrees (3-2-1). The total score of the scale ranges between (30-90) so that the high degree indicates the high level of the variable and **vice versa, there is no specific time for the answer, table (1).**

Table (1) The Main Components and The Number of Items for Each Dimension in The Final Form of (The Bilingual Cognitive Flexibility Scale for late primary school pupils)

Scale components	Item number	Total
Attention Flexibility	1-2-3-4*-5-6-7-8-9*-10-11*-12*-13-14*-15*	15
Bilingual Fluency Shifting	16*-17*-18*-19*-20-21-22-23-24-25-26-27*-28-29*-30	15

(*) negative item- **Source:** prepared by the researcher.

The socioeconomic and cultural level form: The socioeconomic and cultural as a modern (رنا علي عاشور، ٢٠١٩) level form was designed by the researcher tool that suits the conditions of the current society and its different social and economic composition.

It consists of (24) items distributed on four sub-axes: -

A. Personal Data **B.** Educational Level

C. Career Level **D.** Marital Status

There is no specific time to answer the items of the socioeconomic level form, there is no wrong answer and the score ranges between (85) and (24), and high scores indicate a high socioeconomic level and vice versa.

*All participants completed the study scales, for those who did not complete the scales the researcher excluded him or her. Scales instructions include checked data (name, gender, age, scale instructions). *

Scales Stability: The coefficients of validity and reliability of the socioeconomic level questionnaire were calculated on a sample of primary school pupils, (N= 50), using the following method: **the re-test method**; where the form was re-applied with a time difference of 21 days. **The correlation coefficient** was calculated between the first and second applications and was high (0.92).

The psychometric effectiveness of the scales was determined using a sample of (N = 230) middle primary school pupils. The scales were discovered to have high rates of stability; when the stability was estimated using **the re-test method**, the findings were nearly identical between the two measurements with a **correlation coefficient** (٠.81) for the bilingual cognitive flexibility Scale, and the mental executive functions scale (٠.٧٩). To compute the overall reliability coefficient, the researcher utilized **the split-half approach**,

and the correlation coefficient adjustment was calculated using **the Spearman-Brown equation**, for the standard deviation of both halves is the same **tables (2-3)**.

Table (2) Detecting Reliability of (The Bilingual Cognitive Flexibility Scale for primary school pupils N=230)

Reliability Method	BCF- primary school pupils
split-half	(0.424)
Spearman-Brown	(0.595)
Alpha-Cronbach	(0.586)

Source: prepared by the researcher according to SPSS results.

Table (3) Detecting Reliability of (The Mental Executive Functions scale for primary school pupils N=230)

Reliability Method	EF- primary school pupils
split-half	(0.510)
Spearman-Brown	(0.675)
Alpha-Cronbach	(0.705)

Source: prepared by the researcher according to SPSS results.

Scales Credibility: The credibility of the scales was also calculated using the **internal consistency credibility method** to ensure the homogeneity of the test by calculating the correlation coefficients for each component and the

Table (4) correlations between the components of (The Bilingual Cognitive Flexibility Scale- for primary school pupils and the overall score of the scale)

N.	Components	Correlation Coefficient
1	Attention Flexibility	0.391*
2	Bilingual Fluency Shifting	0.425*

*Statistical correlation at (0.05), ** strong statistical correlation at (0.01) correlation

Source: prepared by the researcher according to SPSS results.

scale, for the BCF scale the overall correlation was (0.594) and the EF scale (0.671), **tables (4-5)**

Table (5) correlations between the components of (The Mental Executive Functions scale- for primary school pupils and the overall score of the scale)

N.	Components	Correlation Coefficient
1	Response inhibition	0.420*
2	Working Memory	0.531*
3	Emotional control	0.527*
4	Flexibility	0.661**
5	Sustained attention	0.554**
6	Task initiation	0.434*
7	Planning	0.524**
8	Organization	0.283
9	Time management	0.651**
10	Goal-directed persistence	0.283
11	Metacognition	0.623**

*Statistical correlation at (0.05), ** strong statistical correlation at (0.01)
Source: prepared by the researcher according to SPSS results

The preceding internal stability coefficients are judged satisfactory and statistically significant at a significance level of (0.01) (i.e., 99% confidence and 1% doubt) between the scale components and the overall degree of the scale. The value of the correlation ranges suggests that the scales have **internal coherence** and that the scales in their final forms are stable and efficient. As a result, the scales can be used on the sample.

Confirmatory factor analysis (CFA): To solve this issue, CFA was performed using the diagonally weighted least squares (DWLS) approach to evaluate the factor structure of the scales. For the following two reasons, using the DWLS estimator, which is appropriate for ordinal item-built scales, is an excellent tool for analyzing the dimensionality and psychometric features of the scale. The scales are estimated as latent structures using Likert scale items containing ordinal data, and the DWLS approach is thought to have a less biased and more optimum fit (DiStefano, C., and Morgan, G. B, 2014; Lionetti, F. et al., 2016). The model fit and of course were evaluated based on the following cut-off values: a comparative fit index (CFI) and a Tucker-Lewis fit index (TLI) of greater than (0.950), a standardized root means square residual (SRMR) of less than (0.08), and a root square error of approximation (RMSEA) of less

than (0.06) (Bass, M. et al., 2016). Because of the huge sample size, 2/df three can also suggest an appropriate model (Kline, R. B, 2005).

Noticing through the matching indicators **table (6)** that the current model needs to be modified and does not conform to the conditions, given the inflated chi-square significance, and the value of the Tucker-Lewis index fulfills the conditions, the comparative and incremental matching index also fulfills the matching conditions, except for the approximate root mean square error-index, And the index of the average squares of the residuals, which both do not fulfill the conditions, and therefore it can be said that the current model needs to be modified, and for this reason, the researcher proceeded to review the indicators of the modification, where the most important modifications were the link between **measurem**ent errors and the indicators of the quality of conformity can be observed after the modification in the following table:

Table (6) Results of the confirmatory analysis of the mental executive functions scale before modification

Indicators	Value	Terms of Acceptance
Chi-square (Cmin)	671 .356	not to be statistically significant
Standard chi-square (Df/Cmind)	3.957	to be confined between (1-5)
Significance level (P-value)	0.000	not to be statistically significant
Degrees of freedom (DF)	181	DF>=0
Comparative Conformity Index (CFI)	0.901	CFI>=0.90(best match) CFI>=1(exact match)
Tucker Lewis Index (TLI)	0.900	TLI >= 0.90 (best match) TLI >= 1 (exact match)
Incremental Conformity Index (IFI)	0.911	IFI >= 0.90(best match) IFI >= 1(exact match)
Root Mean Square Approximate Error index	0.057	An index below (05.0) indicates a good match, an index between (08.0-10.0) indicates an insufficient match, and an index above (10.0) indicates a poor match.
Root Mean Square Index of the Residuals	0.146	A value of (0.08) or less is accepted for compliance 0=good match

Table (7) shows the confirmatory factor analysis of the mental executive functions scale after modification

Indicators and Values					
Chi-square (Cmin)	281.221	(DF)	168	IFI	0.977
Standard chi-square (Df/Cmind)	1.788	(CFI)	0.906	RMSEA	0.030
Significance level (P-value)	0.000	(TLI)	0.941	SRMR	0.071

From **table (7)**, it is easy to notice that the conformity indicators are acceptable, as the value of the chi-square is (281.221), the standard chi-square decreased with it where it became (1.788), and the value of the comparative conformity index increased (CFI) became (0.91), and the Tucker Lewis Index (TLI) rose similarly where it became equal to (0.94), and the same applies to the incremental conformity index (IFI), which was estimated at (0.97), the (RMSEA) and (SRMR) indices also fulfill the conditions. All of the indicators indicate a good match.

Noticing through the matching indicators **table (8)** that the current model needs to be modified and does not conform to the conditions, given the inflated chi-square significance. The value of the Tucker-Lewis index fulfills the conditions, and the comparative and incremental matching index also fulfills the matching conditions, except for the approximate root mean square error-index, And the index of the average squares of the residuals, which both do not fulfill the conditions, and therefore it can need to be modified, and for this reason, the researcher proceeded to review the indicators of the modification, where the most important modifications were the link between measurement errors and the indicators of the quality of conformity can be observed after the modification in the following table:

Table (8) Results of the confirmatory analysis of the bilingual cognitive flexibility scale before modification

Indicators	Value	Terms of Acceptance
Chi-square (Cmin)	598 .485	not to be statistically significant
Standard chi-square (Df/Cmind)	3.541	to be confined between (1-5)
Significance level (P-value)	0.000	not to be statistically significant
Degrees of freedom (DF)	169	DF>=0
Comparative Conformity Index (CFI)	0.911	CFI>=0.90(best match) CFI>=1(exact match)
Tucker Lewis Index (TLI)	0.900	TLI >= 0.90 (best match) TLI >= 1 (exact match)
Incremental Conformity Index (IFI)	0.911	IFI >= 0.90(best match) IFI >= 1(exact match)
Root Mean Square Approximate Error index	0.077	An index below (05.0) indicates a good match, an index between (08.0-10.0) indicates an insufficient match, and an index above (10.0) indicates a poor match.
Root Mean Square Index of the Residuals	0.138	A value of (0.08) or less is accepted for compliance 0=good match

Table (9) shows the confirmatory factor analysis of the bilingual cognitive flexibility scale after modification

Indicators and Values					
Chi-square (Cmin)	263.275	(DF)	149	IFI	0.977
Standard chi-square (Df/Cmind)	1.767	(CFI)	0.976	RMSEA	0.042
Significance level (P-value)	0.000	(TLI)	0.970	SRMR	0.082

From table (9), it is easy to notice that the conformity indicators are acceptable, as the value of the chi-square is (263.275), and the standard chi-square decreased with it where it became (1.767). The value of the comparative conformity index increased (CFI) (where it became (0.97), and the Tucker Lewis Index (TLI) rose similarly where it became equal to (0.97), and the same applies to the incremental conformity index (IFI), which was estimated at (0.97), the (RMSEA) and (SRMR) indices also fulfill the conditions. All the indicators indicate a good match.

The credibility of construction and formation: The Bilingual Cognitive Flexibility scale gains credibility by being prepared within the scope of previous studies, theories, and measurements : (Dennis, J. P., and Vander Wal, J. S. 2010); (Johnco, C.2014); (Chan, A.Y.C, and Morgan, S.J,2018); (Briceño, E. M. et al.2021); (Hommel, B. E., 2021) and then using their findings to set a procedural definition of the variables and their components considering what has been learned from a previous theoretical framework. They all serve as theoretical and applied knowledge sources and the scales become true considering what is known as construction and formation credibility.

Statistical Methods:

The researcher could determine the statistical methods used to address the study hypotheses inthe light of several variables, including:

1-The size of the sample.

2-The scales used.

3-The type of the hypotheses.

The analysis was conducted using IBM SPSS 28. By analyzing statistical values and considering the interpretation of those values through graphs of

statistical description of the sample characteristics, kurtosis and skewness metamorphosis coefficients were limited to (1) of kurtosis (3) of skewness and indicating the moderation of distribution of research variables. The sample was picked randomly; therefore the researcher used the parametric method of T-test for two independent samples to calculate the factor of the significance of differences between the mean averages of research variables by the demographic variables: (gender). For the variances for the dependent variable for the two groups are homogeneous according to the result of Levene's Test, which was more than (0.05), the researcher also used one-way ANOVA and Tukey's test to calculate the factor of the significance of differences between the mean averages of the research variable (socioeconomic level). Also, the Pearson correlation coefficient method was used to detect if there is a relationship between the dynamic variables. In addition to some statistical transactions to calculate validity and stability.

The Results of the Study:

Include addressing the assumptions and discussing their results in the light of the previous studiesand the convergences and differences with their results, as follows:

***Hypothesis 1*: There are statistically significant differences between the dynamic variable (bilingual cognitive flexibility), and demographic variables (gender- socioeconomic level) among primary school pupils**.

To verify the validity of this hypothesis, the responses of the study sample (N = 136) on the Bilingual Cognitive Flexibility scale among primary school pupils were statistically processed using the t-test for independent samples, and the result was as follows ***(Table 10)***:

Table (10) The value of (T) to indicate the differences between males and females regarding the dependent variable: Bilingual Cognitive Flexibility among primary school

Statistical values / Ind. variable	gender	(N)	(Mean)	(SD)	(T)	(Sig.)
Bilingual Cognitive Flexibility	Boys	69	34.09	10.44	-1.990	0.04*
	Girls	67	32.55	9.97		

(*) statistically significant.
Source: prepared by the researcher according to SPSS results.

Reading the quantitative values of the previous **table (10)**, it becomes clear that the value (T) of the significance of the differences between the average performance of male and female primary school pupils on the scale of Bilingual Cognitive Flexibility is (-1. 990٠) with a level ofsignificance (0.04) which is less than (0.05) i.e. 95% confidence, and 5% doubt) since it is significant statistically, it is possible to accept the alternative hypothesis that says: Bilingual Cognitive Flexibility varies according to gender, and the null hypothesis is rejected, meaning that there are statistically significant differences at the level of significance (0.05) between male and female primary middle school pupils in the Bilingual Cognitive Flexibility.

Table (11) One-way ANOVA of variance for differences in economic, and socio-cultural level on the bilingual cognitive flexibility scale

Factors	Source of Variance	sum of squares	Degree of Freedom	Mean Square	(F)	(Sig.)
Total Degree	Between Groups	604.274	2	302.137	4.512	0.012*
	Within Groups	11785.905	176	66.965		
	Total	12390.17	178			

(*) statistically significant.
Source: prepared by the researcher according to SPSS results.

Table (12) Examine the significance of the mean and trends of the differences using Tukey's test

Components	Social Situation	(N)	Significance of the mean differences between each two groups		
			2/1	3/1	3/2
Total	1)Low	34	182.0	0.009	0.11
	2)Average	74			
	3)High	28			

Source: prepared by the researcher according to SPSS results.

Reading the quantitative values of the previous **tables (11-12)**, it becomes clear that the value (F) is (4.512) with a level ofsignificance (0.012) which is less than (0.05) i.e. (95% confidence, and 5% doubt) since it is significant statistically, it is possible to accept the alternative hypothesis that says: Bilingual Cognitive Flexibility varies according to economic, and socio-

cultural level, and the null hypothesis is rejected, meaning that there are statistically significant differences at the level of significance (0.05)according to the differences of the economic, and socio-cultural level of primary middle school pupils in the Bilingual Cognitive Flexibility.

Hypothesis 2: ***There are statistically significant differences between the dynamic variables (mental executive functions), and demographic variables (gender- socioeconomic level) among primary school pupils.***

To verify the validity of this hypothesis, the responses of the study sample (N = 136) on the Mental Executive Functions scale among primary school pupils, were statistically processed using the t-test for independent samples, and the result was as follows ***(Table 13):***

Table (13) The value of (T) to indicate the differences between males and females regarding the dependent variable: Mental Executive Functions among primary school

Statistical values / Ind. variable	gender	(N)	(Mean)	(SD)	(T)	(Sig.)
Mental Executive Functions	Boys	69	92.90	9.08	1.531	0.178
	Girls	67	90.93	9.84		

Source: prepared by the researcher according to SPSS results.

Reading the quantitative values of the previous **table (13)**, it becomes clear that the value (T) of the significance of the differences between the average performance of males and females among primary school pupils on the scale of Mental Executive Functions is (1.531) with a level of significance (0.178) which is higher than (0.05) i.e. (95% confidence, and 5% doubt); therefore it is not significant statistically, it is possible to accept the null hypothesis that says: Mental Executive Functions does not vary according to gender, and the alternative hypothesis is rejected, meaning that there are no statistically significant differences at the level of significance (0.05) between male and female among primary school pupils in the Mental Executive Functions.

Table (14) One-way ANOVA of variance for differences in economic, and socio-cultural level on the bilingual cognitive flexibility scale

Factors	Source of Variance	sum of squares	Degree of Freedom	Mean Square	(F)	(Sig.)
Total Degree	Between Groups	1852.93	2	926.465	11.30	0.000*
	Within Groups	14342.12	175	81.955		
	Total	16195.05	177			

(*) statistically significant.
Source: prepared by the researcher according to SPSS results.

Table (15) Examine the significance of the mean and trends of the differences using Tukey's test

Components	Social Situation	(N)	Significance of the mean differences between each two groups		
			2/1	3/1	3/2
Total	1)Low	34	0.000	0.002	0.991
	2)Average	74			
	3)High	28			

Source: prepared by the researcher according to SPSS results.

Reading the quantitative values of the previous **tables (14-15)**, it becomes clear that the value (F) is (11.30) with a level ofsignificance (0.000) which is less than (0.05) i.e. (95% confidence, and 5% doubt) since it is significant statistically, it is possible to accept the alternative hypothesis that says: Mental Executive Functions varies according to economic, and socio-cultural level, and the null hypothesis is rejected, meaning that there are statistically significant differences at the level of significance (0.05)according to the differences of the economic, and socio-cultural level of primary middle school pupils in the Mental Executive Functions.

Hypothesis 3: ***There is a statistically significant relationship between bilingual cognitive flexibility and mental executive functions among primary school pupils.***

To verify the validity of this hypothesis, the responses of the study sample (N = 136) on the two scales among primary school pupils were statistically processed using the Pearson correlation coefficient method, and the result was as follows **(Table 16):**

Table (16) Correlation coefficient values between the bilingual cognitive flexibility scale and the mental executive functions scale (N=136)

BCF scale components / EFs scale components	Attention Flexibility	Bilingual Fluency Shifting	Total
Response inhibition	0.452*	0.645**	0.624**
Working Memory	0.286	0.754**	0.725**
Emotional control	0.754**	0.325*	0.687**
Flexibility	0.598**	0.214	0.521**
Sustained attention	0.349*	0.854**	0.801**
Task initiation	0.874**	0.921**	0.899**
Planning	0.963**	0.432*	0.802**
Organization	0.198	-0.210	0.121
Time management	0.746**	0.825**	0.860**
Goal-directed persistence	0.685**	0.325*	0.754**
Metacognition	0.436*	0.745**	0.684**
Total	0.811**	0.651**	0.789**

*Statistical correlation at (0.05), ** strong statistical correlation at (0.01)
Source: prepared by the researcher according to SPSS results.

Reading the quantitative values of the previous **table (16)**, it becomes clear that there is a positive relationship between the two variables of the study: Bilingual Cognitive Flexibility and Mental Executive Function among middle primary school pupils at the statistical significance level (0.05) * and (0.01) **.

Discussion and Analysis:

In dealing with hypotheses (1 and 2), the study's results showed that there are statistically significant differences between the demographic variables (gender and economic, and socio-cultural level) and the dynamic variables (Cognitive Bilingual Flexibility and Mental Executive Functions). The researchers who dealt with the effect of gender on both bilingual cognitive flexibility and mental executive functions, (Lallo da Silva, B.et al, 2019),

replicate the finding that females perform better than males. This study also discovered that multitasking, regardless of gender, hinders cognitive reflection. However, following multitasking, guys' cognitive reflection is impaired. According to (Diamond, A. 2009; Lengua, L. J., et al., 2007; Conway, A., and Stifter, C. A., 2012), EFs grow fast during childhood, in part due to the prefrontal cortex's remarkable plasticity and maturation, which allows children to develop better control over their behaviors and thoughts. This key stage of development allows for some advantageous contextual experiences, such as socioeconomic status and parenting behaviors, to boost EF development (Matte-Gagné, C., and Bernier, A., 2011; Sarsour, K. et al., 2011; Fay- Stammbach, T. et al., 2014; Lengua, L. J., et al., 2015).

Not all studies yielded the same findings. In several recent studies, executive functions were shown to be the same in monolingual and bilingual populations (Morton, J. B., and Harper, S. N., 2007; Tare, M., and Linck, J. 2011; Duabeitia, J.A. et al., 2014). In one study, bilingual and monolingual flexibility children were closely matched in terms of age, gender, reading and arithmetic skills, verbal and nonverbal IQ, family economic, and socio-cultural level, and the number of years of formal education of the parents (Antón, E. et al., 2014)

In terms of hypothesis (3), the results revealed a positive statistical relationship in the mean study sample scores of elementary school children (9-12) in both bilingual cognitive flexibility and mental executive processes measures. This finding might be understood and enhanced by stating that bilinguals may outperform monolinguals on non-linguistic executive functions tests if their experience in selecting and suppressing languages generalizes to other EF-related tasks. This multilingual benefit may be most obvious in developmental transitional phases, such as childhood and old life (Bialystok et al., 2006; Craik, F. I., & Bialystok, E, 2006).

Bilingual cognitive flexibility, or the ability to transition between brain processes to create appropriate behavioral and verbal responses, develops slowly and is disrupted in various common neurodevelopmental processes. It is unknown whether multilingual cognitive flexibility results from neural foundations independent of executive mental functions or the interaction of nodes in this and other brain networks.

Cognitive flexibility skills begin to develop in early childhood, with a significant rise in ability between the ages of 7 and 9. Executive functions are mostly developed by the age of ten (Dick, A.S. 2014), but skills continue to

grow throughout adolescence and into adulthood (Hunter, SJ., Sparrow, EP.2012), peaking between the ages of 21 and 30. (Cepeda, N.J, et al.2001). These findings corroborate the conclusions of the research, which states a positive relationship between bilingual cognitive flexibility and Mental executive functions.

Other studies have demonstrated bilingual advantages exclusively in certain age groups, such as preschoolers (Bialystok and Martin, 2004; Bialystok et al., 2006), children in middle childhood (Garraffa, M. et al., 2015), young adults, or senior individuals (Pelham, S. D., and Abrams, L. 2014). (Pelham and Abrams, 2014). (Bialystok and Craig, 2006; Bialystok et al., 2014). Other research has not discovered a multilingual advantage in those age ranges (Valian, V, 2015).

One reason for these disparities might be that bilinguals have unique traits that determine when an executive functions advantage is identified (Festman, J. et al., 2010; Valian, V, 2015). Indeed, the previous study has found that bilinguals with more balanced proficiency had greater executive functions. (Yow, W. Q., & Li, X. 2015).

Different developmental mental trajectories are followed by executive function components engaged in bilingual cognitive flexibility. Inhibition develops as early as 12 months of age and is completely formed by 10 to 12 years old. Working memory begins to develop in childhood and continues to improve throughout puberty (Hunter, S.J., and Sparrow, EP.2012). Because cognitive flexibility component executive functions do not follow identical developmental mental trajectories, adults will outperform children on cognitive flexibility tests if compensatory measures for inhibitory and working memory demands are not included in task design.

According to behavioral studies, children and adults develop bilingual flexible cognition in qualitatively distinct ways. Children's control mechanisms transition around the age of 8 to 9 years old, from recovering the task aim by concentrating their attention on the appropriate stimulus parts to cue-stimulus-response links (Lucenet, J. et al.2014). Inhibition and working memory, which begin around the age of four, contribute to successful cognitive flexibility, which is driven by developments in children's goal representation abilities (Chevalier, N. et al.2012). Improvements in perceptual speed, superior working memory, resistance to interference from irrelevant tasks (Cragg L, and Nation K.2009), associative processing use, and task set reconfiguration

abilities may be attributed to faster and more accurate cognitive flexibility skills in adulthood (Manzi, A. et al. al.2011).

Therefore, younger people may be more mentally resistant to bilingual cognitive flexibility thantheir older counterparts, and older people may be more mentally resistant to executive functionsthan their younger counterparts.

What the current study adds:

One of the justifications for this study is that the researcher claims that there is no Arab study – within the limits of the researcher's knowledge – that dealt with diagnosing bilingual cognitive flexibility and cognitive mental functions, and thus this study constitutes a cognitive enrichment for Arab psychological studies, in addition to linking the study variables with other variables. Demographics, namely (gender - socioeconomic and cultural level), which provides a comprehensive view of the relationships that link bilingual cognitive flexibility and cognitive mental functions, in addition to building a diagnostic tool and introducing this tool in the Arab library arena that can be used to determine the level of bilingual cognitive flexibility.

Theoretical, Educational, and Practical Implications:

The study's findings have various practical consequences. Parents, teachers, and administrators, for example, must encourage children to reflect on their efforts and the significance of achievement to facilitate their educational stages, because the institutional setting influences the creation of a student-based identity. Senior students in public educational institutions must also construct appropriate educational programs and offer positive feedback to meet the three basic demands provided by self-determination theory (autonomy, competence, and relatedness) (Vandenabeele, W. 2007).

Limitations:

Through the study, the attempt to understand and delve deeper into the problem over time, as well as a careful reading of the empirical circumstances in other research to try to understand other experimental conditions and to carefully analyze and review the results of previous studies, some procedural recommendations can be made as follows, and the fact that the researcher

studies a particular problem does not imply that she has examined all of its aspects, but Based on this, the following research might be recommended to acquire a better knowledge of the study factors.

This study has several limitations. First, while the data reveal that bilingual cognitive flexibility and mental executive functions strongly impact each other, the researcher cannot conclude that the variables of the study have a causal link. An unidentified third factor may covariate with these variables. People who have high (vs. low) levels of one or more of the mental executive functions' skills, for example, are more likely to have elevated levels of multilingual cognitive flexibility. As a result, the link between mental executive processes and multilingual cognitive flexibility is still being studied.

The assumption that there are fundamental differences between genders in bilingual cognitive flexibility and mental executive functions can be explained by the equality of some demographic variables among sample members, given that the method of selecting participants was random from different classes, but there were no detected differences in demographic variables such as psychological and health status of the inhabitant. The researcher requested permission to copy each participant's school file, which contains information about their economic and social status, IQ level, and psychological and health status, but she didn't measure IQ during the procedure of this study.

Because descriptive approaches limit the breadth of prediction, future researchers must use both cross-sectional and experimental designs. Future researchers can also include additional work-related tasks to determine the extent to which students use

mental executive functions and whether they are aware of when effects on their bilingual flexibility occur, as well as the extent to which other variables such as attention draining, cognitive load, and emotional agility counteract the detrimental effects of bilingual cognitive flexibility and mental executive functions.

Third, the sample size was not very great due to economic considerations. Also, to ensure that the results were objective and acceptable, during picking the sample of elementary school pupils, the researcher attempted to approximately

balance the number of participants between boys, and girls, but they were just (136). As a result, future studies should broaden the sample to include more than (136), conduct brain scanning, and ensure that extraneous factors are identified using IQ and general mental health scales, rather than just written records about students from schools. According to new research, brain signal variability, or neural variability, may reflect a sophisticated neuronal system with a wide dynamic range and an increased ability to interpret a variety of unexpected external inputs. When compared to younger people, the brains of older people with less consistent behavioral performance had less fluctuation in the BOLD signal. These observations have led to the hypothesis that brain function variability is required for effective response to changing environmental demands (Panerai, S. et al.2014).

Recommendations for Future Research*:*

More consistent operationalization and investigation of cognitive flexibility, according to the researcher, is essential in clinical and developmental neuroscience. The researcher suggests that the new analytic approach, dynamic functional connectivity, and attempts to account for variations in brain network topology as a function of time are important avenues for future research, as is the characterization of the relationship between neural flexibility and bilingual cognitive flexibility in typical and atypical development.

Although the functional importance of dynamic functional connectivity in the brain is still being researched, there is evidence that these brain dynamics have ramifications for behavior. Individuals with more dynamic brain networks do better on behavioral tasks such as assessments of sustained attention and fluid intelligence. The extent to which brain dynamics or neural flexibility indices may explain individual variations in cognitive flexibility during development is a natural topic (Jia, H., et al.2014); therefore, brain scanning and neuroimaging investigations are significant.

From what has been mentioned above, the researcher could recommend the following research topics:

1- Neural Cognitive Flexibility among Autistic Children: A Clinical Study.

2- Neural Flexibility and Bilingual Cognitive Flexibility among Bilingual

Toddlers.

3- Dynamic Functional Connectivity and Brain Network Topology among Children, Adults, and Elders: A Cross-Sectional Study.

4-Effectiveness of a Well-Designed Brain Training Program to Develop Mental Executive Function Skills Among Workers: An Experimental Study.

Conclusions:

To summarize, multilingual cognitive flexibility is a vital trait that helps individuals to adapt effectively and efficiently in the face of changing surroundings. The relationships among mental executive processes necessary for successful bilingual cognitive flexibility implementation are still being studied. As researchers begin to investigate the development of cognitive flexibility and its disturbance in various illnesses, critical issues must be considered. Considering developmental disparities, using breakthroughs in the study of brain network dynamics to identify the link between neural flexibility and cognitive flexibility in typical and atypical development will also drive the research ahead in a synergistic approach.

The study verified that mental executive skills have an aftereffect on later multilingual cognitive flexibility. Furthermore, the influence of (gender - socioeconomic and cultural levels) on mental executive processes and bilingual cognitive flexibility was confirmed. The study- like many others- suggests that mental executive functions can change and develop over time and age, that they are influenced by the educational context, where they can be targeted and heightened, and that students can effectively regulate themselves in demanding bilingual cognitive flexibility and can improve their academic performance through mental executive functions.

Ethics Declarations:

1) Ethics approval and consent to participate:

Participants were N= (136) and (230) primary school pupils (9-12) years, both genders, picked from (Nile Egyptian Schools Sheikh Zayed Branch–NES) Egyptian International School -Arabic and English Language Study System. All the participants were bilingual (Arabic – English).

I got agreement and permission from (NES) Egyptian International School to apply the study scales.

Only written measurements were applied, and no humans or animals were subjected to any form of experiments in this study. The study followed the descriptive approach only.

I fully abided by the laws, rules, and regulations of my community, work scope, and country. I followed autonomy, justice, beneficence, nonmaleficence, and fidelity. I conducted myself with integrity, fidelity, and honesty. I openly took responsibility for my actions and only made agreements, which I intended to keep throughout all the procedure steps in my manuscript.

A consent form -to sign as an agreement- was handed to all the parents of the (9-12) years pupils. The consent form was as follows:

"I voluntarily agree for my kid to take part in this study. I understand I will receive a copy of this consent form on demand, as will the school if they ask for a copy. I understand that there are no photographs (audio/video recordings) will be taken during the study. I understand that my kid is free to quit applying the scales any time he/she wants. I know the personal information won't be public."

All methods were carried out per relevant guidelines and regulations.

2) Availability of data and materials:

The Executive Functions Scale was adopted, generated, translated, and analyzed during the current study. For the translated version in Arabic please feel free to contact the researcher.

The Bilingual Cognitive Flexibility Scale for middle primary school pupils is not publicly available, but it is available on demand by contacting: rana.aliashour@women.asu.edu.eg

All the datasets analysis of the samples' responses are not for public publication, but also are available from the author on request.

3) Competing interests:

The author declares there are no competing interests.

No funding.

4) Authors' contributions:

I am the only author of this manuscript.

5) Acknowledgements:

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العلاقة بين المرونة المعرفية ثنائية اللغة والوظائف العقلية التنفيذية لدى طلاب المدارس الإبتدائية

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الملخص:

تهدف الدراسة الحالية إلى التحقق من الاختلافات بين عينة من تلاميذ المدارس الابتدائية وفقًا لاختلاف النوع والمستوى الاجتماعي –الاقتصادي والثقافي، بناءً على قدراتهم العقلية التنفيذية (EFs) من ناحية، ومستوى المرونة المعرفية ثنائية اللغة (BCF) من ناحية أخرى. علاوة على ذلك، تهدف الدراسة إلى تسليط الضوء على العلاقة بين المرونة المعرفية ثنائية اللغة والوظائف العقلية التنفيذية لدى تلاميذ المرحلة الابتدائية. تكونت عينة الدراسة التشخيصية والأساسية من تلاميذ المدارس الابتدائية تتراوح أعمارهم بين (٩–١٢) سنة، ممن يمثّلون مرحلة الطفولة المتأخرة ويتحدثون اللغتين العربية والإنجليزية.

اتبعت الدراسة المنهج الوصفي، وتم اختيار العينة عشوائياً، ن= (١٣٦) من تلاميذ المرحلة الابتدائية.

اعتمدت الدراسة على الأدوات التالية لتشخيص متغيرات الدراسة: استبيان المهارات التنفيذية العقلية (ESQ) ، تأليف: داوسون وغاريف، للأطفال –٣٦ فقرة (ترجمة الباحثة)، مقياس المرونة المعرفية ثنائية اللغة (من إعداد الباحثة)، واستمارة المستوى الاجتماعي– الاقتصادي والثقافي (من إعداد الباحثة).

استخدمت الباحثة الأساليب الإحصائية التالية: t-testللمتغيرات المستقلة، وتحليل التباين أحادي الاتجاه، واختبارTukey ، ومعامل ارتباط بيرسون.

وكشفت نتائج الدراسة عن وجود فروق ذات دلالة إحصائية بين (النوع – المستوى الاجتماعي– الاقتصادي والثقافي)، و(المرونة المعرفية ثنائية اللغة) لدى طلاب المدارس الابتدائية. لا توجد فروق ذات دلالة إحصائية بين (النوع)، و(الوظائف التنفيذية العقلية)، بينما توجد فروق ذات دلالة إحصائية فيما يتعلق بـــ(المستوى الاجتماعي – الاقتصادي والثقافي)، و(الوظائف التنفيذية العقلية) لدى طلاب المدارس الابتدائية، كما أظهرت النتائج وجود علاقة إيجابية دالة احصائيا بين المرونة المعرفية ثنائية اللغة والوظائف التنفيذية العقلية لدى طلاب المدارس الابتدائية.

الكلمات المفتاحية: (المرونة المعرفية ثنائية اللغة، الوظائف العقلية التنفيذية، تلاميذ المدارس الابتدائية)