International Journal of Instruction *April 2025 ● Vol.18, No.2*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 653-670

Article submission code: 20240928170743
Received: 28/09/2024 Revision: 27/12/2024
Accepted: 07/01/2025 OnlineFirst: 03/02/2025

Preschool Children's Language as a Mediator in the Relationship between Their Executive Function and Emotional Competence

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The impact of executive function on individual emotional competence directly may affects individual emotional competence. It may indirectly affects individual emotional competence through language. This study investigates the mediating effect of preschool children's language in the relationship between their executive function and emotional competence. A total of 210 preschool children from four kindergarten in Rafha city were randomly selected. The Pearson's Moment Product Correlation Coefficient Technique was used to determine the relations between study variables. The mediating role of language in the relationship between Executive Function and Emotional Competence was examined with basic mediation analysis using Model 6 in PROCESS macro. The mediation effect results show that language plays a partial mediating role between executive function and the emotional competency of preschool children. The results of mediation analysis show that language plays a partial mediating role in the mediation model of "executive function-language-emotional competence".

Keywords: preschool children, language, executive function, emotional competence, preschool children's language

Citation: Barakat, A. M. M., Metwalli, R. M. F., Elawad, I. H., & Gabr, A. A. (2025). Preschool children's language as a mediator in the relationship between their executive function and emotional competence. *International Journal of Instruction*, *18*(2), 653-670.

INTRODUCTION

Executive function and emotion regulation are both important components of children's self-regulation development. The development of executive function enables young children to inhibit behavior, regulate attention, and work memory to retain information (Zhu, 2024). Zhao (2013) also found that there was a significant correlation between inhibitory control and emotion regulation in 4-year-old children by using a combination of situational observation and parental reporting. A study by Gooch et al. (2016) investigated the longitudinal associations between children's early EF and language abilities in a sample of typically developing children and children at risk of language or literacy difficulties. They found little evidence for a significant bidirectional relationship between EF and language skills as EF and language were concurrently but not longitudinally related.

Emotional competence (EC) is a central resource for flourishing human development (Hohm et al., 2017) and can be understood as "efficacy in accomplishing adaptive goals in emotionally arousing situations" (Saarni, 1999, p. vii). It also refers to the comprehensive ability of children to use emotional knowledge to identify and understand their own and others' emotions and to regulate and express their own emotions. It mainly includes: emotional recognition, emotional understanding, emotional expression, and emotional regulation (Riquelme & Montero, 2013; Wang et al., 2014). Emotion recognition refers to the process of children observing, analyzing, judging, and processing other people's emotions (Koç, & Arslan, 2022). Emotional understanding refers to the ability of children to evaluate the causes and consequences of their own and others' emotions (Parmaksız& Kılıçarslan, 2021). Emotional expression refers to the various ways that children use to vent and express their inner emotional experiences, including verbal and non-verbal (Eissa, 2017). Emotional regulation refers to the ability of children to manage and regulate their own emotions (Eissa, & Omaima, 2020).

The sub-abilities of emotional competence do not exist in isolation, but influence and depend on each other. Among them, emotion recognition and emotional understanding are the core basic abilities of children to adapt to society, while emotional expression and emotional regulation are the ultimate goals and external manifestations of children's adaptation to society (Çoban et al., 2022; Eissa & Omaima, 2020).

Emotional competence accompanies children's growth throughout their lives and runs through their daily lives and learning. It is the basic guarantee for children to adapt to society, be healthy, deal with crises, and establish good social relationships. A large number of studies have found that executive function has considerable predictive power for an individual's future academic performance, social skills, and even social achievements and marital quality, and also plays an important role in emotional competence (Carlson & Moses, 2001; Diamond, 2012; Knight & Stuss, 2002; Li et al., 2020; Zorza et al., 2019).

Executive Function, emotional and linguistic competences

Children's EFs and emotional and linguistic competences are strictly related to each other. EFs and language develop rapidly in early childhood (Blair et al., 2005), and the

relationships between them have been substantiated by numerous studies (e.g., Palomino & Brudvig, 2022; Slot & von Suchodoletz, 2018). For example, White and colleagues (2017) investigated the relations between EFs and language skills in a sample of preschoolers and showed how EFs were strongly related to various components of language. More specifically, they found EF competence to be predictive of vocabulary, syntax, and language learning, when controlling for age, gender, and ethnicity.

Marini and colleagues (2020) highlighted the importance of specific EF skills in supporting the development of language competences: they found that preschoolers' errors in an inhibition task were negatively correlated with phonological discrimination, grammatical comprehension, and sentence completion skills, as well as with the ability to select and produce words that were morphologically, semantically, and pragmatically appropriate to the task.

Oh and Lewis (2008) point out that executive function refers to a series of high-level cognitive abilities such as individual awareness and effective control of thinking and behavior, including core components such as flexible switching, inhibitory control, and working memory. Among them, inhibitory control refers to the ability of young children to inhibit irrelevant stimuli, including emotional control, behavioral control, and temptation control (ElAdl, & Eissa, 2019). Rhoades et al. (2009) selected 146 young children (M age = 54 months; SD = 3.6 months) to explore the relationship between children's inhibitory control and their social and emotional abilities. The results showed that 4-5 year old children with better inhibitory control had higher emotional management ability and lower social behavior. Denham et al. (2012) indicate that self-control is a basic ability for the development of children's emotional competence. Inhibitory control in children can promote the development of emotional expression and emotional regulation in children, making them more in line with the current social situation. Silkenbeumer et al. (2016) also point out that the development of emotional competence in children requires executive functions (especially inhibitory control) to adjust their external emotional behaviors.

Children's cognitive flexibility, also known as "switching ability" refers to the ability of children to inhibit dominant rules and switch from one cognitive activity to another (Eissa & Khalifa, 2021). Regarding the relationship between individual cognitive flexibility and emotional regulation, Wang and Guo (2008) examined the impact of positive and negative emotional activation on individuals to investigate their cognitive switching. The results showed that positive emotional activation can promote individual task switching ability, while negative emotions weaken individual switching abilities. Working memory refers to the ability of children to extract, retain, and operate information for a short period of time (Khalik, 2014).

Smith et al. (2014) examined the relationship between working memory and their social-emotional abilities. The results showed that the effect of working memory on individual social-emotional abilities was mainly achieved indirectly through cognitive empathy. This shows that the effect of working memory on individual emotional competence is achieved indirectly through other psychological abilities. Additionally,

Garcia-Andres et al. (2010) explored the relationship between their executive function and emotion regulation. The results showed that 7-8-year-old children with higher executive function scores also had stronger emotion regulation abilities. Lantrip et al. (2016) concluded that 12-18-year-old children with stronger emotion regulation also had better executive function. Zhu (2024) showed that executive function and language ability had a positive predictive effect on children's emotion regulation, and language ability played a complete mediating role in the relationship between executive function and emotion regulation.

It seems that there is still controversy about the relationship between individual executive function and emotional competence. Some researchers believe that inhibitory control as a basic ability affects the development of children's emotional competence; some researchers believe that emotional competence affects the development of children's cognitive flexibility.

Language as a mediator

Language is the basic ability of children's cognitive development, and it is closely related to individual executive function and emotional competence (Bıyıklı, 2023). Li and Wang (2006) point out that there is a significant positive correlation between cognitive flexibility and children's language, and cognitive flexibility plays an important role in promoting children's language development. Su and Wei (2013) also found that children's inhibitory control and cognitive flexibility have a direct impact on their language development.

Surowiecki et al. (2002) analyzed the relationship between working memory, language comprehension, and language expression. The results showed that there was a significant correlation between children's working memory and language, and working memory could partially explain the differences in individual language development. It can be seen that individual executive functions affect the development of their language abilities.

Beck et al. (2012) selected 210 middle school students as research subjects to explore the relationship between their language and emotional competence. The results showed that language has a positive predictive effect on the development of individual emotional competence. Ghanizadeh and Royaei (2015) used a questionnaire survey to examine the impact of teachers' emotional language on their emotional regulation strategies. The results showed that teachers' emotional language can well predict the development of their emotional regulation level. Kumschick et al. (2014) selected children in the second and third grades of primary school for an 8-week reading and writing emotional language training. The results showed that after the training, the children had significant improvements in emotional knowledge, expression recognition, and mixed emotions. It can be concluded that individual language has a significant predictive effect on emotional competence.

Accordingly, the impact of executive function on individual emotional competence directly may affects individual emotional competence. It may indirectly affects individual emotional competence through language. However, it is not clear whether

executive function has a direct impact on children's emotional competence or an indirect impact through language. Therefore, based on previous studies, this study aims to more systematically and comprehensively examine the relationship between executive function and emotional competence in preschool children by testing several sub-abilities of children's executive function and emotional competence and further exploring the role of language in the impact of executive function on emotional competence. It not only enriches the research field that affects the development of children's emotional competence, which has high scientific value, but also provides theoretical guidance for early psychological and behavioral intervention in children's emotional competence, which has great practical significance.

Thus, this study proposes two hypotheses: (1) There may be a significant positive correlation between executive function and emotional competence, especially in the sub-ability of inhibitory control; (2) The influence of executive function on the emotional competence of preschool children may be mediated by language.

METHOD

Sample

A total of 214 preschool children from four kindergarten in Northern Border, were randomly selected. They aged 4-5 years, M age = 4.2 years, SD = 1.12 months, including 114 girls and 100 boys. After excluding 4 children due to the large number of absences, 210 children were finally included in the study. Children's classroom teacher's was the personal who performed testing and the researchers was the person performed scoring accordingly. Children had all the chance to participate, however, the simple random sampling method was used to recruit them. All children were monolingual (they only speak Arabic). All tests were administered in groups to children in their formal classrooms. This study was approved by the Ethics Committee of Northern Border university (2024). All research children's parents signed an informed consent form. All tests were in Arabic language. See Table 1.

Table 1
Demographic characteristics of participants in the study

	Variable	N	%
Gender	Male	100	47.7
	Female	110	52.3
Parent Age	25-29	100	47.7
	30-35	60	28.5
	36-40	50	23.8
Education status	Primary school	10	4.7
	Middle school	30	14.2
	Undergraduate	20	9.5
	graduate	150	71.4
Number of siblings	1	50	23.8
	2	70	3.35
	3	50	23.8
	more than 3	40	19.4

Data collection tools

Emotional competency tasks: Five tasks were adopted from Bierman et al. (2008).

Expression matching Bierman et al. (2008)refers to giving children four kinds of expression pictures (happy, angry, sad, scared), and asking the children to name the target expression pictures respectively (for example: the experimenter shows the children a happy picture, and asks the children to answer what expression is this), If the child correctly matches the corresponding expression picture, it will be scored as "1 point", and if the child matches incorrectly, it will be scored as "0 points". Cronbach's alpha coefficient for this test is α 0.88.

Expression identification refers to asking children to identify target expression pictures from the given expression pictures (for example: the experimenter presents four expression pictures to the children at the same time and says the words "happy, angry, sad, scared" respectively, and asks the children to identify the target expression pictures from the given expression pictures. If the child can correctly identify it, it will be scored as "1 point", and if the child can identify it incorrectly or not, it will be scored as "0 point". Cronbach's alpha coefficient for this test is α 0.86.

Emotion comprehension: In this task, children choose one of the facial expression pictures given that matches the one described. If the situation is consistent, "1 point" will be awarded for a correct answer and "0 points" for an incorrect answer. It includes four dimensions: "emotion understanding based on desire; emotion understanding based on belief; emotional understanding based on clues; and emotion understanding based on external factors." The emotional understanding score is the sum of the four sub-dimension scores divided by 4. Cronbach's alpha coefficient for this test is α 0.81.

Emotion expression uses the task compiled by Carlson et al. (2002). For example: today is Amr's birthday. His good friend gave Amr a very big birthday gift. Amr hopes to get it. She liked the toy car very much, but when he opened the box, there was an ugly doll inside, and Amr didn't like it at all. Question: (1) True emotions: "Now, how do you feel about Amr 's mood?" (2) Social orientation goals: "If Amr expresses his true emotions, then his good friends will be very sad. "What do you think Amr's face looks like?" (3) Self-orientation goal: "If Amr expresses his true psychological emotions, then his good friends will no longer give him gifts, then what do you think Amr's face looks like?, if the child's external emotional expression meets social expectations, it will be scored as 2 points; if the child's external emotional expression does not meet social expectations, it will be scored as 1 point; if the child does not use emotional expression strategies, it will be scored as 0 points. This task was adapted to ensure that cultural biases are minimize. This test contains 4 sub-dimensions, and the emotional expression score is equal to the sum of the four sub-dimension scores divided by four. Cronbach's alpha coefficient for this test is α 0.84.

Emotion regulation adopts the situational story task compiled by Suzuki (2005). For example: The little boy wearing glasses was building blocks seriously. Suddenly Xiao Ming came over and said: "Your block building is too ugly. "I'll give you a lift", What

would you do if you were the little boy with eyes in the story?. Corresponding to four options: "Don't talk and go play something else; tell the teacher; push Xiao Ming; if you push me, you have to set it up with me." If the child chooses an adjustment strategy that conforms to social expectations, it will be scored as 2 points; if it does not conform to social expectations but does not harm others, it will score 1 point; if it does not conform to social expectations and it is accompanied by behaviors that harm others, it will score 0 points . This test contains four sub-dimensions, and the emotion regulation score is equal to the sum of the four sub-dimension scores divided by four. Cronbach's alpha coefficient for this test is α 0.87.

Executive function task: Inhibition control uses the emotional Stroop paradigm (Cothran & Larsen, 2008). Six positive and negative expression pictures were selected, including 3 for males and 3 for females, 1 happy picture, 1 angry picture, and 1 sad picture. The happy pictures of males/females were defined as happy, and the angry and sad pictures of males/females were defined as unhappy. The children were required to inhibit the original dominant rule and answer "happy" when presented with "unhappy" pictures, and answer "unhappy" when presented with "happy" pictures. The whole experiment included 3 blocks, each block including 20 pictures (8 happy + 12 unhappy). Due to the young age of the children, the main experimenter pressed the buttons uniformly in this task, and the response accuracy was included in the analysis. The response time was only used as a reference. Cronbach's alpha coefficient for this test is α 0.85.The specific experimental process is shown in Figure 1:

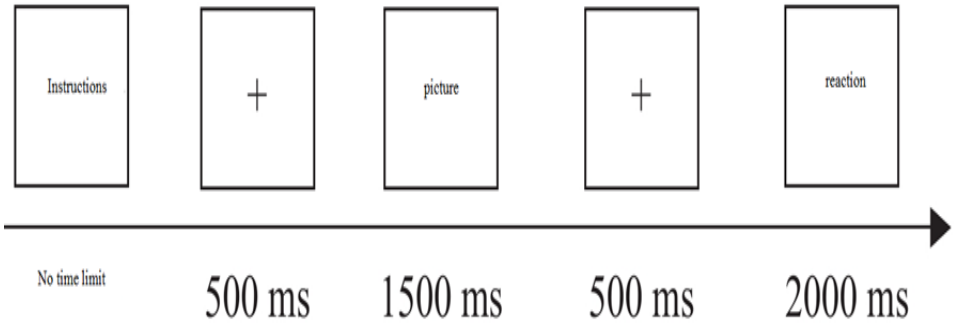

Figure 1
Flowchart of the emotional stroop experiment

Cognitive flexibility: The dimensional change card sort (DCCS).In this task, researchers presented children with cards of different dimensions, including shape and color. First, children were asked to sort cards according to the "shape" card. After 6 times, they were asked to sort by the new dimension, "color". After 6 times, they were asked to sort by the "shape" dimension. In each dimension, 5 correct cards out of 6 cards were considered passed. If 5 cards were correct in the basic dimension, 2 points were awarded if the switching dimension was also correct. On the contrary, if 5 cards were correct in the basic dimension, 1 point was awarded if the correct number of correct cards in the switching dimension was less than 5. The lowest score was 0 and the highest score was 6. Cronbach's alpha coefficient for this test is α 0.86.

Working memory was assessed using WISC-V visual working memory task: “Picture Span”. The Picture Span ranged from 1 to 6. Since the children in this study were 4 years old, the test started from a span of 2. Each correct identification was scored with 1 point. The test was stopped after 4 consecutive errors. The highest score was 32 and the lowest score was 0. Cronbach’s alpha coefficient for this test is α 0.84.

Language: In this study, the Peabody Picture Language Test (PPVT) was used to test the children's language. The children were required to choose one representative picture from four pictures according to the word spoken by the examiner. For example, the examiner read "table" twice at a fast speed, and the children were required to point out the picture that best represented "table" among the four pictures of "fork, table, car, doll". The test was stopped when the children got 6 out of 8 questions wrong. Each correct answer was scored 1 point (Dunn & Dunn, 1997). Another test is comprehension of words and sentences, where students are asked to read the sentence and match the target picture. Cronbach’s alpha coefficient for this test is α 0.89.

Data Analysis

The analysis of the data was done in the SPSS for Windows 22 package program. Descriptive statistics are shown as mean ± standard deviation for variables. The Pearson’s Moment Product Correlation Coefficient Technique was used to determine the relations between study variables. The mediating role of language in the relationship between Executive Function(Inhibition control)and Emotional Competence was examined with basic mediation analysis using Model 6 in PROCESS macro. The mediated moderation model was used to determine the mediating effect.

FINDINGS

Correlation analysis

There were a significant positive correlation between executive function (Inhibition control) and emotional competence, especially in the sub-ability of inhibitory control. In this study, the "inhibition control score, cognitive flexibility score and working memory score" were added together to form a new variable executive function (EF), and the "emotion recognition score, emotion understanding score, emotion expression score, and emotion regulation score" were added together to form a new variable emotional competence (EC), which were correlated with the three basic abilities of executive function, emotional competence and language. The results are shown in Table 2.

Table 2
Correlations between children's executive functions, emotional competence, and language

Variables	Executive Function	Emotional Competence	language
Executive Function (Inhibition control)	-		0.26
Emotional Competence	0.33	-	
language		0.40	-
Mean ± Standard deviation	87.45 ± 2.88	55.20 ± 3.16	46.33 ± 4.11

Table 1 shows that there is a significant positive correlation between executive function and emotional competency ($r=0.33$, $p<0.01$), there is a significant positive correlation

between executive function and language (r=0.26, p<0.05), and language and emotional competency are significantly positive. There is a significant positive correlation between them (r=0.40, p<0.01).

Regression

Using the three core abilities of executive function (Inhibition control) as predictor variables and children's emotional competency as the outcome variable, a regression analysis was performed. The results showed that only inhibitory control entered the regression model, and cognitive flexibility and working memory did not enter the regression model. Among them, adjusted R2= 0.11, Beta=0.33, t=2.99, p<0.01. Executive function (Inhibition control) has good predictive power for preschool children's emotional competence, especially in sub-ability inhibitory control. The explanation rate is as high as 11.10%, which shows that preschool children Inhibitory control can explain 11.10% of the variation in emotional competence.

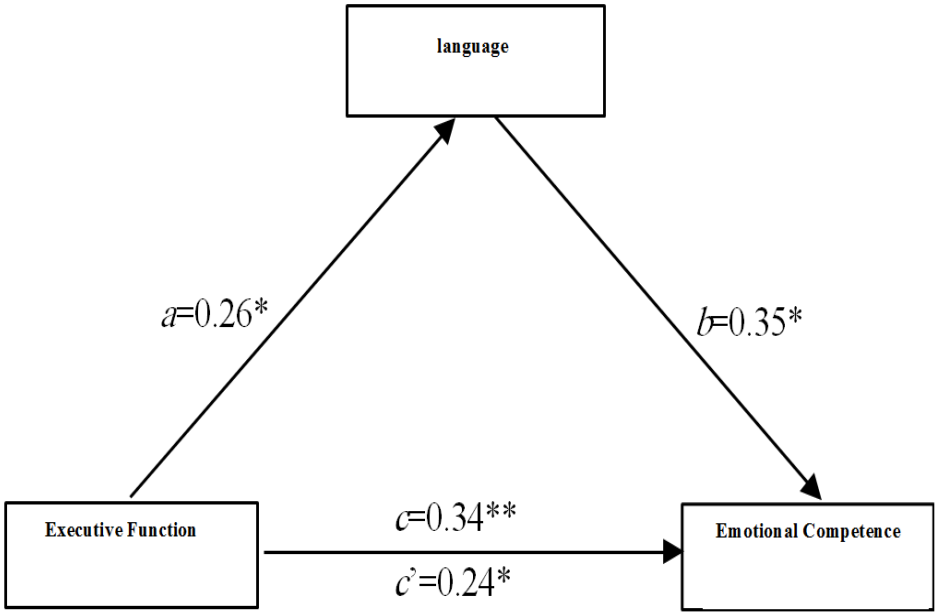

Figure 2
The mediating effect model of executive function (Inhibition control) predicting emotional competence of preschool children

Mediation

The influence of executive function (Inhibition control) on the emotional competence of preschool children may be mediated by language.

Using SPSS, executive function (Inhibition control) was dealt with as the independent variable, language as the mediating variable, and emotional competency as the

dependent variable to conduct a bias-corrected non-parametric percentage Bootstrap test, repeat sampling 5000 times, and calculate 95% of Confidence interval. The results found that the confidence interval of the path of executive function-language-emotional competency is [0.02-0.20], and this interval does not include 0, indicating that the mediating effect is significant. The direct effect from executive function to emotional competency is $c=0.34$, $p<0.01$; the indirect effect (that is, the sum of the mediating effects of the three paths) is $c'=0.24$, $p<0.05$. It shows that executive function can not only directly affect children's emotional competence, but also indirectly affect the development of children's emotional competence through the partial mediation of language. Vocabulary plays the most role in this mediation.

DISCUSSION

This study found that executive function (Inhibition control) significantly and positively predicts the emotional competency of preschool children, and mainly manifests the role of inhibitory control. This shows that the inhibitory control ability of preschool children may be the basic ability guarantee for emotional competency. During early childhood, these relationships are empirically supported; children who have higher EF have been shown to have higher language skills.

White and colleagues (2017) investigated the relations between EFs and language skills in a sample of preschoolers and showed how EFs were strongly related to various components of language. More specifically, they found EF competence to be predictive of vocabulary, syntax, and language learning, when controlling for age, gender, and ethnicity.

Similarly, Marini and colleagues (2020) highlighted the importance of specific EF skills in supporting the development of language competences: they found that preschoolers' errors in an inhibition task were negatively correlated with phonological discrimination, grammatical comprehension, and sentence completion skills, as well as with the ability to select and produce words that were morphologically, semantically, and pragmatically appropriate to the task.

Liew (2012) also found that children's self-control ability has a positive predictive effect on social emotional regulation ability, which further illustrates that young children's inhibitory control can promote the development of emotional competence in preschool children. Research by Riggs et al. (2006) shows that individual inhibitory control plays an important role in the development of emotional competence in young children. Individuals with better inhibitory control also perform better in emotional competence.

Carlson et al. (2007) also found that young children's self-control affects the development of their emotional competence (emotion regulation), and this effect is more obvious in preschool children. In this study, the mediation effect results show that language plays a partial mediating role between executive function and the emotional competency of preschool children. This shows that the direct effect of executive function on the emotional competency of preschool children still exists, and the regression analysis results. Further explanation, inhibitory control is the core sub-ability that affects the emotional competence of preschool children.

Previous research has found that the development of emotional competence in children aged 4 to 6 requires the participation of inhibitory control. Individuals with better developed inhibitory control are more likely to adjust their external behavioral responses to adapt to new emotional situations when facing emotional situations (Sillenbeumer et al., 2016). Penela et al. (2015) also found that individuals with higher inhibitory control scores also have better emotion regulation abilities, and inhibitory control abilities in early childhood can effectively predict their emotion regulation abilities. development.

The mediation

The results of mediation analysis show that language plays a partial mediating role in the mediation model of "executive function-language-emotional competence". It can be seen that the relationship between executive function (Inhibition control) and emotional competence of 4-year-old children is not a single one, and may be jointly affected by other psychological abilities (such as language).

Niu et al. (2005) found that inhibitory control promotes the acquisition and development of language in preschool children, which mainly affects children's language ability through two ways: clearing redundancy and blocking access. Clearing redundancy means that individuals clear irrelevant language information from memory, and blocking access means that individuals inhibit information irrelevant to the task from entering working memory (Wolfe & Bell, 2004). In this study, the executive function of 4-year-old children can not only directly affect the development of emotional competence, but also indirectly affect it through language.

Palikara (2010) found that the development of emotional competence of individuals with impaired language ability will also lag behind. Dockrell et al. (2007) conducted a longitudinal study on the relationship between children's language and social-emotional development. The results showed that individuals who experienced language impairment at the age of 8 also had poor social-emotional development and language literacy at the age of 16. This shows that the development of children's language ability directly affects the development of their emotional competence. However, Zubko et al. (2014) found that emotional language training for middle school students can effectively improve individual social-emotional abilities, especially the regulation of negative emotions.

Beck et al. (2012) also found that good language skills help children develop good social-emotional communication skills. This shows that in addition to improving children's emotional competence through executive function training, it can also indirectly improve the development of children's emotional competence by promoting language improvement.

CONCLUSION

This study used a standard experimental paradigm to systematically and comprehensively analyze the relationship between executive function, language, and emotional competence of preschool children. The results showed that the influence of

executive function on emotional competence of preschool children can directly affect emotional competence of preschool children through executive function; it may also indirectly affect emotional competence of preschool children through language, which has considerable scientific theoretical value.

Educational Utility

Educators, developmentalists, and policymakers should be informed of the importance of factors such as language, Executive Function and Emotional Competence. The development of emotional competence can be promoted through executive function or language (especially emotional language) training, which provides a new idea for promoting the development of emotional competence of preschool children and has important practical significance. These findings in this study can make a theoretical and practical contribution to the field of developmental psychology. As this research suggests that This study found that executive function (Inhibition control) significantly and positively predicts the emotional competency of preschool children, and mainly manifests the role of inhibitory control, It is speculated that the current findings showcase that teachers could find measures potentially useful for predicting positive school outcomes.

LIMITATIONS

Although the strengths of this study, there are some limitations. As the study relies on cross-sectional self-reported data, it does not allow the identification of causality or generalization. Self-reported measures were used to assess study variables; therefore, the results could have been impacted by common method variance. More samples from different geographical areas should be researched. While inhibitory control indeed plays a significant role, other aspects of executive function (e.g., working memory, cognitive flexibility) are minimally discussed. It could be beneficial for future research to explore whether these additional executive functions have similar predictive power or interact with inhibitory control in fostering emotional competency. Despite these limitations, this study has some strengths. It investigates the mediating effect of preschool children's language in the relationship between their executive function and emotional competence. Results indicate that executive function significantly and positively predicts the emotional competency of preschool children, and mainly manifests the role of inhibitory control. This shows that the inhibitory control ability of preschool children may be the basic ability guarantee for emotional competency. Future studies could address current limitations, such as incorporating longitudinal designs or cross-cultural comparisons.

ACKNOWLEDGEMENT

The authors extend their appreciation to the Deanship of Scientific Research at Northern Border University, Arar, KSA for funding this research work "through the project number" NBU-FFR-2024-1480-04.

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