Executive Functions and Self-Esteem in Academic Performance: A Mediational Analysis

Funciones ejecutivas y autoestima en el desempeño académico: un análisis mediacional

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Abstract.

Objective: Once the paradigm of intelligence as the only predictor of academic performance has been overcome, the influence of other variables, such as reasoning, verbal fluency, executive functions, motivation and self-esteem, was studied. **Method:** For this purpose, an exploratory and incidental research design was used in a sample of 132 subjects aged 6-9 years. Different instruments were administered: RAVEN, Effective Reading, Brief II, MAPE II, and Coopersmith Scale, respectively. **Results:** The results indicate that the predictive model formed by reasoning, verbal fluency, executive functions, and self-esteem explains 55.4% of the academic results. As mediating variables, self-esteem emerges as a predictor of both cognitive and motivational variables, and executive functions, as a predictor of emotional and motivational variables. **Discussion:** This implies theoretical and practical implications of an educational nature with practical implications in primary school classrooms, in order to implement plans to develop self-esteem and executive functions.

Resumen.

Objetivo: Superado el paradigma de la inteligencia como predictor único del rendimiento académico, se estudia la influencia de otras variables como el razonamiento, fluidez verbal, funciones ejecutivas, motivación y autoestima. **Método:** Para ello, se sirvió de un diseño de investigación de carácter exploratorio e incidental en una muestra de 132 sujetos de 6 a 9 años. Se administraron diferentes instrumentos, como las pruebas RAVEN, Lectura Eficaz, Brief II, MAPE II y Escala Coopersmith respectivamente. **Resultados:** Los resultados señalan que el modelo predictivo formado por razonamiento, fluidez verbal, funciones ejecutivas y autoestima explica un 55.4% de los resultados académicos. Como variables mediadoras emergen la autoestima, sobre variables tanto de carácter cognitivo como motivacional, y las funciones ejecutivas sobre variables emocionales y motivacionales. **Discusión:** Esto supone implicaciones teóricas y prácticas de carácter educativo con implicaciones prácticas en las aulas de primaria para la implementación de planes de desarrollo de la autoestima y las funciones ejecutivas.

1. Introduction

A recurring issue in the educational community is school failure (de Castro & Pereira, 2019; Fernández-Mellizo & Martínez-García, 2017). The debate about the factors that likely underlie it is refueled every time PISA reports are published (Caro & Kyriakides, 2019; Davis, 2019). However, the paradigm of the intellectual capacity of subjects being solely responsible for school achievement is overcome (Sternberg et al., 2010). There is empirical evidence that other cognitive (executive functions), behavioral (motivation), and emotional (self-esteem) variables help to explain academic success (Cortés Pascual et al., 2019; Moyano et al., 2020). Yet the dilemma comes into play if the predictive value of academic performance is higher in variables like functions, self-esteem, and motivation or intelligence, which play a fundamental role in its reasoning and verbal fluency variants (Best et al., 2011; Birkeland et al., 2012; Mercader et al., 2017). In addition, there is concern about the role that achievements in the first years of regulated education implies for the results obtained at 15 years old of age, an age usually reflected in PISA reports, and the relevance of the different variables for these results when academic performance is understood as the product of the learning process (Lamas, 2015). Nor should we forget the need for integrative models and mediational analyses that better specify the role of different variables.

Accordingly, apart from executive functions, understood as neurocognitive processes that control thoughts and regulate both behavior and cognitive and emotional activity (Zelazo & Carlson, 2012), being a direct predictor, they present a mediating capacity in aspects like cognitive abilities (reasoning, verbal fluency), motor skills or physical fitness (Aadland et al., 2017; Bruijn et al., 2018; Bryce et al., 2015). The different studies that have addressed the relation between executive functions and academic performance point out that it is established from the age of 3 (Mulder et al., 2017), and it remains significant and moderate until the age of 12 (Jacobson et al., 2011). However, the term executive functions is not free of controversy as different authors treat it as an unifactorial component and a predictor of general performance (Wiebe et al., 2008), while other authors find a multifactorial composition capable of predicting specific performances (St. Clair-Thompson & Gathercole, 2006).

The same occurs with variables like self-esteem, understood as the appreciation that we all have of ourselves, that is, an evaluative dimension of our own self-concept (**CidSillero2020**), as a predictor of performance in Mathematics through the mediation of reasoning and motivation, which, in turn, are mediated by verbal fluency when predicting performance in Spanish Language and Literature (Moyano et al., 2020). Self-esteem plays a motivational function, as pointed out by Harter and Whitesell (2003), and has been studied as a mediator between variables and academic performance, especially as far as motivation and social factors are concerned when it comes to adolescent populations (**CidSillero2020**; Kaplan et al., 1994; Masselink et al., 2018).

Currently, the research lines that analyze predictors of academic performance focus on cognitive factors like executive functions or intelligence (Colom et al., 2006). In this last variable, reasoning skills and verbal fluency are useful for explaining academic performance (Floyd et al., 2008). Some studies, such as those by Nascimento and Peixoto (2012), point out that the perception of possessing these cognitive skills helps to achieve academic success and to improve self-esteem. Along the same lines, Evans (2003) points out that significant relations appear between reasoning ability and the development of verbal fluency and high self-esteem. However, this relation sometimes requires the mediation of other variables (Nie et al., 2017).

In response to all these questions, the present work aims to investigate the relation and predictive value that cognitive (reasoning, verbal fluency, and executive functions) behavioral (motivation), and emotional (self-esteem) variables have for the academic performance of pupils aged 6-9 years old, as well as the mediating role of some of them. The set objectives focus on studying possible predictive models in academic performance and the action of different psychological variables for pupils aged 6-9 years, and also on analyzing the interaction between interdependent variables and their mediating action in alternative predictive models. Therefore, the following hypotheses are posed:

1. Academic performance would present a significant relation with all the studied variables: reasoning, verbal fluency, motivation, self-esteem, executive functions.

2. The most important predictive model would be formed by the cognitive variables of reasoning, verbal fluency, and executive functions.

3. On the whole, executive functions has the strongest mediating effect of all the studied variables in relation to the academic performance.

2. Method

2.1 Participants

The sample was made up of 132 Primary Education pupils (6-9 years old) from a state-assisted school, divided into three courses: 35.2% in the first year, 31.5% in the second year, and 33.3% in the third year. Regarding gender distribution, 47.4% were girls and 52.6% boys, with a mean age of 7.54 years and a standard deviation of .95. Finally, it should be noted that the employed sampling method was incidental with a convenience sample, and an exploratory, correlational, and mediational study.

2.2 Measures

The dependent variable of this study, academic performance, was evaluated with the average grade (values from 0 to 10) of all the academic areas during the 2018-2019 academic year.

The RAVEN progressive matrix test (Raven & Court, 2010), which measures analogical, abstract, and perceptual reasoning, allows the determination of the learning potential and estimates general intelligence. It consists of a series of incomplete and abstract figures that gradually appear. The applied test, a progressive color matrix recommended for pupils aged 5-11 years, consists of three series with 12 items each. The result of the direct score is transformed into a percentile for interpretation purposes. The reliability by the split-half method indicates the values ranging between .73 and .94.

For verbal fluency, effective reading games were used Editorial Bruño (2017). This test met the international PISA criteria and the MECES reading competence tests. With age-adapted texts, the number of words read per minute is measured and a series of questions about these texts are asked with true/false responses.

In order to measure motivation, the Motivation Questionnaire toward learning and performance (MAPE-II) was used (Montero & Alonso, 1992). This scale assesses general motivation with 74 items about work capacity, motivation level, and performance. The answer options are yes/no, and the global motivation index is obtained by adding the three dimensions (motivation for learning, motivation for results, fear of failure). This instrument presents adequate reliability indices through Cronbach's alpha: .75.

Regarding self-esteem, the Coopersmith Self-esteem Scale (Coopersmith, 1967) was used in its school version (adapted to Spanish; Miranda Esquer et al., 2011). It consists of 58 quick-response items (true/false) and refers to the level of academic acceptance in relation to the others. The Cronbach's alpha values indicate a reliability level of .81 for the global scale by taking these values as high reliability.

Executive functions were measured by the Behavior Rating Inventory of Executive Function, Second Edition (BRIEF 2) questionnaire, with its Spanish adaptation by Maldonado et al. (Gioia et al., 2017). Its application allows scores to be obtained on nine executive scales (inhibition, flexibility, emotional control, initiative, working memory, planning, self-supervision, organization of materials, and task supervision). The BRIEF-2 test (family version) uses a 63-item Likert-type questionnaire (never, sometimes, frequently) answered by both parents. Finally, it should be noted that the reliability indicated by Cronbach's alpha index is above .85 for all its values, which denotes high reliability.

2.3 Procedure

Following the ethics protocols, the school's authorization and collaboration were obtained first. Subsequently, the research design was presented to the Research Ethics Committee of the Autonomous Community of Aragón (CEICA), which obtained a favorable resolution on February 27, 2019, with issuance code "No. 04/2019". Subsequently, the information and authorization for participation were sent to families through the informed consent document to guarantee data confidentiality and participants' anonymity. The Guidance Department collaborated in the tasks to implement and evaluate tests. The different tests were applied during tutoring hours by the main researcher with the collaboration of different tutors. Sessions lasted 45 minutes. All these actions were performed at the end of the third trimester of 2018-2019 academic year.

2.4 Statistical analyses

First, a descriptive statistical analysis was carried out on the variables under study. Subsequently, as the distribution analysis confirmed that all the variables followed normal distribution, we proceeded to examine the relation between the variables (academic performance, reasoning, verbal fluency, motivation, self-esteem, and executive functions) with Pearson's correlations. Third, a regression analysis was performed to determine the established model's predictive power by taking reasoning, verbal fluency, motivation, self-esteem, and executive functions as independent variables, and academic performance as the dependent variable. Once this predictive model was verified, five mediation analyses were performed between the independent variables for academic performance. Here the purpose was to determine how, in addition to a direct relation model, indirect models could be implemented, where each variable internally interacted with the others by mediating their relation with the dependent variable —following the recommendations of Walters and Mandracchia (2017) for the ordering of causal relationships and their direction—. Analyses were carried out with the statistical program IBM SPSS Statistics Viewer 25 and the macro PROCESS (Preacher & Hayes, 2008), which allowed the mediation analysis of the variables by starting with 5000 samples and a 95% confidence level (Hayes, 2012).

3. Results

First a descriptive and correlational analysis was carried out with academic performance, reasoning, verbal fluency, motivation, self-esteem, and executive functions. Academic performance correlated positively and significantly with all the independent variables, especially with reasoning ($r = .602; p < .01$), as it can be seen in Table 1. However, the variables of reasoning, verbal fluency, and executive functions (all of a cognitive nature) did not correlate with one another, but the behavioral

Table 1

Descriptive data and correlations among reasoning, verbal fluency, motivation, self-esteem, executive functions, and academic performance

	M	SD	1	2	3	4	5	6
1. Academic performance	7.88	1.034						
2. Reasoning	70.14	19.003	.602**					
3. Verbal Fluidity	80.920	30.48	.326**	.133				
4. Motivation	35.33	8.435	.218*	.097	.018			
5. Self-esteem	41.310	7.386	.426**	.217*	.156	.321**		
6. Executive Functions	89.310	17.842	.392**	148.	.050	.237*	.254**	

Note: M=Mean; *SD*= standard deviation; $*p < .05$; $**p < .01$; $***p < .001$

and emotional variables of motivation and self-esteem did ($r = .321; p < .01$). Instead, reasoning correlated with self-esteem ($r = .217; p < .05$), and executive functions correlated with self-esteem ($r = .254; p < .01$) and motivation ($r = .237; p < .05$).

A second statistical analysis was carried out through regression models in which all the studied variables were included to assess their predictive power on academic performance (Table 2). The successive steps method was applied, which included the reasoning variables ($\beta = .479, p < .001$), executive functions ($\beta = .258, p < .001$), verbal fluency ($\beta = .234, p < .001$), and self-esteem ($\beta = .214, p < .001$). Only motivation was left out of the model because it was not significant. This model explained 55.4% of variance. Therefore, an increase in reasoning ability, verbal fluency, and a good development of executive functions and self-esteem would improve academic performance.

Next, we analyzed the direct and indirect interactions between the independent variables of the predictive model, and even the excluded variable (motivation), in its relation with academic performance to know if there was any mediating action. Self-esteem emerged as a mediator for the cognitive factors, such as reasoning and executive functions, but also for motivation (Figure 1). The mediation of self-esteem between reasoning and academic performance explained 45.2% of variance. In addition, when self-esteem mediated the relation between executive functions and academic performance, it explained 26.5% of variance. The mediation of self-esteem on motivation predicted 19.8% of variance for academic performance. Therefore, the students with high values for reasoning, executive functions, and motivation would have higher self-esteem values which would, in turn, imply better overall grades.

The second mediating variable was executive functions, which acted on the relation between motivation and self-esteem (Figure 2). This mediation model, between motivation and academic performance, explained 18.8% of the academic results, and, between self-esteem and academic performance, 26.5%. Thus, the students with higher self-esteem and motivation would obtain

better results in the evaluation tests of executive functions, which would, in turn, imply obtaining better academic results. Therefore, despite the fact that executive functions were good mediators between the behavioral and emotional variables and academic performance, the strongest mediational effect was self-esteem.

4. Discussion

The objective of this study was to investigate the relation, the predictive value, and the mediating effect among the cognitive (reasoning, verbal fluency, and executive functions), behavioral (motivation), and emotional (self-esteem) variables on Primary Education pupils' (6-9 years old) academic performance. Our findings indicate that this relation was powerful with reasoning ($r = .602; p < .01$), although self-esteem also had a strong impact ($r = .426; p < .01$). Therefore, together with an intelligence-related factor like reasoning, self-esteem, as an emotional variable, is capable of explaining academic results (**CidSillero2020**; Bryce et al., 2015). Both reasoning and the verbal component are considered the basis for good school achievement (Schneider & McGrew, 2012), but the results of this study are not consistent because verbal fluency ranks fourth for academic performance. Moreover, self-esteem, emerging in reference to learning, is linked with attention, motivation to learn, and behavioral regulation (Rhoades et al., 2011). Hence, the self-esteem of those students who do not feel very effective is low and their school performance is poor, while better self-esteem is related to academic success (Birkeland et al., 2012; Greene & Way, 2005). These results suggest that reasoning, verbal fluency, executive functions, motivation, and self-esteem contribute to academic performance. Therefore, the first hypothesis of this study is fulfilled by obtaining a significant relation between all the independent variables and academic performance.

The model that comprises reasoning, executive functions, and verbal fluency predicts 51% of the variance for academic performance. However, this model's effectiveness increases when the self-esteem variable is added, predicting 54% of school performance. Although school

Table 2

Linear regression models of the academic performance variable

	R^2	SE	Standardized Coefficients β	t	Sig.
Model 1	.370	.8388		19.294	< .001
Reasoning			.613	8.210	< .001
Model 2	.460	.7765		15.199	< .001
Reasoning			.566	8.097	< .001
Executive Functions			.310	-4.438	< .001
Model 3	.517	.7348		14.015	< .001
Reasoning			.522	7.757	< .001
Executive Functions			.305	-4.611	< .001
Verbal Fluency			.248	3.734	< .001
Model 4	.554	.7056		8.555	< .001
Reasoning			.479	7.266	< .001
Executive Functions			.258	-3.953	< .001
Verbal Fluency			.234	3.646	< .001
Self-esteem			.214	3.211	.002

Note: R^2=Coefficient of Determination; SE=Standard Error; Sig=p, significance; t=statistical t of significance check

Figure 1

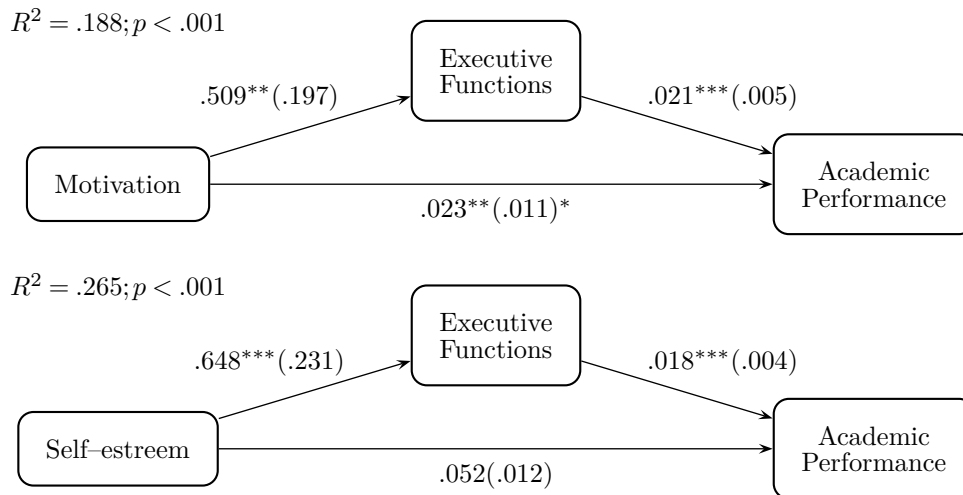*Mediation Models: Self-esteem as a Mediating Variable.*

$R^2 = .452; p < .001$

$R^2 = .265; p < .001$

$R^2 = .198; p < .001$
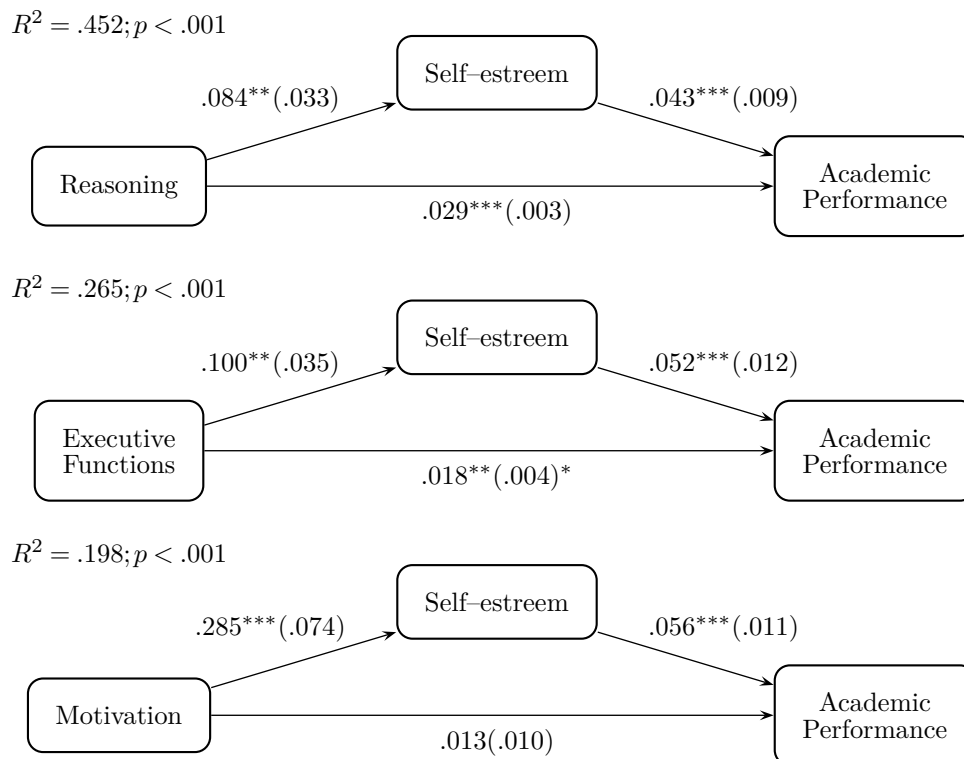
Note: $^{***}p < .001;^{**}p < .01;^{*}p < .05$

success was traditionally explained by subjects' cognitive capacity or intelligence, together with reasoning and verbal fluency, executive functions appear, which are equally placed with intelligence for its predictive power of academic performance (Ren et al., 2015; Willoughby et al., 2010). In addition, executive function contributes to students' use of cognitive skills (Bryce et al., 2015). The results of this research show that our second hy-

Figure 2

Mediation Models: Executive Functions as a Mediating Variable

$R^2 = .188; p < .001$

Motivation → (.509**(.197)) → Executive Functions → (.021***(.005)) → Academic Performance

Motivation → (.023**(.011)*) → Academic Performance

$R^2 = .265; p < .001$

Self–estreem → (.648***(.231)) → Executive Functions → (.018***(.004)) → Academic Performance

Self–estreem → (.052(.012)) → Academic Performance

Note: $***p < .001; **p < .01; *p < .05$

pothesis is partially fulfilled because, although reasoning, verbal fluency, and executive functions are considered cognitive-type variables, and they represent most of the predictive model, there is a clear differentiation in them being manifested in no relation existing among these three variables, despite the fact that together they predict more than 50% of school performance. Along these lines, Gioia et al. (2017) pointed out that executive functions should not be studied only from a cognitive perspective, as their composition includes behavioral and emotional factors, which it was suggested by the results herein obtained. One example of this lies in how important self-esteem is in the predictor model.

On the mediating role of self-esteem and executive functions, previous research confirms our results, because self-esteem has a direct effect on reasoning, executive functions, and motivation with academic performance, and executive functions do so on motivation and self-esteem. Cognitive reasoning ability allows problem solving and obtaining desired success, which facilitate the development of healthy self-esteem (Nascimento & Peixoto, 2012), but self-esteem also reinforces reasoning ability (Evans, 2003; McArthur et al., 2016). The relation with verbal fluency does not seem so clear as the intervention of other variables is necessary (Moyano et al., 2020; Nie et al., 2017). The mediating effect of self-esteem on executive functions is indicated in the research by Gioia et al. (2017), who pointed out that behavioral, emotional, and social aspects also appear in the development of executive functions. Regarding the mediating effect of self-esteem between motivation and

academic performance, their interrelation is indicated insofar as students with good performance perceive their self-esteem to increase and feel, in turn, increasingly motivated to perform their academic tasks (Kaplan et al., 1994; Masselink et al., 2018; Regueiro et al., 2015). It should not be forgotten that both motivation and self-esteem have a social component that might vary depending on the context in which they are found (Kiviruusu et al., 2016). The scientific literature has also attributed a mediational character to executive functions in relation to academic performance, but has pointed it out for variables like cognitive skills, motor skills or physical fitness (Aadland et al., 2017; Bruijn et al., 2018; Bryce et al., 2015). Therefore, our third hypothesis is not fulfilled because the variable with the strongest mediational effect is self-esteem, and not executive functions.

In conclusion, this study shows how academic performance depends on variables that are cognitive, motivational, and emotional in nature. This leads to a mixed predictive model and, in turn, highlights the mediating role of self-esteem among reasoning, executive functions, and motivation with academic performance. In relation to the analyzed multifactorial constructions and, despite the relevance that cognitive variables have traditionally had on learning and academic performance, they are not the only ones capable of building an effective predictive model. In fact, as this work shows, cognitive factors can become more effective through emotional factors like self-esteem, which, in turn, is improved by other variables like executive functions. A feedback relation is established and, therefore, one of flexibility and counter-

balance, by emphasizing both types of factors as being malleable and, hence, not static. One of our research contributions, compared to the many studies that have focused on adolescence or on late childhood, is that it centers on younger ages (6-9 years). This age group undergoes neurocognitive maturation and psychosocial development, which are important for someone's integral development. However, the results may be biased because this study is cross-sectional and includes a convenience sample that should be increased.

5. Conclusions and Limitations

This leads to important implications for the theoretical and practical field, such as the need to develop specific educational plans to improve motivation and self-esteem in Primary Education pupils, and the essential evaluation and monitoring of cognitive factors like reasoning, verbal fluency, and executive functions for their importance in academic performance at early ages (Cortés Pascual et al., 2019). Although the presented predictive models well account for variance, it should be noted that other variables not dealt with in this document, such as teacher profile, learning styles or parental control, would help to explore more precisely the multi-determined nature of school performance, which is one of the limitations of our study. Therefore, future research should consider introducing socio-economic, family, and personality variables to complete the predictor model. It is also necessary to increase our studied sample size and to carry out a longitudinal design to generalize the obtained results to reach a higher level of involvement.

6. Declaration of conflict of interest

The authors do not declare any conflict of interest. This research received no external funding.

7. Declaration of compliance with ethical principles

The authors declare compliance with ethical principles, having submitted the research to be inspected by the Research Ethics Committee of the Autonomous Community of Aragon (CEICA).

8. Certification of authorship

Conceptualization, A.Q.-R., N. M., and A.C.P.; formal analysis, A.Q.-R. and N. M.; research, A.Q.-R.; writing: preparing, revising and editing of the original drafts, A.Q.-R., N. M., and A.C.P. All the authors read and accepted the published version of the manuscript.

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