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RESEARCH IN PROGRESS

Time Management, Fluid Intelligence and Academic Achievement

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Abstract Time management and fluid intelligence have been studied in relation to academic success. Traditionally, fluid intelligence has been measured using performance tests (also called objective tests) meanwhile time management has been measured using self-reports. However, self-reports can be affected by bias and sometimes participant's responses are inaccurate. To address this limitation, we employed objective tests to measure both fluid intelligence (using the TRASI test) and time management (using the My Schedule test) to investigate their relation to academic grades. The sample consisted of 120 university students. Results indicate a positive relation between time management and fluid intelligence. Fluid intelligence is positively related to grades in mathematics. Time management is positively related to mathematics, physics and chemistry grades. While the present study does not establish causality, the results complement prior research and underscore the significance of time management and fluid intelligence in the academic context.

Keywords Intelligence · Fluid intelligence · Time management · Academic achievement · Objective tests

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Abbreviations
Gc Crystallized intelligence
Gf Fluid intelligence

Introduction

Time management and fluid intelligence are two important factors that have been extensively studied in relation to academic achievement. Time management involves behaviors and strategies aimed at completing tasks within a specific time frame. Efficient time management involves displaying behaviors that are aimed at completing high-value tasks within the given time frame while avoiding interruptions. Individuals who exhibit these behaviors are classified as good time managers. In contrast, individuals who engage in low-value tasks, miss deadlines and or interrupt important tasks are considered inefficient in their time management (Claessens et al., 2007, 2009; Koch & Kleinman, 2002; Lakein, 1973; Macan, 1994).

On the other hand, intelligence can be divided into two broad categories: crystallized intelligence (Gc) and fluid intelligence (Gf). Crystallized intelligence refers to the knowledge and skills that individuals acquire through education and experience. It includes vocabulary, general knowledge, and the ability to use language to communicate effectively. In contrast, fluid intelligence is the ability to solve novel problems, reason abstractly, and adapt to new situations. It involves skills such as pattern recognition, abstract reasoning, and problem-solving (e.g., Cattell, 1963; Horn, 1965; Horn & Cattell, 1966). The present work focuses on the latter type of intelligence.

Assessing Fluid Intelligence and Time Management

Fluid intelligence and time management have been measured using different methodologies. Fluid intelligence has been measured using performance tests (also called objective tests). For example, the Raven's test (Raven et al., 1998) is one of the most commonly employed. On the other hand, time management has traditionally been assessed using self-reports. For example, some of the most commonly used questionnaires are the Time Management Behavior Questionnaire (TMBQ; Macan et al., 1990) and the Time Management Questionnaire (TMQ; Britton & Tesser, 1991). Unlike objective tests, self-reports are based on what people say about what they do, rather than on their actual performance. Although self-reports are easy to design and administer, they can suffer from limitations such as inaccurate responses or the possible influence of social desirability (Edwards, 1957; Ortner & Proyer, 2015).

Fluid intelligence is a competence and the utility of objective tests when measuring it is not questioned. Researchers do not ask participants to describe their level of intelligence through self-reports. However, the same is not true for time management competence. Some authors have emphasized the utility of behavioral objective measures to assess time management when studying its relation to other relevant variables (e.g., Jex & Elacqua, 1999; Macan, 1994).

Research on the Relation Between Fluid Intelligence and Time Management

There is published work that has employed objective measures to study the relation between fluid intelligence and time management. (e.g., Colom et al., 2010; Konig et al., 2005; Redick et al., 2016).

Konig et al. (2005) investigated the predictive power of ability measures on multi-tasking performance, a key aspect of time management. To assess fluid intelligence, the Intelligenz–Struktur–Test 2000-R (Amthauer et al., 2001) was employed, while a behavioral task called "Simultaneous capacity/Multi-tasking" (SIMKAP; Bratfisch & Hagman, 2003) was used to measure time management. The study found a significant and positive correlation (0.30) between multitasking performance and fluid intelligence.

Similarly, Colom et al. (2010) explored the link between working memory, intelligence, and time management behaviors in a sample of applicants for an air traffic control course. Computerized tasks were employed to assess the variables and a fluid intelligence measure was obtained through a task known as the "TRASI test" (Rubio & Santacreu, 2003). The results indicated that both working memory and intelligence were associated with multi-tasking performance, but working memory was the stronger predictor.

Redick et al. (2016) utilized a range of behavioral tasks to investigate multi-tasking performance and its relation to working memory and intelligence. The correlation coefficients between the multi-tasking behavioral task and fluid intelligence measures varied between 0.26 and 0.57, with both working memory and intelligence contributing equally to the prediction of time management behaviors.

Research examining the relation between the aforementioned constructs has employed an objective methodology, but has mainly focused on a particular aspect of time management: multitasking performance. It is important to supplement these findings with studies that utilize a more general measure of time management to provide a more comprehensive understanding of the relation between time management and fluid intelligence.

Fluid Intelligence and Time Management in the Academic Context

The scientific literature has made efforts to explore fluid intelligence and time management in various contexts, and one that has gained significant importance is the context of education.

Fluid intelligence is a crucial variable for predicting academic success (Kuncel et al., 2004), and previous studies have shown a positive correlation between fluid intelligence and academic grades (Chamorro-Premuzic & Furnham, 2006; Colom & Flores-Mendoza, 2007; Deary et al., 2007; Navas et al., 2003; Watkins et al., 2007). Fluid intelligence has a greater impact on academic achievement when participants face new, difficult, or abstract tasks or subjects (Ackerman, 1994; Ackerman & Lohman, 2003; Blanch, 2015; Cattell, 1963, 1987; Horn, 1965; Horn & Cattell, 1966; Jensen, 1980; Peng et al., 2019; Thorsen et al., 2014; Voelkle et al., 2006). Furthermore, several studies have found that fluid intelligence has the strongest relation with mathematics grades (Ackerman & Lohman, 2003; Blanch, 2015; McGrew & Wendling, 2010; Peng et al., 2019; Primi et al., 2010; Ren et al., 2015).

In terms of time management, previous research has shown a positive correlation between time management and academic grades (e.g., De la Barrera et al., 2008; Kitsantas et al., 2008; Umerenkova & Flores, 2018). However, further studies are needed to determine which subjects benefit most from efficient time management (e.g. Claessens et al., 2007). In addition, previous research has employed self-reports to assess time management and, as mentioned before, several authors emphasize the need to employ less subjective methods to assess this competence (e.g., Jex & Elacqua, 1999; Macan, 1994).

Aim of the Study

This study aims to investigate the relation between objective measures of general time management and fluid intelligence, and academic grades. The results aim to address the limitations of previous studies and provide a more comprehensive understanding of the variables involved.

Based on the literature review, we expect that time management and fluid intelligence would be positively related. In addition, we hypothesize that there would be a positive relation between fluid intelligence and academic achievement, and that the relation with mathematics would be stronger. Finally, we expect to find a positive relation between time management and academic achievement, although without making preliminary hypotheses as to which subjects will show the strongest relation.

Method

Procedure

The study was approved by the research ethics committee at the Universidad Autónoma de Madrid (CEI-97-1787). In this study, objective tests were used to collect data on intelligence and time management, while academic grades were collected through a form.

In Spain, individuals who wish to pursue university education must take entrance exams that assess the knowledge acquired during their previous education before university. Subjects such as mathematics, Spanish language, physics, chemistry, and others are evaluated, and an overall average grade is calculated. The overall grade is used to determine eligibility for university studies, with each university degree having a specific cut-off mark based on demand. The grade obtained by students in the entrance exams determines whether they can enroll in a degree program.

The inclusion criteria for the study are as follows. The participants should have applied for university studies. Since this was a study with adult students, the first inclusion criterion was that they were 18 years of age or older. In addition, given that computerized objective tests would be used to assess intelligence and time management, an inclusion criterion was that they should be able to operate a computer and, in particular, a computer mouse (Santacreu et al., 2006). All students who met these criteria were selected to participate in the study.

All participants signed informed consent document before participating in the study, allowing the recorded data to be used for this research. Data collection took place in the computer rooms of the Psychology Department of the University. Participants were provided a secure identification and a password to access an online server. In the computer rooms, participants completed two objective tests in an individual computer: an objective test that assessed fluid intelligence and an objective test that assessed time management. At any moment, two psychologists were supervising the process. In addition to taking the tests, participants were asked for their academic grades through an online form. The participants filled out the form and provided a photocopy of their official transcript. In addition, the psychologist checked that the grades appearing on the form matched the grades of the official transcript. There were no differences. To analyze the data recorded we employed SPSS 25.

Participants

The participants were 120 undergraduate students (18 males and 102 females) that were examined to gain access to a Spanish university. The range of age varied between 18 and 29 years, being the average age 18 years.

Instruments

Time Management

My Schedule This behavioral computerized test was designed by Romero et al. (2021) and assesses time management behaviors. It was designed based on behavioral decision-making theory applied to time management behaviors (Koch & Kleinman, 2002). This theory defines time management as the behaviors and strategies aimed at completing tasks within a specific timeframe. Efficient time management involves prioritizing high-value tasks and avoiding low-value tasks that can waste time. It also requires avoiding interruptions that can disrupt the completion of valuable tasks.

The items of My Schedule present a schedule page with office activities (e.g. attending a meeting, answering calls, downloading documents, etc.) that need to be completed in a period of time in order to obtain points (see Fig. 1). The tasks are represented by icons and they have different value (they provide different number of points and take different seconds until they complete). The screen shows the icons and a schedule page with hours. A bar that moves from the top to the bottom of the screen represents time passing. When participants click on an activity, it begins to complete (completion of the task is represented by a black moving bar). When the activity is finally completed it provides points. The schedule page has some hours highlighted. If participants complete the activities in these highlighted hours, they obtain double the points. If they click on the activity that represents having a break (coffee icon), the next activity they click will take half the time to complete.

"Downloading documents" can be completed at the same time as other activities. "Answering calls" icon activates

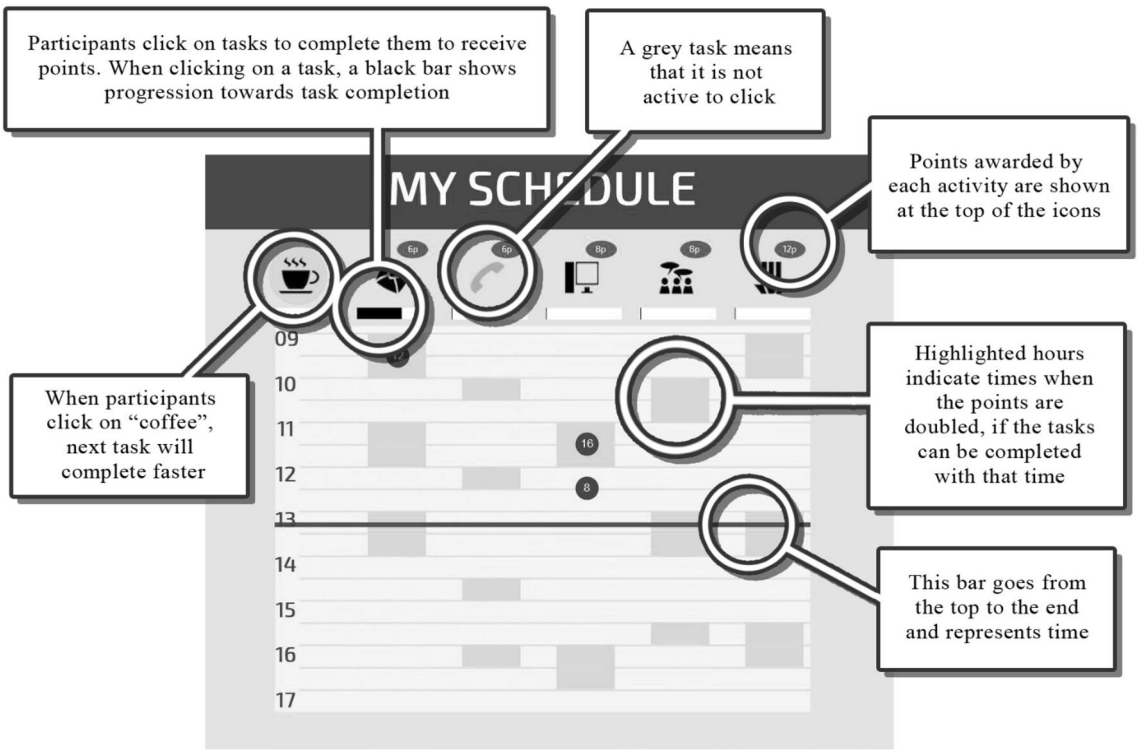

Fig. 1 My schedule test. *Note* Example of a display shown on each trial of *My Schedule* test (Romero et al., 2021). Adopted with permission

every 5 s and if it is clicked while other activity is completed, the other activity is interrupted and therefore the participant does not obtain the potential points it could have provided. "Answering calls" interrupts every activity except for "downloading documents". Table 1 summarizes the value of each activity. In order to obtain a high number of points, participants have to choose the activities that provide a higher value in a given time.

This test has one training trial in which the moving bar goes from the top to the end of the schedule. This trial lasts 120 s and participants can become familiar with the task. After this trial, the task presents 8 test trials and each of them last 60 s. The trials end when the moving bar reaches 2 p.m. Participants would have to ignore the last hours and complete different tasks in the given period.

The time management variable is the mean number of points obtained. It is measured only in the test trials and its range goes from 0 to 300. Higher values mean that the participant is managing time effectively. *My Schedule* has shown high reliability and convergence validity (Romero et al., 2021). In the original study, the Cronbach's alpha of

Table 1 Points awarded by activities of My Schedule

	Time it consumes	Points awarded if completed	Value (points/time)	Value if completed on highlighted hours
Writing emails	4	6	1.5	3
Answering calls*	2	6	3	6
Working on the computer	4	8	2	4
Attending a meeting	4	8	2	4
Downloading documents**	1–12	12	12–1	24–2
Coffee (break)***	5	–	–	–

*Answering calls activates every 5 s

**Downloading documents is available even if another task is being completed. It consumes 1 s if the participant immediately clicks on another activity or up to 12 s if he or she clicks on another activity when "downloading documents" ends

***The function of this activity is to halve the time that consumes the next activity that participants click

the test was 0.92. In the present study the value was 0.90, which is similar to the value reported by the test authors.

Fluid Intelligence

TRASI Test (Rubio & Santacreu, 2003) This test assesses fluid intelligence which is defined as the capacity to solve problems and reason abstractly, particularly in unfamiliar situations. Items of the TRASI test present four abstract figures that have some rules in common. Below the figures, the test shows four alternatives. Participants have to choose the correct answer (see Fig. 2). TRASI is an adaptive computerized test, that is, the items that are presented are adapted depending on the competence level of the participant. It estimates the ability of the participants by using Bayesian procedures. The TRASI test provides a z-score to estimate fluid intelligence. Its range goes from − 3 to 3. The test shows good psychometric properties. The authors reported a reliability of 0.84 (Rubio & Santacreu, 2003). In the present study, a Cronbach's alpha value of 0.81 was obtained, which is similar to the value reported by the test authors and indicates good reliability.

College Grades

Grades Form In order to assess academic achievement, academic grades were collected. Participants filled out a form on which they had to indicate the marks they had obtained in order to gain access to the university: mathematics, Spanish language, biology, physics, chemistry and the final university entrance grade. The grades have a range between 0–10. They also had to provide a photocopy of the official transcript to avoid subjectivity. All the reported grades matched with the grades of the official transcript.

Results

Table 2 shows descriptive data and correlations between the variables. Fluid intelligence and time management showed a significant positive relation (r (118) = 0.28; p = 0.002). Regarding academic performance, fluid intelligence only showed a significant relation with mathematics grade (r (118) = 0.27; p = 0.006). The direction of the relation between fluid intelligence and physics was positive but non-significant. The relation between fluid intelligence, Spanish language, chemistry, and university entrance grades was close to zero.

Time management showed a significant positive relation with mathematics (r (118) = 0.28; p = 0.004), physics (r (118) = 0.38; p = 0.04), and chemistry (r (118) = 0.24; p = 0.02). We found no significant relation between time management, Spanish language, biology and university entrance grades.

Both time management and fluid intelligence were related to mathematics. We conducted a hierarchical regression with this grade as the dependent variable. In stage 1 we entered time management. In stage 2 we entered fluid intelligence.

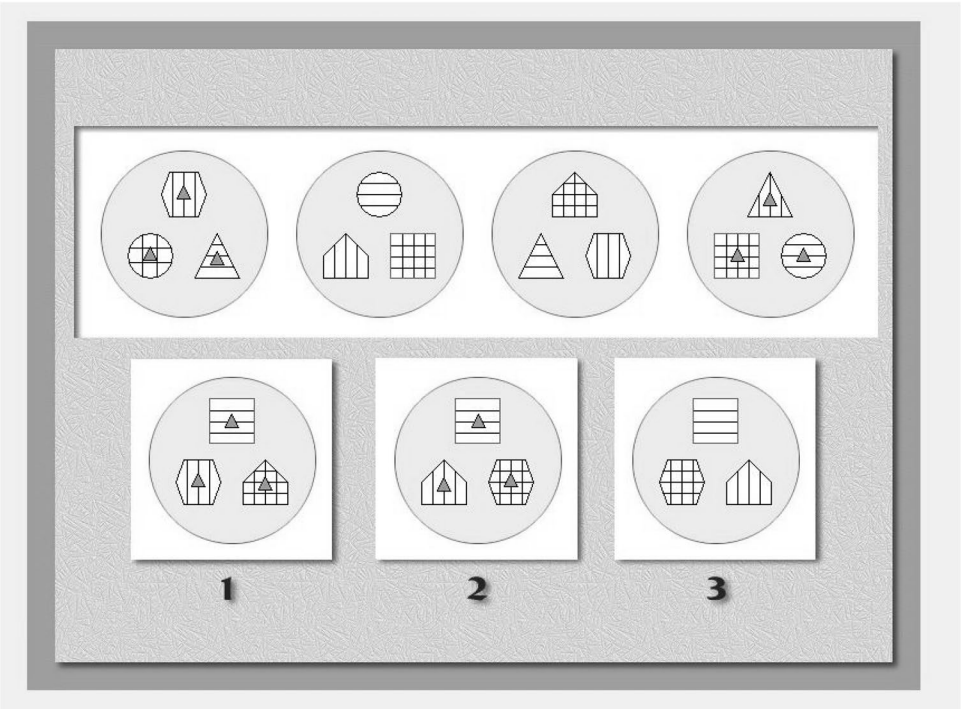

Fig. 2 TRASI test. *Note* Example of an item of the TRASI test (Rubio & Santacreu, 2003). Adopted with permission

Table 2 Means, standard deviations and correlations of the study variables

	M	SD	1	2	3	4	5	6	7	8
1 Fluid intelligence	0.01	0.93	1							
2 Time management	132.62	28.48	.28**	1						
3 Mathematics	6.91	1.80	.27**	.28**	1					
4 Spanish language	7.40	1.65	− .01	− .04	− .01	1				
5 Biology	6.80	1.43	.05	.02	.19	.43**	1			
6 Physics	6.14	2.02	.28	.38*	.17	.18	.41	1		
7 Chemistry	7.13	1.89	.011	.24*	.25*	.22*	.16	.49*	1	
8 University entrance	7.90	0.76	.079	.057	.44**	.52**	.34**	.33	.23*	1

*$p < .05$
**$p < .01$

Table 3 shows the regression statistics. The change in R^2 was significant ($p < 0.05$). For the model that includes time management, we found a significant regression equation, $R^2 = 0.076$, F (1.105) = 8.603, $p < 0.05$. Time management accounted for 7.6% of the variance of the mathematics grade. When including fluid intelligence and time management, we also found a significant regression equation, $R^2 = 0.11$, F (1.104) = 6.497, $p < 0.05$. Fluid intelligence and time management accounted for 11% of the variance of the mathematics grade.

Time management, but not fluid intelligence, was related to physics. We conducted a simple linear regression analysis with time management as the independent variable (β = 0.387; t = 2.764, $p = 0.01$). A significant regression equation was found, $R^2 = 0.15$, F (1.26) = 4.588, $p < 0.05$. Time management accounted for 15% of the variance of the physics grade.

On the other hand, time management but not fluid intelligence was related to chemistry. Again, we performed a simple linear regression analysis with time management as the independent variable (β = 0.235; t = 5.446, $p < 0.001$). A significant regression equation was found $R^2 = 0.05$, F (1.92) = 5.371, $p < 0.05$). Time management accounted for 5% of the variance of the chemistry grade.

Discussion

This work aimed to study the relation between time management, fluid intelligence, and academic grades, measuring both time management and fluid intelligence objectively. We found a significant positive correlation between fluid intelligence (TRASI) and time management (*My Schedule*). The value was low (0.28), but similar to the one obtained by Konig et al., (2005; 0.30) when studying the relation between fluid intelligence and multi-tasking (a time management measure). Redick et al. (2016) found similar but also higher correlation values between fluid intelligence and multi-tasking measures (values between 0.26 and 0.57). The objective test employed in our work measures more general time management behaviors, whereas the objective tests used by Redick et al. (2016) are more specific, which could explain the differences in the size of the correlation. Nevertheless, in any case, a relation with fluid intelligence has been found. Fluid intelligence plays a role in the implementation of time management behaviors. Although we have not established a causal relation, it is possible that fluid intelligence favors the learning of time management behaviors.

Having explored the relation between objective measures of time management and fluid intelligence, we now focus on the relation between the aforementioned variables and academic grades. Regarding fluid intelligence, our results suggest that it does not have a significant influence on the majority of the grades; only on mathematics. The correlation between mathematics and fluid intelligence is in line with

Table 3 Regression analysis for mathematics grade

Variable	β	t	sr^e	R	R^2	ΔR^2
Step 1				.275	.076	.076
Time management	.275	2.93*	.275			
Step 2				.333	.111	.035
Time management	.212	2.18*	.209			
Fluid intelligence	.198	2.03*	.196			

*$p < .05$

the literature. Previous studies conclude that fluid intelligence is strongly connected with mathematics (e.g., Ackerman & Lohman, 2003; Blanch, 2015; McGrew & Wendling, 2010; Peng et al., 2019; Primi et al., 2010; Ren et al., 2015). The correlation between intelligence and grades is higher for subjects that are more abstract (see Ackerman & Lohman, 2003; Jensen, 1980). Mathematics is indeed one of the most abstract subjects so we should expect that it would show the highest correlation with fluid intelligence. On the other hand, other authors have also found a lack of a significant correlation between academic grades and some intelligence measures. For example, Eno (1978) did not find a significant correlation between fluid intelligence and psychology grades. Furnham et al. (2005) found a relation between the grade point average (GPA) and the Baddeley Reasoning Test (Baddeley, 1968) but not with the Wonderlic Personnel Test (Wonderlic, 1992) or with the Raven's test (Raven et al., 1988; a test similar to the TRASI test employed in our study).

Regarding time management, this variable showed significant positive correlations only with mathematics (0.28), physics (0.38), and chemistry (0.24) grades. People who showed better time management scores on *My Schedule* objective test obtained higher results in these exams. In terms of the size of the relation, it is similar to the size obtained in studies that use self-reports to measure time management. For example, Macan et al. (1990) found a correlation value of 0.23 between time management and academic grades. Britton and Tesser (1991) found correlation values between 0.25-0.39. Pintrich et al. (1993) found a correlation of 0.28. De la Barrera et al. (2008) found values around 0.21.

The regression analyses showed that fluid intelligence and time management explained 11% of the variance of the mathematics grade. The increment in R^2 when introducing fluid intelligence in the regression analysis was significant but low. Descals and Rivas (2002) found that the variance explained by intelligence was also low (between 3–4%). However, most of the studies have stated that intelligence can explain a high percentage of the variance of academic grades, reaching values of 25% or higher (e.g., Deary et al., 2007; Kuncel et al., 2004). Authors such as Furnham et al. (2005) argue that the course requirements could be benefited more from some types of measures than others. Fluid intelligence exerts greater influence when new tasks are faced. Its effect is lesser on tasks already learned or studied (e.g., Ackerman, 1994; Cattell, 1963; Thorsen et al., 2014). The academic grades collected for this study refer to the university entrance exams. Students prepare for a long time to face these exams. They take tests throughout the last course of the high school before facing the university entrance exams. As students have been trained, many entrance exams are less likely to be novel and therefore they might not be influenced by fluid intelligence. With respect to the mathematics grade, we have found a relation even though students were also trained to face the exam. The resemblance between the non-verbal reasoning test (TRASI) and the mathematics exam is greater than the resemblance between the non-verbal reasoning test and the other exams. This similarity could explain the significant relation between fluid intelligence and mathematics grade (McGrew & Wendling, 2010; Primi et al., 2010).

On the other hand, time management explained 15% of the variance of the physics grade and 5% of the variance of the chemistry grade. This finding is similar to that obtained in studies using self-reports. Britton and Tesser (1991) used a self-report (TMQ) to assess time management. This instrument has four dimensions: Perceived control of time, short-term Planning, time attitudes and long-term Planning. They found that time attitudes accounted for 15% of the variance of the GPA. The short-range planning dimension accounted for 6% of the variance. Mpofu et al. (1996) also employed the TMQ to assess time management. They reported that the dimension of short-term planning accounted for 7.2% of the variance of the GPA, meanwhile the dimension of perceived control of time accounted for 5% of the variance.

In our study, we did not find significant correlations between time management and Spanish language, biology and the university entrance grades. It seems that some facets of time management play a role in obtaining better results in some exams. Maybe some subjects are more benefited from time management strategies than others. In our work we have found that objective measures of time management are more related to subjects that are more practical and are part of the area of science (mathematics, physics and chemistry). Perhaps, the way of studying these subjects requires students to manage various tasks (reading, memorizing, completing exercises) and therefore time management skills can lead to better results. Further studies will be necessary to obtain firmer conclusions about the reasons for these findings.

In this work we aimed to explore the relation between fluid intelligence, time management and academic performance specifically. We are not exploring which variables best explain academic performance. Undoubtedly, the prediction of performance could be improved if we include other variables, such as the level of anxiety or the level of prior knowledge. In future studies it will be interesting to obtain measures of these variables to compare the weight that each one has in explaining academic performance.

The foregoing leads us to further explore the limitations of this work. The main limitation that is referred to is the sample. We assessed time management and fluid intelligence of students that were examined to apply to a university degree. In addition, the number of women and men in the sample was not balanced. Therefore, the generalization of the results is limited. On the other hand, the study design

does not allow us to establish causal relations. In future work, it will be appropriate to use other types of designs to expand on the conclusions obtained. For example, we could study whether fluid intelligence plays a role when training a group of participants to better manage their time, and whether these variables have an impact on performance, comparing the results with a control group. Additionally, the present research has not collected longitudinal data. To expand the results, it would be necessary to measure, over different academic years, different relevant variables and their effect on academic grades. Obtaining measures such as intelligence level, time management skills, and anxiety levels at different time points would provide a comprehensive understanding of their influence on performance throughout a university student's formative years. Conducting such studies would provide a more complete view of these variables. Ultimately, we hope that the present study inspires future research in this area.

This work makes an important contribution at the theoretical level by complementing the results obtained by previous studies in which time management has been measured by self-reports rather than by an objective test. When exploring the relation between time management and academic grades, the size of the relation is similar to that found in studies using time management self-reports. Nevertheless, our results show that obtaining high scores on time management or fluid intelligence does not always mean obtaining better academic results. Fluid intelligence was related to mathematics meanwhile time management was related to mathematics, physics and chemistry.

This work also has practical implications. We have concluded that fluid intelligence does not always play a relevant role in academic performance, at least in university entrance exams in which students face a task for which they have been extensively trained. On the other hand, we have observed that time management behaviors seem to be related to practical exams in the science area. The results of this study could encourage the development of time management interventions to improve academic outcomes in some subjects. These findings could be useful for educators, as they should be aware of which variables affect exam performance when designing educational programs.

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Author Contributions MR: collection of data, analysis and interpretation of data, revising intellectual content; CC: collection of data; JS: revising intellectual content.

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Availability of Data and Materials The data that support the findings of this study are available from the corresponding author.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics Approval The study was approved by the research ethics committee of the Autonomous University of Madrid. All procedures performed in studies involving human participants were in accordance with the APA ethical standards.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Consent for Publication Consent to publish has been obtained.

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