The added value of creativity: evidence from experiments with teenagers – *the role of patience*

Preliminary work

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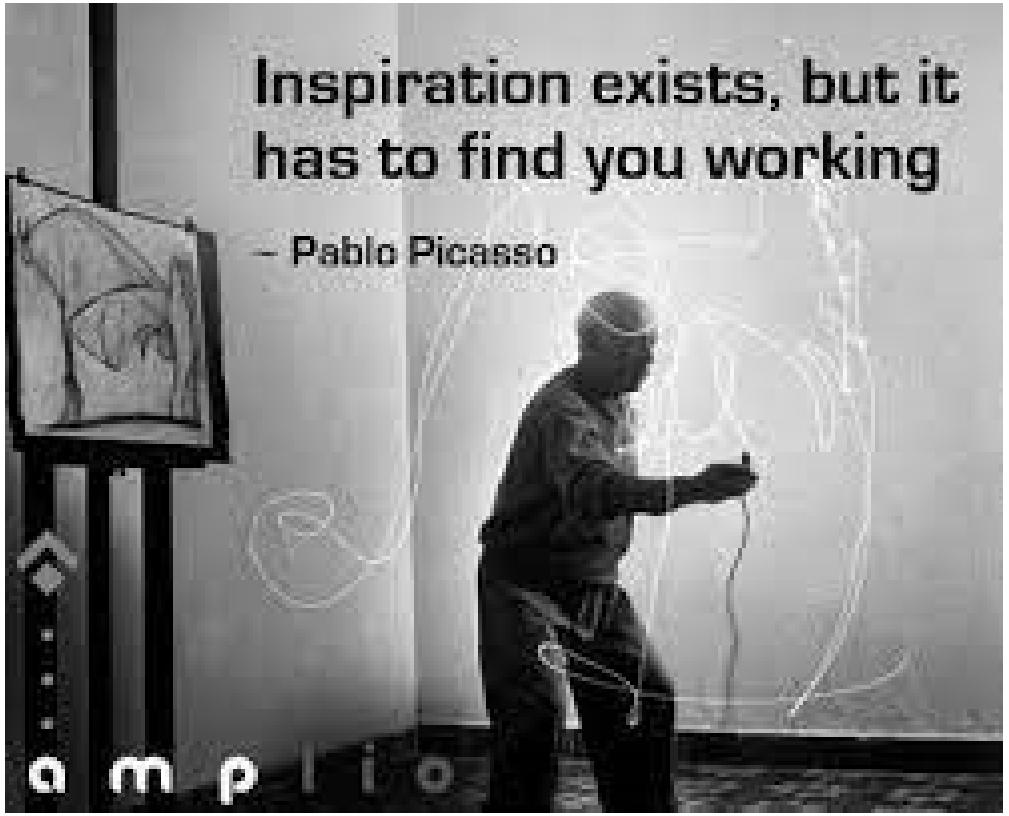
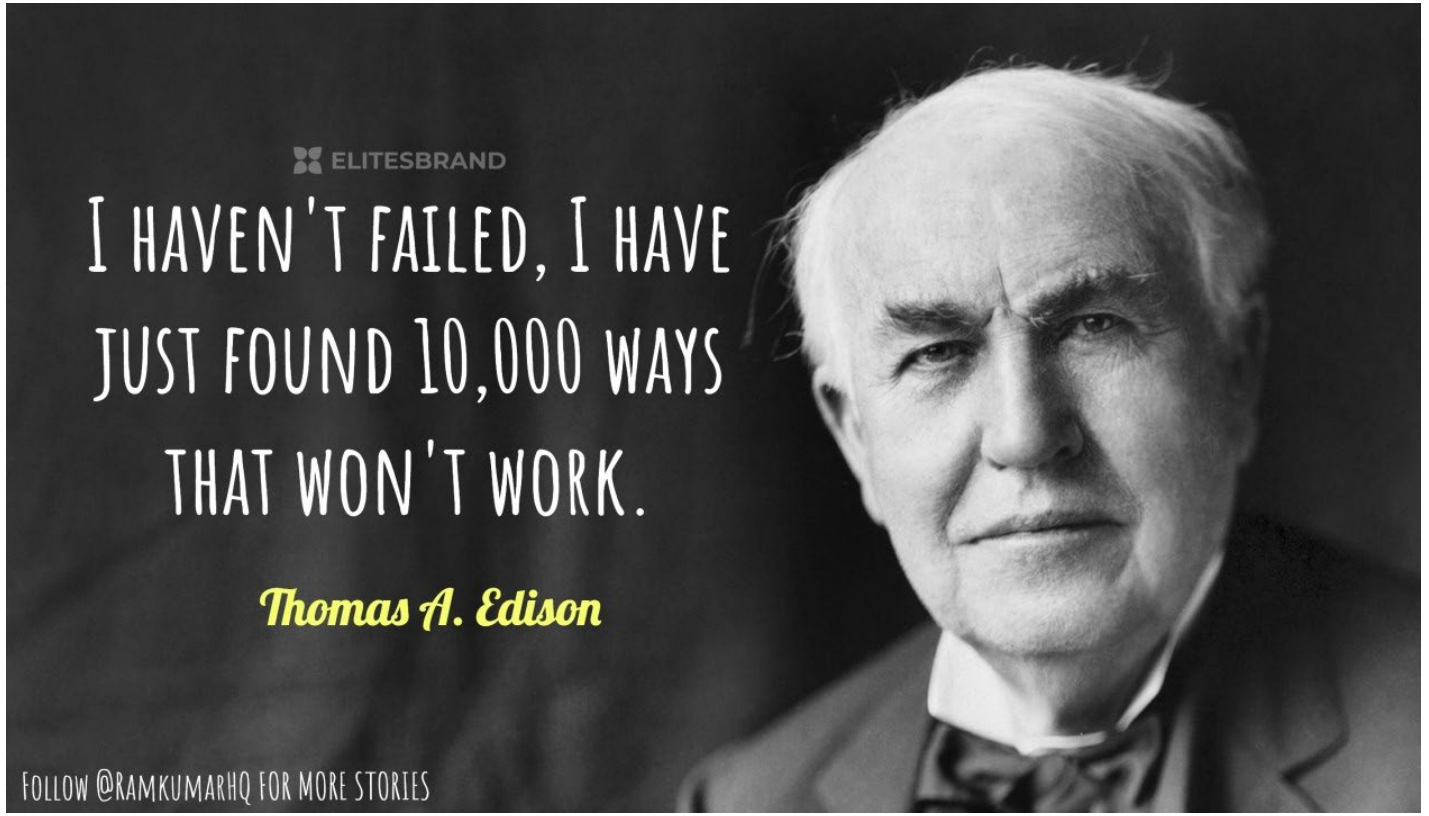
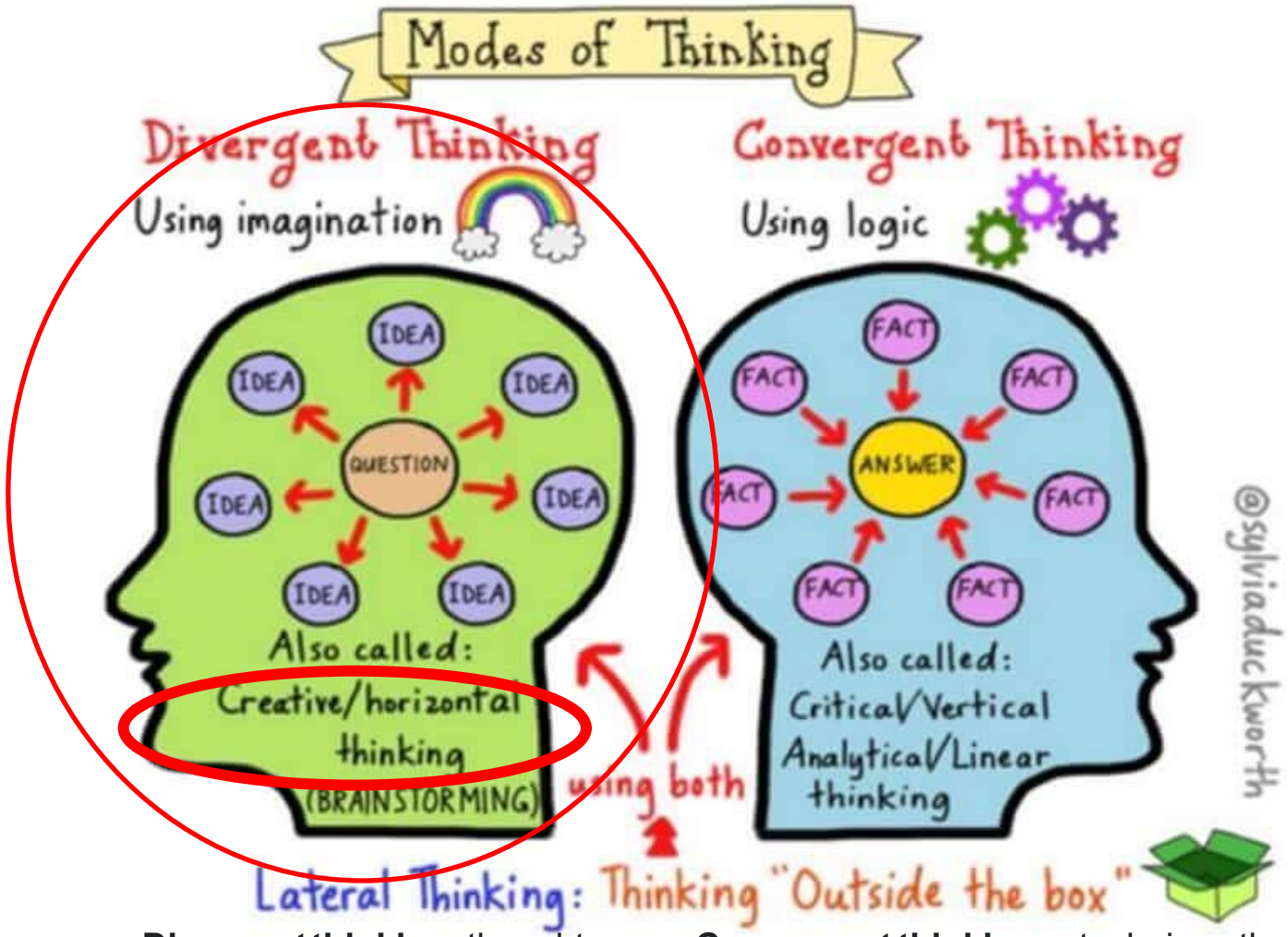
EEA ESEM

When we think about coming up with a creative outcome…





Eureka moment **vs.** **Persistence & patience**



Divergent thinking: thought process or method used to generate creative ideas by exploring many possible solutions

Convergent thinking: a technique that encourages individuals to bring together disparate pieces of information in attempting to solve a particular problem

Guilford (1956): Divergent vs. convergent thinking terms

Introduction

- **Standard definition of Creativity:** originality (or novelty) and effectiveness
- **Creativity tests:**
  - Torrance Test of Creative Thinking (TTCT)
  - Remote Associates Test (RAT)
  - Guilford's Structure of the Intellect (SOI)
- **Guilford (1967): Alternatives uses test (AUT)**
  - **Task:** List as many alternative uses for an object in a period of time to see whether the novel ideas are generated.
  - Measurement of divergent thinking
- **Runco & Acar (2012):** divergent thinking is a reliable indicator of **creative potential**
- We focus only on the divergent thinking part of creativity

Introduction

- **Why AUT?**
  - Data acquisition
  - Natural language processing analysis
  - Discard judges' evaluation, rubrics, and subjectivity.
  - Possibility of measuring different components:
    - Originality: statistically uncommon when compared to responses to the overall data set
    - Fluency: quantity
    - Flexibility: number of different categories
    - Elaboration: amount of detail
- **Hypothesis:**

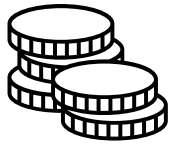
H1. Do time preferences have an effect on the performance of the AUT test?

H2. Are grades, gender, and cognitive abilities of teenagers affecting the performance of the AUT test?

Hypothesis:

Impatient

Quit/underperform **Perform the task**

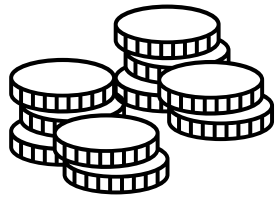
$Period\ t$:  $>$ 

$Period\ t+1$:

Patient

Quit/underperform **Perform the task**

$\wedge$



Prediction: Time preferences will play a role in creative performance: patient participants will perform more creatively than impatients.

Procedure

- Academic years 2021-2022 and 2022-23
- Lab-in-the-field experiment
- The experiment was integrated as an in-class activity
- Use of SAND online platform (Kampal)
- Devices: electronic tablets, mobile phones and laptops

Sample

- $n = 4{,}003$ participants
- 22 schools (208 classes) in Spain
- Ages: 12 to 16 years old
- Female (49%)
  - Low-grade students (1º-2º grade): 1,903 participants (12.9 years old on average)
  - High-grade students (3º-4º grade): 1,432 participants (15.1 years old on average)
- 17% are repeaters
- 9% are migrants

Divergent thinking task

Time preferences

CRT

Experimental Tasks

Example of the Divergent Thinking task

On the next screen you will find an object. We ask you to include in your answer ALL the uses you can think of for it. Separate each use you mention with a semicolon (;). This IS AN EXAMPLE of the question we are going to ask.
Imagine that we ask you: Write down all the alternative uses you can think of with a paper clip. Your answers could be making a hook; making a bracelet; making a fishing hook....

Divergent Thinking task

5:00

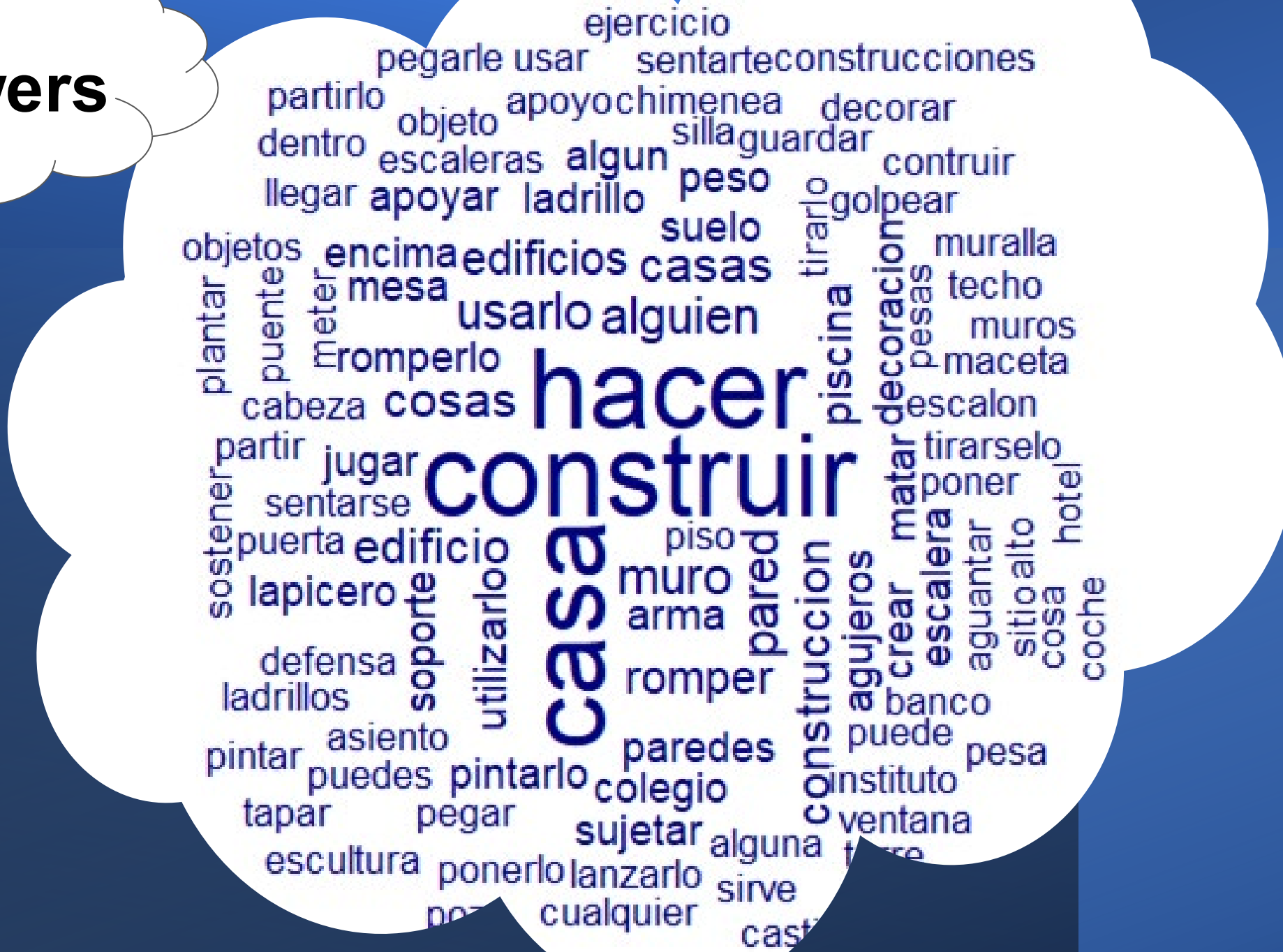
This is the LAST question. Please take 5 minutes to complete it.

Write down all the alternative uses you can imagine with a brick. Remember to separate each idea you write with a semicolon (;).

Introducir texto

Introduzca el valor de la respuesta.

Answers


ejercicio
pegarle usar sentarteconstrucciones
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dentro escaleras algun contruir
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suelo
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decoracion
mesa techo
plantar puente meter usarlo alguien pesas muros
romperlo maceta
hacer
piscina
cabeza cosas escalon
construir
partir jugar tirarselo
matar
sostener sentarse poner
escalera
puerta edificio piso hotel
casa
pared
construccion
agujeros
crear
aguantar
sitio alto
cosa
coche
lapicero muro
soporte
utilizarlo
arma
defensa romper
ladrillos banco
asiento puede
pintar paredes pesa
puedes pintarlo colegio instituto
tapar pegar sujetar alguna ventana
escultura ponerlo lanzarlo sirve
cualquier

Data cleaning

- We eliminate null or empty observations from the dataset.
- We homogenize the dataset, cleaning responses from punctuation, accents, numbers, double blank spaces, ”etc.” references, among others.
- We eliminate ”empty” words (i.e., articles, prepositions, conjunctions, pronouns, etc.) that do not contribute to the answer.
- Normalization: values are normalized between 0 and 1, with 0 representing the lowest value and 1 the highest value.

Creativity measures

Elaboration: amount of detail (words) for the most detailed answer

Flexibility: number of unique words provided by each participant in all their responses

Fluency: total number of complete answers provided by each participant

Originality: number of unique and valid answers based on ChatGPT 1000 most original answers

creativity: addition of the previous four

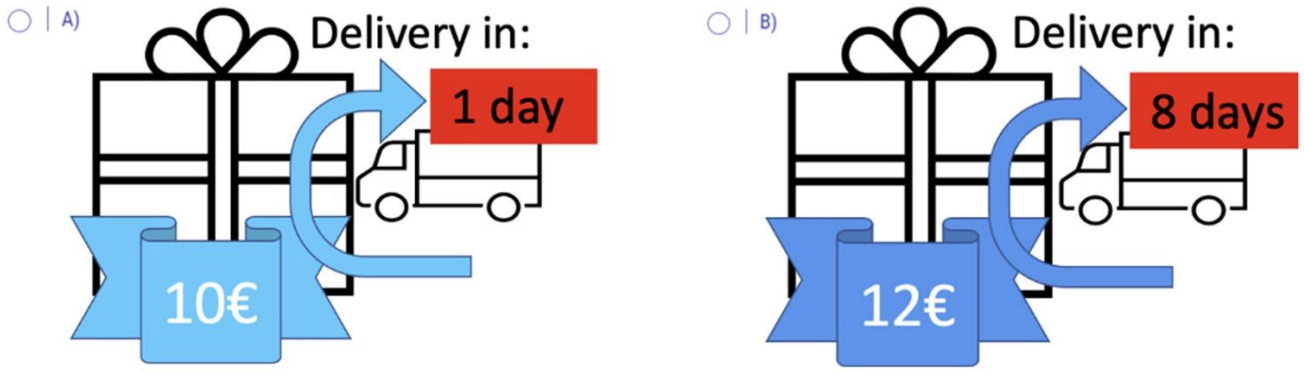
Example





Answer	Elaboration	Flexibility	Fluency	Originality	Creativity
A **house**; **build** a **barbacue**	2	3	2	1	8
To **build** a **house** for **birds**	3	3	1	0	7
A **house**; a **casa** for **birds** for my **grandma's house**	4	3	2	1	10

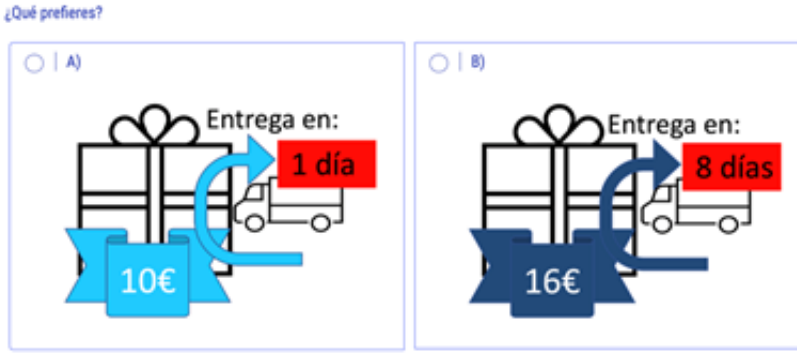
- Visual Multiple Price Lists (MPL) (Coller and Williams, 1999) using monetary payoffs as gifts and waiting times by a van.



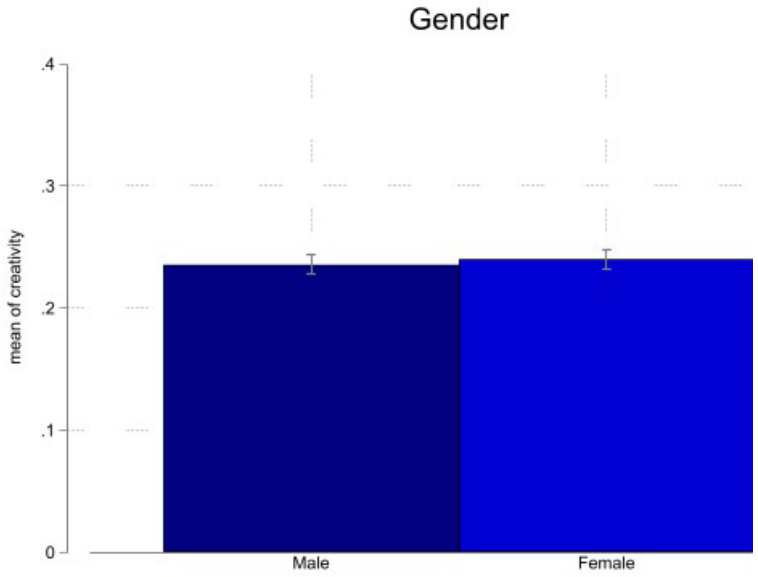
- Six hypothetical decisions: obtain the payoff at the early date of tomorrow (left option) or receive the payoff in one week (right option).
- The amount corresponding to the left is always 10 euros, and the corresponding amount of money on the later date (right) increases by 2 euros from decision to decision.

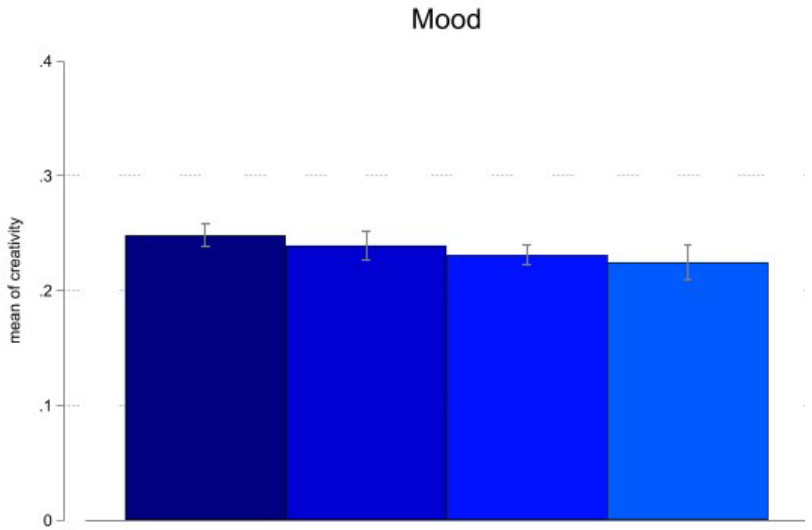
Time preferences

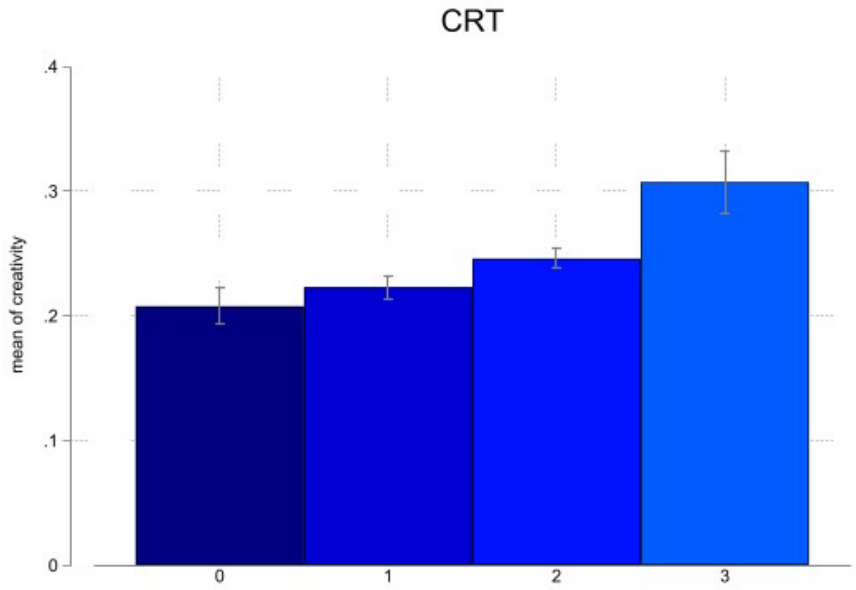
Time preferences:

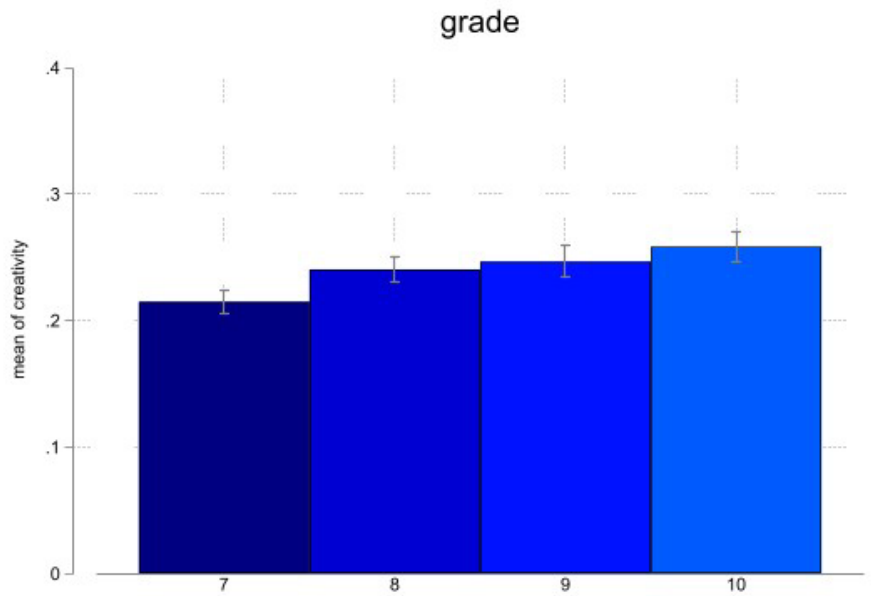


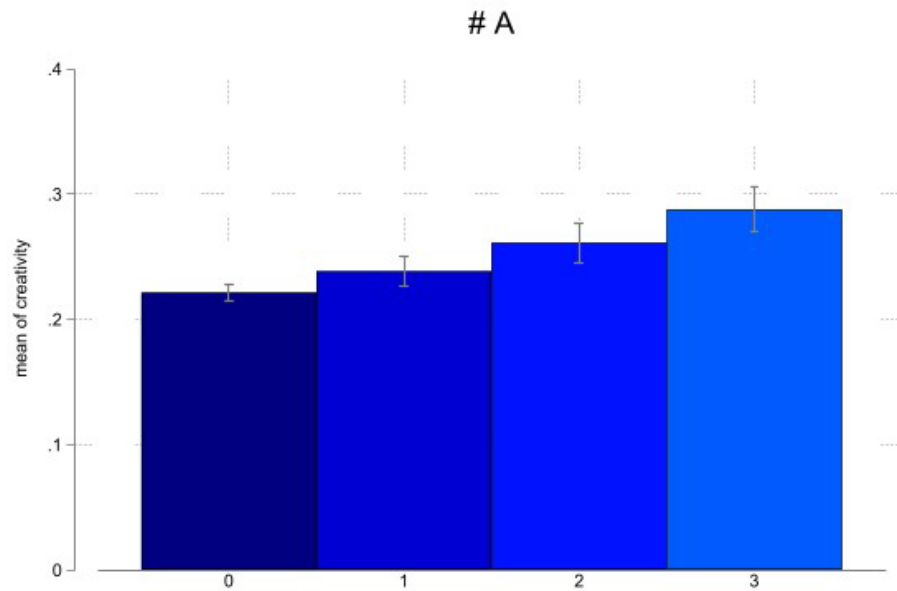
Results: descriptives











Results: descriptives

Divergent thinking

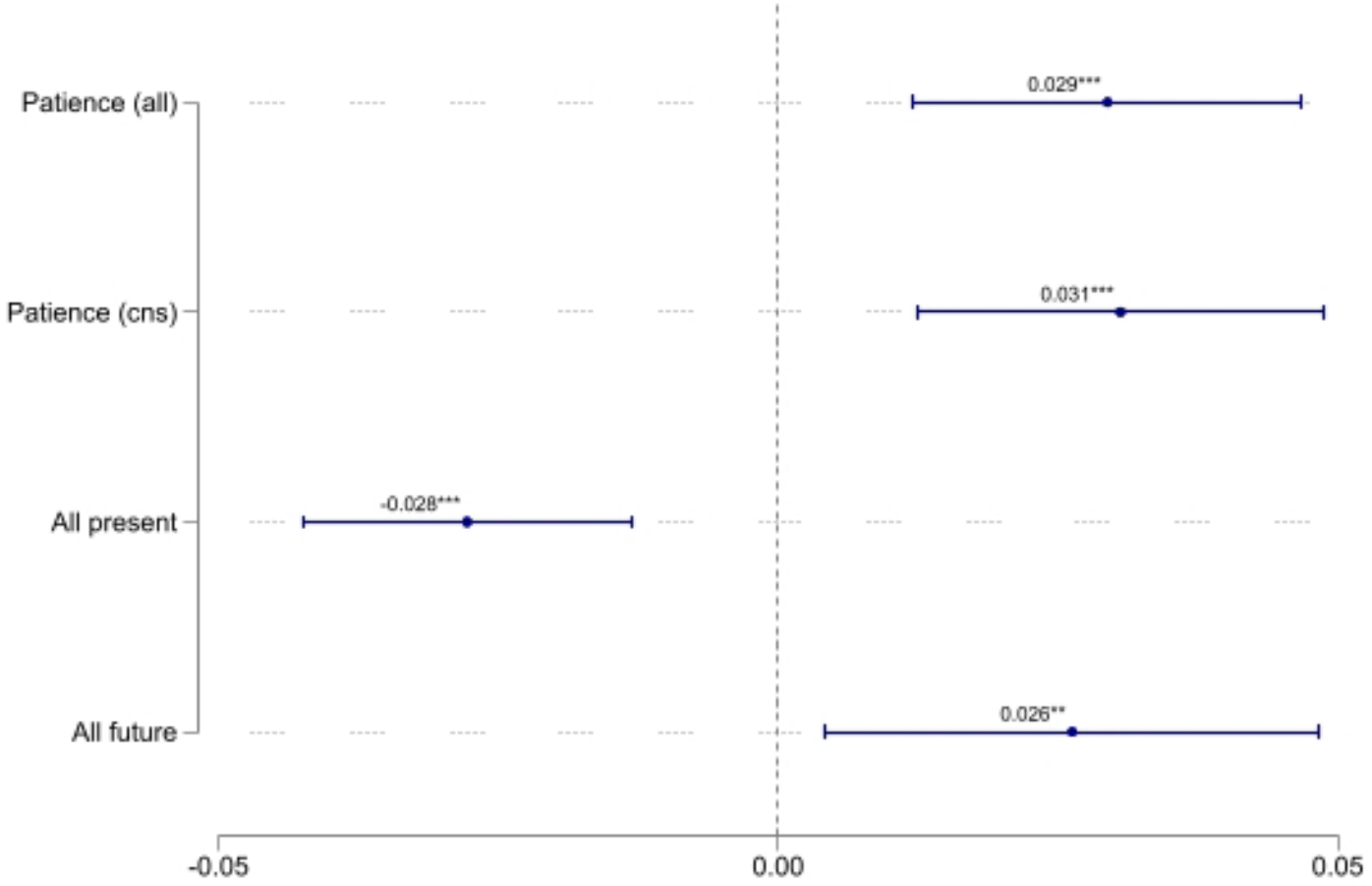
	Overall (N=4003)
Fluency	
Mean (SD)	0.270 (0.201)
Median [Min, Max]	0.182 [0, 1.00]
Flexibility	
Mean (SD)	0.248 (0.212)
Median [Min, Max]	0.190 [0, 1.00]
Elaboration	
Mean (SD)	0.295 (0.199)
Median [Min, Max]	0.250 [0, 1.00]
Missing	802 (16.6%)
Originality	
Mean (SD)	0.139 (0.237)
Median [Min, Max]	0 [0, 1.00]
Creativity	
Mean (SD)	0.238 (0.175)
Median [Min, Max]	0.190 [0, 1.00]
Missing	802 (16.6%)

Missing: responses discarded.

Time preferences

	Overall (N=4003)
All	
Mean (SD)	0.524 (0.343)
Median [Min, Max]	0.667 [0, 1.00]
Patience	
Mean (SD)	0.532 (0.363)
Median [Min, Max]	0.667 [0, 1.00]
Present opt.	
Mean (SD)	0.227 (0.419)
Median [Min, Max]	0 [0, 1.00]
Others	
Mean (SD)	0.656 (0.475)
Median [Min, Max]	1.00 [0, 1.00]
Future opt.	
Mean (SD)	0.117 (0.322)
Median [Min, Max]	0 [0, 1.00]

Results: Patience vs. Fluency

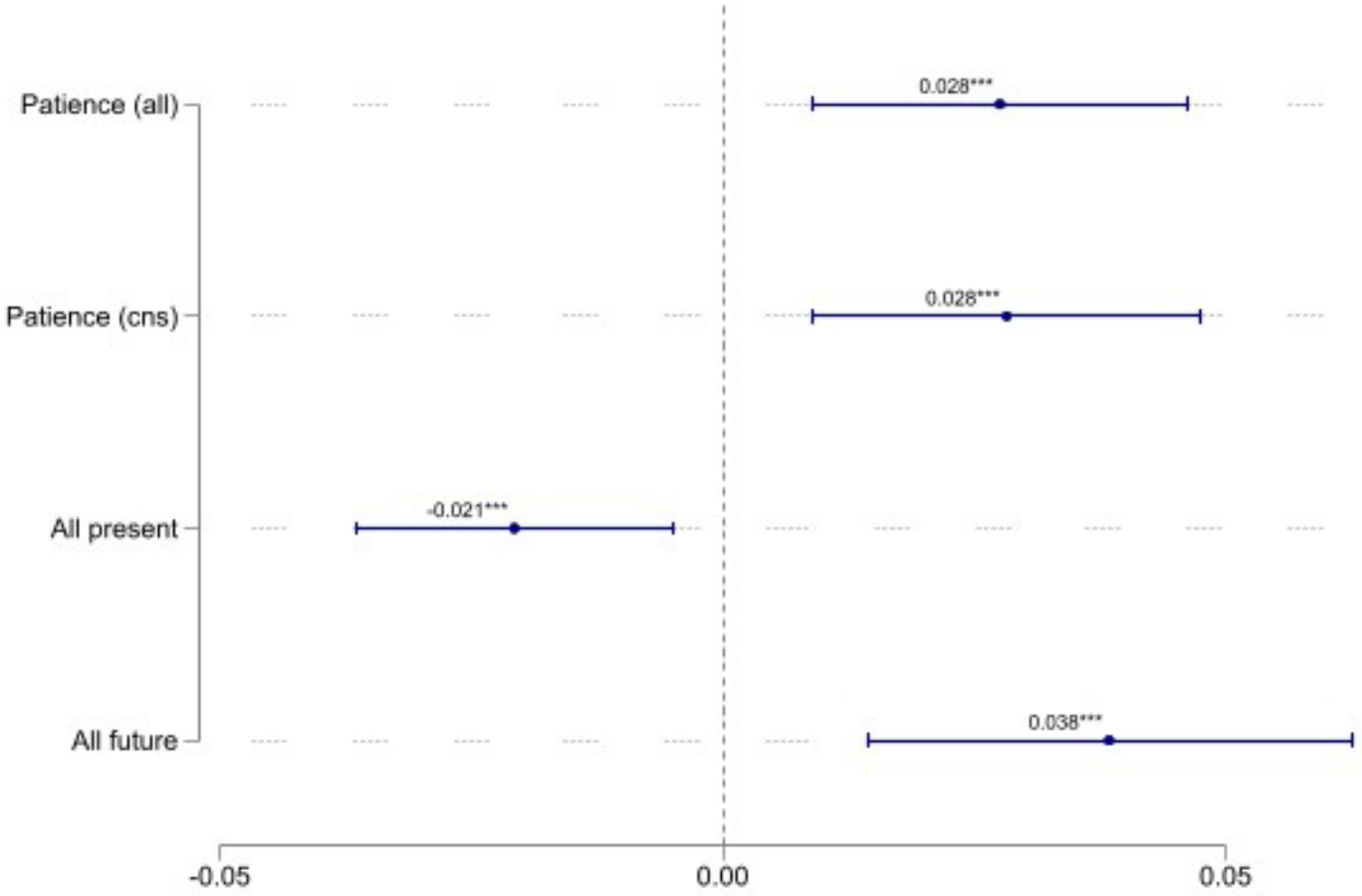


Note: OLS regression model controlled by grade, gender, #A marks, CRT, and mood.

- Patience may be a key determinant in an individual's ability to generate creative uses.
- This effect holds even when we limit our analysis to individuals exhibiting consistent behaviors.
- Those who consistently preferred future rewards demonstrated a greater ability to envision alternative uses.

Fluency: total number of answers provided by each participant

Results: Patience vs. Flexibility



Note: OLS regression model controlled by grade, gender, #A marks, CRT, and mood.

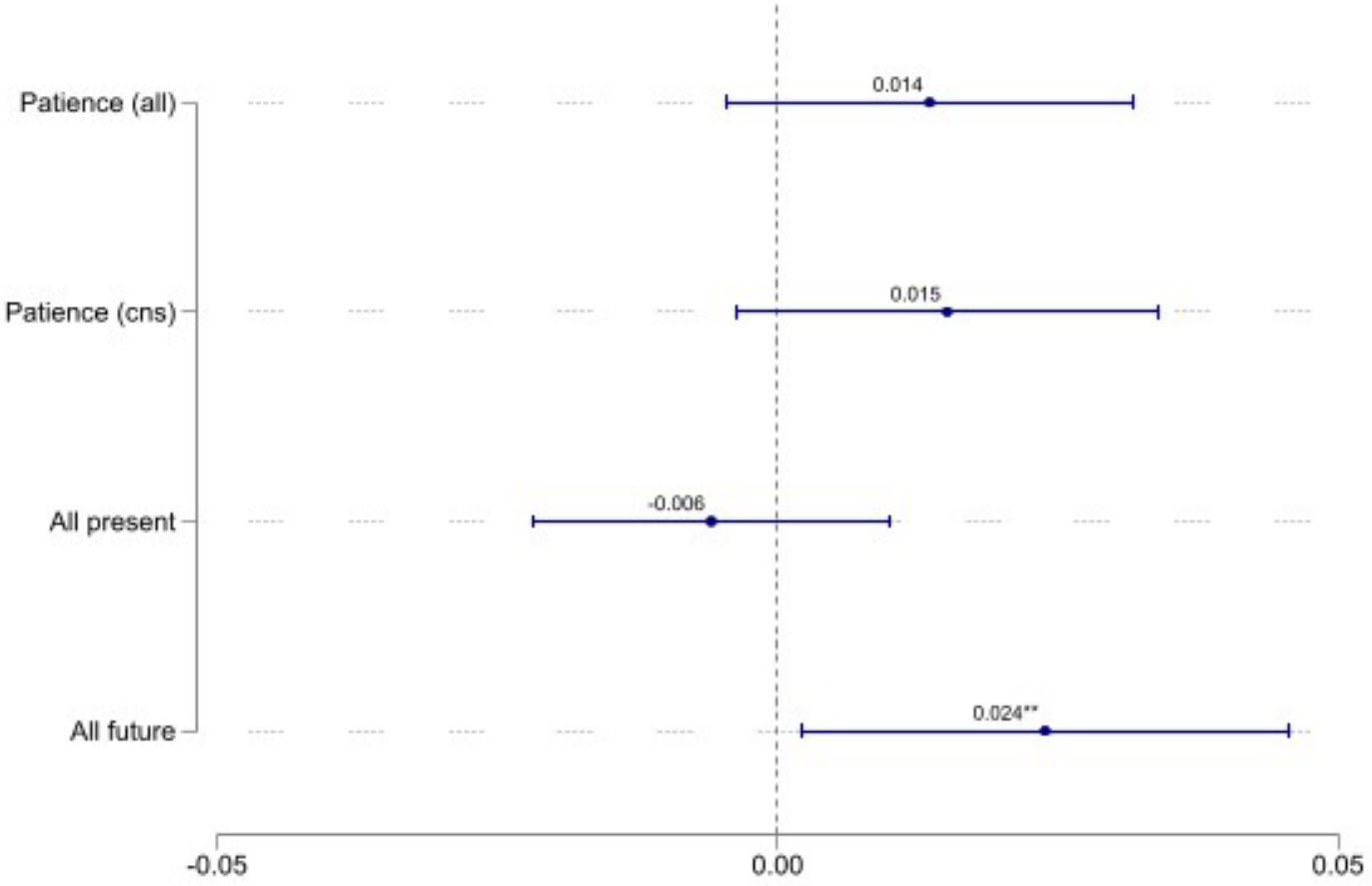
Flexibility

- When we restrict our evaluation to unique uses, eliminating repeated uses and only scoring those that introduce new words, we observe a replication of our previous findings.

- Individuals who consistently opt for future rewards exhibit a higher degree of flexibility in their responses.

Flexibility: number of different categories provided by each participant

Results: Patience vs. Elaboration

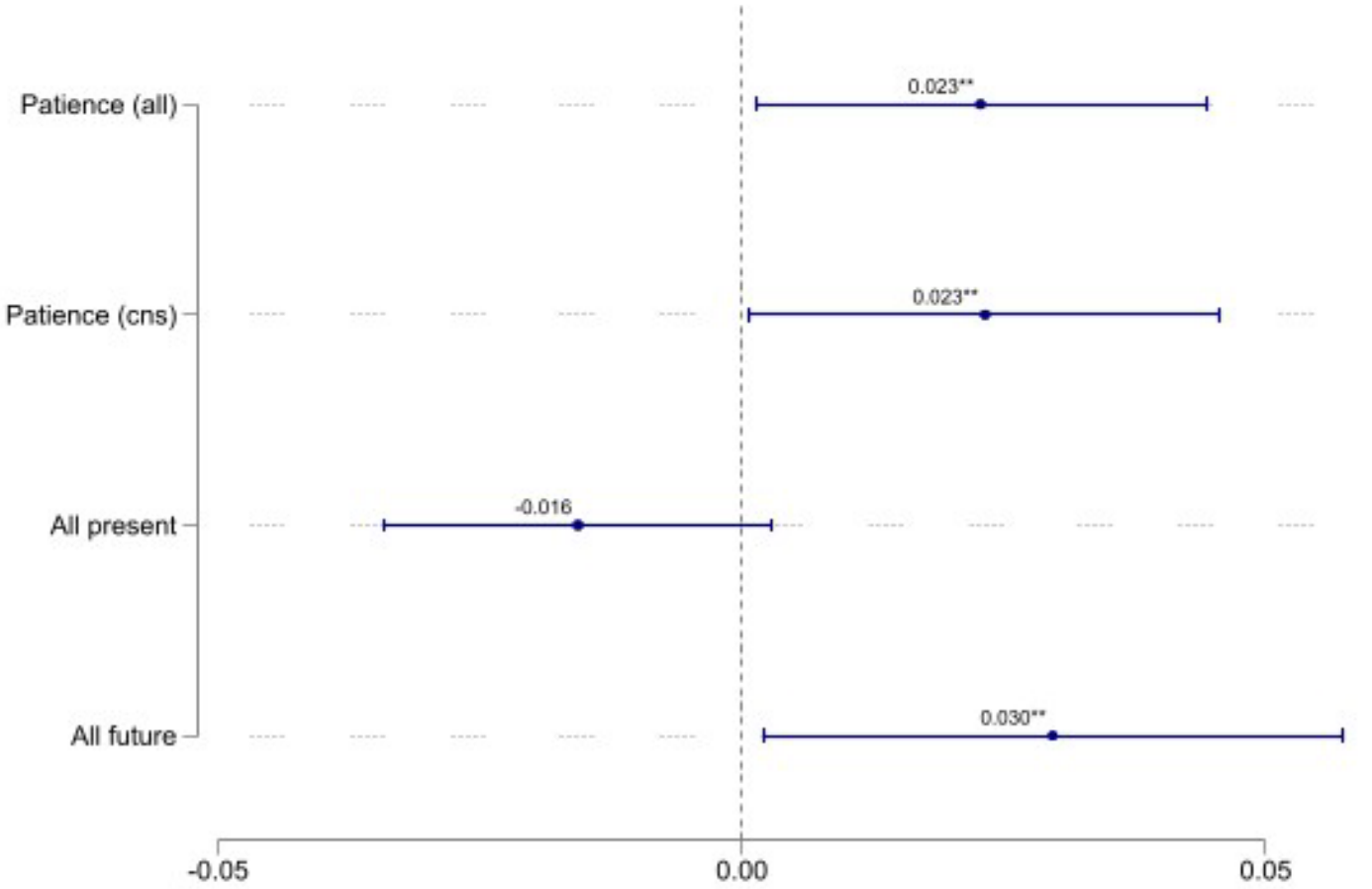


Note: OLS regression model controlled by grade, gender, #A marks, CRT, and mood.

- We found no evidence to suggest that this characteristic is related to an individual's level of patience.
- Patience does not necessarily affect the depth or detail of these uses.
- Individuals who consistently opt for future rewards tend to generate more elaborated ideas.

Elaboration: average amount of detail for the most detailed answer

Results: Patience vs. Originality



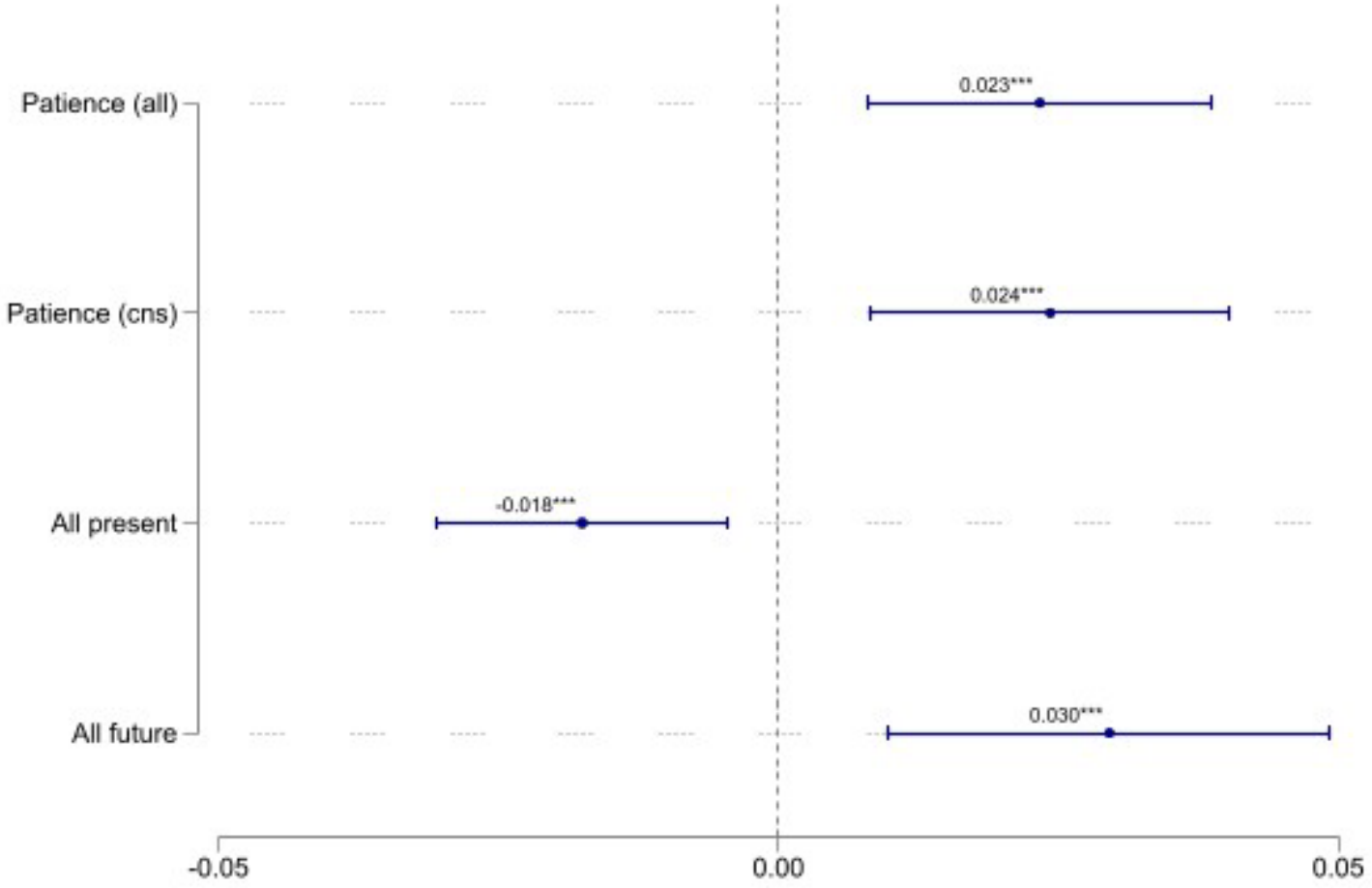
Note: OLS regression model controlled by grade, gender, #A marks, CRT, and mood.

Originality

- We study the number of unique words used compared to those suggested by the 1000 most original answers using artificial intelligence.
- Individuals who exhibit higher levels of patience tend to use a greater number of unique words.
- Patience may be a crucial trait for fostering creativity, allowing individuals to take the necessary time to explore and develop more original and diverse ideas.

Originality: number of unique and valid answers based on ChatGPT 100 most original answers

Results: Patience vs. Creativity



Note: OLS regression model controlled by grade, gender, #A marks, CRT, and mood.

- Our study suggests that patience significantly enhances creative outputs.
- Those who consistently showed a preference for future rewards, indicating higher levels of patience, achieved higher scores.

creativity: addition of the previous four

Results: robustness

	(1) Creativity Data cns	(2) Creativity Low Grade	(3) Creativity High Grade	(4) Creativity Female	(5) Creativity Male	(6) Creativity 0 *As*	(7) Creativity ≥ 1 *As*	(8) Creativity Low CRT	(9) Creativity High CRT	(10) Creativity Low mood	(11) Creativity High mood
Patience	0.0243***	0.0158	0.0342**	0.0259**	0.0206*	0.0235**	0.0250**	0.0187	0.0304***	0.0164	0.0290**
	(0.00824)	(0.0101)	(0.0138)	(0.0112)	(0.0121)	(0.0107)	(0.0125)	(0.0120)	(0.0110)	(0.0150)	(0.0113)
Grade	0.0158***			0.0126***	0.0191***	0.00928**	0.0187***	0.00879**	0.0219***	0.0206***	0.0156***
	(0.00294)			(0.00411)	(0.00422)	(0.00396)	(0.00447)	(0.00433)	(0.00388)	(0.00504)	(0.00422)
Female	-0.00448	0.00561	-0.0180*			-0.0120	0.00881	-0.00494	-0.00446	-0.00880	-0.00868
	(0.00597)	(0.00774)	(0.00945)			(0.00783)	(0.00932)	(0.00897)	(0.00806)	(0.0112)	(0.00817)
#As	0.0722***	0.0461***	0.107***	0.0774***	0.0675***			0.0611***	0.0811***	0.0684***	0.0677***
	(0.00885)	(0.0111)	(0.0167)	(0.0128)	(0.0139)			(0.0148)	(0.0117)	(0.0173)	(0.0121)
CRT	0.0356***	0.0207	0.0611***	0.0344**	0.0356**	0.0302*	0.0576***			0.0486**	0.00870
	(0.0117)	(0.0153)	(0.0188)	(0.0164)	(0.0178)	(0.0155)	(0.0189)			(0.0218)	(0.0162)
Mood	-0.0493***	-0.0304	-0.0796***	-0.0424*	-0.0599**	-0.0419*	-0.0432	-0.0425	-0.0557**		
	(0.0179)	(0.0232)	(0.0300)	(0.0239)	(0.0290)	(0.0230)	(0.0306)	(0.0277)	(0.0249)		
Constant	0.115***	0.236***	0.273***	0.123***	0.109**	0.179***	0.109**	0.174***	0.0922**	0.0467	0.0885**
	(0.0306)	(0.0238)	(0.0308)	(0.0404)	(0.0460)	(0.0404)	(0.0475)	(0.0437)	(0.0420)	(0.0451)	(0.0368)
N	3335	1903	1432	1634	1701	1775	1560	1385	1955	1169	1561
a R^2	0.0766	0.0426	0.108	0.0836	0.0672	0.0356	0.0908	0.0624	0.0764	0.0622	0.0849

Note: OLS regression model. School fixed control effects.

Results: robustness

	(1) Creativity Data cns	(2) Creativity Low Grade	(3) Creativity High Grade	(4) Creativity Female	(5) Creativity Male	(6) Creativity 0 *As*	(7) Creativity ≥ 1 *As*	(8) Creativity Low CRT	(9) Creativity High CRT	(10) Creativity Low mood	(11) Creativity High mood
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Female	-0.00448	0.00561	-0.0180*			-0.0120	0.00881	-0.00494	-0.00446	-0.00880	-0.00868
	(0.00597)	(0.00774)	(0.00945)			(0.00783)	(0.00932)	(0.00897)	(0.00806)	(0.0112)	(0.00817)
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Mood	-0.0493***	-0.0304	-0.0796***	-0.0424*	-0.0599**	-0.0419*	-0.0432	-0.0425	-0.0557**		
	(0.0179)	(0.0232)	(0.0300)	(0.0239)	(0.0290)	(0.0230)	(0.0306)	(0.0277)	(0.0249)		
Constant	0.115***	0.236***	0.273***	0.123***	0.109**	0.179***	0.109**	0.174***	0.0922**	0.0467	0.0885**
	(0.0306)	(0.0238)	(0.0308)	(0.0404)	(0.0460)	(0.0404)	(0.0475)	(0.0437)	(0.0420)	(0.0451)	(0.0368)
N	3335	1903	1432	1634	1701	1775	1560	1385	1955	1169	1561
a R^2	0.0766	0.0426	0.108	0.0836	0.0672	0.0356	0.0908	0.0624	0.0764	0.0622	0.0849

Note: OLS regression model. Fixed control effects.

Results: robustness

	(1) Creativity Data cns	(2) Creativity Low Grade	(3) Creativity High Grade	(4) Creativity Female	(5) Creativity Male	(6) Creativity 0 *As*	(7) Creativity ≥ 1 *As*	(8) Creativity Low CRT	(9) Creativity High CRT	(10) Creativity Low mood	(11) Creativity High mood
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	(0.00824)	(0.0101)	(0.0138)	(0.0112)	(0.0121)	(0.0107)	(0.0125)	(0.0120)	(0.0110)	(0.0150)	(0.0113)
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	(0.00885)	(0.0111)	(0.0167)	(0.0128)	(0.0139)			(0.0148)	(0.0117)	(0.0173)	(0.0121)
CRT	0.0356***	0.0207	0.0611***	0.0344**	0.0356**	0.0302*	0.0576***			0.0486**	0.00870
	(0.0117)	(0.0153)	(0.0188)	(0.0164)	(0.0178)	(0.0155)	(0.0189)			(0.0218)	(0.0162)
Mood	-0.0493***	-0.0304	-0.0796***	-0.0424*	-0.0599**	-0.0419*	-0.0432	-0.0425	-0.0557**		
	(0.0179)	(0.0232)	(0.0300)	(0.0239)	(0.0290)	(0.0230)	(0.0306)	(0.0277)	(0.0249)		
Constant	0.115***	0.236***	0.273***	0.123***	0.109**	0.179***	0.109**	0.174***	0.0922**	0.0467	0.0885**
	(0.0306)	(0.0238)	(0.0308)	(0.0404)	(0.0460)	(0.0404)	(0.0475)	(0.0437)	(0.0420)	(0.0451)	(0.0368)
N	3335	1903	1432	1634	1701	1775	1560	1385	1955	1169	1561
a R^2	0.0766	0.0426	0.108	0.0836	0.0672	0.0356	0.0908	0.0624	0.0764	0.0622	0.0849

Note: OLS regression model. Fixed control effects.

Results: robustness

	(1) Creativity Data cns	(2) Creativity Low Grade	(3) Creativity High Grade	(4) Creativity Female	(5) Creativity Male	(6) Creativity 0 *As*	(7) Creativity ≥ 1 *As*	(8) Creativity Low CRT	(9) Creativity High CRT	(10) Creativity Low mood	(11) Creativity High mood
Patience	0.0243***	0.0158	0.0342**	0.0259**	0.0206*	0.0235**	0.0250**	0.0187	0.0304***	0.0164	0.0290**
	(0.00824)	(0.0101)	(0.0138)	(0.0112)	(0.0121)	(0.0107)	(0.0125)	(0.0120)	(0.0110)	(0.0150)	(0.0113)
Grade	0.0158***			0.0126***	0.0191***	0.00928**	0.0187***	0.00879**	0.0219***	0.0206***	0.0156***
	(0.00294)			(0.00411)	(0.00422)	(0.00396)	(0.00447)	(0.00433)	(0.00388)	(0.00504)	(0.00422)
Female	-0.00448	0.00561	-0.0180*			-0.0120	0.00881	-0.00494	-0.00446	-0.00880	-0.00868
	(0.00597)	(0.00774)	(0.00945)			(0.00783)	(0.00932)	(0.00897)	(0.00806)	(0.0112)	(0.00817)
#As	0.0722***	0.0461***	0.107***	0.0774***	0.0675***			0.0611***	0.0811***	0.0684***	0.0677***
	(0.00885)	(0.0111)	(0.0167)	(0.0128)	(0.0139)			(0.0148)	(0.0117)	(0.0173)	(0.0121)
CRT	0.0356***	0.0207	0.0611***	0.0344**	0.0356**	0.0302*	0.0576***			0.0486**	0.00870
	(0.0117)	(0.0153)	(0.0188)	(0.0164)	(0.0178)	(0.0155)	(0.0189)			(0.0218)	(0.0162)
Mood	-0.0493***	-0.0304	-0.0796***	-0.0424*	-0.0599**	-0.0419*	-0.0432	-0.0425	-0.0557**		
	(0.0179)	(0.0232)	(0.0300)	(0.0239)	(0.0290)	(0.0230)	(0.0306)	(0.0277)	(0.0249)		
Constant	0.115***	0.236***	0.273***	0.123***	0.109**	0.179***	0.109**	0.174***	0.0922**	0.0467	0.0885**
	(0.0306)	(0.0238)	(0.0308)	(0.0404)	(0.0460)	(0.0404)	(0.0475)	(0.0437)	(0.0420)	(0.0451)	(0.0368)
N	3335	1903	1432	1634	1701	1775	1560	1385	1955	1169	1561
a R^2	0.0766	0.0426	0.108	0.0836	0.0672	0.0356	0.0908	0.0624	0.0764	0.0622	0.0849

Note: OLS regression model. Fixed control effects.

Results: robustness

	(1) Creativity Data cns	(2) Creativity Low Grade	(3) Creativity High Grade	(4) Creativity Female	(5) Creativity Male	(6) Creativity 0 *As*	(7) Creativity ≥ 1 *As*	(8) Creativity Low CRT	(9) Creativity High CRT	(10) Creativity Low mood	(11) Creativity High mood
Patience	0.0243***	0.0158	0.0342**	0.0259**	0.0206*	0.0235**	0.0250**	0.0187	0.0304***	0.0164	0.0290**
	(0.00824)	(0.0101)	(0.0138)	(0.0112)	(0.0121)	(0.0107)	(0.0125)	(0.0120)	(0.0110)	(0.0150)	(0.0113)
Grade	0.0158***			0.0126***	0.0191***	0.00928**	0.0187***	0.00879**	0.0219***	0.0206***	0.0156***
	(0.00294)			(0.00411)	(0.00422)	(0.00396)	(0.00447)	(0.00433)	(0.00388)	(0.00504)	(0.00422)
Female	-0.00448	0.00561	-0.0180*			-0.0120	0.00881	-0.00494	-0.00446	-0.00880	-0.00868
	(0.00597)	(0.00774)	(0.00945)			(0.00783)	(0.00932)	(0.00897)	(0.00806)	(0.0112)	(0.00817)
#As	0.0722***	0.0461***	0.107***	0.0774***	0.0675***			0.0611***	0.0811***	0.0684***	0.0677***
	(0.00885)	(0.0111)	(0.0167)	(0.0128)	(0.0139)			(0.0148)	(0.0117)	(0.0173)	(0.0121)
CRT	0.0356***	0.0207	0.0611***	0.0344**	0.0356**	0.0302*	0.0576***			0.0486**	0.00870
	(0.0117)	(0.0153)	(0.0188)	(0.0164)	(0.0178)	(0.0155)	(0.0189)			(0.0218)	(0.0162)
Mood	-0.0493***	-0.0304	-0.0796***	-0.0424*	-0.0599**	-0.0419*	-0.0432	-0.0425	-0.0557**		
	(0.0179)	(0.0232)	(0.0300)	(0.0239)	(0.0290)	(0.0230)	(0.0306)	(0.0277)	(0.0249)		
Constant	0.115***	0.236***	0.273***	0.123***	0.109**	0.179***	0.109**	0.174***	0.0922**	0.0467	0.0885**
	(0.0306)	(0.0238)	(0.0308)	(0.0404)	(0.0460)	(0.0404)	(0.0475)	(0.0437)	(0.0420)	(0.0451)	(0.0368)
N	3335	1903	1432	1634	1701	1775	1560	1385	1955	1169	1561
a R^2	0.0766	0.0426	0.108	0.0836	0.0672	0.0356	0.0908	0.0624	0.0764	0.0622	0.0849

Note: OLS regression model. Fixed control effects.

Quick Takeaways

- Measure of divergent thinking with a massive dataset
- Use of natural language processing analysis (no judges)
- Patience vs. divergent thinking
  - Participants opting for present options underperform on the AUT test, fluency and flexibility
  - Participants opting for future options perform better on the AUT test and positively and significantly score at each component
- Secondary results:
  - CRT, grades, #A marks positively relate with a better performance on the AUT test (gender not significant)
  - Mood is negatively related to the AUT test (further research)
- Limitations

Thanks!