



CEGA

Center for Effective Global Action



XLAB

UC BERKELEY

The Effect of Monetary Incentives on Cognitive Effort, Emotions and Test-Solving Performance

**Juan F.
Castro**^{/1}

**Gustavo
Yamada**^{/1}

**Hans
Contreras**^{/2}

**Freddy
Linares**^{/3}

**Herwig
Watson**^{/3}

^{/1} Universidad del Pacifico

^{/2} Universidad Nacional Mayor de San Marcos

^{/3} Neurometrics

May 2019





Motivation

- The relation among **monetary incentives**, **cognitive effort** and **task performance** has been extensively studied, with **mixed results** (e.g. Li, et al., 2018; Heitz, et al., 2008; Pochon, et al., 2002; O'Neil, et al., 2001).
- The relation among monetary incentives, **emotions** and task performance is **less explored** (e.g. Meloy, et al., 2006; Konheim-Kalstein and van den Broek, 2008). The available evidence is also **mixed**.



Motivation

- Scant experimental evidence on how the concurrent effect of incentives on **cognitive effort and emotions** affect task performance (e.g. Meloy et al. (2006)).
- Education literature: it is well documented that high-stake tests correlate with anxiety which, in turn, correlates with performance. But no experimental evidence.
- We estimate the effect of providing a monetary prize on the cognitive effort, emotions and efficacy exhibited by a group of university students when solving four mathematics and logical reasoning questions
- The incentive was conditional on answering all four questions correctly, and was randomly assigned within a group of 126 participants.



Motivation

- Three contributions:
 - Provide causal evidence about the role of emotions in the mechanism linking incentives, cognitive effort and performance.
 - Explain why is that monetary incentives will not necessarily lead to increased performance despite triggering a greater deployment of cognitive resources.
 - Identify the particular emotions involved in the mechanism linking incentives and performance.
 - Offer experimental evidence on the effect of shifting the consequences of test results on students' emotional status and test performance.
 - Advance correlational evidence produced so far.



Spoiler alert!

- The incentive caused an increase in cognitive effort (increased visual interaction with the information required to solve the test).
- At best, the incentive had no effect on participants' efficacy in solving the test. Some evidence it produced a negative effect.
- The group that received the incentive had a different emotional response than the group that did not receive the incentive: the incentive increased the intensity of facial expressions related to anger, surprise and fear.



The experiment

- The experiment was performed during the third quarter of 2017 at Universidad del Pacifico.
- A random sample of 126 Economics students was selected among those enrolled in Introduction to Economics (first year) and Economic Research (senior year).
- The test involved solving 4 multiple-choice mathematics and logical reasoning questions in 1 minute 30 seconds per question.



The experiment

- Before starting the test, participants were randomly assigned to one of two groups: (i) with incentive (can receive S/20 if all questions are answered correctly); (ii) without incentive (receives nothing).
- 70 participants were assigned to treatment (with incentive) and 56 participants were assigned to control (without incentive).



The experiment

- While participants' solved the test, we gauged:
 - **Cognitive effort**, based on:
 - The degree of visual interaction with the information required to solve each question (area of interest - AOI)
 - Fixation count: number of fixation points
 - Time spent: total time as fixation points
 - Revisits: number of times a participant returns to an AOI
 - Pupillary dilation
 - **Emotions**, based on facial expressions
 - Identify micro-expressions throughout the test
 - Proportion of time the participant expressed: joy, anger, sadness, surprise, fear, contempt, disgust and frustration.



The experiment





The experiment

El programa "Futuro Incierto" otorga becas para que jóvenes con secundaria completa estudien en la universidad. El último reporte indica que el programa discrimina en contra de los jóvenes de lengua materna Íbero y Huno porque sólo el 20% de los beneficiarios tiene alguna de estas lenguas maternas.

Distribución de beneficiarios del programa "Futuro Incierto" según lengua materna

Lengua materna	Porcentaje
Castellano	70%
Íbero	10%
Huno	10%
Otras	10%

Distribución de jóvenes con secundaria completa según lengua materna

Lengua materna	Porcentaje
Castellano	80%
Íbero	5%
Huno	5%
Otras	10%

¿Cómo calificas esta afirmación?

Verdadera Falsa Incierta. Faltan datos.

Next ➔



Results: balanced characteristics

	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)
	GPA	Number of semesters	Age	Sex (Male=1)	Tuition scale (First=1)	Tuition scale (Second=1)	Tuition scale (Third=1)	Tuition scale (Fourth=1)
Incentive	-0.0441 (0.248)	-0.764 (0.875)	-0.246 (0.471)	0.0643 (0.0894)	0.0464 (0.0818)	0.0107 (0.0672)	-0.0571 (0.0791)	0.0179 (0.0808)
Constant	13.61*** (0.192)	7.893*** (0.643)	21.16*** (0.342)	0.536*** (0.0672)	0.268*** (0.0597)	0.161*** (0.0495)	0.286*** (0.0609)	0.268*** (0.0597)
Obs.	126	126	126	126	126	126	126	126

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1



Results: visual interaction

	Fixation Count (No.)			Time Spent (ms.)			Revisits (No.)		
	Incentive	No Incentive	Difference	Incentive	No Incentive	Difference	Incentive	No Incentive	Difference
AOI's Q1	56.04	42.25	13.79*** (4.564)	10,551.68	7,667.68	2,884*** (907.4)	22.94	19.53	3.409** (1.623)
AOI's Q2	106.99	71.72	35.27*** (8.276)	25,046.00	14,224.00	10,822*** (2,141)	40.14	30.56	9.589*** (3.048)
AOI's Q3	84.94	78.91	6.031 (7.648)	16,836.61	15,442.08	1,395 (1,709)	32.68	33.37	-0.688 (2.557)
AOI's Q4	111.10	67.58	43.53*** (9.868)	25,486.65	13,364.76	12,122*** (2,366)	61.20	41.36	19.84*** (5.980)

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses



Results: pupillary dilation (in mm)

	Incentive	No Incentive	Difference
Question 1	0.6272	0.593	0.0342** (0.0169)
Question 2	0.6420	0.6220	0.0200 (0.0210)
Question 3	0.6141	0.6200	-0.00595 (0.0195)
Question 4	0.6707	0.6350	0.0357* (0.0211)

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses



Results: efficacy - Q1 & Q2

	Question 1		
	Incentive	No Incentive	Difference
Correct answer (%)	0.97	0.95	0.025 (0.0364)
Incorrect answer (%)	0.03	0.05	-0.025 (0.0364)
No answer (%)	NA	NA	NA
Total	1.00	1.00	

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

	Question 2		
	Incentive	No Incentive	Difference
Correct answer (%)	0.27	0.38	-0.104 (0.0844)
Incorrect answer (%)	0.57	0.61	-0.0357 (0.0888)
No answer (%)	0.16	0.02	0.139*** (0.0473)
Total	1.00	1.00	

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses



Results: efficacy - Q3 & Q4

	Question 3		
	Incentive	No Incentive	Difference
Correct answer (%)	0.44	0.52	-0.0750 (0.0901)
Incorrect answer (%)	0.50	0.46	0.0357 (0.0902)
No answer (%)	0.06	0.02	0.0393 (0.0331)
Total	1.00	1.00	

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

	Question 4		
	Incentive	No Incentive	Difference
Correct answer (%)	0.50	0.61	-0.107 (0.0892)
Incorrect answer (%)	0.40	0.32	0.0786 (0.0863)
No answer (%)	0.10	0.07	0.0286 (0.0500)
Total	1.00	1.00	

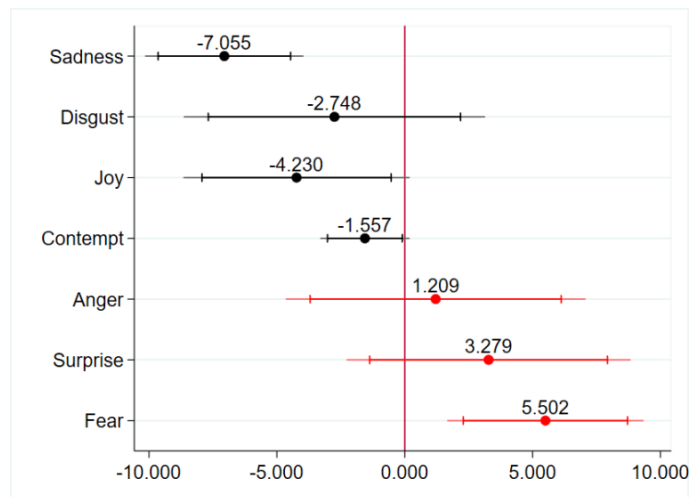
*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses



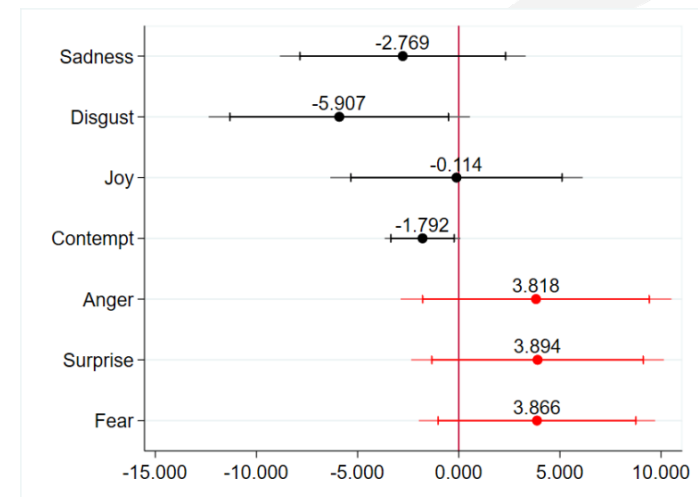
Results: difference in intensity of emotion (% of time) - Q1 & Q2

Q1



90% and 95% confidence intervals shown.

Q2

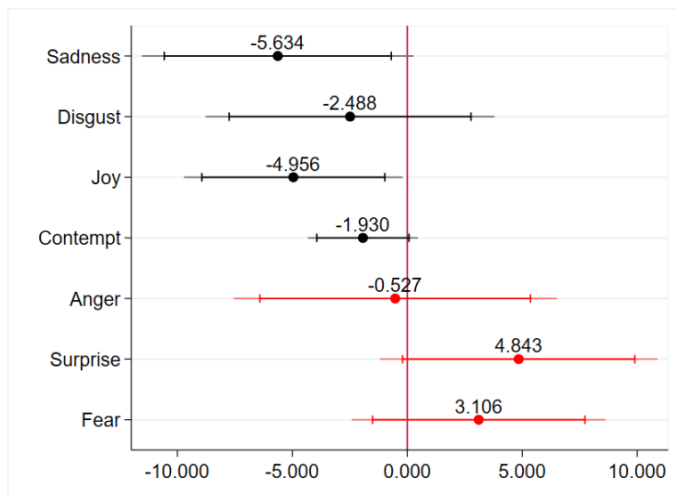


90% and 95% confidence intervals shown.



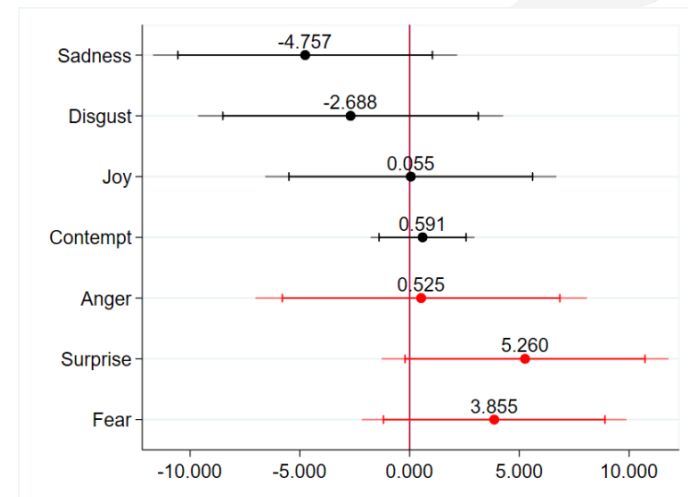
Results: difference in intensity of emotion (% of time) - Q3 & Q4

Q3



90% and 95% confidence intervals shown.

Q4



90% and 95% confidence intervals shown.



Concluding remarks

- The incentive caused an increase in cognitive effort:
 - Increased visual interaction: more fixation points, time spent and revisits in AOIs in 3 out of 4 questions.
 - Larger pupillary dilation in 2 out of 4 questions.
- Additional effort did not translate into increased efficacy.
 - At best, the incentive had no effect on participants' efficacy in solving the test. Some evidence it produced a negative effect.



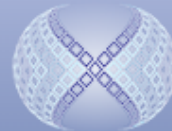
Concluding remarks

- Absence of increased efficacy despite greater input of cognitive effort appears related to the participants' emotional response to the incentive.
 - The group that received the incentive had a different emotional response: the incentive increased the intensity of facial expressions related to anger, surprise and fear.



CEGA

Center for Effective Global Action



XLAB

UC BERKELEY

The Effect of Monetary Incentives on Cognitive Effort, Emotions and Test-Solving Performance

**Juan F.
Castro^{/1}**

**Gustavo
Yamada^{/1}**

**Hans
Contreras^{/2}**

**Freddy
Linares^{/3}**

**Herwig
Watson^{/3}**

^{/1} Universidad del Pacifico

^{/2} Universidad Nacional Mayor de San Marcos

^{/3} Neurometrics

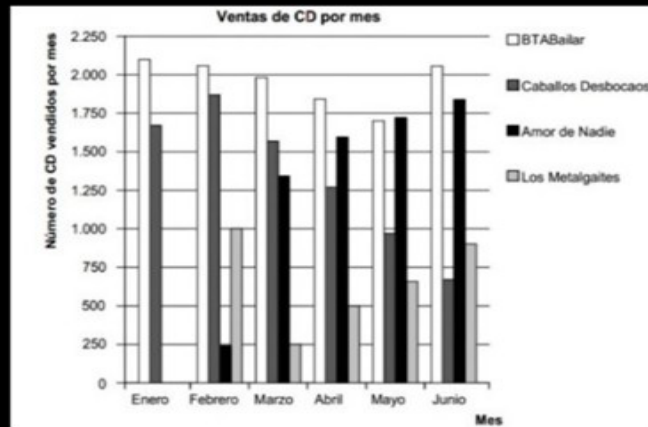
May 2019





Question 1

Los nuevos CD de los grupos BTABailar y Caballos Desbocaos salieron a la venta en enero. En febrero los siguieron los CD de los grupos Amor de Nadie y los Metalgaites. El siguiente gráfico muestra las ventas de CD de estos grupos desde enero hasta junio.



¿Cuántos CD vendió el grupo Los Metalgaites en abril?

250



500



1000



1270



Next ➔



Question 2

Sara se da cuenta de que Ropa Cálida ha cometido un error en la factura. Sara pidió y recibió dos camisetas, no tres. La tarifa de envío es un gasto fijo.

				
Ropa Cálida			Factura	
			Factura número: 2034	
Sara Jiménez			Fecha de emisión: 28 febrero	
Limonero 29			Ropa Cálida	
La Navata 56092			Avda. Magnolius 79	
Zedland			Villarriba 98347	
			Zedland	
Código de producto	Descripción	Cantidad	Precio unitario	Total (antes de impuestos)
T011	Camiseta	3	20	60 zeds
X023	Vaqueros	1	60	60 zeds
S002	Bufanda	1	10	10 zeds
Total antes de impuestos:				130 zeds
Impuestos 10%:				13 zeds
Gastos de envío:				10 zeds
Total después de impuestos:				153 zeds
Cantidad abonada:				0 zeds
Precio total:				153 zeds
Fecha de pago:				31 marzo

¿Cuál será el total de la nueva factura?

133

121

131

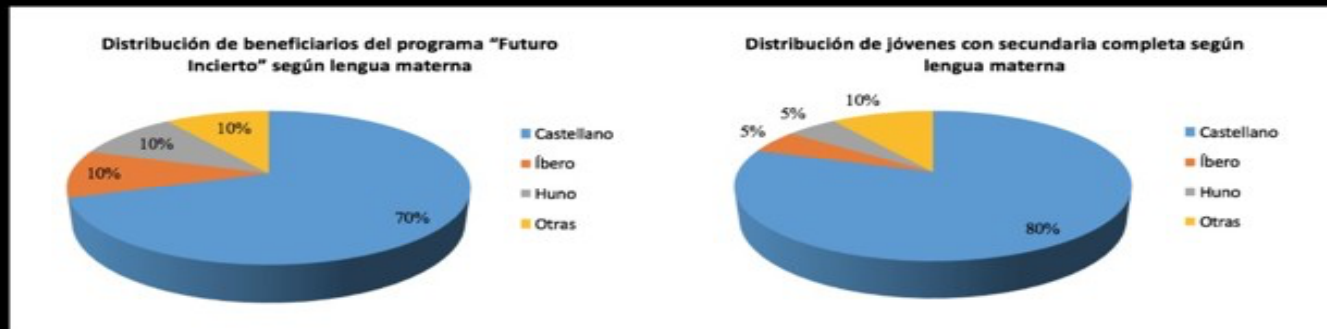
Ninguno de los anteriores.

Next ➔



Question 3

El programa "Futuro Incierto" otorga becas para que jóvenes con secundaria completa estudien en la universidad. El último reporte indica que el programa discrimina en contra de los jóvenes de lengua materna Íbero y Huno porque sólo el 20% de los beneficiarios tiene alguna de estas lenguas maternas.



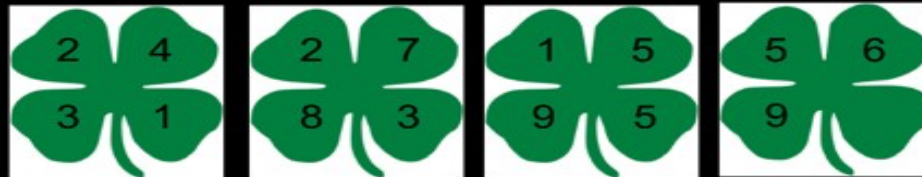
¿Cómo calificas esta afirmación?

Verdadera ☐ Falsa ☐ Incierta. Faltan datos. ☐

Next ➔



Question 4



¿Qué número falta?

7



6



5



8



Next →

