Studying the Effect of Human Cognition on Text and Image Recognition CAPTCHA Mechanisms

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CAPTCHA

- Completely Automated Public Turing test to tell Computers and Humans Apart

Fig. 1. Example of a text-recognition CAPTCHA

Method of Study

- Web-based environment was developed
- The text-recognition mechanism was developed using available open-source software that produced distorted images of random characters1 .
- Furthermore, we have utilized Microsoft ASIRRA (Animal Species Image Recognition for Restricting Access)

Psychometric dimension

- speed of processing
- controlled attention
- working memory capacity

Kinds of captcha

- Text- recognition
- Image recognition

Fig. 2. Text-recognition CAPTCHA used in the study

Fig. 3. Image-recognition CAPTCHA used in the study

Users' Speed of Processing Elicitation Test

- "red", "green" or "blue"
- Recognize the words

Users' Controlled Attention Elicitation Test

- s "red", "green" or "blue" either written in red, green or blue ink color
- The participants were instructed to press the R key of the keyboard for the word written in red ink color, the G key for the word written in green ink color and the B key for the word written in blue ink color.

Users' Working Memory Capacity Elicitation Test

- t illustrated a geometric figure on the screen and the participant was required to memorize the figure.
- 5 similar figures were illustrated on the screen, numbered from 1 to 5.
- (seven levels of three trials each

Participants

- n September and November 2012 with a total of 107 participants
- 52 male,
- 55 female,
- age 17-26,
- mean 22

Analysis of Results

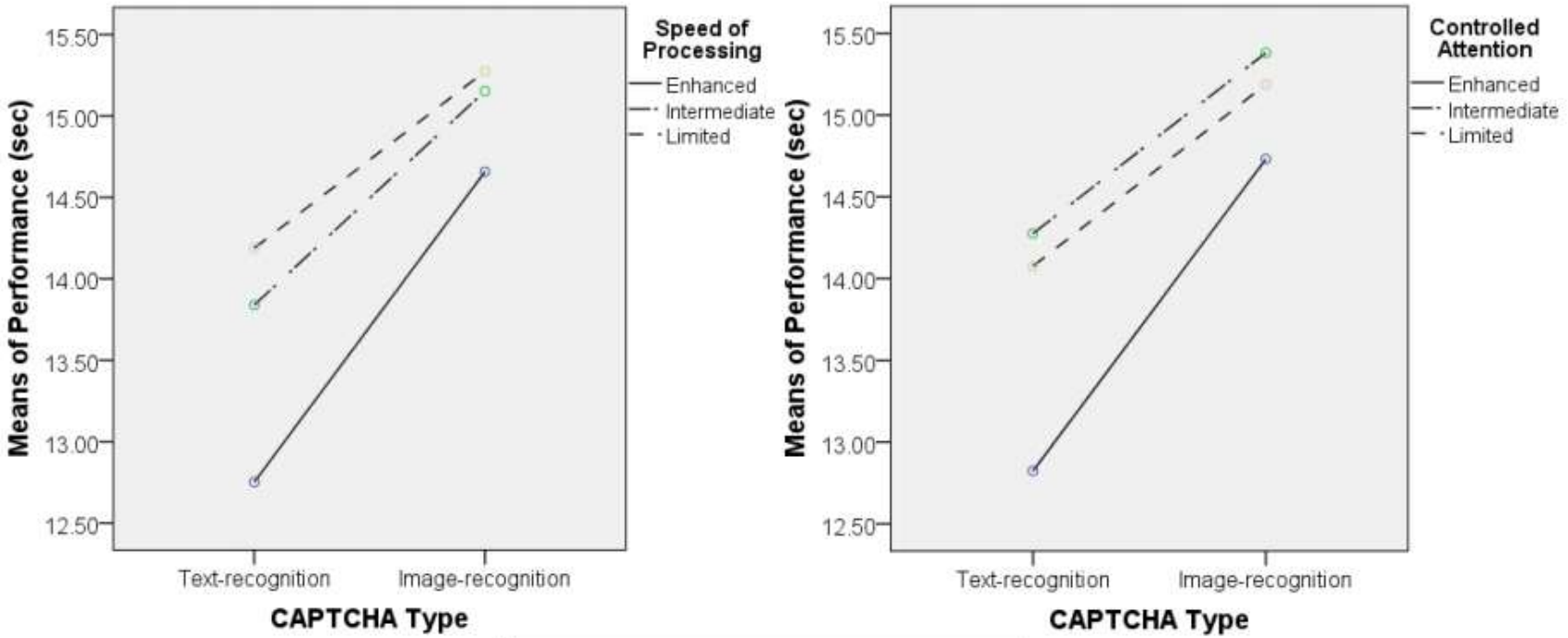
- Efficiency : time spent taking on the challenge
- Effectiveness : number of trails

Groups of participants

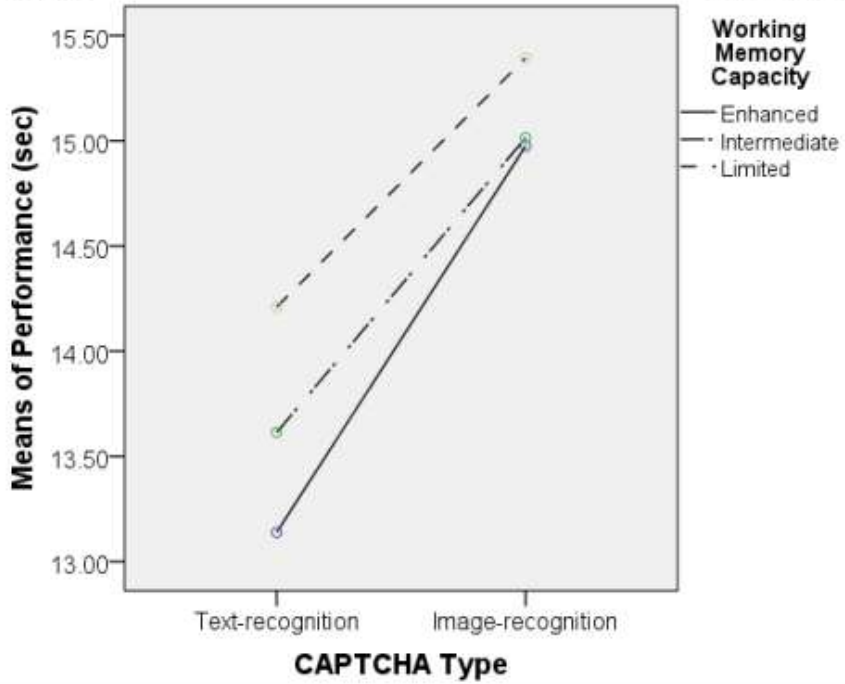
- Limited
- Intermediate
- enhanced

CAPTCHA Solving Efficiency

- three by two way factorial analyses of variance (ANOVA)
- a main effect of the speed of processing and controlled attention dimensions on the time needed to solve a CAPTCHA challenge
- No main effect of working memory capacity
- A further comparison between CAPTCHA types (text- vs. image-recognition) for each cognitive processing dimension revealed that users with enhanced cognitive processing abilities performed significantly faster in text-recognition CAPTCHAs than image-recognition
- users with intermediate and limited speed of processing and controlled attention, no significant differences were observed between solving efficiency in text- and imagerecognition CAPTCHAs.


Means of Performance (sec)
15.50
15.00
14.50
14.00
13.50
13.00
12.50
Text-recognition
Image-recognition
CAPTCHA Type
Speed of Processing
Enhanced
Intermediate
Limited

Means of Performance (sec)
15.50
15.00
14.50
14.00
13.50
13.00
12.50
Text-recognition
Image-recognition
CAPTCHA Type
Controlled Attention
Enhanced
Intermediate
Limited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15.50
15.00
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14.00
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13.00
Text-recognition
Image-recognition
CAPTCHA Type
Working Memory Capacity
Enhanced
Intermediate
Limited

CAPTCHA Solving Effectiveness

- In the case of text-recognition CAPTCHAs, on average, users with limited CA and limited WMC needed more attempts to solve the CAPTCHA challenges than the other two groups (intermediate and enhanced groups).
- difference between controlled attention users was statistically significant
- as well as in the case of working memory capacity users
- In the case of the speed of processing user group, no significant differences have been observed between number of attempts of each user group, as the Kruskal-Wallis test revealed

Table 1. Means of Attempts per User Group for Text-recognition CAPTCHA

	Speed of Processing		Controlled Attention		Working Memory Capacity	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Enhanced	2	1.37	1.71	1.07	1.82	1.06
Intermediate	1.71	1.1	1.38	0.81	1.51	0.98
Limited	1.6	1.05	2.1	1.42	2.21	1.66

Table 2. Means of Attempts per User Group for Image-recognition CAPTCHA

	Speed of Processing		Controlled Attention		Working Memory Capacity	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Enhanced	1.5	0.59	1.17	0.57	1.26	0.45
Intermediate	1.13	0.35	1.21	0.41	1.35	0.56
Limited	1.17	0.38	1.46	0.5	1.3	0.48

conclusion

- Control the physical environment more
- Vary the ages more (student ages 17 to 26)
- Make adjustable captchas