Red, White, & Blue:
Does Background Color Affect Solving Anagrams?

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Introduction

Mehta and Zhu (2009) reported several studies that demonstrated effects of red and blue on a series of cognitive tasks. Red was hypothesized to induce a state of avoidance motivation which was predicted to make people more vigilant and risk-averse in a cognitive task. Blue was hypothesized to induce a state of approach motivation which was predicted to increase use of innovative, risky strategies in problem-solving tasks.

Study 1a of Mehta and Zhu (2009) tested the effects of red on anagram solutions. Participants solved anagrams on red, white, or blue backgrounds. Words were chosen to be consistent with either an avoidance, neutral, or approach motivational state. Mehta and Zhu reported a significant color by word-type interaction. Anagrams were solved more quickly when the word and screen color invoked matching motivational states.

Steele et al. (2010) replicated the procedure of the Mehta and Zhu (2009) study but did not obtain their results. Anagrams were not solved more quickly when the word and screen color invoked matching motivational states.

A methodological deficiency was discovered in the Mehta and Zhu (2009) procedure. Word length was not equated across the three groups and mean word length was confounded with the hypothesized motivational status of the words.

The purpose of this study was to replicate the procedure of Mehta and Zhu using motivationally appropriate words that were counterbalanced for length to determine whether a color effect would be obtained.

References

Gilhooly, K. J., & Hay, D. (1977). Imagery, concreteness, age-of-acquisition, familiarity, and meaningfulness values for 205 five-letter words having single-solution anagrams. *Behavior Research Methods & Instrumentation, 9,* 12-17.

Mehta, R., & Zhu, R. J. (2009). Blue or red? Exploring the effect of color on cognitive performances. *Science, 323,* 1226-1229.

Steele, K. M., Putnam, E., Ayers, A., Tracy, S., & Antolic, E. (2010, November). *Does color influence anagram-solution speed?* Poster presented at the 51st annual meeting of The Psychonomic Society, St. Louis, MO.

Method

Participants
232 ASU undergraduate students participated in the study for course credit.

Apparatus
Sessions were computer-based and programmed using E-Prime software.

Procedure
Participants were asked to solve 15 anagrams (5 = Avoidance, 5 = Neutral, 5 = Approach). The anagrams were from Gilhooly and Hay (1977) and were pretested to ensure they were consistent with the Mehta and Zhu motivation definitions. The words are shown in Table 1.

Each person was exposed to the anagrams on one color background. The screen color, Red, was programmed to have the values of H[ue] S[aturation] L[ightness] = 0, 240, 120 and the screen color, Blue, was programmed to be HSL = 160, 240, 120, consistent with the Mehta and Zhu specifications.

Participants initiated each anagram problem. Anagrams were presented in randomized order. Word solution, solution time, and accuracy of the solution were recorded on each trial.

Participants were then asked three questions about their speed-accuracy strategy on a 7-point bipolar (Agree/Disagree) scale.

Finally, participants were tested for color blindness on a short version of the Ishihara color deficiency test. Participant's data were excluded if the color deficiency test was not passed.

Only correct solutions were included in the analysis.

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Steele et al. 2010 Reprint

Steele et al. 2011 Reprint

Results

No Color by Word-Type Interaction

Table 2 shows mean solution times in seconds for anagrams as a function of screen color and word type.

A Repeated Measures ANOVA was performed with Color as the Between-Subject factor and Word-Type as the Within-Subject factor. There was no Color effect, $F(2, 226) = 1.37$, $p = .26$, a clear effect of Word-Type, $F(2, 452) = 20.9$, $p < .001$, and no significant Color by Word-Type interaction, $F(4, 452) = 2.12$, $p = .08$.

The possibility that the interaction effect was hidden by the occasional extreme score was tested by performing a Repeated Measures ANOVA on the *log* transform of the solution times. The same pattern of results was obtained. There was no Color effect, $F(2, 226) = 1.37$, $p = .26$, a clear effect of Word-Type, $F(2, 452) = 27.8$, $p < .001$, and no significant Color by Word-Type interaction, $F(4, 452) = 0.84$, $p = .50$.

The lack of a significant Color by Word-Type interaction is not explained by the presence of extreme scores.

Semantic effect on Solution Times

Word-Type had clear effects on the speed and accuracy of solution times.

Approach words ($M = 14.0$ s , SD = 13.0) were solved more quickly than Neutral words ($M = 19.0$ *s*, $SD = 18.3$), $t(228) = 4.1$, $p < .001$.

Approach words ($M = 80.3\%$, $SD = 21.5$) were solved more accurately than Neutral words ($M = 75.5\%$, $SD = 21.8$, $t(232) = 3.3$, $p = .001$.

Avoidance words ($M = 22.7$ *s*, $SD = 21.8$) were solved more slowly than Neutral words, $t(228) = 2.6$, $p = .01$.

Avoidance words ($M = 72.3\%$, $SD = 21.5$) were solved less accurately than Neutral words, $t(232) = 2.3$, $p = .02$.

Table 1

Anagrams from Gilhooly & Hay (1977)

Approach	Neutral	Avoidance
lover	album	agony
youth	month	panic
child	batch	virus
world	thumb	guilt
prize	index	wreck

Table 2

Anagram Correct Solution Time (*sec*)

		Approach	Neutral	Avoidance
Red	*M*	13.8	19.0	19.7
	SD	(10.8)	(21.4)	(17.8)
White	*M*	11.9	19.6	21.4
	SD	(7.1)	(17.7)	(18.3)
Blue	*M*	16.1	18.5	27.1
	SD	(18.2)	(15.3)	(27.5)

Conclusions

The procedure of Study 1a of Mehta and Zhu (2009) was replicated using words that were pretested to be consistent with their hypothesized motivations and were all of equal length.

The Mehta and Zhu results were not replicated. Anagrams were not solved more quickly when the word and screen color invoked matching motivational states.

An additional finding was that solution speeds and accuracy for anagrams were dependent on the semantic attractiveness of the words.