

Looking outside the box:

Blinks and eye movements associated with insight versus analytic problem solving

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Solving problems with insight is associated with creative thinking and cognitive flexibility, also described as “Thinking outside the box”.

Features

- Solution appears as a sudden and obvious: “Aha!”
- Distinct patterns of neural activity in occipital cortex for solving verbal problems via insight compared to analysis:
- Preparation Period
 - Increase of occipital activity predicted problems solved by analysis (Kounios et al., 2006)
- Solution Period (immediately prior to solution)
 - Increase of the alpha-band frequency over visual cortex about 1.5 seconds before solution via insight (Jung- Beeman et al., 2004)
 - Right anterior superior temporal gyrus (R aSTG - Jung-Beeman et al. 2004)
 - Anterior & posterior cingulate - cognitive control, monitoring / switching

These result were explained as possibly the brain’s covert alternative to closing the eyes or looking away (Kounios & Beeman, 2009), suggesting that **attention to – or from – visual input strongly influences analytic and insight solving**. Here, we performed a deeper analysis of the phenomena through eye tracking.

Method & Procedure

Participants

- 21 NU students (10 M, 11 F, mean age 18.52±0.67 years)
- Normal, or corrected to normal vision
- Skilled readers, Native English Speakers
- Right handed

Stimuli

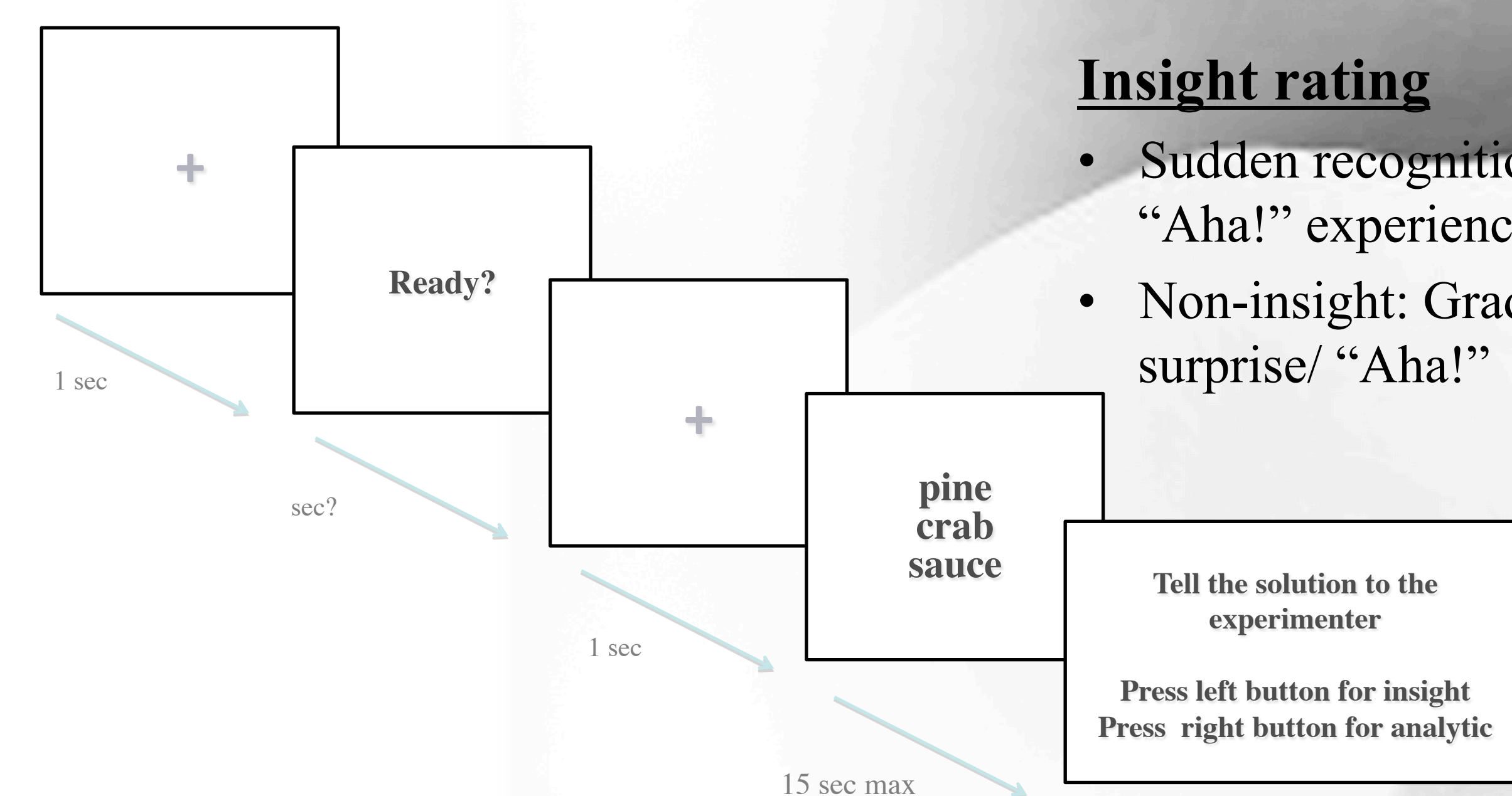
- 120 Compound Remote Associate problems (CRA);
- Problem words were 28-pt Times New Roman, separated by 1.36° empty space; each character occupying 0.34° of visual angle at a distance of 84 cm from the screen.

CRA Task

Test problems contained three words, each of which could form a compound word or phrase with the solution word (e.g., crab/ pine/ sauce —APPLE).

The solution to each problem could be obtained either by insight or via analysis (Bowden & Jung-Beeman, 2003b; Jung-Beeman et al., 2004; Kounios et al., 2006; Subramaniam et al., 2009).

Instructions → Practice → Calibration → 4 blocks



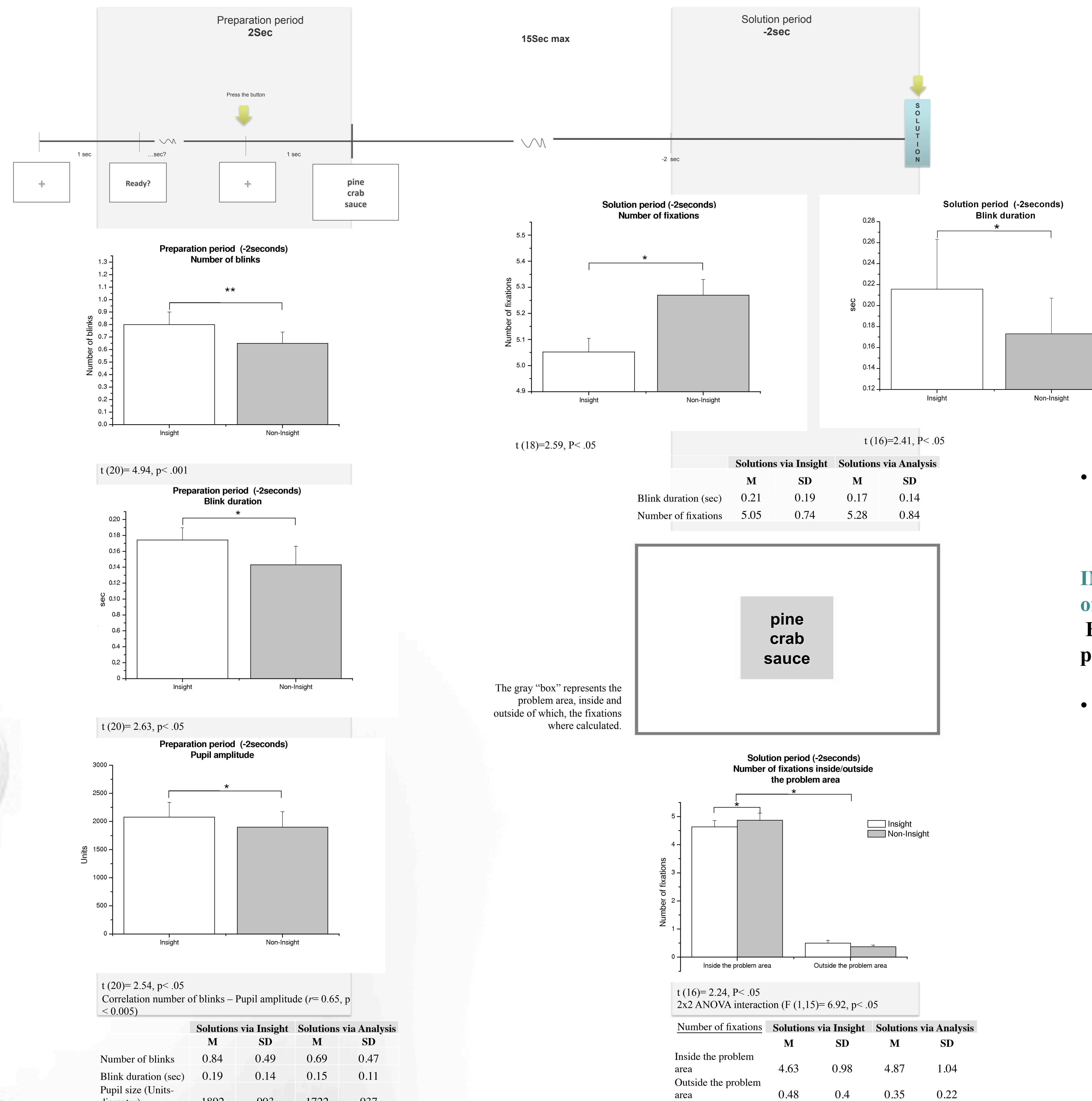
Insight rating

- Sudden recognition, surprise, came all at once, “Aha!” experience
- Non-insight: Gradual recognition, methodical, no surprise/ “Aha!”

Tell the solution to the experimenter
 Press left button for insight
 Press right button for analytic

Eye movements data and Analysis*

Eye blinks and eye movement patterns were analyzed across the two solution styles during the preparation and solution periods; two seconds before the problem appeared on the screen and the solution button was pressed respectively.



Conclusions

- The study demonstrates that the two problem-solving styles are associated with two distinct eye movement and eye blink patterns.

- Consistent with differences in occipital activity found in other studies, the dependent variables that were measured indicate that:

INSIGHT is facilitated by the reduction of interfering visual inputs: Before the solution and Immediately prior to the presentation of the problems.

- These results suggest that internally versus externally directed visual attention might influence the two solving styles.

The difference in number of fixations found inside and outside the problem area might reformulate, giving scientific support to the popular phrase: “Thinking outside the box” in “Looking outside the box!”

References:

*Bowden, E. M., & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate problems. *Behavior research methods, instruments, & computers: a journal of the Psychonomic Society, Inc.*, 35(4), 634-9.
 *Jung-Beeman, M., Bowden, E. M., Haberman, J., Frymiare, J. L., Arambel-Liu, S., Greenblatt, R., Reber, P. J., et al. (2004). Neural activity when people solve verbal problems with insight. *PLoS biology*, 2(4), E97.
 *Kounios, J. (2009). Aha!Moment: The Cognitive Neuroscience of Insight. *Current Directions in Psychological Science*, 21(4), 415-216.
 *Kounios, J., Frymiare, J. L., Bowden, E. M., Fleck, J. I., Subramaniam, K., Parrish, T. B., & Jung-beeman, M. (2006). Subsequent Solution by Sudden Insight. *Psychological Science*, 17(10), 882-890.
 *Subramaniam, K., Kounios, J., Parrish, T. B., & Jung-Beeman, M. (2009). A brain mechanism for facilitation of insight by positive affect. *Journal of cognitive neuroscience*, 21(3), 415-32.

Preparation Period

Subs solved 46.5 (sd: 9) problems correctly
 62.7% (sd: 14.2) with insight (RT 5.15 sec, sd: 1.09)
 37.2% (sd: 14.2) without insight (RT 8.28 sec, sd: 1.70).
 Errors average = 6.3 (sd: 5.7)

*Differences in blinks and eye movement fixation were contrasted with two-tailed tests (alpha = .05) (*p < .05; **p < .005).

Participants’ eye movements were recorded monocularly with a Tower-mounted Eye Tracker (Eyelink 1000 system, SR Research, Mississauga, Ontario, Canada; sampling rate: 1000 Hz; spatial resolution: ≥ 1°).
 All stimuli were presented on a 19-in. View- Sonic E90FB CRT monitor driven at 75 Hz with a 1024 x 768 pixels resolution.

Solution Period

Only problems solved in more than four seconds were considered.

Subs solved 31.6 (sd: 6.1) problems correctly
 50% (sd: 18.1) with insight (RT 6.53 sec, sd: 1.71)
 50% (sd: 18.1) without insight (RT 8.16 sec, sd: 2.24).
 Errors average = 5.7 (sd: 5.2)