Eyes open and shut in cognition: Closing your eyes does not change Intelligence

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The Logic of the following study is as follows.

- i. Alpha waves correlate with intelligence (Klimesch, 1999; Dopelmayr et al., 2002; Grandy et al., 2013).
- ii. Closing your eyes has been found to be an artifact in EEG research, whereby when a participant closes their eyes there is a spike in EEG alpha activity (Barry et al., 2007).
- iii. If the correlation of alpha waves to intelligence is causal, then increasing alpha waves should increase intelligence. Therefore, people may be more intelligent simply by closing their eyes.

The purpose of this study was to provide a pilot test of the theory that closing your eyes increases intelligence.

Methods

Participants were 96 students from the psychology subject pool at a large public University in California, Santa Barbara specifically. We intended to run 100 participants over the course of two academic quarters (winter and spring). We stopped data collection because we had ended the academic year and did not wish to continue running the study another year, as we were already close to our target sample size.

Measuring Intelligence without sight

The difficulty with measuring general intelligence while someone's eyes are closed lies in the fact that most single-tests which are highly correlated with overall intelligence involve

pictures or matrices (e.g. Raven, 1970). Furthermore, most tests for the blind are almost entirely verbal-intelligence centered and often poorly correlated with overall intelligence (e.g. Reid, 2002).

To address this question, we used the verbal fluid intelligence subtest from the Stanford-Binet V Intelligence battery (Roid, 2003). This subtest involves solving verbal analogies of the form *fish:swim as birds:fly*. What makes this task so difficult is that participants have to fill in the blanks on both sides of the equation. While on tests like the Graduate Record Exam, the questions are posed as “*fish:swim as birds:_____*” the verbal fluid intelligence are posed as “*_____:swim as birds:_____*”. The sample problem to this subtest is “blank is to color as daisy is to blank”. Due to concerns that participants would score very low on this task and we would have serious floor effects, we also administered the simple verbal fluid reasoning task ‘Verbal Absurdities’ first. This task involves telling participants about a scenario and they have to say what is silly or absurd about it (Roid, 2003).

Procedure

To minimize placebo or expectancy effects, participants were not told the reason underlying this study. Instead, they were lead to believe that they were participating in a study about visual imagery. After each question, we asked participants if they imagined or visualized anything while solving the questions to keep the cover story.

Participants were randomly assigned to either the eyes open or shut group. In the eyes open group, participants were administered the intelligence measures and asked to keep their eyes open. In the eyes shut condition, participants were asked to keep their eyes shut for the duration of the experiment. If they opened their eyes, they were asked to close them again. No

participants violated their group assignment (shut eyes in the open condition or opened eyes in the shut condition). All data was analyzed in R.

Results

There was absolutely no difference between the two groups. Participants in the control (eyes open) condition scored exactly the same ($M = 7.17$, $SD = 2.371$) as if they had performed the intelligence test with their eyes shut ($M = 7.061$, $SD = 2.349$, $F < 1$, $p > .82$).

Statistical non-significance, however, does not necessarily mean equivalence. To test whether two groups are truly equivalent, a test of equivalence using two one-sided tests is often required (e.g. Shuirmann, 1987; Lakens, 2014). Equivalence testing tests whether a result obtained can be said to be different from the smallest effect of interest. The procedure involves identifying a smallest effect of interest, and then a one-sided t -test is conducted on both the upper and lower bound of the confidence interval. The results from this equivalence test are presented in Fig 1.

As can be seen, the effect size of closing your eyes on intelligence is $-.046$ (left dot with CI in Fig 1). As we had 80% power to detect a difference of $.6$, we used that to test our equivalence. The right dot and confidence interval in Fig 1. shows the equivalence range of a null effect. As the upper and lower bound of our observed effect of closing your eyes overlaps with both lines, we can say our results are equivalent to there being no large effect of closing your eyes on intelligence. Due to power of only have around 48 participants in each condition, however, we cannot conclude that the causal effect of closing eyes is not present but very small. We take comfort that this is not the case, however, as our theorized direction of effects were for increasing intelligence, and our observed effects size, while nearly zero, is also negative in sign.

This suggests we would not see the predicted effects based on the logic of this study presented in the introduction.

Discussion

There is absolutely no effect whatsoever of closing your eyes on intellectual performance. This leads us to one of a couple conclusions based on the logic of the study. Either: i) closing one's eyes does not increase alpha activity; or ii) alpha is not causally related to intelligence. As this was only a pilot test to see if we could find the behavioral phenomena, we

cannot comment on whether the eyes closed intervention actually increased alpha waves. We can only conclude that closing one's eyes is not causally related to intelligence performance.

Our lack of results here is also not likely a power issue, as not only were the results equivalent to zero, they were even in the wrong direction (sign of mean change was negative). Thus, it is unlikely that future research using EEG alpha as a mediator, which would help answer the causal chain and provide substantially more power (e.g. Kenny & Judd, 2014), would provide any different results than those obtained here.

We may thus skeptically believe that if the logic of this study is correct, then there may be evidence that the alpha power correlation with intelligence is not directly causally related, but instead may be spurious or reflective of a common-cause.

References

- Barry, R. J., Clarke, A. R., Johnstone, S. J., Magee, C. A., & Rushby, J. A. (2007). EEG differences between eyes-closed and eyes-open resting conditions. *Clinical Neurophysiology*, 118(12), 2765-2773.
- Doppelmayr, M., Klimesch, W., Stadler, W., Pöhlhuber, D., & Heine, C. (2002). EEG alpha power and intelligence. *Intelligence*, 30(3), 289-302.
- Deary, I. J., & Smith, P. (2004). Intelligence research and assessment in the United Kingdom. In R. J. Sternberg (Ed.), *International handbook of intelligence* (pp. 1–48). Cambridge, UK: Cambridge University Press.
- Grandy, T. H., Werkle-Bergner, M., Chicherio, C., Lövdén, M., Schmiedek, F., & Lindenberger, U. (2013). Individual alpha peak frequency is related to latent factors of general cognitive abilities. *Neuroimage*, 79, 10-18.
- Kenny, D. A., & Judd, C. M. (2014). Power anomalies in testing mediation. *Psychological Science*, 25(2) 334– 339
- Klimesch, W. (1999). EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis. *Brain research reviews*, 29(2), 169-195.
- Lakens, D. (2014). Performing high-powered studies efficiently with sequential analyses: Sequential analyses. *European Journal of Social Psychology*, 44(7), 701–710.
- Reid, J. V. (2002). Testing nonverbal intelligence of working-age visually impaired adults: Evaluation of the Adapted Kohs Block Design Test. *Journal of Visual Impairment & Blindness (JVIB)*, 96(08).

Schuirman, D. J. (1987). A comparison of the two one-sided tests procedure and the power approach for assessing the equivalence of average bioavailability. *Journal of Pharmacokinetics and Biopharmaceutics*, 15(6), 657–680.