LETTER

Reply to Hupé *et al*.: The predictive correlation of pupil dilation and relative dominance durations in rivalry is not a statistical artifact

We are encouraged by Hupé *et al*.'s (1) independent replication of our findings (2) and the fact that our data *per se* stands uncontested. Hupé *et al*. argue against our interpretation of these results, based on removal of short dominance durations from the analysis. Although it is no surprise that selective removal of data points can reduce the significance of any correlation, we appreciate the theoretic basis of their concern: Because pupil dilation persists for 1–2 s, short preswitch dominance durations may be disproportionately affected by the pupil dilation accompanying the previous switch event (figure 1F in ref. 2). This was indeed the primary motivation for our "replay" condition, with unambiguous stimulus-driven switches matched exactly to the time course of reported rivalry switches. The absence of any statistically predictive relationship in replay (figure 2A in ref. 2), despite a striking similarity in response magnitude and duration (figure 2C in ref. 2), rules out that our predictive effect in rivalry was an artifact of the time course of the pupil response or of the inherent variability in rivalry switch intervals. Furthermore, we do find—at least for the plaid stimulus—some correlation between pupil diameter and the absolute post-switch dominance duration (supporting information in ref. 2), which cannot be confounded by the concerns raised in ref. 1. A related concern mentioned in ref. 1 is that our correlation could be caused by a systematic tendency for longer durations to follow shorter durations. This effect apparently is observed in Hupé *et al*.'s own data but is absent from ours: if anything, the opposite is the case—median dominance durations after "short" dominance durations (<3 s as defined in ref. 1) tend to be shorter. Finally, we do not deny the involvement of the overt (motor) response in late phases of pupil dilation. We can, however, rule it out as the sole contributor to pupil dilation by performing the "counting" control and by the very correlation analysis that Hupé *et al*. are contesting.

***Wolfgang Einhäuser*[*†], James Stout*[*], Christof Koch*[*], and Olivia Carter*[‡§¶]**

*[*]*Division of Biology, California Institute of Technology, Pasadena, CA 91125; [†]Department of Neurophysics, Philipps University, Marburg 35032, Germany; [‡]Vision Sciences Laboratory, Harvard University, Cambridge, MA 02138; and [§]Molecular Psychopharmacology Laboratory, Mental Health Research Institute, Parkville VIC 3053, Australia*

1. Hupé J-M, Lamirel C, Lorenceau J (2008) Pupil dilation does not predict subsequent stability in perceptual rivalry. *Proc Natl Acad Sci USA* 105:E43.
2. Einhäuser W, Stout J, Koch C, Carter O (2008) Pupil dilation reflects perceptual selection and predicts subsequent stability in perceptual rivalry. *Proc Natl Acad Sci USA* 105:1704–1709.

Author contributions: W.E., J.S., C.K., and O.C. wrote the paper.

The authors declare no conflict of interest.

¶To whom correspondence should be addressed. E-mail: ocarter@wjh.harvard.edu.

www.pnas.org/cgi/doi/10.1073/pnas.0803927105