Time course of cortical responses to illusory and real lightness changes

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VSS 2008 - Naples, FL

Context-dependent lightness processing in V1 & V2

- Boyaci, Fang, Murray & Kersten (2007) - Human
- Sasaki, Y., and Watanabe, T. (2004) - Human
- Rossi, A.F., Rittenhouse, C.D., & Paradiso, M.A. (1996) - Animal
- McCourt, M.E., & Foxe, J.J. (2006) - Human
- Roe, A.W., Lu, H.D., & Hung, C.P. (2005) - Animal
- Haynes, J., Lotto, R.B., & Rees, G. (2004) - Human
- Cornelissen, F.W., Wade, A.R., Vladusich, T., Dougherty, R.F., & Wandell, B.A. (2005) - Human
- Perna, A., Tosetti, M., Montanaro, D., and Morrone, M.C. (2005) - Human

Questions

- Do the V1 & V2 activities correlate with context dependent lightness changes?

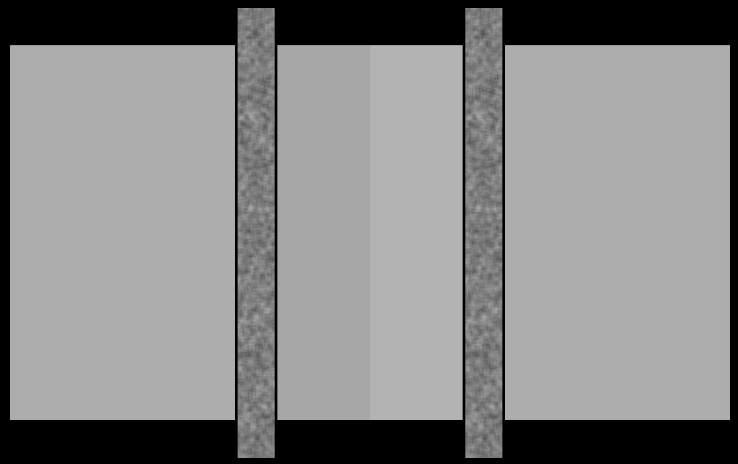
If so,

- How do their a) magnitudes, b) time courses compare to those in response to actual luminance changes?
- Are there any differences between V1 & V2 activities?

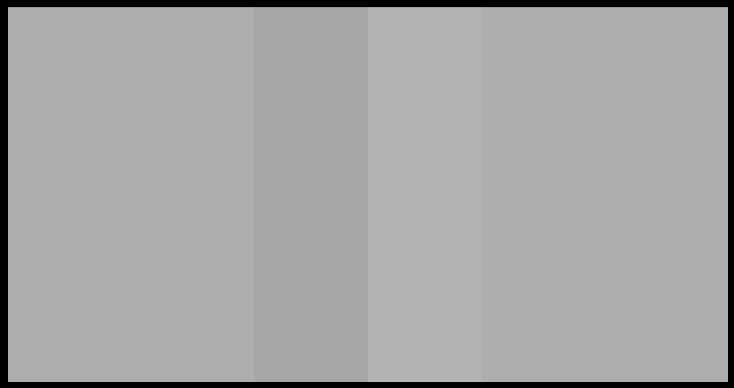
Collaborators

Fang Fang
Scott Murray
Katja Doerschner
Gina Albanese
Dan Kersten

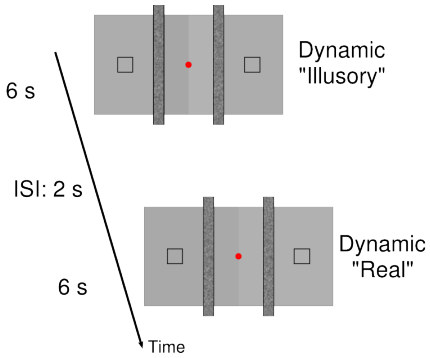
Amodal completion (AC) effect

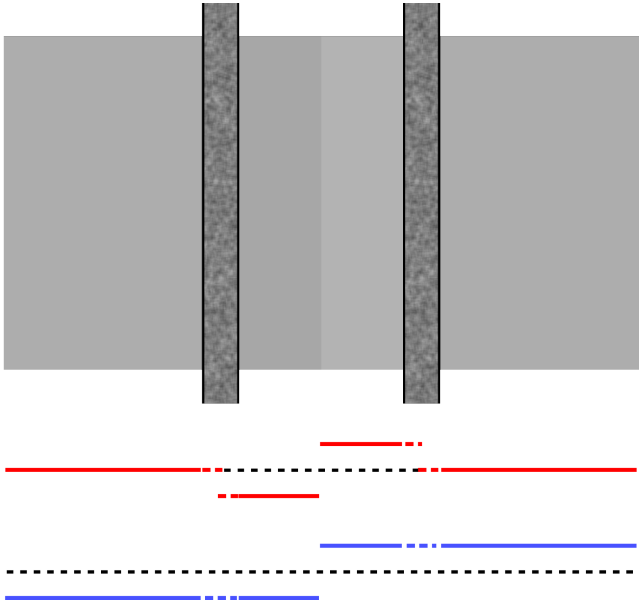


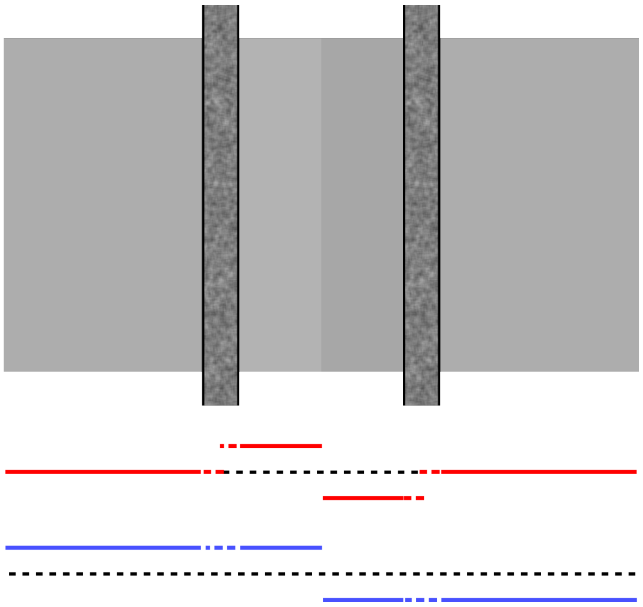
Amodal completion (AC) effect

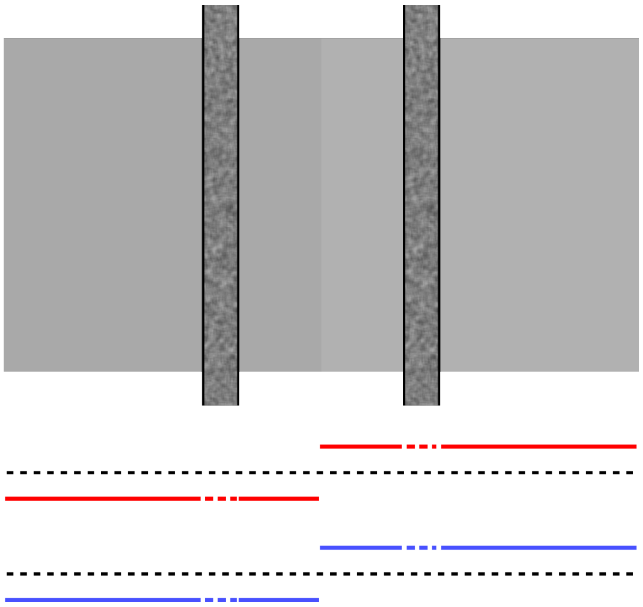


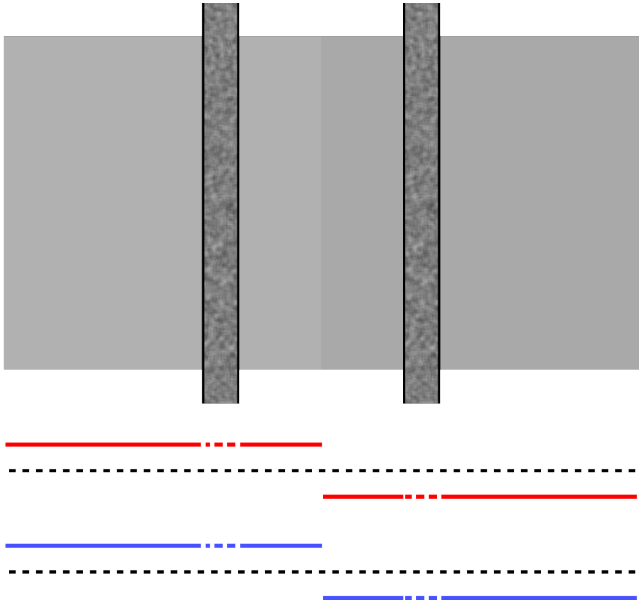
Behavioral measure of the AC effect











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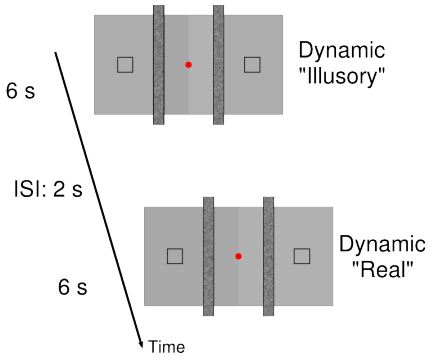

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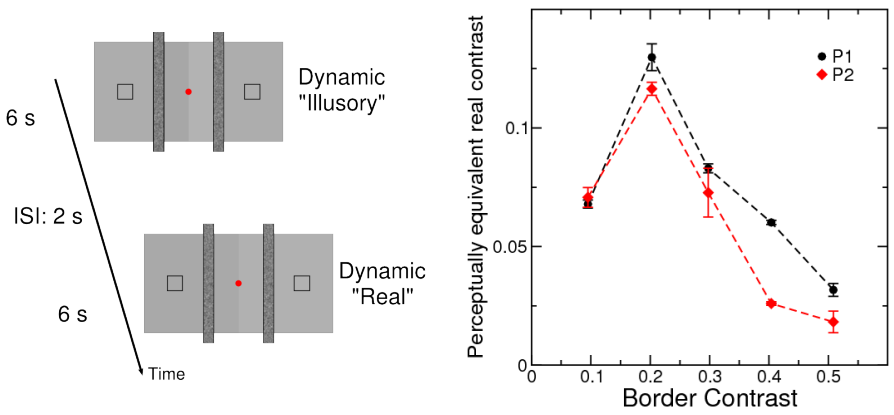
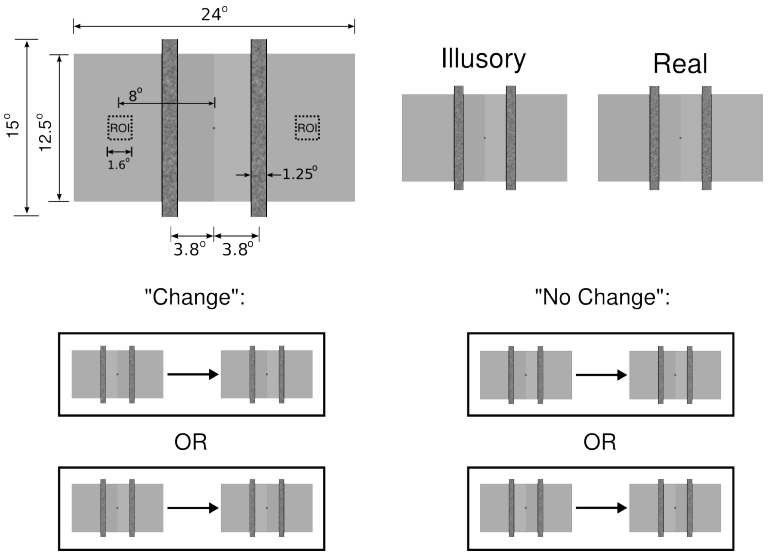


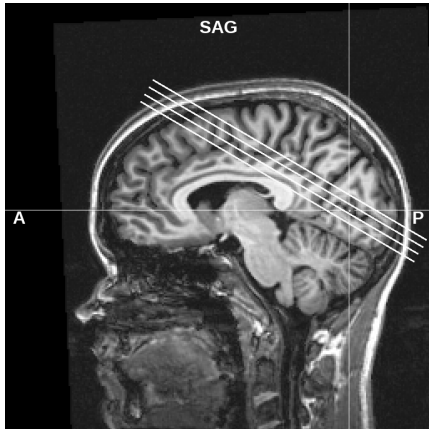
FMRI measure of the AC effect - Design



FMRI measure of the AC effect - Design

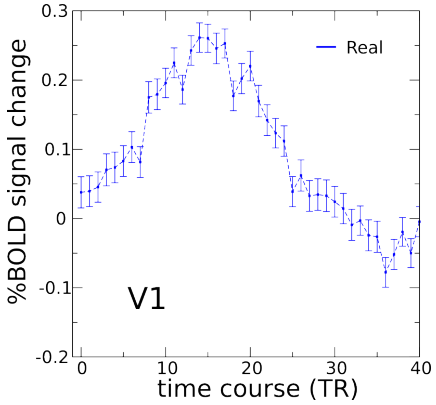
- Two participants
- Illusory contrast = 0.2 for both participants
- Real contrast chosen per observer
- Demanding fixation task to control for attention
- Conditions blocked in different scans
- Number of scans: about 12 scans for each condition for each observer
- Trial presentation randomized using m-sequence

FMRI measure of the AC effect - Design

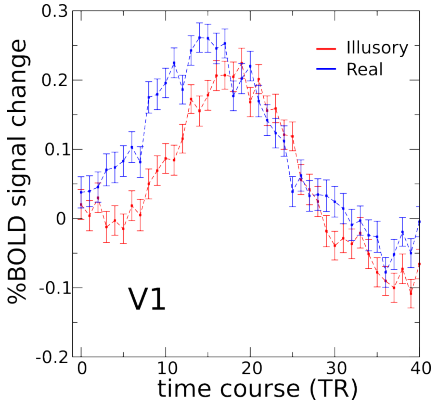


- TR = 227 ms
- Number of slices = 4
- In-plane = 3 by 3 mm
- Slice thickness = 5 mm
- $B_0 = 3$ Tesla
- 12 coil array

FMRI measure of the AC effect - Results



FMRI measure of the AC effect - Results



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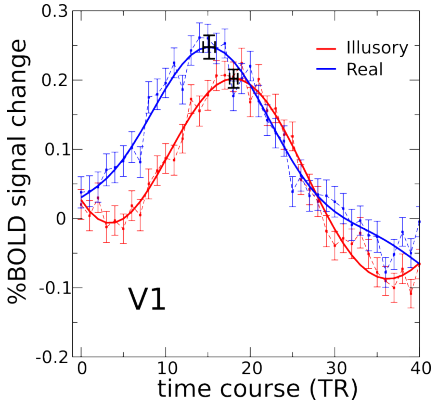

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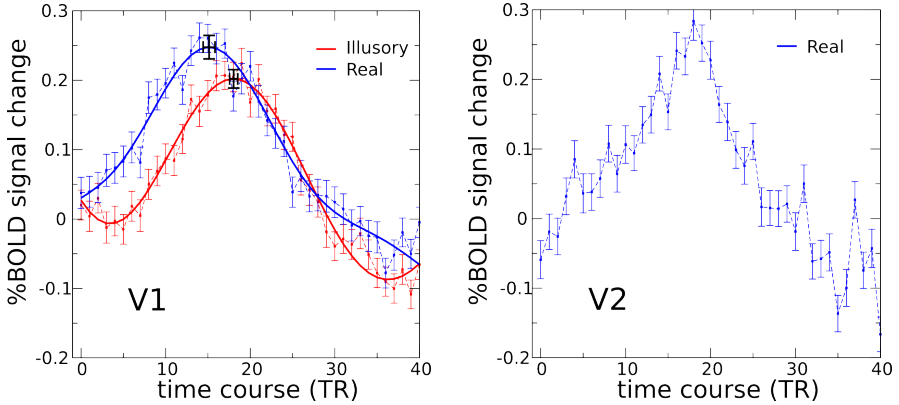

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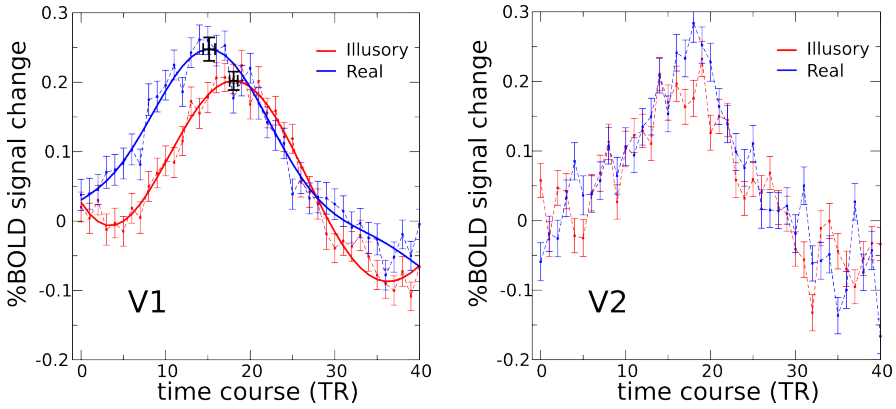

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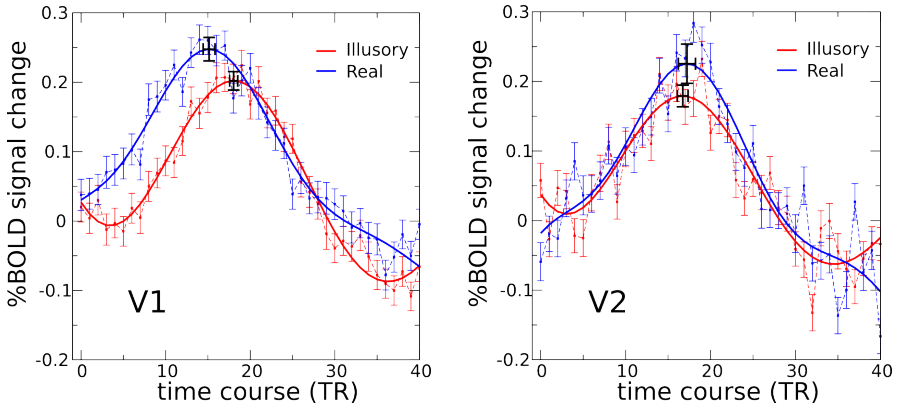

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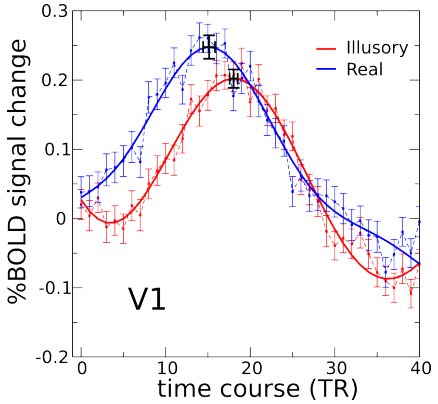
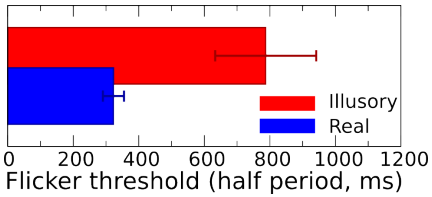
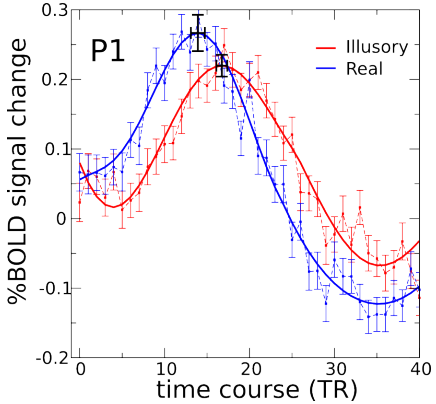
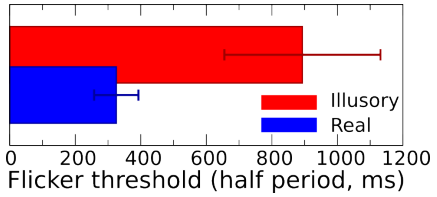




Davey, Maddes, and Srinivasan, Vision Research (1997)

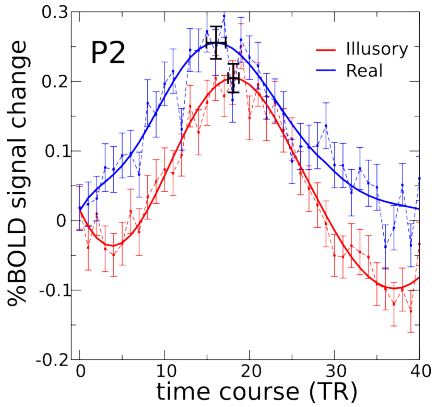
FMRI measure of the AC effect - Individual data in V1

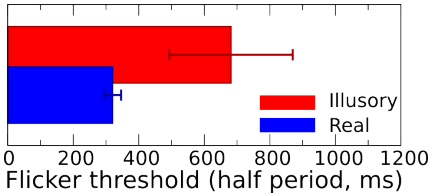




fMRI Time Lag in V1: 642ms
Behavioral Time Lag: 568ms

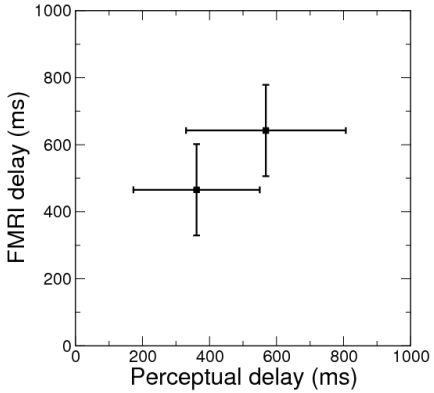
FMRI measure of the AC effect - Individual data in V1



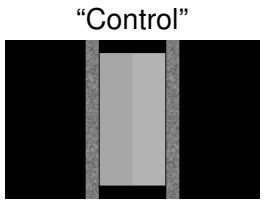


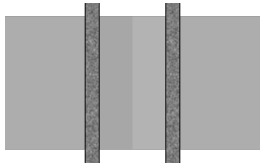
fMRI Time Lag in V1: 467ms
Behavioral Time Lag: 361ms

Perceptual delay versus fMRI delay



FMRI measure of the AC effect - Control





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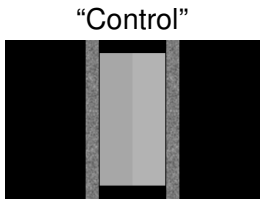

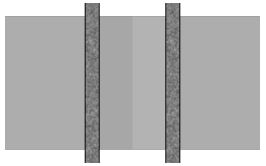

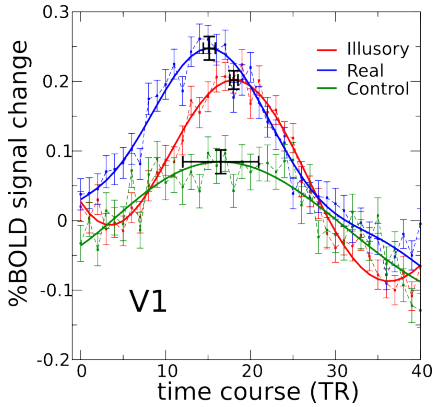

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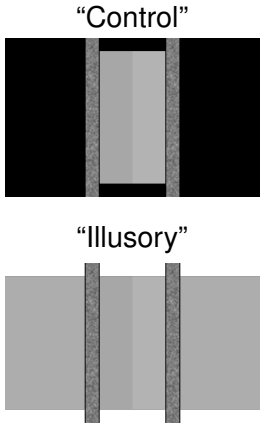

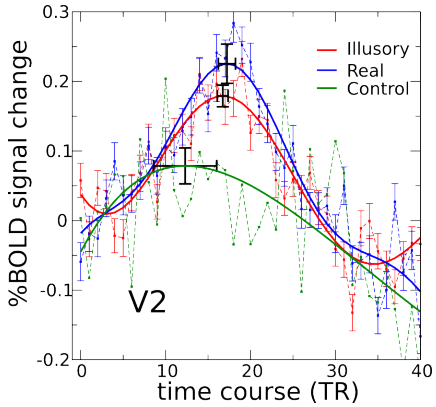

Summary

- FMRI activity correlates with context-dependent lightness changes not actual luminance
- The response to real luminance variations is larger than that to illusory variations in V1 & V2
- The activity in V1 to illusory lightness changes is delayed relative to real changes by about 700ms. Such a delay is not observed in V2
- The lag in V1 to illusory lightness changes agrees with the time course of the perceptual effect
- The activity occurs automatically even when attention is directed away from the lightness effect