Turning a Blind Eye to Bad News:

Pupillary correlates of the optimism bias

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Pupillometry reveals temporally distinct processing of confidence and valence during belief-updating

INTRODUCTION

BACKGROUND:

- People are often more accepting of personally advantageous information
  - **Optimism Bias of Risk Perception:** people feel they are less likely to experience negative events in the future and more likely to experience positive ones[1]
- **Findings of the belief-updating task:** after desirable news people update their beliefs more than after undesirable news → **optimism bias**[2]

AIMS:

- Provide more neurophysiological evidence for the optimism bias
- Use pupillometry to investigate how confidence in the initial belief and news valence influences pupil dilation

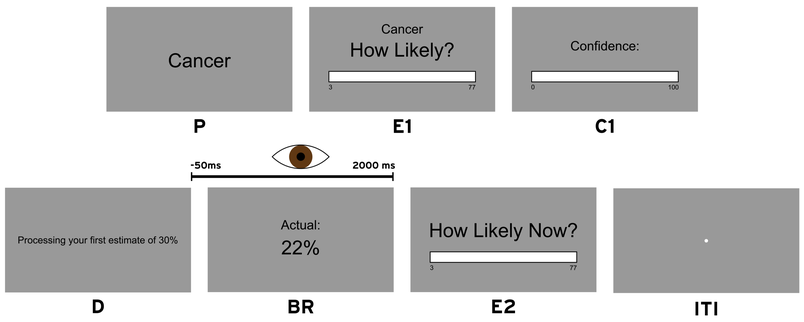
METHODS

STUDY DESIGN:

- 39 participants, 34 retained for analysis (21 female, age = 28.4 ± 12.9)
- Single-session with EEG, pupillometry, and belief-updating task

BELIEF-UPDATING TASK:

- 56 negative life events presented, 4 blocks of 14 events with 7 phases
- Event presentation (P), 1st estimate (E1), confidence rating (C1), delay (D), base rate presentation (BR), 2nd estimate (E2), inter-trial interval (ITI)
- **Good news:** BR < E1
- **Bad news:** BR > E1
- **ER** = | BR – E1 |
- **Update** = | E1 – E2 |



PUPILLOMETRY:

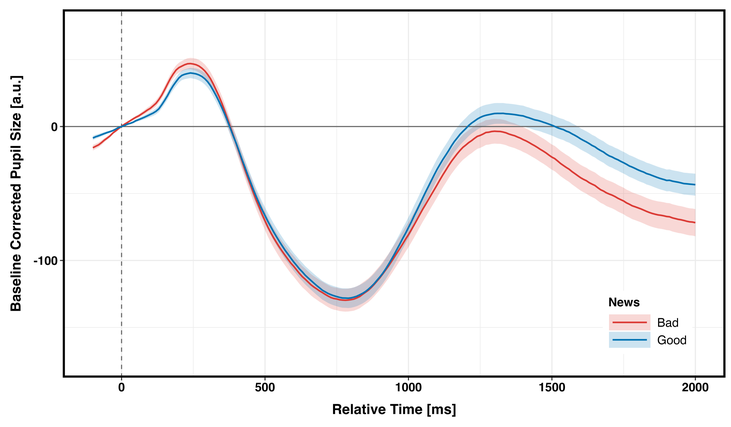
- Data collected from both eyes with Eyelink 1000Plus
- Sampling rate of 1000Hz and standard 5-point calibration
- Preprocessing to remove blink artifacts, trials with insufficient data, and remove invalid trials to align with behavioral data

STATISTICAL ANALYSIS:

- Analyzed 50 ms before BR and 2000 ms after BR
- Linear mixed model with cluster permutation testing
  - **Model**: *update ~ News * C1 + ER*
- 5000 permutations, Freedman-Lane sampling, clustermass correction

RESULTS

News Valence Modulates Pupil Size

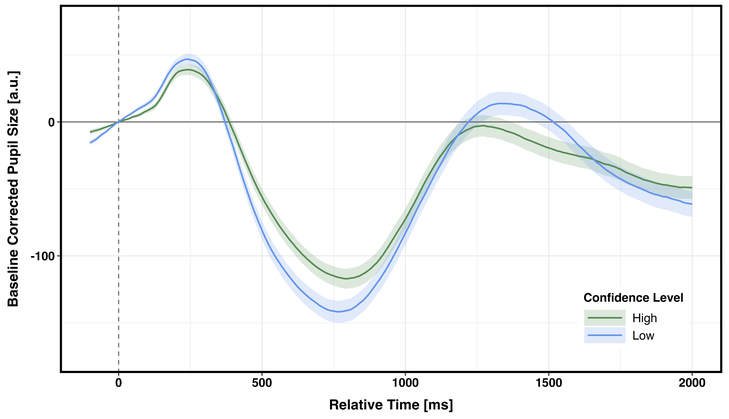


NEWS x CONFIDENCE EFFECT:
Cluster: ~650 to 2000 ms, cluster mass = 1414.979, p = .002
→ Good news and low confidence resulted in larger pupil size

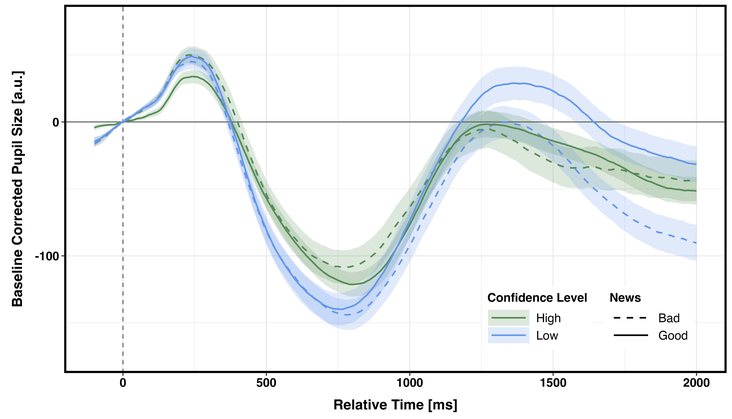
NEWS MAIN EFFECT:
Cluster: ~710 to 2000 ms, cluster mass = 1239.394, p = .001
→ Good news elicited greater pupil size as compared to bad news

CONFIDENCE MAIN EFFECT:
Cluster: ~480 to 1360 ms, cluster mass = 989.714, p = .005
→ Higher levels of confidence led to greater pupil size dilation

Confidence in Estimate Modulates Pupil Size



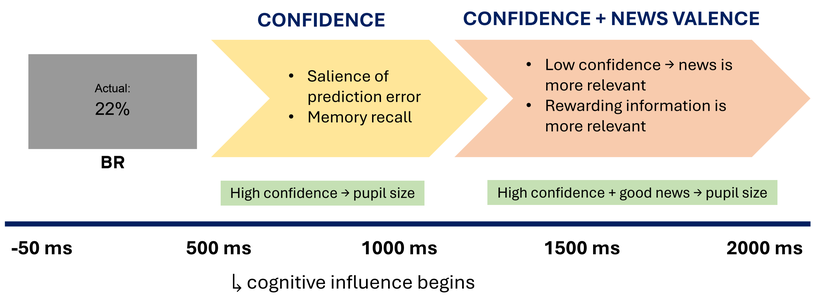
Greatest Pupil Size after Good News and High Confidence



DISCUSSION

Temporally distinct processing of confidence & news

- Confidence → early influence on pupil size
- Interaction of news and confidence → later influence on pupil size
  - Cognitive influence on pupil size begins at ~500 ms



Main effect of high confidence – Early component

- More salient prediction error after high confidence → surprise[3]
- Recall of past experiences → high confidence in estimation
  - Greater memory recall → dilation of pupil size[4]
  - Effect may be carried over from C1 and delay period

Main effect of good news – Late component

- Aligns with ERP findings: good news → elevated P300[5]
  - Locus coeruleus (LC) → pupil size
  - LC-norepinephrine parietal activity → P3b component
- More cognitive resources allocated to rewarding information

Interaction of news and confidence – Late component

- Matches behavioral findings
  - low C1 and good news → greater belief-update and pupil size

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References

1. Weinstein, N. D. (1989). Optimistic Biases About Personal Risks. *Science*, *246*(4935), 1232–1233.
2. Sharot, T., Korn, C. W., & Dolan, R. J. (2011). How unrealistic optimism is maintained in the face of reality. *Nature Neuroscience,* 14(11), 1475–1479.
3. Preuschoff, K., 't Hart, B. M., & Einhauser, W. (2011). Pupil Dilation Signals Surprise: Evidence for Noradrenaline's Role in Decision Making. *Frontiers in Neuroscience*, 5.
4. Kucewicz, M. T., Dolezal, J., Kremen, V., Berry, B. M., Miller, L. R., Magee, A. L., Fabian, V., & Worrell, G. A. (2018). Pupil size reflects successful encoding and recall of memory in humans. *Scientific Reports*, 8(1), 4949.
5. Yao, Z., Lin, X., & Hu, X. (2021). Optimistic amnesia: How online and offline processing shape belief updating and memory biases in immediate and long-term optimism biases. *Social Cognitive and Affective Neuroscience*, 16(5), 453–462.

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