



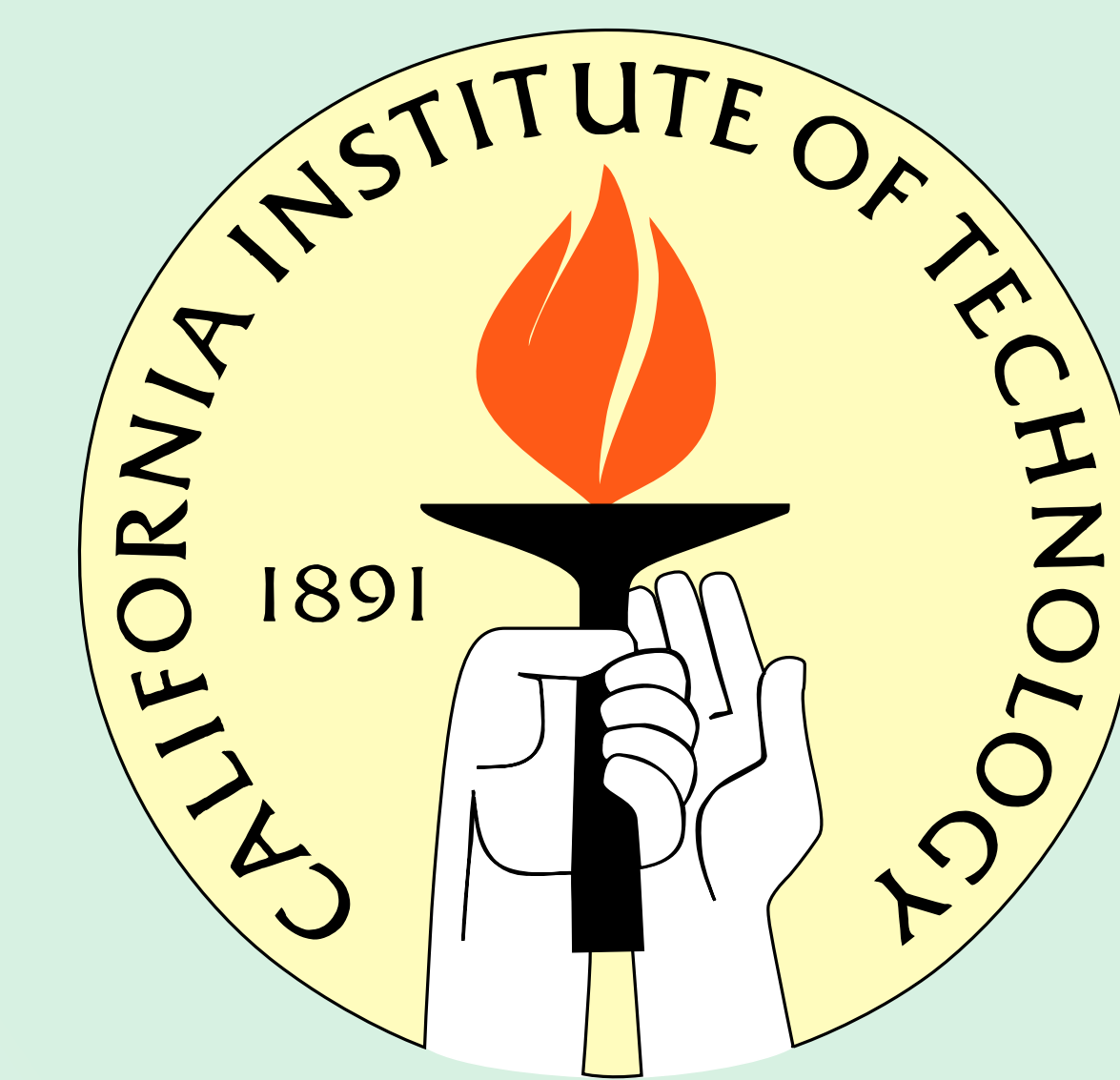
A Mind for the Market: An fMRI Study of Attribution of Mental States to Financial Markets

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1. Experimental data collection

Setup:

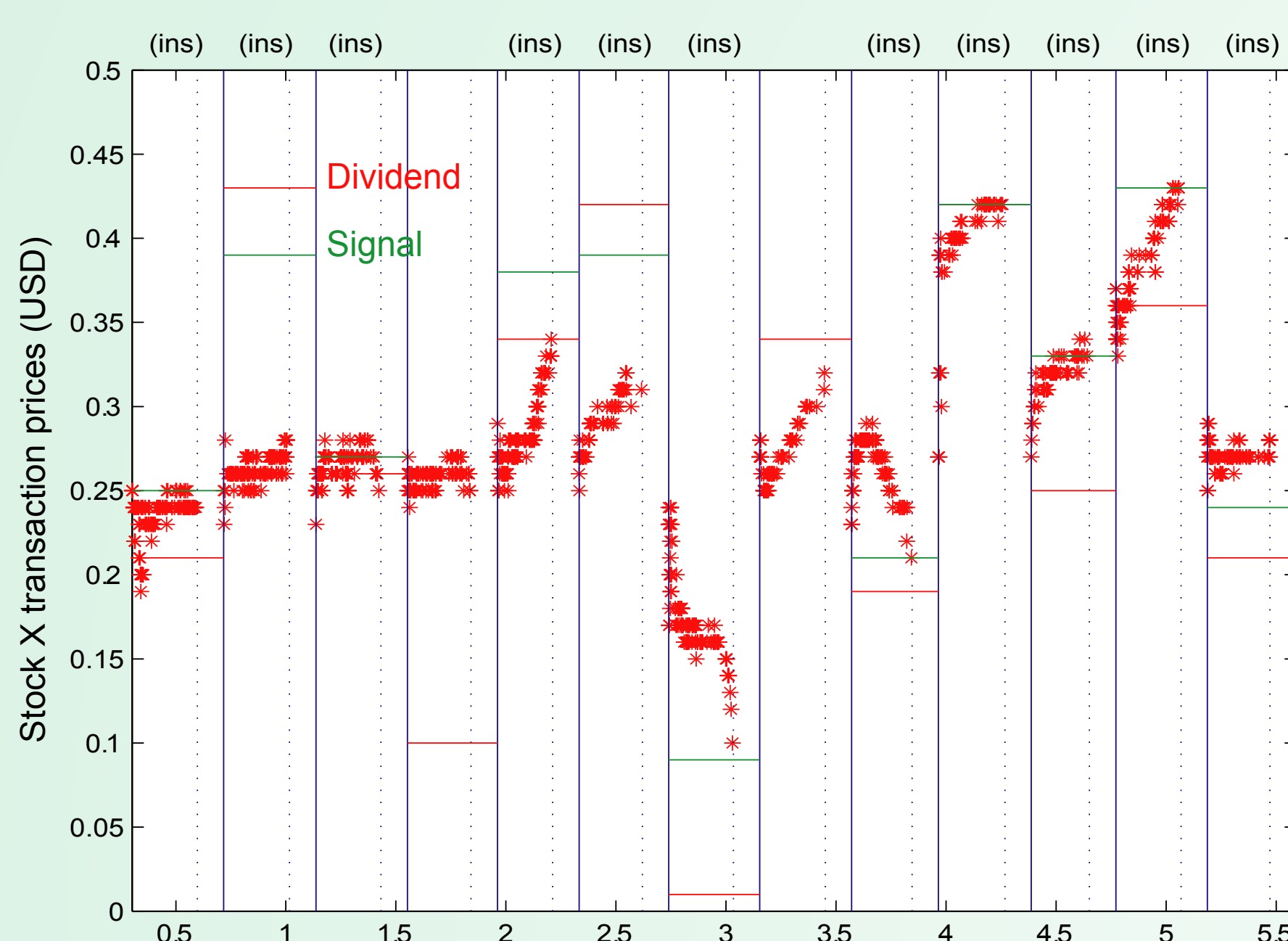
- 20 subjects divided into two groups (insiders and non insiders)
- insiders are given a **signal** (green line)
- signal within \$0.10 of the **dividend** (red line) of a stock X
- also add stock Z (dividend(X) + dividend(Z) = \$0.50) and a bond

Insiders skew trades:

- if insiders have a signal at \$0.09
- if stock trades at \$0.40
- then they sell stock and price goes down

Control periods:

- periods where there are no insider(s)



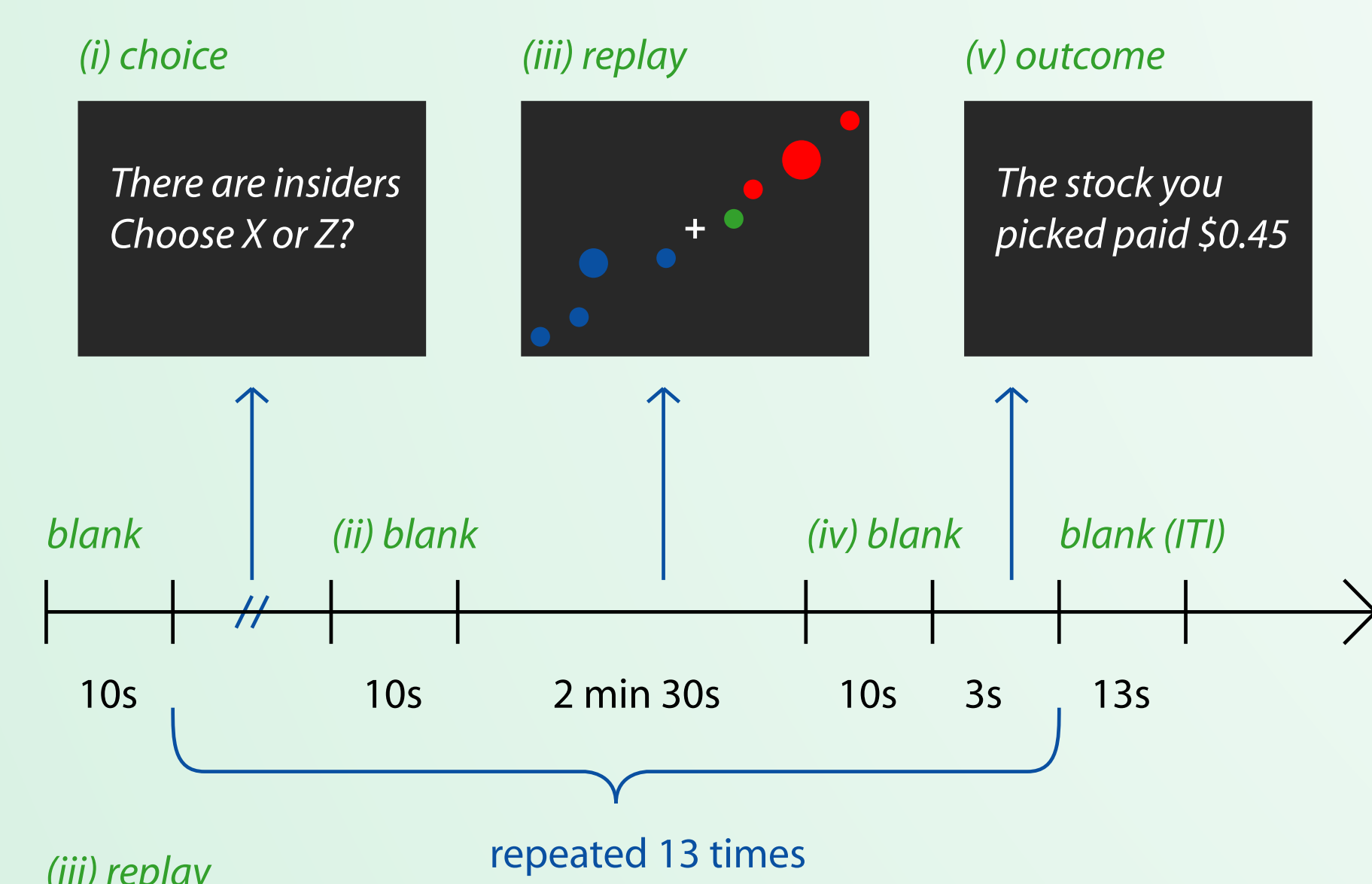
Question: How can non-insiders use insiders' behavior to guess signal? We hypothesize that subjects anthropomorphize markets.

2. fMRI experiment

- replay all the recorded trades to 18 subjects (other pool)

Step (i):

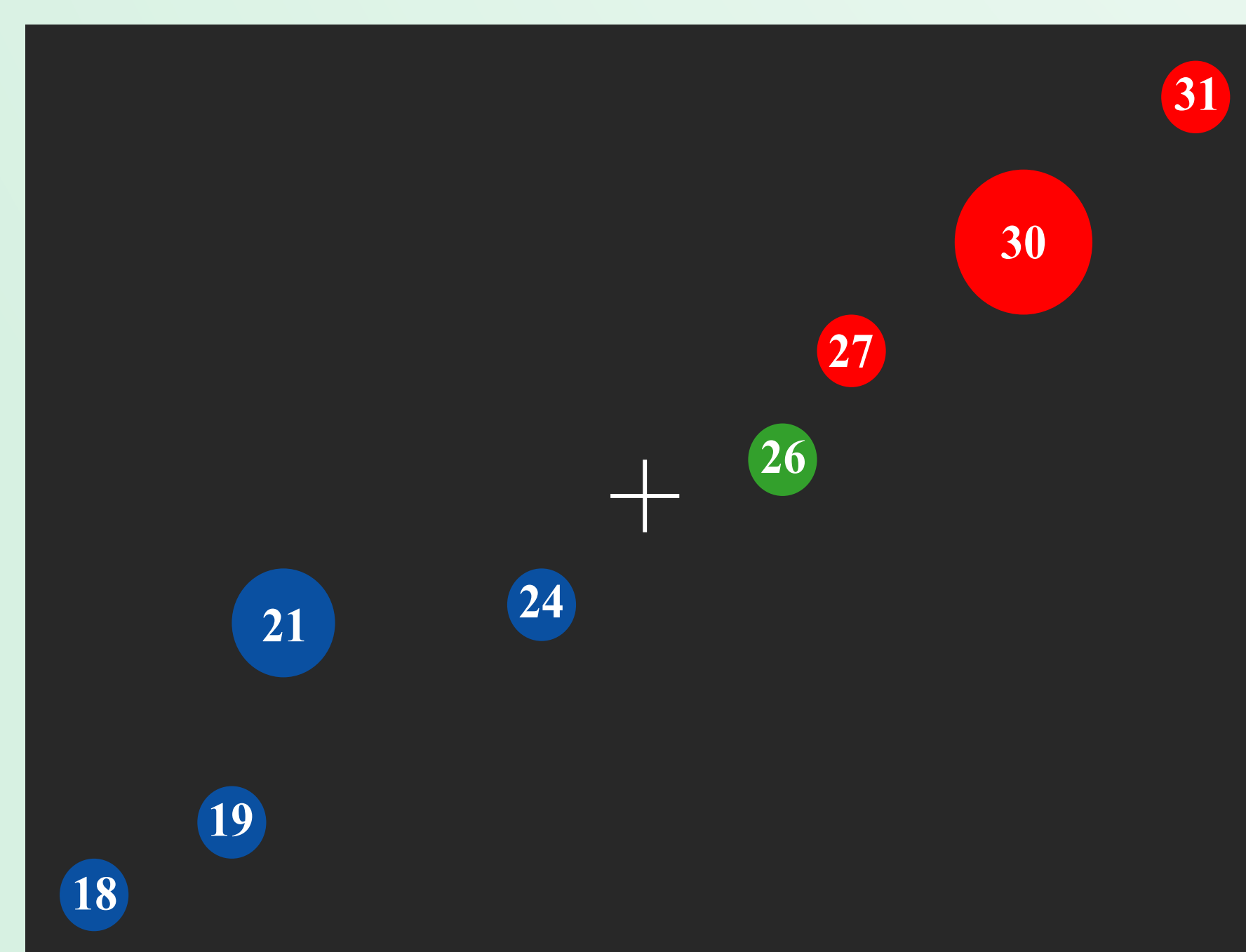
- tell them whether the session has insiders
- ask them to choose between stock X or Z



Step (iii):

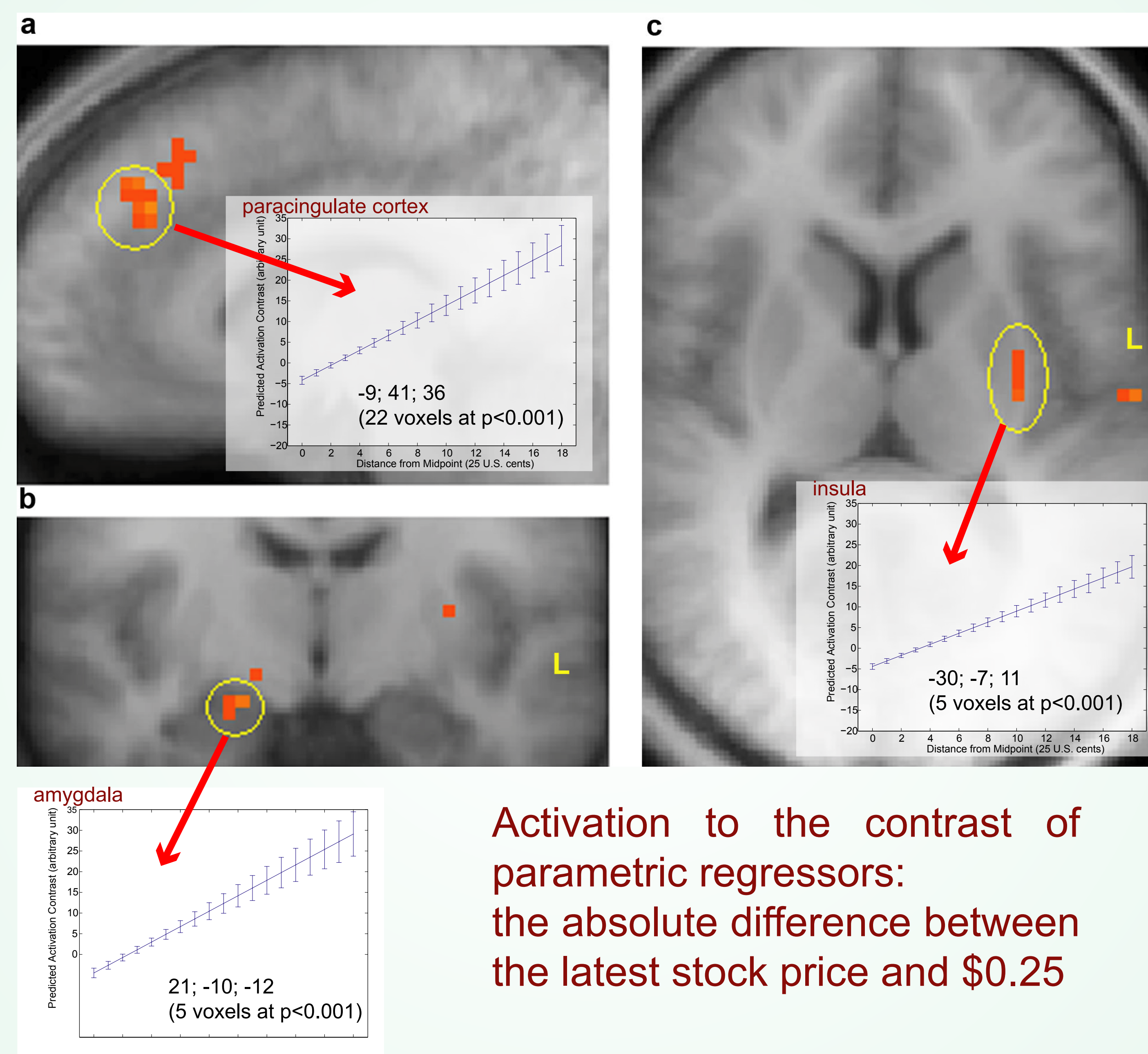
- replay the market with moving bubbles
- always display X
- numbers indicate prices (cents)
- blue/red circles are offers to buy/sell (bids/asks)
- subjects must press key every time there's a trade (green circle for 500ms).

Step (v): subjects are informed of the outcome



3. A mind for the market

All the activations reported are the contrasts between insider and non-insider sessions. We therefore remove the influence of the traders and look at the perception of the stock market itself.



Activation to the contrast of parametric regressors: the absolute difference between the latest stock price and \$0.25

Observations:

- theory of mind (ToM) circuitry
- modulation of the saliency of the ToM (Frith et al.)

Paracingulate cortex activation in:

- strategic games with other humans vs. computers
- choice vs. belief expression in strategic games with humans (McCabe et al., Gallagher et al., Bhatt et al.)

Conclusions:

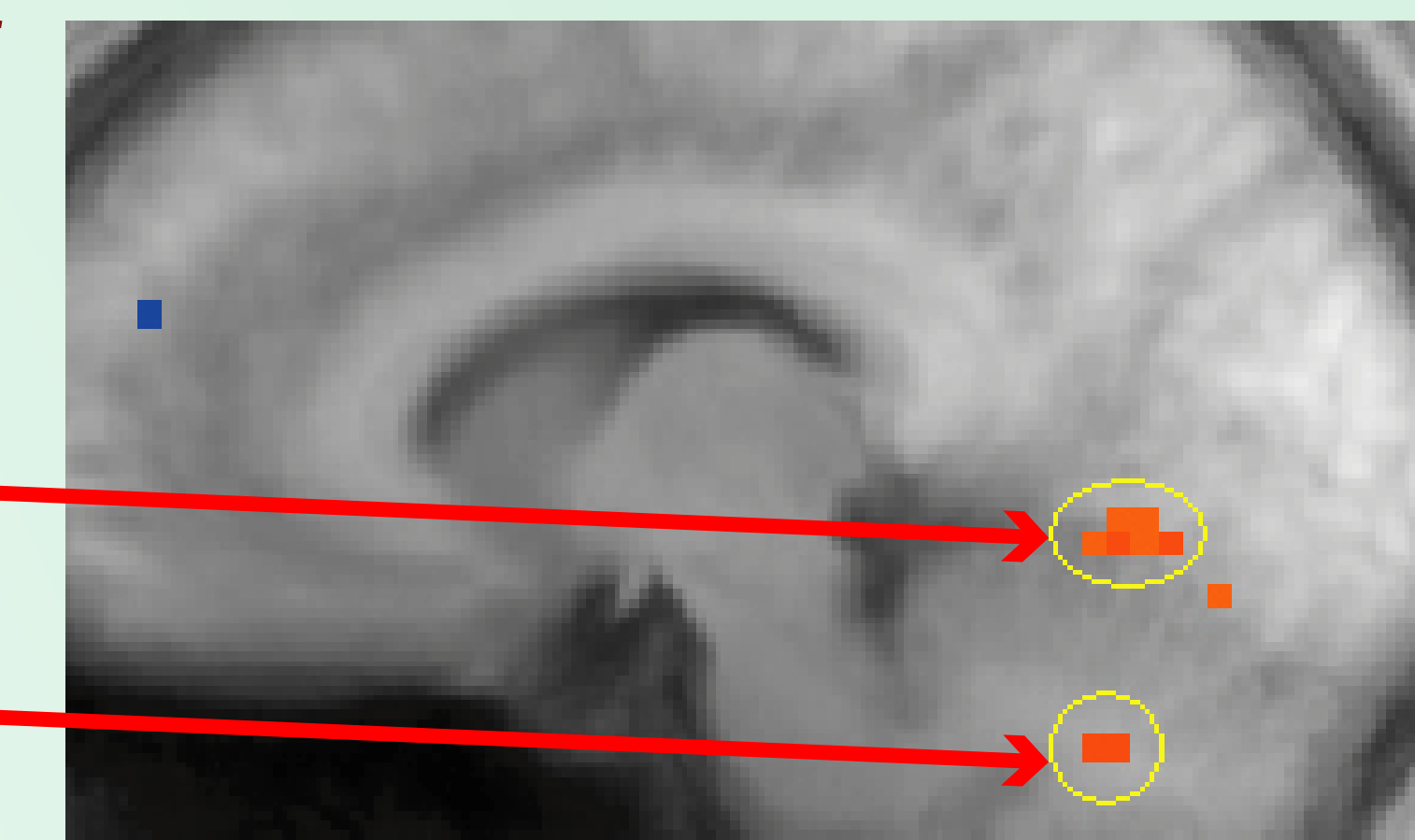
- markets not perceived like a computer that acts in a pre-programmed way
- anthropomorphization of the stock market
- against standard view of financial markets (Rational Expectations Theory, Glosten et al., Admati)

4. Looking beyond the trades

Activation to the contrast of block regressors: compares mean activation between sessions

Lingual gyrus
-9; -65; -6
(25 voxels at $p < 0.001$)

Cerebellum
-13; -58; -30
(9 voxels at $p < 0.001$)



Do subjects use bids and asks?

- standard theory (Barner) predicts that subjects need only pay attention to trades (green circles, section 2, step (iii))
- our hypothesis: subjects use bids and asks (red and blue circles) to better understand the market

Lingual gyrus activation:

- when extracting global meaning despite local distractors, activation of lingual gyrus (Fink et al. 96, Fink et al. 97)
- local distractor = green circle
- global meaning = entire screen

Conclusions:

- attention to outstanding offers, not just trades

5. Future work

Goals:

- detect which signals in order flow are used
- understand and predict how humans behave in a market
- find where in the brain the signals are analyzed

Methods:

- Hotelling's T^2 analysis to find location of integration
- reverse correlation / ridge regression
- potentially create another experiment (coupon market crash)

References and notes

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Videos of the stimuli available at: <http://www.hss.caltech.edu/~antoine>
An electronic copy of this poster is available at: http://www.bruguier.com/pub/HSD_PI_Meeting.png
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