The valuation system: A coordinate-based meta-analysis examining BOLD correlates of subjective value

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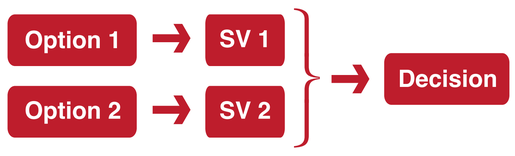
Objective

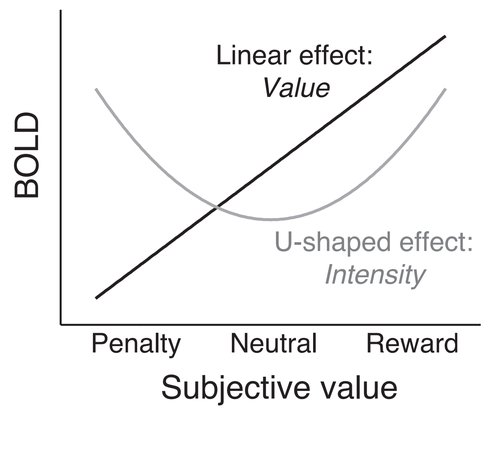
Subjective value (SV) is a theoretical variable akin to the economic utility of an outcome *[1]*.



SV functions as a ***domain-general currency*** for decision making.

A large number of neuroimaging experiments have investigated the neural encoding of SV.

There is evidence for both **direct** *[2]* and **nonlinear** *[3]* effects of SV on regional BOLD signal.



Here we quantitatively synthesize this literature, extending previous reviews and meta-analyses *[4,5]*.

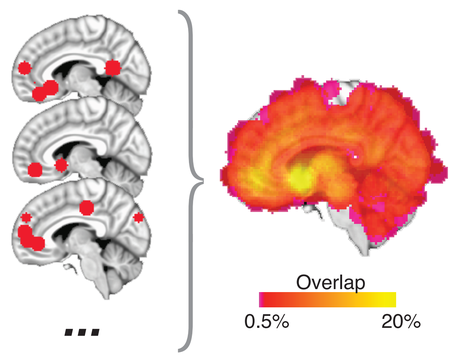
Meta-analytic results offer a principled basis for defining ROIs. **Our results are available for download:**

www.sas.upenn.edu/~mcguirej/meta-analysis.html

Method

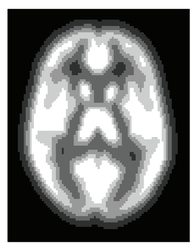
Each study is converted to an **indicator map**, with spheres at reported peak foci *[6]*.

Indicator maps are averaged across comparable studies to yield a map of **percent overlap**.



Single-group analyses test whether foci are clustered more densely than chance.

Permutation tests randomize locations of foci, accounting for gray-matter probability, to control familywise error rate.



Gray matter probability bins

Comparisons between two groups of studies test whether clustering density differs more than if groups were defined randomly.

Permutation tests shuffle the two sets of indicator maps to control familywise error rate.

Positive and negative effects of subjective value on BOLD

We categorized the results of BOLD contrasts comparing levels of SV.

Positive effects involve greater BOLD for **higher** SV.

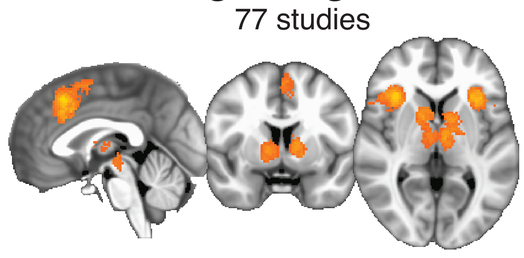
Negative effects involve greater BOLD for **lower** SV.

A **mixture of positive and negative effects** fits an underlying U-shaped pattern.

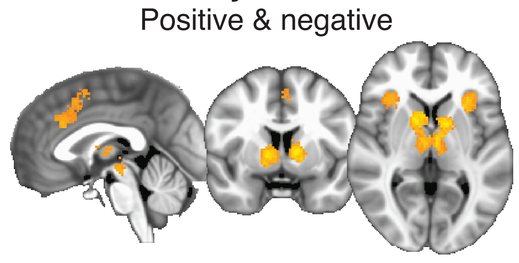
Predominantly positive effects fit an underlying linear pattern.

Clustering of positive effects
200 studies

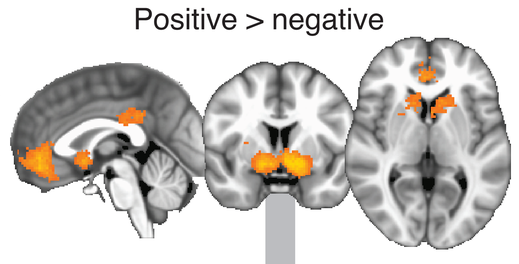
Clustering of negative effects
77 studies



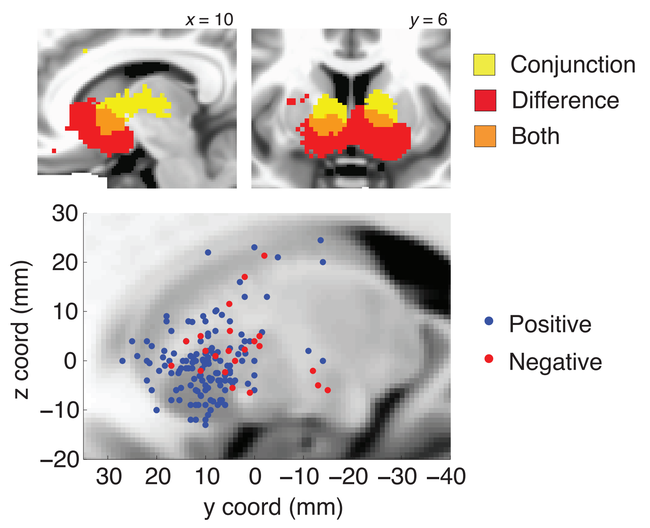
Conjunction
Positive & negative



Difference
Positive > negative



Striatal subregions show different profiles:



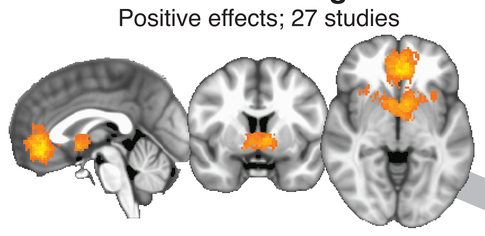
Spatial logistic regression: negative effects fall dorsal and posterior to positive effects.

A valuation system

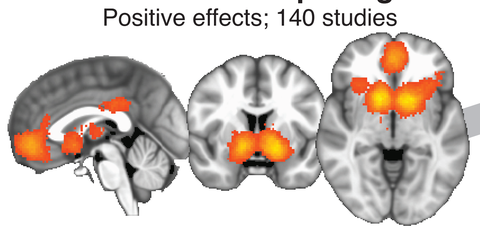
SV signals are expected to show a **linear pattern** and to be similar across **modalities of reward** and **stages of the decision process**.

Areas of striatum and VMPFC showed the expected conjunction of effects.

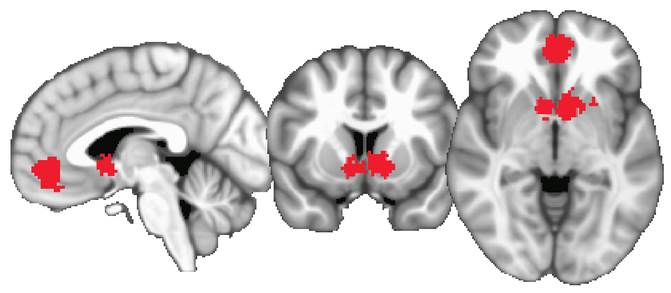
Decision stage
Positive effects; 27 studies



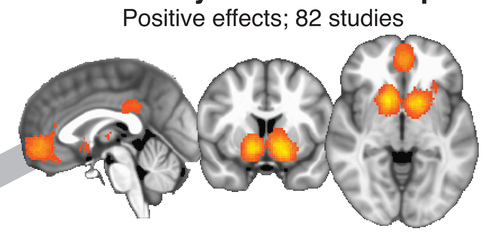
Outcome receipt stage
Positive effects; 140 studies



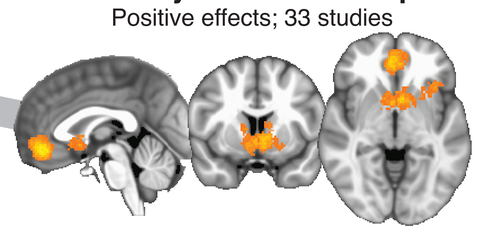
Five-way conjunction



Monetary outcome receipt
Positive effects; 82 studies



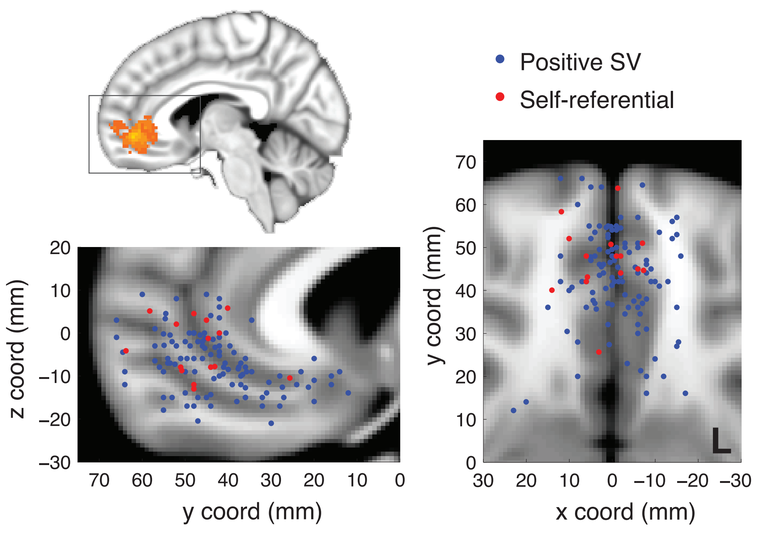
Primary outcome receipt
Positive effects; 33 studies



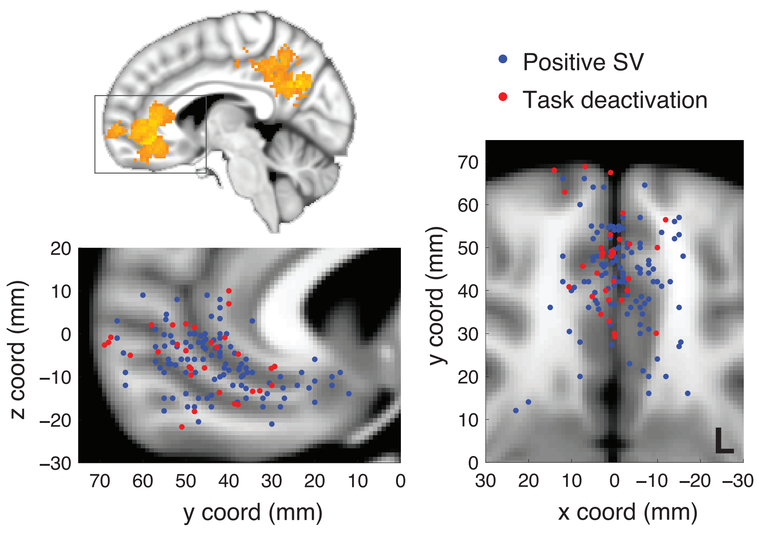
Colocalized responses to other variables

Other experimental variables also implicate ventromedial prefrontal cortex.

Self-referential cognition *[7]* (37 studies)



Task-related deactivation *[8]* (82 studies)



Foci in each domain are interspersed with positive effects of SV.

References

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Associated paper

Bartra, O., McGuire, J.T., & Kable, J.W. (2013). *NeuroImage, 76,* 412–427.

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