Interactive effects of attention and context in value-based chioce.

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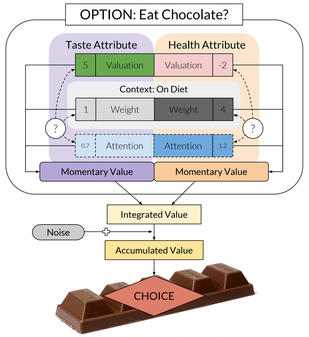
// BACKGROUND

• **Decisions** are often captured as a **weighted sum** over **multiple attributes** [1]: *Summed Value* = $w_1{*}a_1 + w_2{*}a_2 + ... + w_n{*}a_n$
• **Choices** are made by integrating these attributes in a process of context-informed sequential sampling and evidence accumulation.
• **Example:**



• Remains **unclear** how valuation, weighting and attention **interact**.
• Neuroimaging studies find attribute areas correlate with value of specific attributes but unclear how this may relate to attention [2,3].

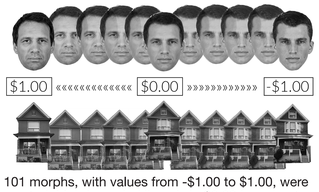
// GOALS

1. **Investigate** influence of attribute value and weighting on attention.
2. **Investigate** influence of attention on choice.
3. **Develop** fMRI and EEG-compatible paradigm for tracking value and attention during multi-attribute choice.

// METHODS

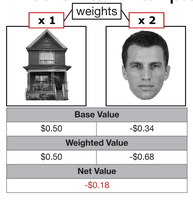
1. Subjects (Study 1: n=23, Study 2: n=31) learned values from morphed pairs of images of houses and faces.
2. Subjects accepted or rejected a proposed combination of 2 attributes (1 face and 1 house) based on the summed value. Weights were applied to attributes on a trial-by-trial basis to affect importance.
3. Participants used a button to alternate between display of each separate attribute. Allows for dynamic attention tracking.

Stimuli

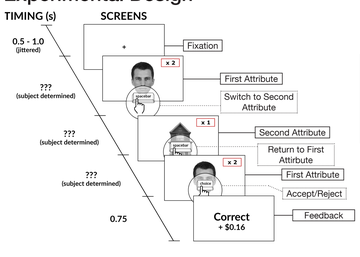


101 morphs, with values from -$1.00 to $1.00, were created. Morphs varied linearly in $0.02 increments.

Attribute Pair Example



Experimental Design



Payment Logic

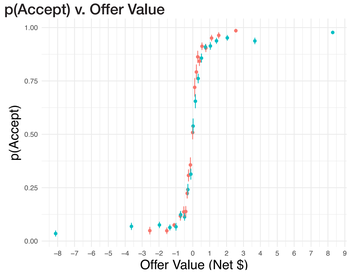
NET VALUE	CHOICE: Accept	CHOICE: Reject
> 0	Earn $	Lose $
< 0	Lose $	No Change

Four blocks of 100 trials.

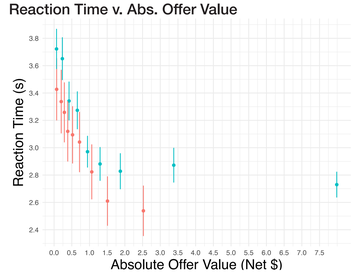
// RESULTS

// Basic Psychometrics

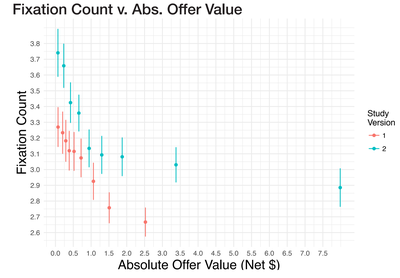
p(Accept) v. Offer Value



Reaction Time v. Abs. Offer Value

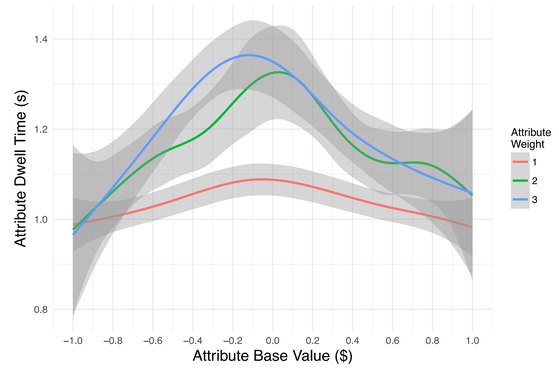


Fixation Count v. Abs. Offer Value

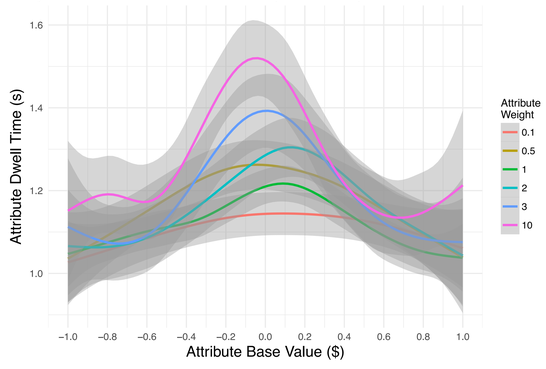


// Effects of Attribute Value & Weighting on Attention

Study 1: Dwell Time vs. Attribute Value (2nd fixation)



Study 2: Dwell Time vs. Attribute Value (2nd fixation)



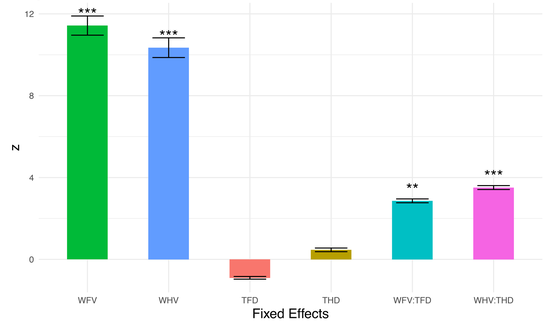
Attribute **attention** is **influenced by weighting** and **value**, but only for the second fixation (once all decision information is known). The initial fixation duration is unaffected by weighting.

// Attention, Value and Choice

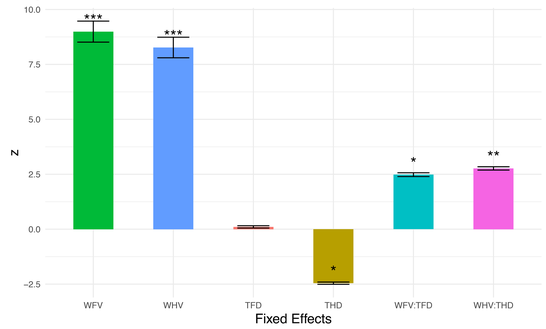
Mixed Effects Logistic Regression on Difficult* Trials

Choice~ Weighted Face Value (WFV) + Total Face Dwell Time (TFD) + Weighted House Value (WHV) + Total House Dwell Time (THD) + WFV x TFD + WHV x THD

Study 1



Study 2

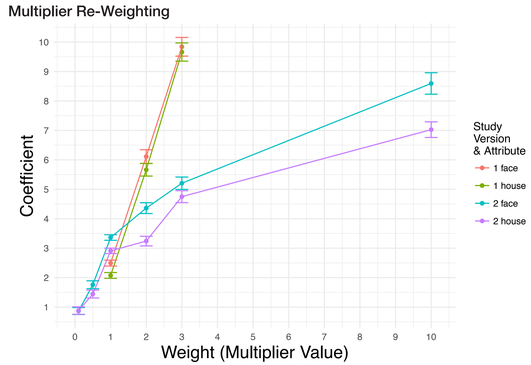


• Attention alone **is not** predictive of choice.
• The **interaction** between attention (total attribute dwell time) and value **is a significant predictor** of subject decisions.
• Results suggest that attention **amplifies** the influence of the target attribute.

* Difficult trials defined as those that have attribute values with opposite signs, and an absolute value of less than 0.25

// Attribute Re-weighting

Multiplier Re-Weighting



1. Subjects effectively re-weighted both attributes at all multiplier levels.
2. Subjects **weighted faces** significantly **more strongly** than houses across multiplier level.
2. Study 2 shows marked **range compression** in subject weighting of attributes.

// DISCUSSION

1. Attention, as measured by attribute fixation duration, is **not random**. It is affected by value and weighting.
2. Subjects **are able** to dynamically and **flexibly re-weight** attribute values, in order to make correct choices.
3. Attention influences choice when making difficult decisions.
4. Re-weighting reveals bias and distortion. More accessible attributes show **overweighting** (e.g. face attribute), and extreme weights (e.g. 10x) show value **compression**.
5. Future work aims to explore these effects in more natural contexts, using endogenous subject valuation and weighting, as well as employing neuroimaging to seek the neural correlates of these dynamic reweighting processes.

// REFERENCES

1. Belton, Valerie. (1986). A Comparison of the Analytic Hierarchy Process and a Simple Multi-Attribute Value Function. *European Journal of Operational Research 26* (1): 7–21.
2. Lim, S.-L., O'Doherty, J. P., & Rangel, A. (2013). Stimulus value signals in ventromedial PFC reflect the integration of attribute value signals computed in fusiform gyrus and posterior superior temporal gyrus. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience*, 33(20), 8729–8741.
3. Philiastides, M. G., Biele, G., & Heekeren, H. R. (2010). A mechanistic account of value computation in the human brain. *Proceedings of the National Academy of Sciences of the United States of America*, 107(20), 9430–9435.

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// FURTHER INFORMATION

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