Attention and value integration in multi-attribute choice

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// BACKGROUND

1. Decisions are often captured as a **weighted sum** over **multiple attributes** [1]:

$$\textit{Summed Value} = w_1 {*} a_1 + w_2 {*} a_2 + \ldots + w_n {*} a_n$$

where a is how "good" the attribute is, and w how "important".

2. Good decisions require **flexibly re-weighting** attributes based on contextual information [2].

3. To date most models looking at multi-attribute choice have not taken **attention** into account. Those that have, tend to ignore the affects of attribute value and weight on attention.

// GOALS

1. Paradigm Confirmation. Can we explicity track subject attention to attributes while manipulating value and weighting?

2. Attribute Re-weighting. Can people accurately and flexibly re-weight based on contextual information?

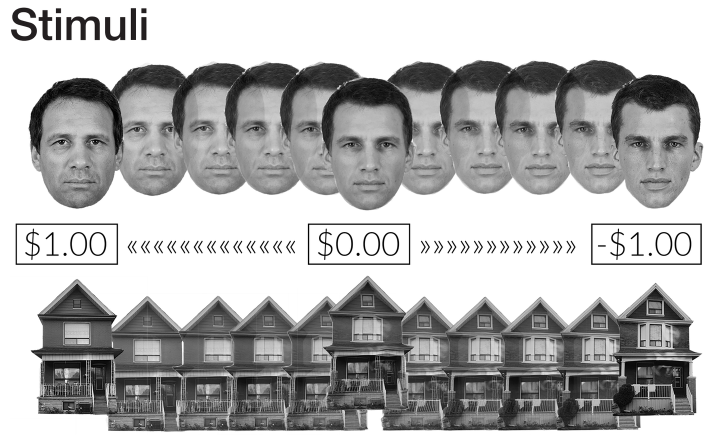
3. Attention/Value Interaction. Can we demonstrate that attention is not independent of value (as assumed in aDDM models)?

// METHODS

1. Subjects (n=23) learned to interpret values from morphed pairs of images of houses and faces.

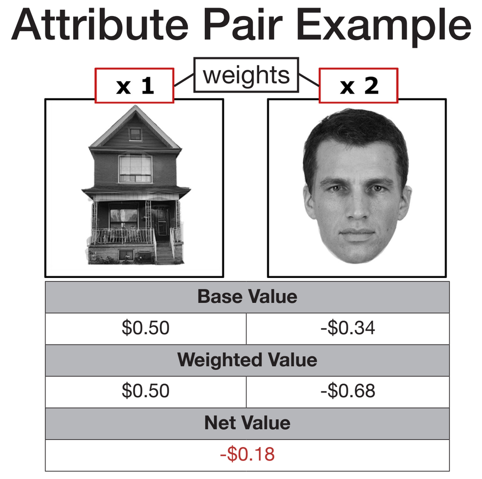
2. Subjects accepted or rejected a proposed combination of 2 attributes (1 face and 1 house) based on the summed value.

Stimuli



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

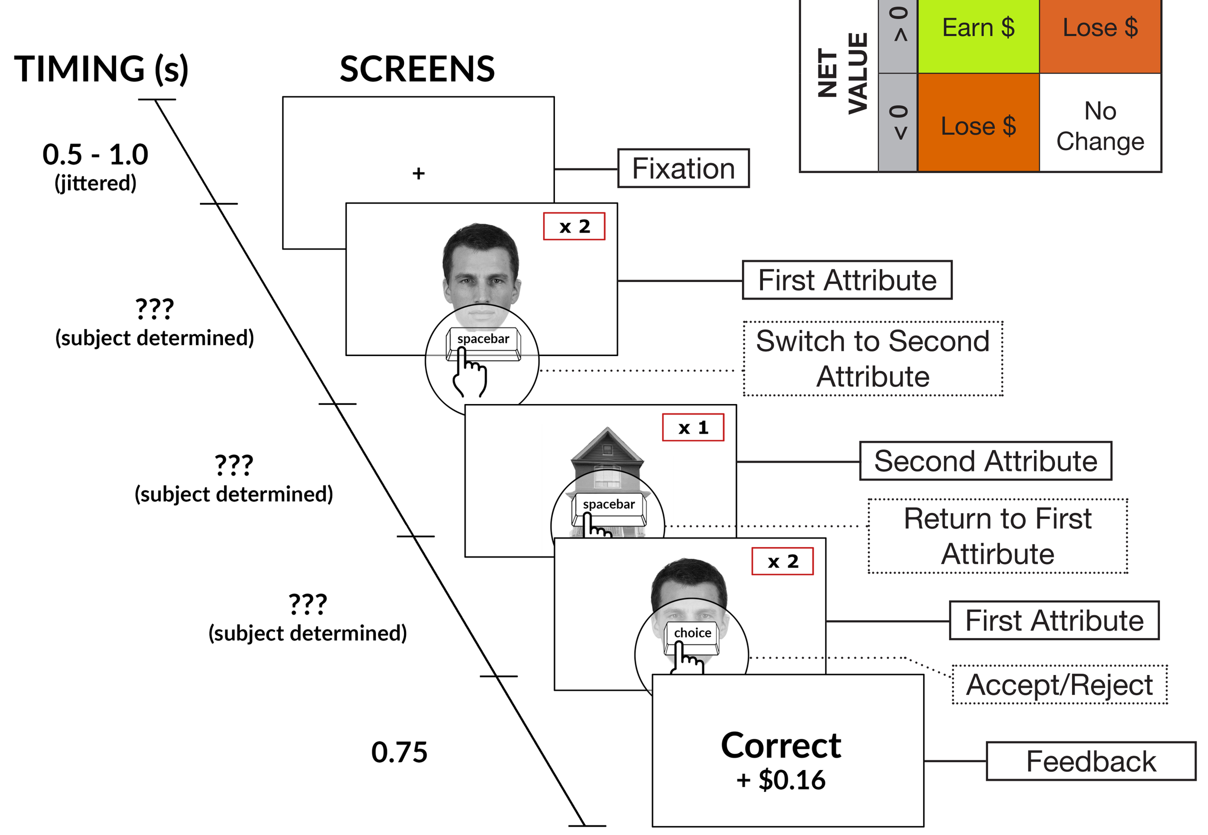
Attribute Pair Example



Payment Logic

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

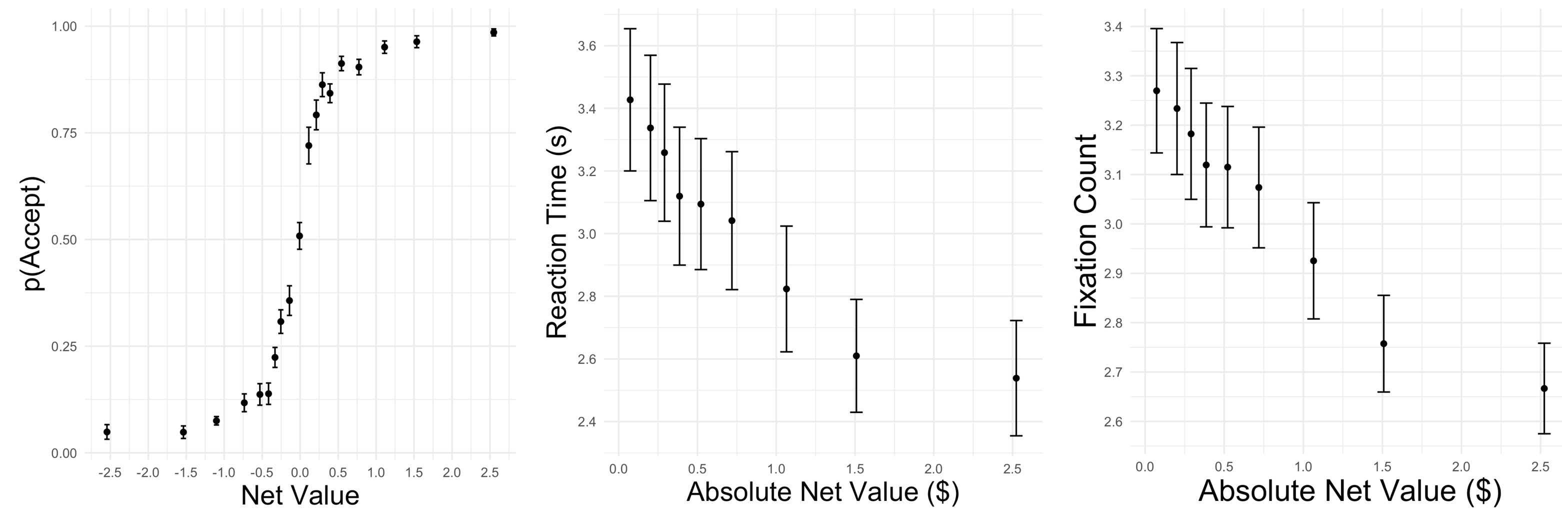
Experimental Design



100 trials with no multipliers. 3 blocks of 100 trials with multipliers.

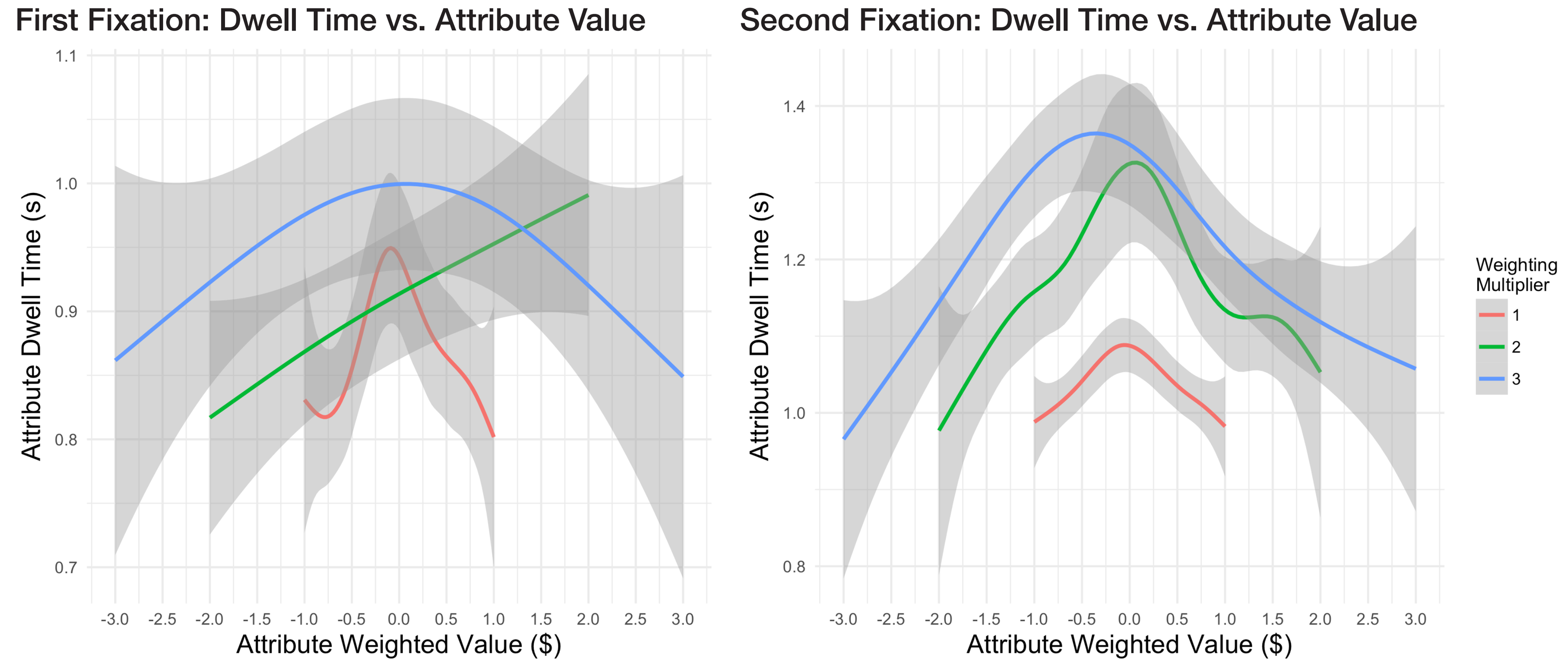
// RESULTS

// Basic Psychometrics



Basic psychometric plots confirm expected behavior.
There is **no evident choice bias** (p(Accept) @ $0.00 ≈ 0.5)

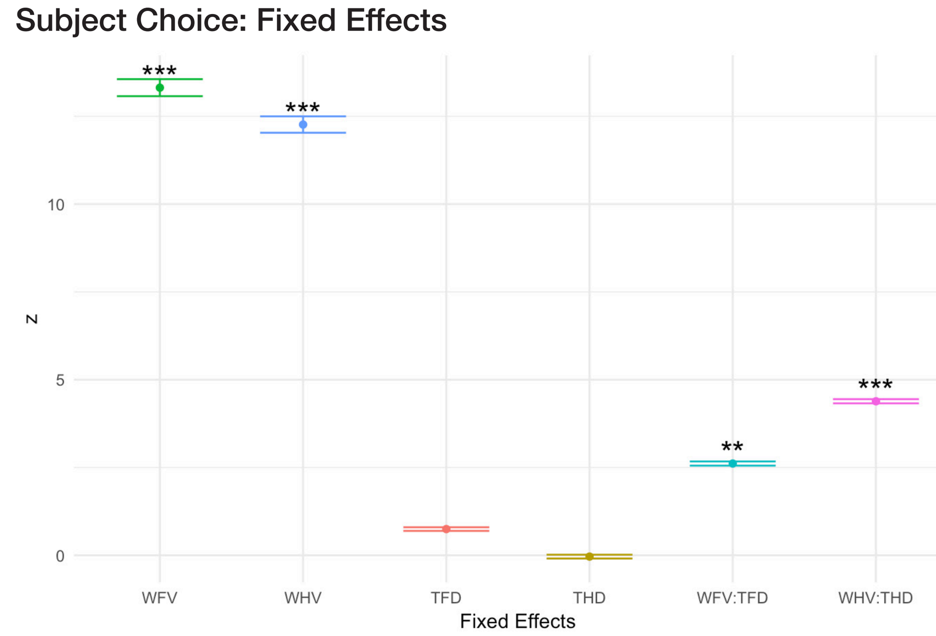
// Affects of Value on Attention



Weighting multiplier refers to the multiplier value present on each fixation's attribute.

During the second fixation attention is significantly affected by **both** attribute value and attribute weight.

// Attention, Value and Choice



WFV = weighted face value

WHV = weighted house value

TFD = total face dwell time

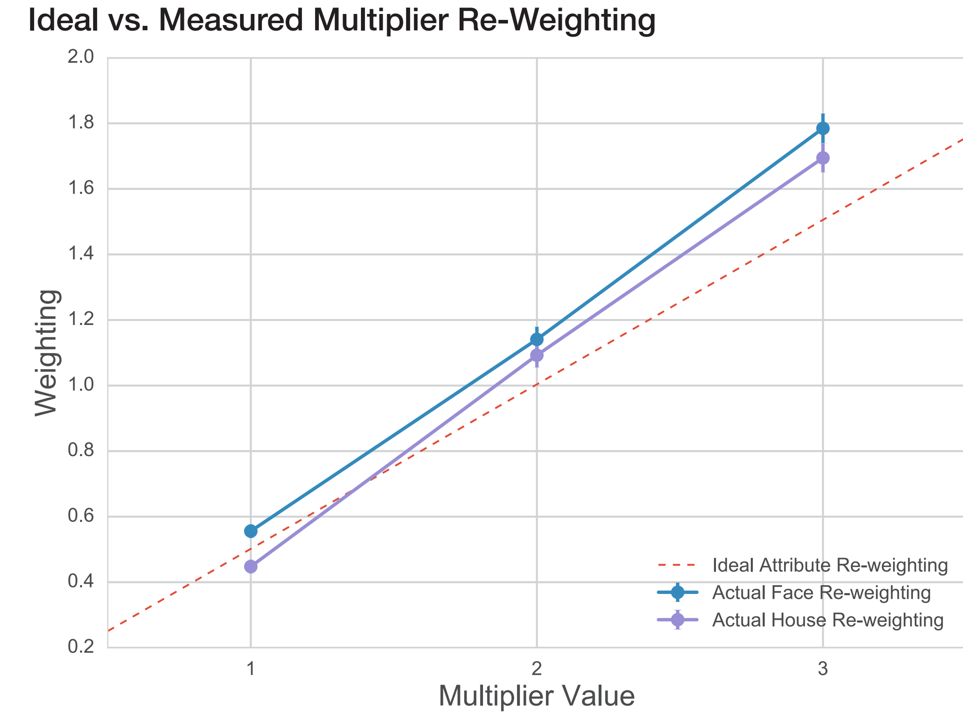
THD = total house dwell time

Mixed effects logistic regression:

Choice ~ WFV + TFD + WHV + THD + WFV : TFD + WHV : THD

Attention alone **is not** predictive of choice.
However, the **interaction** between attention (total attribute dwell time) and value **is a significant predictor** of subject decisions.

// Attribute Re-Weighting



Modeling

Group drift values were calculated by fitting a hierarchical Bayesian drift diffusion model (HDDM)[5]. Parameters modeled:

a (boundary): # of multipliers

$\mathbf{T_{er}}$ (nondecision): # of fixations

v (drift rate): $\beta_0 + \beta_1{*}Face_{M1} + \beta_2{*}House_{M1} + \beta_3{*}Face_{M2} + \beta_4{*}House_{M2} + \beta_5{*}Face_{M3} + \beta_6{*}House_{M3}$

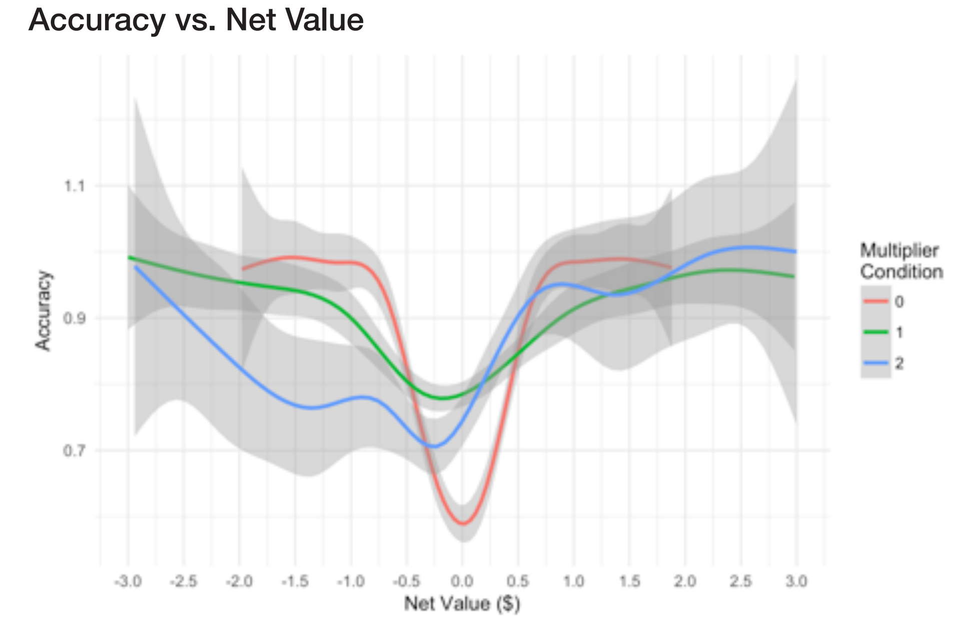
where the β coefficients (β_1-β_6) are the subject weightings of the multipliers (e.g. $Face_{M2}$ is a Face stimulus with a multiplier of 2)

Two sources of bias were found in re-weighting trials:

1. Subjects significantly **over-estimated the re-weighting effects** of multipliers applied to all attributes.

2. Subjects **weighted faces** significantly **more strongly** than houses at all multiplier level.

// Weighting, Value and Accuracy



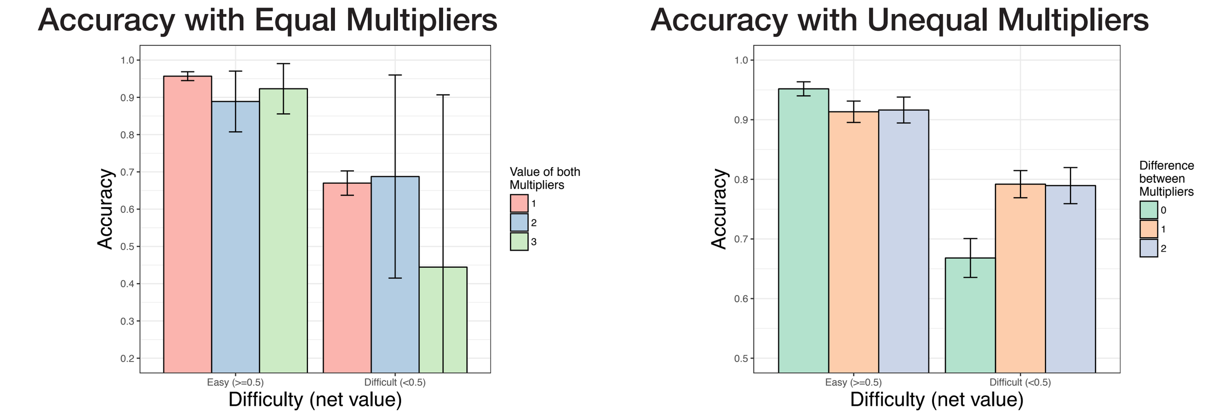
Multiplier Condition refers to the total number of multipliers (greater than x1) in a trial.

For **difficult trials** (-$0.50>Net Value>$0.50), subjects were **more accurate with attribute re-weighting** than without.

For **easy trials** this relationship reverses.

This effect does not exist for trials with two equivalent multipliers.

// Differential Re-Weighting and Accuracy



For the equal multiplier condition there were few trials with both a net value < $0.50 and two multipliers of weight 2 or 3.

// DISCUSSION

1. The proposed paradigm can track attention while manipulating value and weighting of attributes.

2. Subjects **are able** to dynamically and **flexibly re-weight** attribute values.

3. More accessible or discernable attributes may tend to be **overweighted**.

4. **Attention**, as measured by attribute fixation duration, **is not random**. It is affected by value and weighting.

// FUTURE DIRECTIONS

Imaging

Collect functional magnetic resonance imaging and electroencephalogram data in order to localize the neural correlates of attribute evaluation and weighting.

// REFERENCES

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// FURTHER INFORMATION

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