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Predicting variation in endowment effect magnitudes

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ABSTRACT

Hundreds of studies demonstrate human cognitive biases that are both inconsistent with "rational" decision-making and puzzlingly patterned. One such bias, the "endowment effect" (also known as "reluctance to trade"), occurs when people instantly value an item they have just acquired at a much higher price than the maximum they would have paid to acquire it. This bias impedes a vast range of real-world transactions, making it important to understand. Prior studies have documented items that do or do not generate endowment effects, and have noted that the effects vary in magnitude. But none has predicted any of the substantial between-item variation in those magnitudes across a large and novel set of items. Working from evolutionary theory, we derived six factors that predicted 52% of the between-item variation in magnitudes for a novel set of 24 items. These results deepen understanding of both the causes of and patterns in endowment effects. More broadly, they suggest that many other cognitive biases may be similarly approached, and potentially linked by a common theoretical framework.

1. Introduction

Behavioral scientists in many disciplines have long studied cognitive biases that lead people astray from "rational" decision-making (Corr & Plagnol, 2018; Kahneman, 1991; Kahneman, Slovic, & Tversky, 1982; Sunstein, 2000). Prominent among these is the "endowment effect," the finding that the minimum price people will accept to part with an item they have just acquired (here, "Sell Price") often greatly exceeds the maximum price they would have paid to acquire it ("Buy Price"; Knetsch & Sinden, 1984). This matters because, as over 1000 published articles have argued (per Arlen & Tontrup, 2015), society suffers when the ratio of those two prices is not 1:1 (Ericson & Fuster, 2014; Kahneman, Knetsch, & Thaler, 2008).

Specifically, endowment effects cause market inefficiencies in real-world transactions, such as those involving real property, contracts, intellectual property, employment, and consumer debt, as well as in allocations and trades of various legal rights (such as property rights). According to the influential Coase Theorem (Coase, 1960), society can increase efficiencies by reducing transaction costs, on the assumption that goods and services will then migrate through the market, winding up in the hands of the people who value them most. But in the presence of endowment effects – which decouple an owner's perceived value of an item from features that potential buyers can discern – goods and services will instead tend to stick longer, sometimes forever, to those hands that first received them, impeding efficient flow and distribution of resources (Arlen & Tontrup, 2015; McDermott, Fowler, & Smirnov, 2008). Predicting where endowment effects will occur, and how large those effects will be, is therefore important for behavioral scientists and policymakers alike (Jones & Brosnan, 2008; Zeiler, 2018).

We should note, at the outset, that the meaning of the word "endowment" varies across disciplines. We use the term "endowment effect" because it is the most prominent label for the phenomenon in the literature, but note that the use of "endowment" within the term should be read to mean ownership, the common meaning in Economics and in Law. This is a somewhat different meaning than readers in life science fields – for whom an organism's phenotypic features often reflect, in part, its genetic endowment – may otherwise assume.

Because the contexts that give rise to the endowment effect are only a subset of all trading behavior, an example – exaggerated for emphasis – will explain the fundamental points. Imagine you are seated across from a jeweler, with a watch that you are interested in purchasing resting at the mid-point of the small table between you. Privately, you

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know that the maximum you would pay for that watch (your Buy Price) is $500. Not a penny more. (And, to be clear, that is not your opening negotiating posture; it is your true, private bottom line.) The jeweler agrees to sell that watch to you for $450. And you promptly pay that sum in cash. Although the watch hasn't moved, it is now legally yours. You own it. At that instant, a third person walks into the store, likes the watch, learns it's yours, and quite credibly offers you $750 for it, in cash – take it or leave it – on the spot.

Now under traditional economic analysis, you *must* take the money, or you are dramatically irrational. That's because you already established, mere seconds ago, that you value $501 in cash more than that particular watch. Yet hundreds of studies designed to probe human behavior under buying and selling conditions indicate that a very large proportion of people would refuse to sell the watch for sums greater than $500. Indeed, this often true even when an offer is many multiples above the Buy Price (not just 50% more, as in our example). That the Buy Price and Sell Price differ indicates the presence of the endowment effect, while the ratio between the two prices is a measure of its magnitude.

Puzzlingly, the magnitude of the endowment effect varies considerably across items. For example, Heberlein and Bishop (1986) found that participants would pay no more than $25 to acquire a hunting permit while other participants, given such a permit, wouldn't sell it for less than $172—a nearly seven-fold endowment effect. In contrast, people are willing to pay about the same price to acquire coffee-table books ($17.94) as they would accept to part with them ($18.65) (Chapman & Johnson, 1995). (For reviews, see Horowitz & McConnell, 2002; Sayman & Öncüler, 2005; Plott & Zeiler, 2007; Tunçel & Hammitt, 2014; Zeiler, 2018).

At this point, one might wonder whether variations in the existence and magnitudes of endowment effects can be explained as economically rational, reflecting variations in the scarcity of the items in question. But unless there is a market-wide asymmetry in access to available information between buyers on one hand and sellers on the other, the scarcity of an item should affect each of them equally, as they *both* take the scarcity into account when determining their Buy Prices and Sell Prices, respectively. So while Sell Prices and Buy Prices may increase with scarcity, there still should be no difference between them, and hence no endowment effect. Endowment effects are irrational for pencils and Picassos alike.

Although some studies have documented variation in endowment effect magnitudes across particular categories of items (e.g., Chapman & Johnson, 1995), most studies investigate the effect using a particular item or two (e.g., Maddux et al., 2010; Morewedge, Shu, Gilbert, & Wilson, 2009). No single study has systematically attempted to explore factors that might predict how the endowment effect varies in magnitude across a large set of novel items. It is curious there has been so little work on these between-item variations in magnitude (Zeiler, 2018), given the potential of such work to illuminate the effect's origins and patterns (Jones, 2018; Jones & Brosnan, 2008). This may reflect that many prominent causal theories of the endowment effect do not make any predictions about how magnitudes will vary across items.

Causes of the endowment effect remain hotly debated (see Bruner, Calegari, & Handfield, 2019; Morewedge & Giblin, 2015; Zeiler, 2018). Many argue that the effect is caused by loss aversion (Kahneman, Knetsch, & Thaler, 1990, 1991), which features prominently in theories of reference dependence (Koszegi & Rabin, 2006; Tversky & Kahneman, 1991), such as Prospect Theory (Kahneman & Tversky, 1979). Others ascribe the phenomenon to self-association (Gawronski, Bodenhausen, & Becker, 2007; Morewedge et al., 2009), to psychological inertia (Gal, 2006), or to value construction (which is based on a person's sampling of each item's attributes; Johnson & Busemeyer, 2005; Stewart, Chater, & Brown, 2006; Willemsen, Böckenholt, & Johnson, 2011). These approaches have sometimes suffered the criticism that they are more descriptive than predictive, and merely explain one psychological phenomenon, the cause for which is unknown, with another psychological phenomenon, the cause for which is also unknown (Klass & Zeiler, 2013; McCaffery, 1994). Some important contributions have shown the sensitivity of the endowment effect to experimental conditions (Plott & Zeiler, 2005a, 2005b, 2007), or have mathematically modeled the effect as a reaction to the twin risks of over- and underestimating an item's value (Bruner et al., 2019). Others have suggested that a wide set of cognitive biases, generally speaking, may have origins in our species' evolutionary history. Publications proposing error management theory (Haselton & Buss, 2000), ecological rationality (Gigerenzer, 2000), and time-shifted rationality (Jones, 2001a, 2001b) independently (and virtually simultaneously, within the span of several months) argued that a great many cognitive biases likely reflect mismatches between evolved cognitive adaptations to environments long past, on one hand, and the novel environments in which humans now live, on the other. This is in much the same way that our evolved taste for sweets, which long led our species adaptively to seek high-calorie foods, is mismatched to an environment that suddenly supplies refined, ubiquitous, and cheap sugars.

In this vein, and addressing the endowment effect specifically, Jones proposed it may reflect a specific time-shifted rationality (Jones, 2001a), whereby a psychological leaning to favor what one has over what one could acquire was substantively rational (as economists use that term, meaning that on average it results in the maximum utility, or benefit, for that individual) over our species' evolutionary history, despite predisposing us to irrational outcomes in modern, evolutionarily novel contexts. Specifically, the absence, across nearly all our evolutionary history, of modern inventions like abstract and tradeable property “rights” and reliable third-party mechanisms to enforce trade left it inherently risky for a member of a social species to give up an item in hand for the chance to exchange it for something potentially slightly better. In short, giving up one thing for another risked having neither in the end. And natural selection may therefore have favored any tendency to discount the value of an item that might be acquired in a trade, compared to the value of what was already possessed.

It is important to note, at the outset, that this time-shifted rationality hypothesis for the origins and patterns of the endowment effect is rooted in the well-known capacity of natural selection to create psychological and behavioral predispositions that, on average, lead to better outcomes to individuals over evolutionary time. For this reason, the hypothesis does not require – or even expect – that an individual be consciously aware of, or concerned about, the evolutionary reasons (or indeed any reasons) for the predisposition. Nor does it assume conscious motivation of the individual to achieve the evolutionarily adaptive result as a consequence of the behavior (just as an evolved predisposition toward sexual intercourse does not require the conscious motive to make babies). With respect to the endowment effect, if these are evolved predispositions, nothing in the underlying logic of the hypothesis requires that traders rely on higher-order cognition to represent or reason about the mental states of potential trading partners (cf. Bruner et al., 2019). The differential risks of holding versus trading can create selection pressure that contributes to the evolution of context-specific and risk-sensitive behavioral predispositions without any conscious appreciation of risk. Indeed, trade's riskiness, in the absence of reliable enforcement mechanisms, may explain the rarity of trading behavior between individuals in other species (Brosnan & Beran, 2009).

The time-shifted rationality perspective generated several unique predictions about the endowment effect. First, it would likely be observable in at least some other species, including close primate relatives, because it would likely have been adaptive for them as well. Second, the prevalence of the effect in species would vary across categories of items, because not all items that might be lost in trade have equal impacts on evolutionary fitness (i.e. surviving, thriving, and reproducing). Third, the prevalence and magnitude of the endowment effect for particular items would tend to correlate positively with the degree to which items of that type were relevant, under ancestral conditions, to evolutionary fitness. That is because the larger the effect

of any item's possession on fitness, over evolutionary timescales, the stronger are the psychological and behavioral predispositions, regarding it, that natural selection tends to generate.

Jones, Brosnan, and colleagues found evidence supporting all three predictions in non-human primates. The first papers in their series of studies compared endowment effects for items within two different categories, which differ by the fitness value (high or low) of the items they contain. Specifically, one category involved items, in this case foods, for which there are likely psychological systems that evolved to assess expected fitness value. The second category involved items, in this case toys, for which there likely are not (or there are, but to a far lesser extent) psychological systems that evolved to assess expected fitness value. For convenience, we will refer to variations in the fitness value of items or contexts as variations in "evolutionary salience."

Using a paradigm similar to Knetsch (1989), the researchers allowed chimpanzees to express a preference between two offered items in one condition, and to trade, in two other conditions, either item for the other. Chimpanzees were 14 times as likely to keep their less-preferred food item when they could have traded it for their preferred food item (indicating an endowment effect) than they were to keep their less-preferred toy when they could have traded it for their preferred toy. This was true both across- and within-subjects (Brosnan et al., 2007). The same pattern was found in other apes (Drayton, Brosnan, Carrigan, & Stoinski, 2013; Flemming, Jones, Mayo, Stoinski, & Brosnan, 2012; Kanngiesser, Santos, Hood, & Call, 2011) and monkeys (Lakshminaryanan, Chen, & Santos, 2008).

Following this result, Brosnan, Jones, Gardner, Lambeth, and Schapiro (2012) predicted that the magnitude of endowment effects could be increased or decreased, for the very same objects, by manipulating the context. In a test of this prediction, chimpanzees could trade food-extracting tools that had no inherent value, and did so either in the presence or absence of food (in the within-subjects design, subjects participated in all conditions in randomized order). Subjects exhibited no endowment effect for tools when foods were absent or present but out of reach, yet exhibited a strong endowment effect for the very same tools when foods they could extract were both present and reachable. This suggests chimpanzees' endowment effects are considerably larger in contexts that render tradable items more immediately salient.

This group of findings suggested that evolutionary salience underlies the endowment effect, and that it can explain variability in the effect both across items and situations. However, this cross-species work did not provide direct evidence that variance in evolutionary salience can predict any of the variance in endowment effect magnitudes in humans. And no study has yet predicted such variance across a set of items (Zeiler, 2018).

We therefore developed a short, broadly-applicable set of six prompts to quantify the evolutionary salience of items. In Stage 1, one group of participants rated each item, in a set of 24, according to those prompts. In Stage 2, different subjects responded to either standard Sell Price or Buy Price scenarios for the 24 items, enabling calculation of an endowment effect magnitude for each item.

We predicted that items with greater relevance to evolutionary fitness (i.e., health, reproductive opportunities, and the like) would invoke larger endowment effects than would potentially-useful items less relevant to fitness. More specifically, we predicted that evolutionary salience scores from Stage 1 would predict some of the variation in endowment effect magnitudes found in Stage 2.

2. Stage 1: measuring evolutionary salience

2.1. Method

2.1.1. Participants

We sampled 100 participants to rate items in response to prompts. All participants were U.S. residents over the age of 18, and each was paid $2.50 to complete the 19-min study via Amazon Mechanical Turk. After applying a priori exclusion criteria, 87 participants (33 female; ages 21–71 years, mean = 35.79 years) were included in final data analyses. Of the excluded participants, four were excluded due to duplicate IP addresses or geographic locations, three were excluded for incorrectly answering basic attention checks, and six were excluded because their data failed to satisfy an a priori criterion for attentiveness (their ratings were uncorrelated with the sample's mean ratings, r's $<$ 0.175 compared with an average participant-to-population r of 0.809).

2.1.2. Materials and procedure

Working from evolutionary theory, we derived a short series of salience-relevant prompts intended to be broad enough to apply to any item of interest, and straightforward enough to be understood by novice raters. After pilot testing, we selected six prompts to constitute a composite evolutionary salience score between 6 and 54 for each item:

(1) Having the following would benefit a person's health.
[1 = "strongly disagree" to 9 = "strongly agree"]
(2) Having the following tends to increase a person's attractiveness to potential dates.
[1 = "strongly disagree" to 9 = "strongly agree"]
(3) Having the following would increase a person's social status.
[1 = "strongly disagree" to 9 = "strongly agree"]
(4) People often define the "basic human needs" as things such as food, clothing, or shelter. Please rate the extent to which having the following would be helpful for satisfying a basic human need on a scale from 1 ("not at all helpful") to 9 ("extremely helpful").
(5) Please rate how valuable the following is or would be on a scale from 1 ("worthless") to 9 ("enormous value").
(6) "Tangible" items are usually physical and can often be touched by hand, while "intangible" items are more abstract, and often exist only in the context of something else. Please place the following along the continuum from "tangible" to "intangible" by rating it on a scale from 1 (completely tangible) to 9 (completely intangible).

The first and fourth prompts were included based on their relevance to thriving and survival (even though, as mentioned earlier, it is not necessary to the hypothesis that any person be consciously concerned with the fitness values of tradeable items). The second and third prompts were included based on their relevance to reproductive opportunities. The fifth prompt was included as a broader measure of value that might tap forms of evolutionary salience that participants have difficulty verbalizing. (Of course, an evolutionary perspective suggests a generally positive correlation, on average, between things one "values" and things that have proved evolutionarily salient across our species' history, and indeed suggests the latter often underlies the former.) Lastly, because the cognitive machinery for valuing tradeable items that can be seen and touched vastly predates the still brand new (in evolutionary terms) emergence of tradeable abstractions (such as a *right* to a thing), we included a tangibility prompt, predicting that participants would show a stronger endowment effect for tangible than intangible items.

We did not predict that ratings on all of our salience prompts would be perfectly aligned. In the same way that an organism's features (such as overall size) can increase fitness in some conditions while decreasing it in others, some of our prompts will pull the overall score for certain item in opposite directions. For instance, an item with the capacity to satisfy a person's basic needs (e.g. an apple) might also contribute little if anything to a person's social status. We observed how items fared, cumulatively, on our measure by summing ratings (and examining correlations) across prompts. Specifically, for each item, the response to the tangibility prompt was reverse scored, and then summed with the other five responses to yield a total evolutionary salience score.

Using these six prompts, participants rated each of 24 items. The items (listed in Table 1) were intended to elicit responses across the spectrum for each prompt. To avoid potential bias, 22 of the 24 items

Table 1
Evolutionary salience score and endowment effect magnitude for each item.

	Evolutionary salience score	Endowment effect magnitude
One year's worth of a rare and safe pill that enables a person to maintain ideal weight	39.76	1.846*
A lifetime's worth of dental treatments providing healthy teeth and gums	39.28	1.395*
An entitlement to the best available healthcare, for life, for free	38.43	1.703*
A half-pound of pure gold	38.41	1.421*
A luxury car widely recognized as expensive and well made	36.68	1.132*
A lifetime supply of toothbrushes that minimize tooth and gum irritation during brushing	35.80	1.299*
A warm coat for cold weather	35.43	0.906
A pair of shoes widely recognized as expensive and well made	35.36	1.091
One year's worth of a rare and safe pill that enables a small and temporary memory boost	33.53	1.705*
A brand new smartphone	32.57	1.037
A high-end bottle of wine	32.10	1.172
A new and expensive hair product that makes hair look and feel its sexiest	30.80	1.181
A pair of mid-cost sneakers	28.90	0.951
A ripe apple	28.13	0.750
A knitted wool cap, of random colors	25.69	0.893
A new hard-copy dictionary	21.51	0.862
A leather bookmark	20.46	0.902
A ceramic mug	20.20	0.786
A desktop strobe-light	19.56	1.074
A “Mummy” Halloween costume	19.20	0.842
An annual membership in a streaming video service	18.95	1.020
A brand new plastic pencil cup	17.79	0.877
A voucher for a free ceramic mug	17.07	0.904
A half-pound of styrofoam packing peanuts	16.95	0.848

Note: An item's endowment effect magnitude was calculated by dividing its mean (log-transformed) Sell Price by its mean (log-transformed) Buy Price. Significant endowment effects (with Bonferroni-corrected alpha of 0.05/24 = 0.00208) are denoted with an asterisk; for each, $t(114) \geq 4.164$, $p < .001$, $d \geq 0.773$ (details provided in Supplemental Online Materials Table S2).

had not, to our knowledge, previously been the subject of endowment effect studies. Thus, we could not pick items based on information about their associated endowment effects. The two exceptions were a ceramic mug and a voucher for a ceramic mug, which were included to investigate whether participants differentiated these frequently-studied items in terms of tangibility.

Prompts were presented in random sequence. Participants responded to a particular prompt for all 24 items (also presented in random sequence), then moved on to the next prompt. Each participant responded to a total of 144 prompt-item pairings.

2.2. Results

Participants' ratings showed excellent interrater reliability, $ICC(2,87) = 0.99$. Ratings were consistent across sex: men's average ratings for items were closely correlated with women's average ratings, $r = 0.99$. Participants' ratings also appeared valid: items one would expect to be rated particularly high or low on a dimension tended to be so rated. For example, with respect to the social status prompt, participants most strongly agreed with the statement that owning a luxury car would increase their social status (M = 8.06), and most strongly disagreed with the statement that owning a half-pound of Styrofoam packing peanuts would increase their social status (M = 1.70).

Table 1 shows the mean ratings for each of the 24 items. For mean item ratings on each of the six salience-related prompts, see Supplemental Online Materials Table S1.

3. Stage 2: predicting endowment effect magnitudes

3.1. Method

3.1.1. Participants

We recruited 150 adult U.S. residents. Each participant was paid $1.20 for completing the 10-min study on Mechanical Turk. After applying a priori exclusion criteria, 116 participants (42 female; ages 21–64 years, mean = 35.28 years) were included in final data analysis. Of the excluded participants, 13 were excluded due to duplicate IP addresses or geographic locations, three were excluded for incorrectly answering basic attention checks, and 18 were excluded for incorrectly answering an instruction check (described below) testing whether they distinguished Sell Price and Buy Price.

3.1.2. Materials and procedure

In Stage 2, we ascertained endowment effect magnitudes for the 24 items used in Stage 1. The purpose was to test how strongly the evolutionary salience scores obtained in Stage 1 predicted these magnitudes.

Like most endowment effect studies, Stage 2 used a between-group paradigm. Our methods were adapted from Chapman and Johnson (1995). Participants were assigned randomly to one of two conditions: the Sell Price condition or the Buy Price condition. Participants in the Sell Price condition ($N = 57$) were instructed to assume that they currently possessed each item and asked to indicate (in U.S. dollars) the minimum amount of money that they, personally, would accept to sell the item. Participants in the Buy Price condition ($N = 59$) were instructed to assume that they did not currently possess each item, and asked to indicate (in U.S. dollars) the maximum amount of money that they, personally, would pay to buy the item. Next, participants answered a multiple choice instruction check question, which asked them to identify the instructions they had read from among the Sell Price instruction, the Buy Price instruction, and two distractor instructions. Participants then proceeded to evaluate the 24 items (presented in random sequence).

Our approach allowed us to use precisely the same method to elicit Sell Price and Buy Price for all 24 items of interest, which included some items (such as “one year's worth of a rare and safe pill that enables a person to maintain ideal weight”) that could not be studied with real-item exchange methods. While participants did not make actual exchanges in our paradigm, prior articles have noted that gaps between Sell Price and Buy Price are comparable in experiments using real versus hypothetical exchanges (Horowitz & McConnell, 2002; Morewedge & Giblin, 2015).

3.2. Results

Participants' Buy Prices and Sell Prices were not normally distributed, so we performed log transformations[1] on these variables before conducting our analyses. Male participants' average Buy Prices and Sell Prices for items were closely correlated to female participants' average Buy Prices and Sell Prices ($r = 0.99$ and $r = 0.98$, respectively).

Averaging across all items, we observed a significant endowment effect. Participants' mean Sell Price ($123.60 in back-transformed dollars) significantly exceeded participants' mean Buy Price ($54.09 in back-transformed dollars; $t(114) = 6.023$, $p < .001$, $d = 1.119$).

More importantly, for our purposes, the relationship between Sell Price and Buy Price varied substantially across items. For seven items, we observed significant endowment effects: Bonferroni-corrected independent-samples *t*-tests revealed that Sell Prices were significantly greater than Buy Prices (see Table 1). For other items, Sell Price and Buy Price did not significantly differ.

Our ultimate research question was whether an item's evolutionary salience score from Stage 1 predicted its endowment effect magnitude (i.e. the ratio of its Sell Price to its Buy Price) in Stage 2. A regression revealed that evolutionary salience scores significantly predicted endowment effect magnitudes, accounting for 52% of the variance, $r = 0.721$, $R^2 = 0.520$, $p < .001$ (see Fig. 1). Further, all of the seven individual items for which we observed significant endowment effects were among the top nine in evolutionary salience (see Table 1).

Each of the six evolutionary salience prompts, taken individually, was itself a significant predictor of endowment effect magnitude. Table 2 summarizes the correlations among mean ratings on each of the six individual prompts, total evolutionary salience score, and endowment effect magnitude.

While five of the six evolutionary salience prompts were significant predictors in the expected positive direction, the sixth prompt—concerning tangibility—was a significant predictor in the negative direction. Specifically, items rated *less* tangible had *greater* endowment effect magnitudes, which was opposite our prediction. For this reason, we reran the analyses excluding the tangibility prompt, and found that evolutionary salience accounted for 10% more variance in endowment effect magnitude, $r = 0.792$, $R^2 = 0.627$, $p < .001$, indicating that the predictive power of the six-prompt tool did not depend on the tangibility prompt.

Because the value rating was broad and may have encompassed non-evolutionary factors, we verified that predictiveness of our scale remained strong even without it. Predictive power remained strong when we removed the value prompt ($r = 0.671$, $R^2 = 0.450$, $p < .001$), and when we removed both the value and tangibility prompts, leaving only 4 prompts remaining ($r = 0.775$, $R^2 = 0.601$, $p < .001$).

4. General discussion

This paper is the first to successfully predict variation in the magnitudes of endowment effects across items. In Stage 1 of our study, participants responded to a set of prompts designed to assess items' evolutionary salience, demonstrating very high consistency in their ratings of 24 different items. A separate set of participants then indicated either the maximum they would pay to obtain each item, or the minimum they would require to sell it if they already owned it. As predicted, evolutionary salience scores from Stage 1 predicted endowment effect magnitudes observed in Stage 2, explaining 52% of the variance. In addition, we observed significant endowment effects for seven of the top nine rated items in terms of evolutionary salience, and for none of the bottom fifteen rated items. The three largest endowment effects we observed were for items related to good health (lifetime health care, weight loss pill) and ability (memory pill). Our data demonstrate a previously unobserved relationship between evolutionary salience and endowment effects in humans, which was predicted by time-shifted rationality theory.

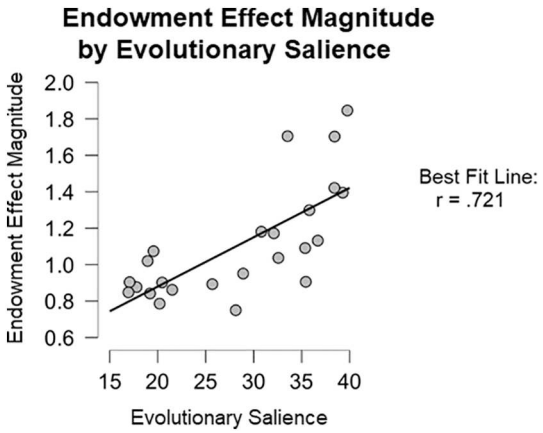

Fig. 1. Relationship between endowment effect magnitude (on Y axis) and evolutionary salience (on X axis). Each of the 24 plotted dots represents one of the 24 items studied.

For this study, we intentionally selected items to test the predictive power of our approach. As a result, we would not expect that using our evolutionary salience tool will always predict more than half of the variance for any future study of endowment effects, using any set of items. The 24 items that we used as test cases included an array of items considered in advance to be of high or low evolutionary salience, which provided a maximum opportunity for our participants' ratings to vary, and to thus reveal the success or failure of the scoring tool in predicting endowment effect magnitudes. Therefore our experiment validated the power of this tool in predicting variation in magnitudes, but this tool may predict less of the variation in magnitudes under other conditions, such as studies involving items that are more uniform in evolutionary salience.

Although our six prompts predicted a substantial amount of variation in magnitudes of the endowment effect, one finding was unexpected. The tangibility criterion showed the opposite pattern from that predicted, with subjects showing a stronger endowment effect for items rated *less* tangible. We do not have a good explanation for this. Perhaps most of the items that scored highest on the other salience prompts (such as an entitlement to healthcare) happened to be intangible. Or perhaps presenting items only as abstractions represented by words is a poor way to test whether the cognitive machinery for valuing items that can be seen and touched generates larger endowment effects than the cognitive machinery that values abstractions. Future work should explore these and other possibilities to determine the role of tangibility in the endowment effect.

We also found that an item's value is a strong predictor of its endowment effect magnitude, independent of the other prompts. Three things are worth noting in this regard. First, this is unsurprising; as mentioned earlier, value is a more abstract and general measure, highly correlated with the other evolutionary salience prompts (see Table 2). Second, the predictiveness of the evolutionary salience prompts as a set does not depend on the value prompt. In fact, if value is excluded, the remaining five prompts together account for 45% of the variance in endowment effect magnitudes; if both value and tangibility are excluded, the remaining four prompts account for 60%. Third, it would be a conceptual mistake to consider value, because of its predictive power, as somehow a free-standing explanation, independent of and alternative to that of evolutionary salience. This is because, from a biological perspective, features of an organism always reflect two distinct necessarily interdependent categories of causes: proximate causes

[1] Log transformed price = $\log_{10}$(price +1).

Table 2
Correlations among responses to individual evolutionary salience prompts, total evolutionary salience scores, and endowment effect magnitudes.

Pearson correlations								
	Health	Dates	Social Status	Basic Human Need	Value	Tangibility	Ev. Salience	EE Magnitude
Health	–							
Dates	0.476*	–						
Social Status	0.316	0.945***	–					
Basic Human Need	0.899***	0.416*	0.290	–				
Value	0.594**	0.902***	0.920***	0.574**	–			
Tangibility	−0.527**	−0.308	−0.247	−0.357	−0.434*	–		
Ev. Salience	0.736***	0.881***	0.824***	0.748***	0.920***	−0.248	–	
EE Magnitude	0.680***	0.721***	0.670***	0.460*	0.790***	−0.573**	0.721***	–

* $p < .05$.
** $p < .01$.
*** $p < .001$.

(which are more immediate and mechanical) and ultimate causes (which reflect evolutionary processes and species history). In this case, the perception of an item's value is a proximate cause and its evolutionary salience is an ultimate cause, so these explanations are complementary, providing an answer to two different levels of analysis, rather than contradictory. Put another way, species have generally evolved to place a high value on types of things that historically made strong contributions to fitness, much as organisms evolved to prefer sweet foods because of their high caloric value, or evolved to prefer helping others because of the long term benefits reciprocal relationships may bring.

Our results suggest several avenues for future research. New endowment effect studies using other item sets and valuation mechanisms may help define the contours and contexts of evolutionary theory's predictive power. Also, future meta-analytic work might investigate the relationship between evolutionary salience of previously-studied items and their endowment effects, while controlling for confounding variables. Future studies proposing and testing new factors relating to the endowment effect (e.g. cultural variation, Maddux et al., 2010; Apicella, Azvedo, Christakis, & Fowler, 2014) may help uncover additional contributions to the unexplained variance in endowment effect magnitudes. And our salience tool may be useful to future studies in psychology (e.g. of depression, religious tenets, or marketing campaigns) and biology (e.g. of mating behavior) beyond cognitive bias contexts, because although evolutionary salience is frequently discussed in the behavioral sciences, it remains unquantified.

Finally, and perhaps most importantly, the time-shifted rationality approach that we have applied to the endowment effect might usefully extend to a large number of the dozens of other cognitive biases that researchers have already discovered, such as those reflected in hyperbolic discounting, availability heuristics, framing effects, base rate fallacies, illusory correlation, biases in optimism and pessimism, status quo bias, inconsistent preferences, and mistaken assessments of probabilities.

This study continues a series of papers that has systematically explored specific endowment effect predictions of the time-shifted rationality theory. Time-shifted rationality – a theory that traces some currently irrational cognitive biases to evolved psychological adaptations that were beneficial in our evolutionary past – suggests that the endowment effect evolved as a cognitive adaptation through the process of natural selection. Specifically, abstract property rights and reliable third-party enforcement mechanisms were almost entirely absent during most of our evolutionary history, leaving trades far riskier than they are today, and making a predisposition to often favor actual possessions over theoretical possessions more successful than alternative predispositions.

This theory generated hypotheses that the endowment effect should be seen in closely related species, that it should vary across items, that evolutionarily salient items will more frequently evoke the effect, and that the very same items will evoke the effect more often in evolutionarily salient contexts than in others. Our previous work with primates found evidence consistent with all these hypotheses—hypotheses that no other endowment effect theories generate, either singly or together (Brosnan et al., 2007; Brosnan et al., 2012).

The current study provides further support for this theory, finding both that the magnitude of the endowment effect varies across items and that evolutionary salience predicted 52% of that variability. The success of an evolutionary perspective in predicting variation in endowment effect magnitudes suggests, more broadly, that a common theoretical understructure, rooted in the effects of natural selection on behavioral predispositions, may connect a broader set of cognitive biases together, beyond the borders of the endowment effect alone.

Author contributions

CBJ, SFB, and ODJ developed the concept and study design. CBJ collected, analyzed, and interpreted data with input from all authors. CBJ and ODJ prepared the initial draft of the manuscript and all authors contributed to the writing. All authors approved the final version of the manuscript for submission.

Data availability

The data associated with this research are available at https://osf.io/dqm8p/files/.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2020.04.002.

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