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Response time in choosing the most or least preferred option

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Abstract

When a choice yields an uncertain future value, choosing the most preferred among many options is more demanding than excluding one, because the first task requires comparing all the options while the second task requires only finding one stochastically dominant binary relation. Even when a choice does not have any future value, choosing the most preferred one is cognitively costlier than choosing the least preferred. All else being equal, choosing the most preferred option from eight images selected at random takes more time than choosing the least preferred. Also, consistent with binary choice studies, the response time is shorter when preference orders are more distinct.

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1 Introduction

I ran a paid online survey to answer the following question: "Is choosing the most preferred among many options cognitively costlier than choosing the least preferred, even when the choice doesn't yield any future value?"

Each survey question had eight images randomly selected from the Internet. Every odd-numbered question was to choose the most preferred image among the eight, and every even-numbered question was to choose the least preferred. Payment for participation didn't depend on the choices.

The regression results of the response time are shown in Table 1. The coefficients with two asterisks are statistically significant at the 5% level. *DChoose1* is a dummy variable indicating whether the question was to choose the most preferred image, *Round* captures a time trend and *Top12ratio* is the ratio of the choice frequency of the most preferred image to that of the second most preferred.[1] Each of the other dummy variables, labeled as Dn, indicates the theme of the images. For example, $D1$ indicates that the images were about cities, and $D4$ indicates images about food.[2] The negative coefficient on *Top12ratio* captures a well-documented observation: When the preferences on images are distinct, choosing one image was done more quickly (Krajbich et al. (2014)). Also the negative coefficient on *Round* captures that the participants made faster decisions as they got farther into the survey. I claim that the positive coefficient of *DChoose1* is a new observation.

There are many studies analyzing response times to help understand the cognitive costs of making choices. Though response time in a binary choice is studied well,[3] observations from binary choices were not good enough to tell how choosing the most preferred option is different from choosing the least preferred, because in a binary choice both are simultaneously determined. If the response time depends on how preference orderings are distinct, we may infer the cognitive costs from observed response times (Saito and Echenique (2015)). However, past research hasn't tested whether the cognitive costs depend only on preferences, or whether revealing the most preferred option is cognitively costlier than doing the least preferred.

2 Experimental design and procedure

One hundred participants were recruited from the Amazon Mechanical Turk. The survey consisted of 26 main questions, each asking to select an image from eight randomly collected images, one question on gender, one on and age and 4 auxiliary questions that addressed other possible issues.

Main questions: In the odd questions, subjects were asked to choose the most preferred image. In the even questions, where all the choices were preselected, they were asked to

[1] If I had collected images completely indifferent, as I intended, the ratio should have been close to 1.

[2] Another theme of the images was wildlife, which was not coded as a dummy due to multicollinearity.

[3] See Luce (1986) and Krajbich et al. (2014) for the surveys.

Table 1: Regression result: Pooled sample, $n = 2600$, Demographic dummies included

Response Time	$\hat{\beta}$	p-value	$\hat{\beta}$	p-value	$\hat{\beta}$	p-value
Constant	15.1825***	< 0.001	24.6289***	< 0.001	27.2741**	< 0.001
Dchoose1	**1.8295****	**0.0377**	**1.7230****	**0.0499**	**1.8705****	**0.0346**
Round			-0.4276***	< 0.001	-0.4321***	< 0.001
Top12Ratio			-2.3585***	0.0036	-3.4748***	0.0026
D1 (cities)					-1.9477	0.3831
D2 (people)					-2.2861	0.3110
D3 (streets)					0.4385	0.8467
D4 (food)					-0.5320	0.8145
D5 (politicians)					-1.3346	0.5522
D6 (markets)					-0.9809	0.6645
D7 (devices)					0.4653	0.8529
D8 (tools)					-3.8103*	0.0967
D9 (activities)					1.9940	0.4807
D10 (pets)					-3.3227	0.1596
D11 (paintings)					-0.5364	0.8197
D12 (scenery)					-0.4287	0.8561
Adjusted R^2	0.0340		0.0552		0.0547	

deselect the least preferred. There are two reasons why I asked to deselect the least preferred image rather than asking to select one. First, when all the images were preselected, subjects could easily recognize that the current question is different to the previous one. If all the questions were to choose the most or least preferred image, from the perspective of survey participants, every question is displayed in an identical manner, so they may spend additional time determining what the current question was about. The second, and perhaps more important reason, was that I wanted to minimize, if any, the possibility of misinterpreting 'choosing the least preferred image' as 'excluding anything that I will not eventually consume or possess.' If this is the case, and their preferences are transitive, excluding one could be done much quicker because such a task only requires one binary comparison between any randomly selected pair. Even for those who misinterpreted, by preselecting all the images, I implicitly conveyed a message that the task is not 'excluding anything' but 'consuming or possessing 7 out of 8.'

I considered 13 themes of images and each theme appeared twice in questions k and $k+13$, $k = 1, \ldots, 13$. When k is odd (respectively, even,) $k+13$ is even (odd.) Thus, survey participants conducted both of the tasks, choosing the most and the least preferred images, per theme. No images were reused. In each question, the display of images was randomized.

Auxiliary questions: Four questions at the end of the survey were to choose the maximum or minimum among eight random numbers. There are two purposes for using these auxiliary questions. First, unlike choosing images where it cannot be told whether they were truthfully reporting their preferences or randomly selecting one, there are correct answers in finding the largest or smallest number. Therefore, it helps to check whether participants followed the instructions. Second, it also helps to check whether the differences in cognitive costs, if any, are mainly due to the internalized sorting algorithm. Suppose choosing the most or least preferred image is processed by the following two steps: (1) subjectively value each image and (2) then sort them by the subjective values. The auxiliary questions test whether there are noticeable differences in the second step. If human beings would have evolved in a way to sort from the smallest value to the largest, so finding the smallest can be done before completing the entire sorting process, then finding the smallest value can be done quickly. If this is the case, the response time may not work as a good proxy of cognitive costs. One half of survey participants answered these questions in the order of max/min/max/min, and the other half did it in the order of min/max/min/max. In each question, the display of numbers was randomized.

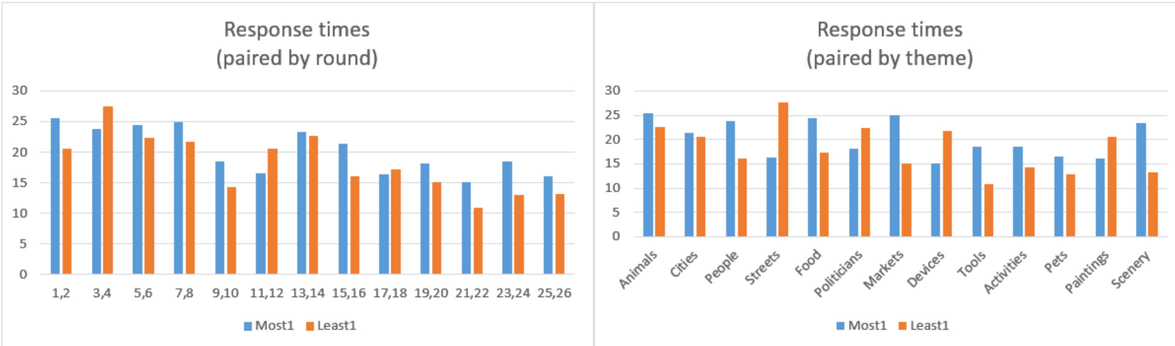
Response time: Response time was calculated by taking the difference between the time the question was loaded and the first click for that question was made.[4] Subjects were asked to focus on the survey and conduct no irrelevant tasks during the survey, but other than that, they didn't have any signals that the response time would matter. Nine response times out of 2600 were top-coded by 200 seconds, and this was interpreted that the subjects were not entirely focusing on their task for that question.[5]

Payment: Subjects got paid at the same rate ($0.87) for completing the survey, so there was no incentive for them to spend a different amount of time per question.

3 Results

The average time spent for the whole survey was 721.8 seconds. The average response time per main question was 18.73 seconds. Aggregate data summaries are shown in Figure 1. The left graph displays response times, paired by round, and the right one shows response times paired by the image theme. Though those figures summarize aggregate data without any controls, response time was, in general, longer when the task was to choose the most

Figure 1: Average response times (in seconds): Aggregate data



preferred image.

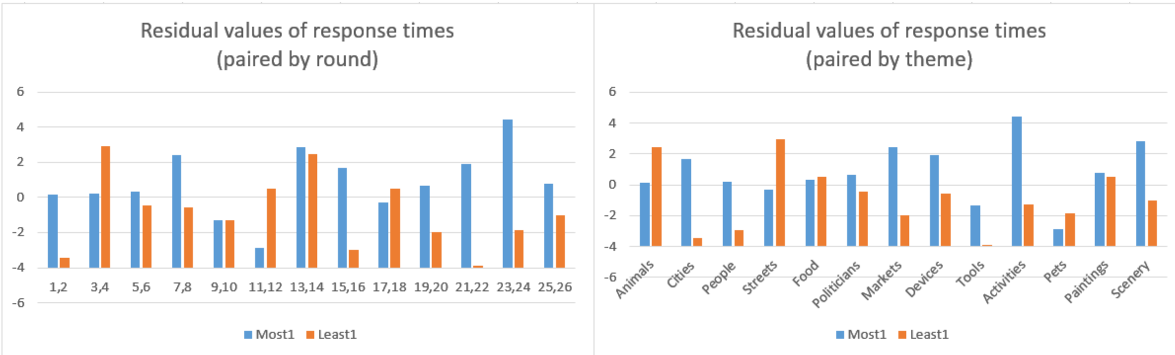
As well reported in neuroscience and psychology literature, response time is shorter when preference orders are more distinct. To capture this, I considered the ratio of the frequency of the most chosen preferred or least preferred image to that of the second most chosen one. A higher ratio means that there is a distinctively preferred or non-preferred option. As shown in Table 1, a unit increase of the ratio decreases the response time by 3.4748 seconds. After controlling for the ratio, the difference is more distinct. Figure 2 shows column charts of the residual values from the regression of response times on $Constant$, $Top12ratio$, and $Round$. The Kolmogorov-Smirnov two-sample test on the residual values significantly rejects the null hypothesis of the same distribution with a p-value of 0.0108.

As for the auxiliary questions, 98 out of 100 subjects chose correct answers to all four questions, and two of them got one question wrong. It suggests that the subjects were not randomly selecting any number just to complete the survey and get paid. For each auxiliary question, the average response times varied from 6.52 to 6.97 seconds. There were no statistically significant differences in response time to find the largest or smallest number. This confirms that the differences in response time are not due to the internal sorting process.

[4] Another proxy for the response time is the difference between the time the previous question was loaded and the current question was loaded. This may be a better proxy if most of the survey participants click any one, and spend time to confirm or modify their choice. I didn't use it for two reasons: First, the time difference between when the first click of the previous question was made and the current question was loaded was very stable across individuals, and short, which implies that they didn't stay at the question after making a choice. Second, it may contain some noise because of the time variance of moving a mouse to the 'Next' button.

[5] With considering that the average response time was about 18.73 seconds, 200 seconds is a conservative upper bound. Six participants spent more than 200 seconds only once. One participant spent more than 200 seconds for three questions, but even in this case the top coding was conservative: the average response time, except for those three, was 59.78 seconds, and the standard deviation was 49.95.

Figure 2: Average residual values (in seconds)



Residual values from the regression of response times on $Constant$, $Top12ratio$, and $Round$

4 Concluding Remarks

Even when a choice doesn't yield any future value, it takes more time to choose the most preferred option than the least preferred. There are two broad directions for future research to go to use this observation. First, decision theorists may want to investigate further what drives this difference. The internalized sorting process, which I hypothesized, does not lead to a difference in response times. Second, researchers could consider how this observation can be applied to various real-life situations. Online retail businesses may want customers to spend less or no time choosing to opt out of their promotions, nutritionists and health policymakers may want people to contemplate more about their dietary choices and matching mechanism designers may or may not want their clients to spend more time considering the choices that would lead to a desirable outcome. The disposition effect on the stock markets (Odean (1998)), dietary choices when how food is served varies (Wansink (2010)), marketing promotions (Milne and Rohm (2000)), and organ donation decisions (Kessler and Roth (2014)) may be some examples of studies worth revisiting with this new observation.

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