REDUCING CHOICE OVERLOAD WITHOUT REDUCING CHOICES

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Abstract—Previous studies have demonstrated that a multitude of options can lead to choice overload, reducing decision quality. Through controlled experiments, we examine sequential choice architectures that enable the choice set to remain large while potentially reducing the effect of choice overload. A specific tournament-style architecture achieves this goal. An alternate architecture in which subjects compare each subset of options to the most preferred option encountered thus far fails to improve performance due to the status quo bias. Subject preferences over different choice architectures are negatively correlated with performance, suggesting that providing choice over architectures might reduce the quality of decisions.

I. Introduction

MANY decisions involve large choice sets from which one option must be selected. Financial retirement planning and health care insurance selection present individuals with a seemingly limitless number of options. For example, Medicare participants are confronted with numerous health insurance and prescription drug plans. Even less-consequential decisions often involve large choice sets, including shopping for a car, a cell phone plan, or a box of cereal. Traditional economic theory holds that more choice is better, as the optimum over a proper subset can never be larger than the optimum over the original set. While a rational decision maker benefits from a wealth of choice, studies have found that larger choice sets can reduce one's satisfaction with the decision (Iyengar & Lepper, 2000), the likelihood of making a decision (Redelmeier & Shafir, 1995; Iyengar & Lepper, 2000; Roswarski & Murray, 2006), and the quality and optimality of the decision (Payne, Bettman, & Johnson 1993, Tanius et al., 2009; Schram & Sonnemans, 2011; Hanoch et al., 2011; Besedeš et al., 2012a, 2012b; Heiss et al., 2013).

One way of dealing with a large choice set is simply to reduce its size. However, such an approach clearly has many undesirable consequences, chief among which are ethical concerns over paternalism and the reduction in some individuals' ability to obtain their most preferred option. Alternatively, one can ask what tools can assist decision makers while still maintaining a plethora of options. Some have suggested a form of "libertarian paternalism" that nudges toward a decision while preserving all options (Sunstein & Thaler, 2003), such as presenting additional options only if an individual requests them (Sethi-Iyengar, Huberman, & Jiang, 2004). The effectiveness of this approach relies on an assumption that people who request the additional options are benefited by them, and those who do not are benefited by the smaller choice set. We examine experimentally the ability of different choice architectures to improve decision making. Additionally, as people are likely heterogeneous in their decision-making approaches, we examine individuals' ability to identify their most suitable choice architecture.

The choice architectures we consider reduce a large decision problem into a series of smaller ones. Such procedures approach a problem sequentially, eliminating a few options at a time. Sequential elimination techniques have been recommended for managerial decision making (Stroh, Northcraft, & Neele, 2008) and patient counseling (Oostendorp et al., 2011) and are enshrined in the rules of parliamentary procedure (Robert, Honemann, & Balch, 2011). Nevertheless, to the best of our knowledge, their ability to stimulate optimal decision making has not been considered.

The choice set we consider consists of lotteries structured in such a way that choices can be objectively ranked independent of personal (idiosyncratic) preferences. This is an advantage of the laboratory over the real world, where decisions cannot be ranked without knowing each person's tastes, risk preferences, and subjective beliefs. For example, examining the optimality of insurance choices or labor decisions requires strong assumptions about the governing choice set and the nature of preferences (Heiss et al., 2013, Iyengar et al., 2006). Our research addresses this shortcoming through the use of objective tasks, akin to the approach of Caplin, Dean, & Martin (2011) and Besedeš et al. (2012a, 2012b). Our full choice set and the value of each option are clearly defined.[1]

We consider three choice architectures. The benchmark simultaneous choice procedure involves picking one option among sixteen considered all at once, a large enough number of options where the effects of choice overload have been found (Tanius et al., 2009; Hanoch et al., 2011; Besedeš et al., 2012a, 2012b). We also consider two sequential procedures, with subjects considering subsets of the sixteen options over several rounds. In the sequential

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[1] The literature on choice overload has examined both tasks with and without objectively right answers (Schram & Sonnemans, 2011; Iyengar et al., 2006). On one hand, a subjective task may be harder than an objective one, as it requires learning one's own preferences. On the other hand, an objective task may be more demotivating as a person knows that there are "wrong" answers (Iyengar & Lepper, 2000).

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elimination architecture, the decision maker first selects among four randomly provided options. Then the three options that were not selected are eliminated and replaced with three new options alongside the previously selected one. This procedure repeats for a total of five rounds, until all sixteen options have been considered. In the sequential tournament architecture, the sixteen options are randomly divided into four sets of four options each. In the first four rounds, the decision maker selects one option from each of the four smaller sets. In the final (fifth) round, the subject selects from among the four previously selected options. Both sequential architectures involve subjects working through five rounds, each with four options, but they differ in whether the previously selected option is carried into the next round (sequential elimination) or the final round (sequential tournament).

After subjects make decisions under all three choice architectures, we elicit their preferences over the three choice architectures. The computer then randomly eliminates one of the three architectures, and subjects complete another task in the more preferred of the two remaining architectures. This allows us to examine whether subject preferences coincide with the architecture that leads each to the best decision.

A rational decision maker who evaluates the expected profit from each option and selects the optimal one from each choice set should not be affected by the simultaneous or sequential nature of the decision problem. However, a number of heuristic approaches, including sequential rationales (Manzini & Mariotti, 2007) and satisficing strategies (Simon, 1956; Caplin et al., 2011), suggest that an option chosen from a larger choice set need not necessarily be chosen from a smaller choice set in which it is available. Depending on the heuristics employed, a smaller choice set may yield better or worse decisions on average. When subjects tailor their heuristics to the decision problem, smaller choice sets may help by encouraging the adoption of better heuristics (Payne et al., 1993). Specifically, a subject susceptible to choice overload may benefit from the smaller choice sets inherent in sequential choice. Alternatively, Caplin et al. (2011) find that larger choice sets encourage subjects to adopt higher aspiration levels (and thus continue a search until a better option is found) than do smaller choice sets. Regardless of any effects of smaller choice sets, the introduction of sequential choice also itself changes decision making (Read & Loewenstein, 1995).

Sequential decisions are subject to a status quo bias, an inertia by which the most recent selection is likely to be maintained in the next decision (Agnew, Balduzzi, & Annika, 2003; Kool et al., 2010). Explanations for the status quo bias include psychological attachment to the previous choice, satisficing behavior, decision avoidance, and reduction of cognitive costs. While the sequential elimination architecture is perhaps more intuitive, its carryover of the selected option into the next decision round may exacerbate the status quo bias, reducing the likelihood of optimal choice. The sequential tournament architecture in which all previously selected options appear together in the final round may mitigate this effect.

We identify three main results. First, we find that the sequential tournament generates the best overall performance. Second, sequential elimination offers no improvement over simultaneous choice due to the presence of significant inertia in subjects' sequential decisions. Third, while the sequential tournament generates the best performance, this choice architecture is least preferred by subjects. We find evidence of adverse self-sorting, by which a portion of subjects select choice architectures that lead them to suboptimal choices. This suggests that allowing individuals to select their preferred choice architecture need not lead to improvements in decision making.

II. Experimental Design and Procedures

Subjects participated in a computerized experiment consisting of four decision tasks. Every decision task contained sixteen options and twelve potential states of nature. Options were characterized by the possibility of payment of $25 under some states of nature and no payment otherwise. After each decision task, a state of nature was randomly drawn from a known probability distribution. If the option that the subject selected contained the drawn state of nature, the subject earned $25 for that task. Thus, the optimal option was the option for which the prize was paid with the greatest probability. The critical feature of this design is that it allows for an objective evaluation and ranking of options, independent of subjects' tastes and risk preferences so long as subjects are not satiated in money (Besedeš et al., 2012a, 2012b).

While each task involved selecting one of sixteen options, the choice architecture, or process that governed the selection, varied. Three choice architectures were employed. First, in the simultaneous choice procedure, subjects selected one option from all sixteen displayed at once. Figure 1 presents a sample screenshot of this task. To the subjects, the states of nature were presented as cards numbered 1 to 12. The likelihood of a particular state was reflected in the frequency with which that card type appeared in a deck of 100 cards and presented in the "Odds" column. The sixteen options were labeled A through P, and the inclusion of certain cards (states) in an option was denoted by a checkmark. In this example, the deck contains three card 1s, five card 2s, 4 card 3s, and so on. A person who selected option A would earn $25 for this task if a card 1, card 3, card 5, card 7, card 8, or card 11 were randomly drawn and would receive nothing otherwise. Thus, the likelihood of a card 1 being drawn is 3 out of 100, and the likelihood that option A results in payment is $3 + 4 + 9 + 4 + 12 + 15 = 47$ out of 100.

Second, in the sequential elimination architecture, subjects selected one option from sixteen possible options through a series of five rounds. In the first round, options A

FIGURE 1.—SCREENSHOT OF A SAMPLE SIMULTANEOUS CHOICE PRODURE

		Options															
	Odds	A select	B select	C select	D select	E select	F select	G select	H select	I select	J select	K select	L select	M select	N select	O select	P select
Card 1	3	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓		✓
Card 2	5					✓		✓	✓			✓	✓		✓	✓	
Card 3	4	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓		
Card 4	6			✓	✓			✓	✓	✓	✓	✓		✓		✓	✓
Card 5	9	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓		
Card 6	14		✓				✓		✓	✓	✓		✓	✓		✓	
Card 7	4	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓		✓
Card 8	12	✓			✓		✓	✓	✓	✓	✓				✓		✓
Card 9	11		✓				✓		✓	✓	✓		✓	✓		✓	
Card 10	7					✓		✓	✓			✓	✓		✓	✓	
Card 11	15	✓			✓		✓	✓	✓	✓	✓				✓		✓
Card 12	10			✓	✓			✓	✓	✓	✓	✓		✓		✓	✓

through D were presented and one was selected. The selected option, along with options E through G, was presented, in round 2. When the selected option was joined by three new options, it remained in its original position. The option selected in round 2 was then presented along with options H through J in round 3, and so on through rounds 4 and 5 until all sixteen options had been presented. The final (fifth round) decision was the subject's selected option for the task.

Third, in the sequential tournament architecture, subjects also selected one option from sixteen possible options through a series of five rounds. In the first round, options A through D were presented, and one was selected. In the second round, options E through H were presented and one was selected, and so on. By the end of the fourth round, the subject had seen all sixteen options and selected one from each round. These four previously selected options were then presented in the fifth round in the same order in which they were selected, and the final choice was made. The difference between sequential elimination and sequential tournament is that in sequential elimination, the option selected in one round appears again in the next round, whereas in sequential tournament, a selected option does not reappear until the final round.[2]

By design, our decision tasks are fairly straightforward, with each option representing a binary lottery with some probability. While real-world decisions are more complex, they also do not allow for an objective measure of decision quality, as subjects differ in tastes and opinions regarding relative importance of different attributes. Our design allows us to evaluate and rank choices objectively and essentially follows standard economic theory by assuming a well-behaved utility function that numerically ranks items in the choice set. Despite each option's simplicity, studies have shown that a majority of people fail to select optimally (Besedeš et al., 2012a, 2012b).

Subjects were first required to complete a task using each of the three choice architectures, the order of which was randomized for each subject. Architecture-specific instructions were provided just before completing each task and subjects learned their earnings from each task at the end of that task.[3] Prior to the fourth task, subjects provided a ranking of the three architectures used to select the choice architecture for the fourth task. This was incentivized by having the computer randomly eliminate one of the three choice architectures and implement the higher ranked of the two remaining choice architectures for the fourth task. This procedure provides incentive for subjects to rank not only their most preferred architecture first, but also to take seriously the second and third ranking. Subjects received instruction that it was in their best interest to reveal their preferences truthfully, as the procedure yielded a two-thirds chance of using the choice architecture reported as being most preferred and no chance of using the one reported as being least preferred. While subjects experienced the three choice architectures in a random order over the first three tasks, this ranking procedure was always last so that subjects could make an informed decision.

To provide four similar but not identical choice tasks, the probability distributions were altered slightly across decision tasks. The four choice tasks are described in figure 2. The four probability distributions, PDF1 through PDF4, have similar probabilities for the most and least likely outcomes and nearly identical average probabilities across options (between 56.3 and 56.4). The black areas in the figure represent the states covered by each option. No two options are identical in terms of either the states contained or expected value under any of the PDFs. The optimal option resulted in receiving the prize with approximately an 80% chance, while the worst option yielded the prize with

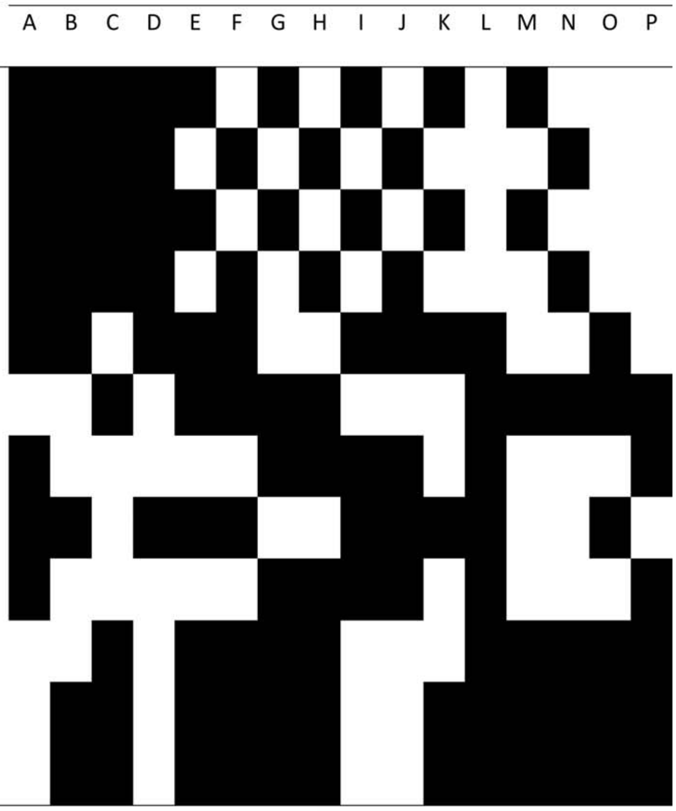
[2] In experimental instructions, we referred to simultaneous choice as *select one*, to sequential elimination as *keep one*, and to sequential tournament as *send to final*. These terms describe what subjects do in each task.

[3] Copies of the instructions are available in the online appendix.

FIGURE 2.—CHOICE TASKS

Card	PDF 1	PDF 2	PDF 3	PDF 4
1	15	13	13	12
2	14	14	14	12
3	12	11	12	9
4	11	8	8	14
5	10	12	10	11
6	9	7	5	10
7	7	6	9	5
8	6	7	7	8
9	5	9	6	7
10	4	5	9	6
11	4	4	4	3
12	3	4	3	3

Options



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
States Covered:	8	8	8	6	8	8	8	8	6	6	6	8	6	6	6	6
Expected payoffs:																
PDF 1	80	75	72	68	63	61	59	57	55	53	50	48	47	45	36	32
PDF 2	80	73	66	65	63	61	59	57	58	56	51	54	44	42	39	35
PDF 3	79	71	68	64	63	60	61	58	57	54	49	53	46	43	38	36
PDF 4	78	72	69	66	62	67	55	60	52	57	46	53	43	48	41	34

approximately 34% chance, varying slightly by PDF. To further ensure that the choice tasks appeared significantly different to subjects, the order of PDFs across tasks and of options and states within tasks was randomized. Thus, the subjects faced four similar decision problems but could not use information about one problem on a subsequent one. Notably, while subjects had the ability to provide post-experiment feedback, none noted any similarity in the underlying set of options across tasks.

Prior to the four tasks of interest, subjects reviewed instructions and completed a four-option, four-state task to familiarize them with the computer interface. After selecting among the options in a task, subjects were shown a deck of cards reflecting the appropriate PDF. A subject then had the computer turn the cards face down and shuffle the deck, following which she chose one card (see the online appendix for the graphical interface). If the chosen card reflected a state covered by the selected option, the subject earned $25 for the task with the exception of the initial familiarization task, which provided no payment.

After the experiment was completed, one of the four tasks was randomly selected for payment. Each subject was paid his or her earnings for that task. In addition, subjects were paid a $5 participation fee. The average salient earnings were $17.66 exclusive of the $5 participation payment, while the average amount of time spent in the experiment was 26 minutes, of which an average of 5½ minutes was spent on instructions and just under 9 minutes actively making decisions.[4]

The experiment was conducted through Vanderbilt University's eLab, an online lab with a pool of more than 70,000 subjects who have expressed a willingness to participate in experiments. Consistent with eLab policies, subjects were mailed a check for their earnings in this study immediately after participating. eLab recruits subjects into its pool using links from partner sites, online advertisements, referrals from other panelists, and links from online search results, among other sources. eLab collects information on age, sex, and educational attainment from members of its subject pool, allowing us to capture this demographic information without collecting it directly during the study. Our subject pool was 51% male with an average age of 48 years (standard deviation of 16). In terms of educational attainment, 30% of subjects were college graduates, 32% had some college, and 38% had no schooling beyond high school.

III. Results

A. *Choice Architecture and Quality of Decisions*

We begin with a summary of overall performance on the first three tasks using two different measures. The first measure, optimal choice, is the frequency with which subjects select the option that yields the highest likelihood of payment. The second measure reflects how far the selected option is from the optimal one. It is equal to the difference between the probability of receiving payment under the optimal option and the probability of receiving payment under the selected option. We refer to this measure as money left on the table since it reflects the reduction in the probability of payment from suboptimal choice.[5] Across all tasks, subjects select optimally 28% of the time, and selected options have an average probability of payment that is 14 percentage points lower than the optimal option. Thus, with \$25 at stake, subjects on average earn \$3.50 ($= \$25 \times 0.14$) less than they would with optimal choices.[6]

Results across choice architectures are presented in table 1. The sequential tournament leads to a significantly higher frequency of optimal choice than either simultaneous choice or sequential elimination (Wilcoxon $p = 0.011$ and 0.029, respectively), while sequential elimination and simultaneous choice are not significantly different from each other ($p = 0.470$). Sequential tournament also leads to less money left on the table than simultaneous choice ($p = 0.047$), while sequential elimination is not significantly different from simultaneous choice ($p = 0.864$). Although table 1 suggests that the three architectures lead to similar amounts of money left on the table in the aggregate, there is significant heterogeneity across subjects. In particular, the average difference between a subject's best and worst architecture (in the amount of money left on the table) is 0.15. On average, each subject's best architecture represents a 26% increase in expected payment over his or her worst architecture.

Table 1.—Average Performance across Choice Architectures

	Optimal Choice	Money Left on the Table	Decision Time
Simultaneous choice	23%	0.14	89
Sequential elimination	25%	0.14	124
Sequential tournament	36%	0.12	142

Table 1 also reports the average amount of time spent making decisions in each architecture measured in seconds. In general, subjects spend less time in simultaneous choice than either sequential architecture (Wilcoxon $p < 0.001$). Only ten subjects spend more time in simultaneous choice than they do in sequential tournament, and only thirteen spend more time in simultaneous choice than sequential elimination. The most time is spent in sequential tournament, where performance is best. However, the difference between the two sequential architectures is not significant ($p = 0.982$). Half (56) of the subjects spend more time in sequential elimination than in sequential tournament. Kendall's coefficient of concordance for time spent in the three architectures is 0.754 ($p < 0.001$), indicating that subjects who spend more time in one architecture tend to spend more time in all architectures.[7] One must of course be careful in drawing a causal relationship between time spent and performance, especially across architectures. Spending more time may lead to better decisions, or people may spend more time because they are making better decisions.[8]

To understand the effect of both task and demographic characteristics on decision quality, we estimate a probit regression for optimal choice and an OLS regression for money left on the table. We have 333 observations—3 for each subject. We include demographic variables for age, sex, and dummies for educational attainment (some college and college graduate, with high school the omitted variable). We also include PDF and task order fixed effects (suppressed for brevity). Treatment dummy variables for the sequential choice architectures are included (with simultaneous choice as the omitted variable). We also report lin-

[4] The difference in expected payment between optimal and random choice was approximately \$6. When accounting for active decision time, this extrapolates to a potential hourly wage of \$42.

[5] We are grateful to David Laibson for suggesting this measure.

[6] The main results are qualitatively unchanged if we use alternative measures of efficiency, such as the ratio of payoffs of the chosen and optimal options.

[7] The Spearman rank correlation between time in simultaneous and elimination architectures is 0.623 ($p < 0.001$), while that between time in simultaneous and tournament is 0.726 ($p < 0.001$). The rank correlation between the two sequential architectures is 0.544 ($p < 0.001$).

[8] We also looked at how demographic characteristics affect decision time but found no statistically significant results.

Table 2.—Factors Influencing Choice Quality

	Optimal Choice		Money Left on the Table
	Probit	LPM	
Sequential elimination	0.108	0.030	−0.443
	(0.128)	(0.039)	(1.368)
Sequential tournament	0.448***	0.141***	−2.164*
	(0.163)	(0.053)	(1.151)
Age	−0.006	−0.002	0.061
	(0.006)	(0.002)	(0.049)
Male dummy	−0.087	−0.022	2.167
	(0.202)	(0.065)	(1.690)
Some college	0.678***	0.204***	−5.608***
	(0.240)	(0.075)	(2.059)
College/graduate	0.584**	0.173**	−5.892***
	(0.253)	(0.079)	(1.890)
Constant	−0.670*	0.265**	12.141***
	(0.392)	(0.123)	(3.275)
Observations	333	333	333
Log likelihood	−184	−193	−1,280
Pseudo-R^2	0.065	0.072	0.092

Note: Probit and linear probability model (LPM) coefficients reported for optimal choice, OLS for money left on the table. Robust standard errors in parentheses: Significant at *10%, **5%, ***1%. PDF and task order fixed effects included, but not reported. Money left on the table was measured on a 0–100 scale.

ear probability model estimates for optimal choice as the probit coefficients may suffer from the incidental parameter problem since we are using a large number of fixed effects with what is effectively a short panel. However, our results are qualitatively unaffected by the choice of estimator.[9]

Estimated coefficients in table 2 confirm the relative performance results in table 1. Sequential elimination does not lead to a significant improvement over simultaneous choice, while the sequential tournament architecture significantly improves the quality of choices in terms of both increased frequency of optimal choice and reduced amount of money left on the table. Of the demographic variables, age and sex appear to play no role, while education beyond high school is correlated with an estimated 20 percentage point increase in the chance of selecting the optimal option.[10] The sequential tournament architecture leads to a predicted 14 percentage point increase in optimal choice frequency relative to simultaneous choice, using either the LPM estimate or the probit marginal effects averaged across all subjects. Conversely, sequential elimination leads to no significant improvement.

B. *Choice Overload and the Status Quo Bias*

The choice overload hypothesis suggests that smaller choice sets can result in better decisions. In our experiment,

Table 3.—Round-by-Round Performance

Task	Optimal Choice	Money Left on the Table
Simultaneous choice (16 options)	23%	0.14
Sequential elimination (4 options)	46%	0.08
Sequential tournament (4 options)	48%	0.08

each round in the sequential elimination and sequential tournament architectures involves a choice among only four options, whereas the simultaneous decision architecture involves a choice among sixteen options. We first examine whether decision making is better in four-option choice sets than in sixteen-option ones in table 3. Measures of optimal choice and money left on the table are relative to the set of options available in each round. Thus, for the simultaneous decision, these measures coincide with those in table 2, but do not for the other two architectures. To avoid endogeneity issues, we again consider only the first three tasks, and exclude the fourth task in which subjects chose the choice architecture. The frequency of optimal choice when selecting among 16 options at once is only 23%, while the average across all rounds in sequential architectures is 47%. This is consistent with choice overload.

Our results so far indicate that decision making is better when fewer options are considered at once, but that the way a large set of options is broken into smaller parts matters for the quality of the final decision. Given this result, we try to understand why performance in the sequential tournament architecture is superior to performance in the sequential elimination architecture even though both entail the same number of decisions over choice sets of the same size. We offer two possible explanations.

First, we consider the possibility that subjects simply make independent errors in each round. These independent errors, even if equal across architectures, produce different rates of optimal choice among all sixteen options for the two sequential architectures. For a subject to select the optimal option in the sequential tournament architecture, she or he must select optimally in two rounds: the round in which the option first appears and the final round. For the sequential elimination architecture, the subject must select optimally in the first round in which the optimal option appears and in each subsequent round, if any. Statistically, this makes the chance of selecting the optimal option in the sequential tournament architecture higher or lower than in the sequential elimination architecture depending on the rate of optimal selection in each round.[11] In our case, the

[9] Out of 333 possible predicted values, the linear probability model predicts three values outside the plausible 0–1 range. This is not the case in the absence of fixed effects, which also does not affect our results in a qualitative way.

[10] To examine whether our difference in performance across choice architectures is driven by education, we analyzed these differences within each educational category. We find that a higher proportion of subjects select the optimal option under sequential tournament than under either of the other two architectures for each educational category.

[11] Denote by p the probability of selecting the best option in each round. For the sequential tournament architecture, this translates into a probability of ultimately selecting the optimal option of p^2. For the sequential elimination architecture, the probability that the optimal option appears in the first round is 4/16, and it is 3/16 for subsequent rounds. Thus, the probability of selecting the optimal option is $\frac{3}{16}p\left(1+p+p^2+p^3+\frac{4}{3}p^4\right)$. The sequential tournament architecture leads to a higher probability of selecting the optimal option whenever $p > 1/4$.

TABLE 4.—STATUS QUO BIAS

	Sequential Elimination	Sequential Tournament	Pooled Sequential
Expected payoff	4.700***	5.300***	4.888***
	(0.629)	(0.604)	(0.517)
Selected previous round	0.473***		0.457***
	(0.133)		(0.130)
Observations (options)	2,220	2,220	4,440
Observations (decisions)	111	111	222
Log likelihood	−690	−691	−1,382

Conditional logit coefficients. Robust standard errors clustered by subject in parentheses: significant at ***1%.

46% chance of selecting the best option in each round of sequential elimination would translate into a 16% overall chance of selecting the optimal option under the assumption of independent errors. For the sequential tournament architecture, the 48% in each round translates into a 23% chance of selecting the optimal option in the final round. The actual rates from table 1 are substantially higher for both architectures, suggesting that simple independent error rates cannot fully explain our results.

Second, we consider the possibility that errors are not independent across rounds due to the status quo bias. The selection of an option in one round may cause a subject to overvalue that same option in the next round or to view selecting another option as a psychologically costly disaffirmation of their previous choice (Kahneman, Knetsch, & Thaler, 1991), or simply to prefer not to have to make another decision. Whatever its cause, sequential elimination may lay a trap for subjects susceptible to the status quo bias by carrying a selected option over to the next round. An error in selection in one round is likely to persist as the subject continues to select the same option in subsequent rounds. Conversely, in the sequential tournament architecture, all options presented concurrently are on equal footing: either none has been previously considered or, in the final round, all have been selected in a previous round.

We use McFadden's (1974) conditional logit model to estimate subject choices in each round as a function of two predictive variables: (a) the expected payoff, or expected probability of payment of each option, which proxies for optimal choice, and (b) in the sequential elimination architecture, whether the option was selected in the previous round. Specifically, expected payoff is coded as the probability of payment, between 0 and 1. The selected-previous-round dummy equals 1 for options in rounds 2 through 5 of the sequential elimination architecture that were selected in the previous round and equals 0 for all other options. We consider three subsets of data: decisions in each of the sequential architectures separately and pooled. Table 4 presents the estimates.

The significance of expected payoff indicates that better options are selected with higher probability. The significance of selected previous round suggests that subjects exhibit the status quo bias in the sequential elimination tasks. Given the within-subject nature of our design, the consistency of the payoff heuristic across architectures is not surprising.[12] Yet when the status quo bias is provided an opportunity to manifest, subjects change their decision-making approach to place additional reliance on the option previously selected. The relative parameter magnitudes indicate that the status quo bias is equivalent to approximately 10 (= 4.700/0.473) percentage points of the probability of payment. For example, a previously selected option with a 70% chance of payment has a similar probability of being selected as a new option with an 80% chance of payment. Thus, in addition to any potential statistical disadvantage, sequential elimination allows the status quo bias to manifest. Subjects stick with options they selected even if they are not optimal.

TABLE 5.—PERFORMANCE ON TASK 4 (AVERAGE PERFORMANCE ON TASKS 1–3)

Task	Optimal Choice	Money Left on the Table
Simultaneous choice (N = 53)	15% (23%)	0.15 (0.14)
Sequential elimination (N = 33)	27% (25%)	0.11 (0.14)
Sequential tournament (N = 25)	40% (36%)	0.09 (0.12)

C. *Revealed Preferences for Choice Architecture*

Thus far, our results have focused on how the choice architecture affects decision quality. We now examine which choice architecture subjects prefer according to their rankings of architectures and how those revealed preferences correlate with the quality of their decisions. More than half of our subjects, 59 out of 111, preferred the simultaneous choice architecture, while 29 (26%) preferred sequential elimination and the remaining 23 (21%) preferred the sequential tournament. These preferences run opposite to the proportion of subjects selecting optimally under each architecture. The joint preference ranking of the least preferred choice architecture is almost a mirror image of the most preferred ranking. Just over half of our subjects, 56, revealed sequential tournament as the least preferred architecture, followed by 30 (27%) who rated sequential elimination as the least preferred and 25 (23%) who rated simultaneous choice as the least preferred architecture.

Given our procedure for eliciting rankings, subjects had a two-thirds chance of using their most preferred architecture for the fourth task and a one-third chance of using their second-most preferred architecture. Table 5 reports overall performance on the fourth task by choice architecture and includes performance from the first three tasks in parentheses for comparison. Again, performance is best under the sequential tournament architecture despite the fact that it is

[12] We pool across both sequential architectures to show the consistency of the payoff variable. By the nature of the conditional logit estimator, separate regressions do not allow direct comparisons of parameters due to their confluence with potentially different variances. Confidence that these are similar is gained in column 3, which imposes identical variance on both.

TABLE 6.—UNAMBIGUOUSLY BEST ARCHITECTURE PERFORMANCE AND ARCHITECTURE PREFERENCES

	Most Preferred Architecture		
Unambiguously Best Architecture	Simultaneous Choice	Sequential Elimination	Sequential Tournament
Simultaneous choice ($N = 21$)	62%	14%	24%
Sequential elimination ($N = 22$)	36%	50%	14%
Sequential tournament ($N = 30$)	73%	10%	17%
None ($N = 38$)	42%	32%	26%

TABLE 7.—ARCHITECTURE PERFORMANCE, TIME, AND ARCHITECTURE PREFERENCES

		Most Preferred Architecture	
Relative Time	Unambiguously Best Architecture	Simultaneous Choice	Sequential Tournament
Below median	Simultaneous choice ($N = 12$)	67%	17%
	Sequential tournament ($N = 17$)	71%	18%
Above median	Simultaneous choice ($N = 9$)	55%	33%
	Sequential tournament ($N = 13$)	77%	15%

Relative time = time on sequential tournament/time on simultaneous.

the least preferred. Table 5 also reveals a suggestive pattern. While performance in both sequential architectures is better the second time it is used (in task 4), performance in the simultaneous decision is actually worse the second time it is used than when it was first encountered. This suggests an adverse self-sorting in subjects' preferences for the simultaneous choice architecture.

To explore the possibility of adverse self-sorting, we investigate the frequency with which subjects prefer the choice architecture under which they performed best initially. We focus on subjects whose performance under one architecture was strictly better than under the other two. For this purpose, we say a subject performed unambiguously best in a particular choice architecture if the rank of the selected option is higher in that architecture than in the other two.[13] If a subject did equally well under two procedures then no unambiguously best architecture is identified. The data are tabulated in table 6.

If subjects' preferences over choice architecture were associated with how well they performed in each, entries should fall along the diagonal in table 6. Twenty-one subjects did best in simultaneous choice, of whom 62% identified it as their most preferred architecture. Of the 22 subjects who did best in sequential elimination, 50% identified it as their most preferred procedure. The most surprising results are for those who do best in the sequential tournament. Of the 30 subjects who did best in sequential tournament, only 17% identified it as their most preferred architecture, while 73% preferred simultaneous choice. This means that individuals who perform best in sequential tournament are more likely to prefer simultaneous choice than those who actually performed best in simultaneous choice. The 38 subjects for whom no unambiguously best architecture is identified exhibit a similar adverse self-sorting. While a plurality of these subjects prefers simultaneous choice, 85% do at least as well under the sequential tournament architecture.

There are several potential reasons for subjects' selecting an architecture that does not lead to the best choice. We first consider that subjects may be making a rational choice that trades off the costs of a suboptimal architecture against its perceived benefits. Specifically, we noted above that the simultaneous choice architecture takes less time than the sequential architectures. This is not due to any technological differences, as one could navigate through the sequential decision screens in a mere couple of seconds. Instead, as Payne et al. (1993) noted, this is likely the result of an accuracy-effort trade-off. The more complex choice inherent in the simultaneous architecture likely leads to the adoption of simpler decision rules that require less effort to implement but also lead to less accurate decisions. The choice of architecture then may imply a second effort-accuracy trade-off between the simultaneous architecture (in which subjects elect to spend less time at the expense of accuracy) and one of the sequential architectures (in which subjects elect to spend more time and enjoy better accuracy). Such a trade-off would suggest that subjects are more likely to prefer an architecture if its relative performance is better and its relative time is shorter.

We examine this possibility in table 7. We measure for each subject the ratio of time spent on the sequential tournament architecture to time spent on the simultaneous architecture and examine architecture preferences by performance and whether the ratio of time is above or below the median. The table indicates that relative time spent on simultaneous versus sequential tournament architectures is

[13] We obtain the same qualitative results if we consider only subjects who chose optimally under exactly one mechanism or by defining "unambiguously best" based on which architecture yielded the highest expected payoff or lowest amount of money left on the table. The challenge with the latter two definitions is that ordinally equivalent choices lead to different payoffs due to slight variations across PDFs by design.

not predictive of architecture preference. Among subjects who do unambiguously best under the sequential tournament architecture, a vast majority prefer the simultaneous architecture independent of relative time.[14] These results suggest that time, at least, does not strongly enter into subjects' preferences over architecture.

Aside from time, simultaneous choice may also be less effortful and therefore heavily preferred precisely because it entails making only one decision, while both sequential architectures require more cognitive effort as they entail five decisions. Further, the sequential tournament may be considered more psychologically discomforting because it requires five active decisions. In contrast, sequential elimination allows for a subject to make one active decision in the first round and simply stick with that choice in every subsequent round. That is, the status quo bias may be a rational response to decision costs. As anticipated cognitive demands play an important role in decision making (Kool et al., 2010), subjects may be willing to accept a less optimal outcome in exchange for less cognitive effort.

However, if the simultaneous architecture is inherently least effortful (whether in terms of time or psychological costs), then this can only explain a general preference for it. It cannot explain why we observe reverse sorting, by which subjects who do best in sequential tournament are even more likely to prefer simultaneous choice than those who did best in simultaneous choice architecture. Therefore, subject preferences seem to reflect not only a simple tradeoff between accuracy and effort. It is entirely possible that subjects are not good at evaluating the quality of their decisions and thus err in selecting an architecture. Whatever the cause, the key insight is that subjects are unlikely to select the architecture that leads to the best choice.

IV. Conclusions

By now, several studies have suggested that increased choice may not be beneficial to decision makers. Despite the greater likelihood of a better option being available, a larger number of choices may lead to choice overload, greater regret, and more indecision. This has led some to suggest that choice sets should be restricted (Schwartz, 2005). From a practical standpoint, all proposals calling for restricting a choice set face the criticism of being paternalistic in determining how choices are restricted.

Instead of attempting to restrict the choice set, we seek to identify whether restructuring choice architectures can enhance decision quality while still maintaining the size of the choice set. Consistent with previous work, we find that decision making improves when fewer options are considered concurrently. Thus, our focus is on two sequential processes that break a decision into a series of choices, each among a small number of options. The intuitive and commonly suggested sequential elimination approach appears to encourage a suboptimal heuristic. When a previously selected option is compared to a new subset of options, subjects exhibit a status quo bias, which causes them to undervalue new options.

The sequential tournament process does succeed in improving the quality of decision making in our setting. This choice architecture first places options into subgroups, and then the options selected from each subgroup are combined into a final set from which the ultimate decision is made. It captures the advantage of a small choice set for each decision while avoiding the effects of the status quo bias.

In the aggregate, while subjects can benefit from alternative choice architectures, there is a negative correlation between architecture performance and architecture preference. We find evidence of adverse self-sorting with subjects preferring choice architectures in which they did not have their best performance. The performance of these architectures in the real world might vary greatly from our highly stylized environment. However, our results suggest that simply letting people select a choice architecture may be insufficient to facilitate improved decision making.

Thaler and Sunstein (2008) argue for "libertarian paternalism," a decision-making intervention in which choice architectures direct individuals toward certain choices while maintaining the opportunity to select among the full range of options. For example, Sethi-Iyengar et al. (2004) suggest that people should initially be presented with only a few options while retaining the ability to consider a larger set of options if they so choose. The desirability of such a choice architecture inherently assumes that adverse self-sorting is not a problem and that only the right people expand the choice set. Specifically, for such an architecture to improve choice quality, preferences over choice set size and performance under different choice set sizes need to correspond.

Our findings essentially push the paternalistic discussion associated with choice overload back one level. Our work suggests that more, but not all, people would select better options with a sequential tournament; however, this choice architecture may be the least preferred of those we consider. Therefore, in some cases, policymakers or others designing a choice problem may wish to impose an unpopular procedure in order to improve decision-making quality. Clearly, the appropriateness of such libertarian paternalism needs to be evaluated on a case-by-case basis.

[14] We conduct the same analysis using the difference in time between the two mechanisms rather than the ratio of time and obtain the same qualitative results.

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