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Choosing to choose or not

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Abstract

To what degree do people prefer to choose for themselves and what drives this preference? Is it memory-based and results from a life-long association between choices and better outcomes, or is the process of choice itself reinforcing? In a new paradigm, across 6 experiments, participants experienced both 'Own Choice' and 'Computer Picks' conditions with identical outcomes before selecting which condition to re-experience in the final part of the experiment. Consistent with previous work, an overwhelming majority (83%) preferred own-choice. Several variations of the paradigm reveal that (1) Preference For Choice (PFC) is reduced when thinking about the task without actually choosing in it, (2) PFC is substantially reduced by choice-unrelated cognitive load, and (3) Preference For Choice is further diminished when selection is based on criteria other than one's preferences. Across experiments, participants' self-rated enjoyment predicted a significant portion of their PFC, while their perceived gains had little to no predictive value. If PFC stems solely from past reinforcement learning (i.e., memory) then neither performing another few scores of choices nor adding cognitive load to that sequence of choices would be expected to dramatically affect it. Hence, our findings suggest that a significant part of this preference stems from the process of choice itself, and that the experience it confers can itself be reinforcing. We discuss the implications of the proposed mechanism for PFC, which leads us to the prediction that PFC may be muted or even reversed under specific conditions and what this means for when the 'opposite' effect – sticking with the default – will occur.

Keywords: choice; agency; reinforcement, will

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1 Introduction

> "The origin of action... is choice, and that of choice is desire and reasoning with a view to an end." – Aristotle (Broadie, 1974)

Numerous situations are construed as ones in which we 'have a choice'. It has been suggested that people value choice in and of itself (Leotti et al., 2010, 2015; Szrek & Baron, 2007). For example, participants liked a cue that was experimentally associated with a Choice trial more than a cue that was associated with a No-choice trial (Leotti & Delgado, 2011). Importantly, this held although the monetary outcomes of both trials were identical. Such findings indicate that choice is valued but to what degree do people prefer choice over no-choice situations and what drives this preference?

The process of choice can be broadly construed as selecting on the basis of one's preferences (Ullmann-Margalit & Morgenbesser, 1977). Accordingly, the lion's share of the research on choice has focused on how choice is affected by, and itself affects, one's subjective perception of the outcomes (e.g., Kahneman & Tversky, 1979). A classic example is how one's preferences are altered in favor of the chosen alternative after a choice has been made (Brehm, 1956; Jarcho et al., 2011; Sharot et al., 2009). Hence, even if there was no superior alternative to begin with, the process of choice itself leads to a subjectively better outcome that may act as a secondary reinforcement of the choice process (but see Chen, 2008; Chen & Risen, 2009; Holden, 2013; Izuma & Murayama, 2013; Klusowski et al., 2021).

Relatedly, it has recently been suggested that preference for choice (PFC) is the result of life-long reinforcement learning (Leotti et al., 2015). Specifically, the repeated association between choosing and receiving the subjectively preferred outcome is offered as a reason for preference toward choice itself. Importantly, this 'PFC due to life-long reinforcement' explanation, implies that the bias should operate regardless of whether exercising choice has recently occurred or not – as it is based on a large set of previously reinforced instances.

Yet it is possible that other elements that are part and parcel of the process of choice itself and are independent of the subjective quality of the outcomes it confers, also contribute to people's preference for choice. According to theory (Higgins, 1997; Redgrave et al., 2008; White, 1959) and behavioral evidence (Eitam et al., 2013; Karsh et al., 2016, 2020; Karsh & Eitam, 2015), merely affecting the environment is reinforcing in and of itself, at least for some mental processes. Here we ask whether choice, as an instance of exercising control over our environment (Leotti et al., 2010), may be self-reinforcing. In other words, we propose to test whether PFC is driven by reinforcement that stems from the process of choice itself.

Indeed, having control and own choice are closely related and are often researched together, being treated almost as synonyms. In several studies, participants were asked to decide on a trial-to-trial basis, whether to choose for themselves or delegate the choice to a computer. In Bobadilla-Suarez et al.'s (2017) study, for instance, participants decided to

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retain control and choose for themselves at a rate that led to lower monetary gains compared to what they would have obtained if they would have delegated more control to the computer. The results also indicated that participants were aware that their bias toward own choice leads to sub-optimal gains, and hence, it seems that they were willing to pay to maintain their control. Another study in which participants repeatedly decided to choose or not yielded equivalent behavioral results of own-choice bias at the cost of reduced gains, as well as neural indications that this bias was led by valuing control (Wang & Delgado, 2019). Overall, these studies suggest that people value choice over comparable no-choice trials, but the studies cannot evaluate the exact degree to which people value choice over no-choice situations. Moreover, previous studies did not test the extent to which PFC is based on life-long associations of choices with subjectively better outcomes and on the reinforcing properties of the choice process itself.

There is evidence that people do prefer choice situations and there are clues for what drives this preference.). For example, in one study participants preferred to choose for themselves instead of tossing a coin "to choose for them" even though they judged both of these scenarios as equivalent concerning the outcomes (Keren & Teigen, 2010). It has also been shown that people attached a greater monetary value to situations with more options to choose from, independently from their preference for specific items in the sets (Fujiwara et al., 2013). Similarly, choosing from a larger set is more appealing and produces greater enjoyment, although the chances of buying and being satisfied by an item (i.e. the value attached to the subjective outcome) decrease (Iyengar & Lepper, 2000).

This preference for choice situations can be found in settings that do not include hedonic values as their outcomes. For instance, in one experiment participants allegedly choose (or not), without prior knowledge, which of three conditions to complete, but then performed the same visual-search task (Kunar et al., 2016). Nevertheless, participants who “chose” their condition reported enjoying the task more than the no-choice group even though their performance (i.e., outcome) was worse. Furthermore, multiple positive effects of choice on physical performance have also been reported (for a review see Wulf & Lewthwaite, 2016). These results suggest that the bias towards choice situations is a general tendency found across contexts, and that there may be multiple outcomes that stem from choosing which contribute to this preference.

In the current research, we use a new paradigm to quantify PFC and to examine why people may prefer situations in which they choose for themselves versus situations in which the choice is made for them.

2 Experiments’ overview

All experiments, except Experiment 1c, followed a similar paradigm. Participants were seated in front of a desktop computer and completed two within-subject conditions – Own

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Choice (OC) and Computer Picks (CP). No mention of the two conditions was made in advance.

On each trial (50 per condition), a pair of opaque "boxes" appeared onscreen. Participants were to open one box with a mouse click which led to the number of points gained appearing above the opened box for 750 ms (see Figure 1). No information was given about the number of points that could have been gained by opening the other box. In the Own Choice (OC) condition, participants freely chose which box to open, while in the Computer Picks (CP) condition a green rectangle around one of the boxes indicated that it should be opened (clicking on the other box failed to open it). Hence, in both conditions, participants were equally active and engaged with the same number of boxes.

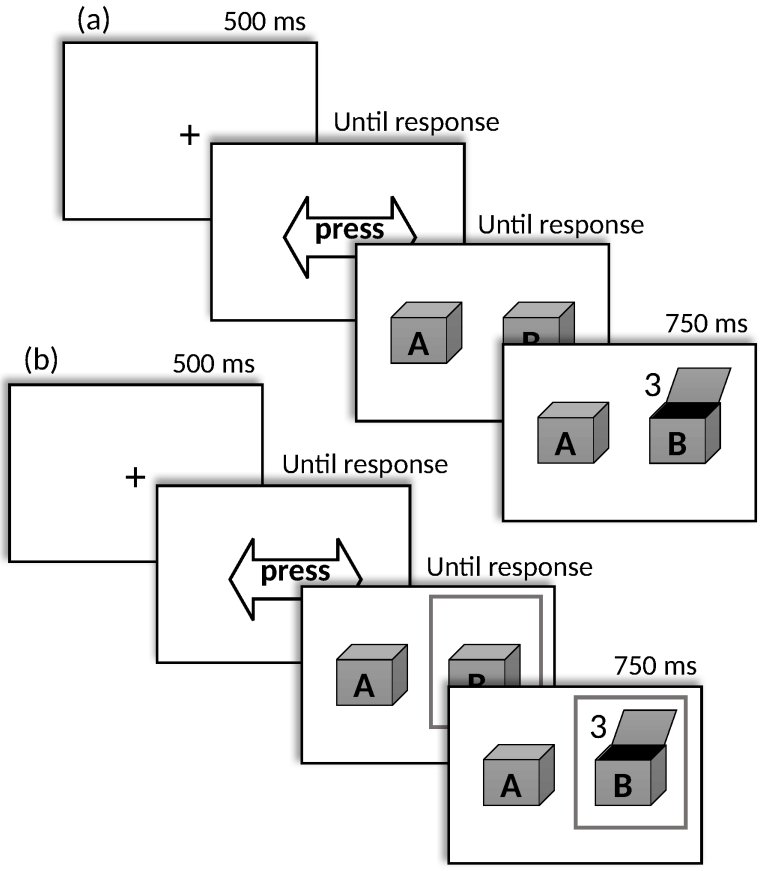

FIGURE 1: Example trials of the basic Own Choice (a) and Computer Picks (b) conditions that were used across most experiments.

Participants were informed that each point is worth money which would be added to their payment for participation. While each box could allegedly contain a varying number of points; 1, 3, or 5, the actual sequence of points gained was identical across conditions and participants and payment was fixed at 5 NIS (~1.25$).

After completion of each condition, participants reported their subjective experiences regarding this condition in a fixed order. First, they freely reported how many points they

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thought they had gained. Then, they used 1–9 point rating scales to indicate how much they felt a sense of control, and how much they enjoyed this condition. Generally, these subjective experience measures were taken across all experiments; whenever additional measures were taken or when specific measures were not included, it is specified in the method sections for that experiment. Finally, participants indicated if they had counted points.

After both conditions, participants were informed that a third part of the experiment is about to begin and had to decide whether, in this part, they would prefer to choose for themselves or let the computer choose for them. The experiment ended at this point and no third part was performed.

Crucially, as participants completed each condition in a separate block before deciding which condition to complete again, this paradigm enables us to compare which situation is preferable – a choice-situation (where people experienced making their own choices) or a no-choice-situation (where the computer picked for them).

All experiments wereself-programmed using a combination of the following tools: MediaLab (Jarvis, 2012) and DirectRT (Jarvis, 2014), PsychoPy (Peirce, 2007), and google forms.Students from the University of Haifa, Israel, participated in only one experiment for course credit or pay (~5$), after signing an informed consent form.

3 Experiment 1a – PFC after experiencing Choice and No-Choice situations

3.1 Method

3.1.1 Participants and Design

One-hundred and nine students (69 females; Mean age=25.02, SD=4.68) completed the experiment. Data from two participants was excluded before data analysis as the post-experiment debriefing revealed they did not understand the experimental procedure, resulting in a final sample of 107.

Our design afforded several comparisons between (and within) conditions, and to obtain stable estimations we decided to run the experiment until there were at least 25 participants for each comparison after applying our pre-determined filters (see Analytic procedure for details). To do so, we periodically applied these filters to the data and stopped the experiment when we reached this designated sample size. Similar stopping rules were applied across all experiments.

3.1.2 Stimuli, Measures, and Procedure

Our basic paradigm (see the Experiments' overview section) was employed. However, only in Exp. 1a, were participants informed about the specific monetary worth of each point;

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in all following experiments they only knew that these points equal money. Specifically, participants were told that each point is worth a random amount on each trial, ranging from 1 to 5 Agorot (the Israeli equivalent of Pennies).[1] For that reason, only in Exp. 1a, an additional subjective experience measure was collected after each block – here participants freely reported how much money they thought they had gained.

3.1.3 Analytic procedure

A similar analytic procedure was applied to data from all experiments, and minor differences are reported when applicable. The only exception was Experiment 1c, due to its different design.

Our central hypothesis was that participants would prefer to choose for themselves after experiencing both conditions. This was tested using a one-sample Fischer's exact test of proportions with 50% as a reference value because it represents indifference regarding who will choose.

Subjective experience. We further hypothesized that participants' subjective experience will differ between the OC and CP conditions (in favor of the OC condition). To robustly estimate participants' subjective experience and assess its consistency, three separate t-tests were conducted for each subjective measure. Two of these t-tests were between-subject comparisons – one that compared participants that performed the OC condition to those that performed the CP condition in the first block, and a second similar comparison for the second block. The third comparison was a paired-samples t-test that compared the first (OC or CP condition) and second block (CP or OC condition, respectively) within participants. Our working assumption is that the subjective experience measures following Block 1 (the first independent t-test) are the most valid and informative as they were collected when participants were naive regarding the second condition of the experiment.

Predicting PFC. Finally, we tested whether differences in subjective experiences between the OC and CP conditions will (at least partially) predict PFC. To test this, participants' subjective self-reports in the CP condition were subtracted from their corresponding self-reports in the OC condition to create the Difference Variables (e.g., a participant with an Enjoyment difference of 2 enjoyed the task under the OC condition more by 2 scale points than under the CP condition). Then, these Difference Variables were used as input variables in logistic regressions with PFC as the output variable.

Filters. To analyze only data from participants that fully understood the instructions and dedicated sufficient attention to the experiment, we applied several pre-determined filters across all experiments. However, applying these filters led to large proportions of excluded

[1]This was done to discourage participants from counting points, but was only partially successful.

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participants. Hence, to gain more statistical power, and as the results barely differed between the filtered and unfiltered data, the following results sections include the unfiltered data of all participants. The description of these filters, their rationale, and the results of the filtered data are specified in the Supplement (S1). In addition, when there are major differences between the unfiltered and filtered data we indicate it in the main text.

Correlations between subjective experience and additional variables. We expected some association between the subjective experience measures. We present the correlation matrix for each experiment in the Supplement (S4). As no two measures were consistently associated across experiments we decided not to combine individual probes although some capture similar experiences.

Finally, the Supplement (S5) also include descriptive statistics of additional measurements. Crucially, most of these measurements were collected after the experiment had ended so they could not affect the reported results and are presented for the sake of completeness and transparency.

3.2 Results

Preference for choice. A large majority of participants (81.31%, CI95% 73.8–88.81) preferred choosing for themselves over letting the computer choose for them, significantly higher than the point of indifference (50%; $z=6.48$, $p<.001$).

Subjective experience. The descriptive statistics and t-tests results for all subjective experience measures are presented in Table 1. Overall, while the results support greater enjoyment in the OC compared to the CP condition, no consistent difference between the conditions was observed for the measures that reflect the subjective value of the outcomes (i.e., the Points and Money measures).

The findings regarding participants' sense of control were highly similar across Experiments 1a, 1b, and 2. No difference was found between participants that completed the OC condition and those that completed the CP condition in the independent t-test of the 1st block of the experiment. When a difference did emerge, it was only in the 2nd block, after participants were exposed to both the OC and CP conditions (suggesting that 'demand' maybe at work here). For this reason, we treat these results as less informative compared to the other subjective experiences and do not discuss them in the following results sections, but we include their statistics in Table 1.

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TABLE 1: Descriptive and inference statistic results of the unfiltered subjective experience measures across all experiments. The first line of each measure presents the mean and standard deviation for each condition, and the second line shows the hypothesis test result of the comparison between these conditions. Most hypothesis tests were t-test – between-subjects tests that compared the OC and CP conditions in each block (i.e., participants that completed the OC condition in block 1 to those that completed the CP condition in block 1), and within-subject tests for the comparison of block 1 to block 2 within participants. Note that in Exp. 3 the Single-Task and Dual-Task conditions that were identical during the part of the experiment in which the subjective experiences measures were collected (before the PFC question), were combined to one Preference-based choice condition that was compared to the Random condition. Additionally, in experiment 3, ANOVA models with the OC/CP and the Dual-Task/Single-Task/Random conditions as between-subjects factors were used for the between-subjects comparisons, while mixed ANOVA models with the CP/OC condition as a within-subject and the Dual-Task/Single-Task/Random condition as a between-subjects factor were used for the block comparisons. The tables, however, present the pairwise comparisons that followed these models. Finally, note that the differences in df within experiments originated from two sources — the exclusion of different numbers of participants that counted points on each block, and the exclusion of outliers participants that was done separately for each condition.

Experiment 1a

	Block 1 (Between-Ss)		Block 2 (Between-Ss)		Comparison (Within-S)	
Subjective measure	Own choice	Computer picks	Own choice	Computer picks	Own choice	Computer picks
Enjoyment	6.6 (1.62)	5.16 (2.43)	6.4 (1.88)	4.87 (2.11)	6.5 (1.76)	5.02 (2.27)
	t(105)=3.56, p<.001		t(105)=3.98, p<.001		t(106)=8.65, p<.001	
Points	86.8 (62.19)	89.22 (93.69)	123.36 (94.03)	115.06 (53.91)	105.59 (81.87)	101.78 (77.71)
	t(105)=–.16, p=.88		t(105)=.56, p=.58		t(106)=.41, p=.69	
Control	4.83 (2.26)	4.35 (3.16)	5.75 (2.37)	3.21 (2.67)	5.3 (2.35)	3.79 (2.97)
	t(105)=.9, p=.37		t(105)=5.21, p<.001		t(106)=5.76, p<.001	
Money	178.19 (168.35)	161.09 (161.92)	286.6 (224.68)	245.5 (205.81)	233.92 (205.71)	202.11 (188.5)
	t(105)=.54, p=.59		t(105)=.99, p=.33		t(106)=1.74, p=.09	

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Experiment 1b

	Block 1 (Between-Ss)		Block 2 (Between-Ss)		Comparison (Within-S)	
Subjective measure	Own choice	Computer picks	Own choice	Computer picks	Own choice	Computer picks
Enjoyment	6.87 (1.63)	5.31 (2.11)	6.5 (1.39)	3.43 (2.01)	6.7 (1.52)	4.3 (2.25)
	t(54)=3.11, p<.01		t(54)=6.53, p<.001		t(55)=7.39, p<.001	
Points	89.83 (57.45)	106.15 (41.59)	119.89 (42.12)	111.03 (44.38)	103.79 (52.68)	108.77 (42.78)
	t(54)=–1.2, p=.24		t(54)=.76, p=.45		t(55)=–.74, p=.46	
Control	4.23 (1.83)	3.69 (2.99)	5.35 (2.45)	1.63 (1.92)	4.75 (2.19)	2.59 (2.66)
	t(54)=.83, p=.41		t(54)=6.35, p<.001		t(55)=7.39, p<.001	

Experiment 2

	Block 1 (Between-Ss)		Block 2 (Between-Ss)		Comparison (Within-S)	
Subjective measure	Own choice	Computer picks	Own choice	Computer picks	Own choice	Computer picks
Enjoyment	5.87 (2.21)	5.88 (2.05)	6.12 (2.27)	3.91 (2.42)	5.99 (2.24)	4.91 (2.44)
	t(197)=–.05, p=.96		t(197)=6.63, p<.001		t(198)=6.77, p<.001	
Points	116.3 (72.86)	222.53 (603.73)	246.21 (820.65)	162.92 (416.63)	182.23 (589.05)	193.18 (519.63)
	t(197)=–1.73, p=.09		t(197)=.9, p=.37		t(198)=–45, p=.65	
Control	3.26 (2.26)	3.09 (2.39)	4.5 (2.51)	1.9 (1.96)	3.89 (2.47)	2.5 (2.26)
	t(197)=.5, p=.62		t(197)=8.15, p<.001		t(198)=9.67, p<.001	

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Experiment 3 Preference based

	Block 1 (Between-Ss)		Block 2 (Between-Ss)		Comparison (Within-S)	
Subjective measure	Own choice	Computer picks	Own choice	Computer picks	Own choice	Computer picks
Enjoyment	7.5 (1.68)	6.95 (1.75)	6.58 (1.84)	6.45 (2.05)	6.7 (1.91)	7.04 (1.81)
	t(114)=1.42, p=.16		t(114)=0.3, p=.77		z=–1.69, p=.09	
Interest	6.4 (1.81)	6.48 (1.83)	6.25 (1.85)	5.58 (2.09)	6.33 (1.82)	6.03 (2)
	t(114)=–0.19, p=.85		t(114)=1.58, p=.12		z=1.57, p=.12	
Boredom	2.65 (1.51)	2.9 (1.57)	3.25 (1.71)	3.8 (2.33)	2.95 (1.63)	3.35 (2.03)
	t(114)=–0.63, p=.53		t(114)=–1.23, p=.22		z=–1.92, p=.06	
Hard 1-back task	3.25 (1.56)	3.9 (2.07)	4.33 (1.98)	3.53 (1.69)	3.79 (1.85)	3.71 (1.89)
	t(114)=–1.6, p=.11		t(114)=2.09 p=.04		z=,0.36 p=.72	

Experiment 3 Random

	Block 1 (Between-Ss)		Block 2 (Between-Ss)		Comparison (Within-S)	
Subjective measure	Own choice	Computer picks	Own choice	Computer picks	Own choice	Computer picks
Enjoyment	6.68 (1.86)	6.68 (1.67)	6.05 (1.78)	6.58 (1.54)	6.63 (1.58)	6.37 (1.82)
	t(114)=0, p=1		t(114)=–0.87, p=.39		z=.91, p=.36	
Interest	6.42 (1.92)	5.63 (1.67)	6.16 (1.77)	6.05 (1.75)	6.29 (1.83)	5.84 (1.7)
	t(114)=1.34, p=.18		t(114)=0.17, p=.87		Z=1.61, p=.11	
Boredom	3.21 (1.99)	3.74 (2.45)	3.21 (2.04)	3.74 (1.79)	3.21 (1.99)	3.74 (2.11)
	t(114)=–0.91, p=.37		t(114)=–0.81, p=.42		z=–1.74, p=.08	
Hard 1-back task	4.37 (1.86)	3.37 (1.71)	4.63 (1.61)	3.32 (1.16)	4.5 (1.72)	3.34 (1.44)
	t(114)=1.69, p=.09		t(114)=2.36, p=.02		z=3.83, p<.001	

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Experiment 4

	Block 1 (Between-Ss)		Block 2 (Between-Ss)		Comparison (Within-S)	
Subjective measure	Own choice	Computer picks	Own choice	Computer picks	Own choice	Computer picks
Enjoyment	6.64 (2.73)	5.7 (1.77)	5.7 (1.7)	6.18 (2.89)	6.19 (2.29)	5.95 (2.38)
	t(19)=.92, p=.37		t(19)=0.46, p=.65		t(20)=0.89, p=.38	
Interest	4.36 (2.25)	5.1 (1.85)	5.57 (0.53)	4 (2.37)	4.86 (2.03)	4.52 (2.16)
	t(19)=–.81, p=.43		t(16)=1.71, p=.11		t(20)=1.2, p=.23	
Control	8.27 (1.35)	7 (1.33)	6.2 (2.94)	7.55 (1.81)	7.29 (2.43)	7.29 (1.59)
	t(19)=2.17, p=.04		t(19)=–1.28, p=22		t(20)=0, p=1	
Hard	1.2 (0.42)	1.4 (0.52)	1 (0)	1.11 (0.33)	1.62 (1.53)	1.71 (1.62)
	t(18)=–.95, p=.36		t(15)=.94, p=.36		t(20)=–0.49, p=.63	

Predicting PFC using self-reported experiences. To test which and whether participants' subjective experience predicts their PFC, each of the Difference Variables (i.e., Enjoyment, Points, and Money) that reflect the difference in subjective experience between the OC to the CP condition, was used as an input variable in a logistic regression with PFC as its output. The sole significant predictor was the difference in enjoyment, $\chi^2(1)=16.57$, p<.001, R2=.16 (difference in points - $\chi^2(1)=.16$, p=.69; difference in money — $\chi^2(1)=.46$, p=.5). To evaluate how the probability to choose was related to the difference in enjoyment we tested its influence around the mean difference in enjoyment (M=1.48; Gelman & Hill, 2006), and found that a shift from 1-point enjoyment difference below the mean (0.48) to 1-point above it (2.48) corresponded to a change of 17.74% in the probability of deciding to choose for oneself.

3.3 Discussion

Over 80% of our participants decided to choose after experiencing both OC and CP conditions. No consistent difference emerged between the OC and CP conditions in their perceived gains, and these perceived gains did not predict participants' PFC. Conversely, a consistent difference in participants' enjoyment emerged whereby participants reported having enjoyed themselves more when choosing for themselves compared to when the computer chose for them, and this difference in enjoyment predicted a significant proportion of the variance in PFC.

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We designed the next experiment to test whether the results replicate and to reduce the large proportion of participants that were (initially) excluded based on the pre-determined filters in Exp. 1a (see S1.b. in the Supplement for further details). These exclusions were mostly due to our "success" in making the estimation of points difficult, and to address this we simplified the task.

4 Experiment 1b – PFC after experiencing Choice and No-Choice situations (replication)

4.0.1 Participants and design

Fifty-seven students (38 females; Mean age=25.73, SD=5.29) completed the experiment. Data from one participant was excluded as she failed to answer several subjective experiences items, resulting in 56 participants.

The same stopping rule as in Exp. 1a was used. However, data collection ended after the first application of the pre-determined filters, as there were already at least 25 participants for each comparison.

4.0.2 Procedure

The basic procedure was employed with two changes which aimed to simplify the task, reduce statistical noise, and reduce the massive filtering of participants. First, the instructions specified that each condition would include 50 trials. Second, 3 example trials preceded the actual experiment – the experimenter stood behind each participant, narrated what happened during each trial ("you picked the box on the right and gained 5 points"), and answered participant's questions if there were any.

4.1 Results

Preference for choice. As in Exp. 1a, the vast majority of participants (87.5%, CI95% 78.56-96.44) preferred choosing for themselves in the third part of the experiment, significantly higher than 50% (z=5.61, p<.001).

Subjective experience. Also, as in Exp. 1a, all comparisons showed greater enjoyment in the OC than the CP condition, while no stable difference between conditions was found for perceived gains (see Table 1).

Predicting PFC using self-reported experiences. Once again, the sole significant predictor of PFC was the difference in enjoyment, $\chi^2(1)=5.87$, p<.05, R2=.14 (difference in

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points - $\chi^2(1)=.12$, p=.73). The mean enjoyment difference was 2.39 and a shift from 1-point enjoyment difference below this mean (1.39) to 1-point above it (3.39) corresponded to a change of 6.96% in the probability of deciding to choose for oneself.

4.2 Discussion

Since Experiment 1b fully replicated the results of Experiment 1a we can attach an initial value to peoples' PFC – about 83% of participants preferred to choose for themselves (grand mean of PFC in both experiments). Furthermore, and in apparent contrast with an application of outcome-related frameworks (e.g., Brehm, 1956; Langer, 1975) to the current context, perceived gains did not differ between conditions and were not correlated with PFC. Instead, participants consistently reported higher enjoyment when choosing for themselves and this difference predicted a significant proportion of the variance in PFC.[2]

5 Experiment 1c – PFC at the group and individual level

In Experiment 1c, the paradigm was modified to test the generality of the effect and whether it holds at the individual level. Participants had to decide on each trial if to choose or to let the computer choose for them. Then, they further decided whether to choose or let the computer choose throughout a second part of the experiment. Preference for choice under these circumstances will be a strong indication for the reinforcing nature of the choice process, in the sense of the persistence of PFC after thoroughly manifesting it in the first part of the experiment.

5.1 Method

5.1.1 Participants and design

Forty-four students (33 females; Mean age=24.14, SD=3.3) participated in one of two experimental conditions. To attain reasonable estimates, we decided to stop the experiment when there are at least 20 participants in each condition. We had four extra participants when we first checked, and they are included in the analysis.

5.1.2 Procedure

On each trial, four closed boxes appeared onscreen and participants were to decide whether to choose a box or let the computer choose for them. The length of each trial was fixed – two seconds for the boxes-display and 750 milliseconds for the points-display (a total of 2.75

[2]In a follow-up experiment (not reported here), the same task was employed but the instructions stated the words "computer chooses" instead of "computer picks". After 19 participants, a Bayesian Binomial Test (JASP Team, 2020) was conducted and showed that the PFC did not differ from 87% (BF01=4.028). Hence, the different wording yields equal results.

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seconds). When a participant clicked on a box it opened, but the number of points gained appeared only when two seconds from the beginning of the trial had elapsed. Each box contained between 1 to 20 points, but crucially, the sequence of points gained was identical across conditions and participants. Participants were informed that their accumulated points would be converted to money at the end of the experiment.

The experiment included two between-subject conditions with 50 trials each. Conditions differed in what participants were required to do in order to let the computer choose. Participants in the Passive Computer Picks condition were required to click on one of the boxes if they wanted to choose for themselves or wait for two seconds to let the computer choose for them. To directly control for the possibility that idly waiting is aversive and may push participants to prefer choosing (merely to "do something") the Active Computer Picks condition included a button labeled "let the computer pick", in addition to the four boxes. If a participant decided to let the computer choose, she could either click on that button or wait 2 seconds.

At the end of the experiment, participants were told that there will be 20 additional rounds and were asked to indicate whether they want to choose for themselves, let the computer choose for them, or that they are indifferent regarding how boxes will be selected. We added the possibility to indicate an indifference regarding who will choose the boxes to verify that our effect is not limited to a forced choice between own and computer's choices. After indicating their preference, the experiment ended, and no second part was performed.

5.2 Results

Individual-level PFC. We calculated the percent by which a participant preferred to choose for herself and found a wide range between choice 'aversion' (choosing only on 30% of trials) to a maximal PFC (choosing on all trials). Averaging across these individual differences, PFC was 77.78% (CI95% 72.75-82.8) with a one-sample t-test confirming that it differed from the point of indifference (50%; $t(43)=11.14$, $p<.001$).

Although this result is somewhat lower compared to the PFC revealed in the previous experiments, participants nevertheless decided to choose for themselves on a large majority of the trials. Importantly, the pattern of results was not driven by participants merely 'wanting to act', but rather, by their wanting to choose, as similar PFC emerged at the Active Computer Picks (76.27%) and the Passive Computer Picks conditions (79.27%; $t(42)=-.6$, $p=.55$).

Group-level PFC. Regarding participants' preference for who will choose throughout the second part of the experiment, a substantial minority of 38.64% were indifferent. Yet, even this group mostly choose for themselves (69.29% of trials, CI95% 61.08-77.5) throughout the experiment's 50 trials. Among participants who did have a preference (n=27), 85.19% (CI95% 70.86-99.5) preferred choosing for themselves (again, after repeatedly expressing this preference throughout the experiment's 50 trials), significantly higher than 50% ($z=3.66$, $p<.001$).

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5.3 Discussion

When participants could indicate their indifference regarding who will choose, of the ones who had any preference more than 85% preferred own-choice. Thus, once again, the >30% above chance level seems to be a robust estimate of people's PFC. This estimation is particularly informative as it was obtained after participants repeatedly expressed their PFC throughout the experiment and even though they could have minimized their mental effort and do nothing throughout the entire experiment without any cost to their time or outcomes (PFC of ~79% in the Passive Computer Picks condition).

6 Experiment 2 - Memory-based PFC (without recent experience of Choice and No-Choice situations)

Experiment 2 aimed to test what proportion (if any) of PFC is memory-based – that is, stems from a history of contingencies between choice and positive outcomes (e.g., Leotti et al., 2015). Our logic is that if a database created by years of choosing is responsible for PFC, then a brief experience with choices in our paradigm should have little to no influence on such an overlearned preference. Alternatively, if the actual 'act' of choosing is reinforcing, then a recent experience of choosing should enhance participants' PFC above and beyond the assumed 'memory-based' PFC.

To test this, the basic paradigm was employed with a key difference – participants answered the experimental questions before having any experience with the task, thus revealing their life-long expectations regarding choice and no-choice situations and their memory-based PFC.

6.1 Method

6.1.1 Participants and design

We present the pooled results of three experiments with an identical procedure and highly similar results, in which participants had no actual experience with the task. Overall, 254 individuals participated in these experiments: 100 individuals (66 females; Mean age=24.95, SD=5.27) in the first (online) experiment, 99 individuals (44 females; Mean age=27.11, SD=6.4) in the second (online) experiment, and 55 individuals (31 females; Mean age=24.66, SD=2.8) in the third (lab) experiment.

Participants in the online experiments were recruited using snowball sampling over the internet for a chance of winning 300 NIS (~75$). Participants in the lab experiment were compensated for their time with 10 NIS (~2.5$) and a chance of winning 300 NIS (~75$).

As a stopping rule, we decided to run each experiment until there were at least 40 participants after the application of the pre-determined filters and of a Belief filter that is unique to this study and represents participants' conviction that they will actually perform

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the task. This Belief filter seems important as participants that do not believe the task is real might treat the experiment differently than those that do. However, the pre-determined filters led again to excluding a large proportion of participants, and hence, only the Belief filter was applied in the following results.

6.1.2 Procedure

The online experiments were conducted using Google Forms and participants completed them at their leisure. Participants knew they could win 300 NIS (~75$), depending on their performance – specifically, the instructions stated that "The 3 participants who will gain the largest number of points will win".

First, participants read the instruction for one experimental condition (OC or CP). Then, before having any experience with the boxes, they answered ("according to your gut-feeling") questions about their expectations regarding the upcoming task (i.e., the points to be gained, their [expected] enjoyment, and their [expected] degree of control). Next, they were informed about the second condition (either OC or CP; order counterbalanced between participants), red its instructions, and answered the same questions about their expectations once more, this time regarding the second condition. Next, they decided whether to participate in either the OC or CP condition and then were informed that the experiment was finished. Finally, they were asked "How much did you believe that the boxes will soon appear" and answered using a 1–9 scale in which 1 is "did not believe at all" and 9 is "fully believed". However, as the pattern of results was similar regardless of the belief filter (excluding participants with a belief score lower than 5), here we present the full data of all 254 participants, without the application of this filter.

6.2 Results

Preference for choice. Most participants (72.05%, CI95% 66.49–77.6) preferred choosing for themselves over letting the computer choose for them (Exp.2a – 68% [CI95% 58.7-77.3]; Exp.2b – 73.74% [CI95% 64.92–82.56]; Exp.2c – 76.36% [CI95% 64.77–87.95]). This datum was different from the point of indifference (50%) – $z=7.03$, $p<.001$.

Subjective experience. Once again, the results supported greater enjoyment in the OC than the CP condition (notably, there was no difference between conditions in the first block), while no difference in favor of the choice condition emerged for perceived gains (see Table 1).

Predicting PFC using self-reported predicted experiences. Replicating experiments 1a & 1b, the difference in predicted enjoyment predicted PFC, $\chi^2(1)=8.71$, $p<.005$, $R2=.03$, while the difference in points did not, $\chi^2(1)=.89$, $p=.35$. The mean enjoyment difference was 1.06 and a shift from 1-point enjoyment difference below (.06) to 1-point above (2.06) this mean corresponded to a change of 8.28% in the probability of deciding to choose for oneself.

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6.3 Discussion

Consistent with a solely memory-based PFC, participants preferred to choose for themselves even when they had no immediate experience with choosing, but such PFC is weaker compared to when participants have just experienced choosing. At a first glance, the subjective experience measures present a similar pattern to Exp. 1a & 1b – predicted enjoyment but not predicted points were higher in the OC condition and also predicted PFC.

However, contrary to Exp. 1a & 1b, the filtered data of Exp. 2 produced a slightly different pattern, probably because participants' estimations of the points to-be-gained greatly exceeded the maximum possible accumulated amount under the experimental settings (i.e., 50 rounds with a maximum of 5 points per round) – 39 estimations exceeded this maximum, and 6 of which were extremely high (≥1,000). After applying the pre-determined filters (see S1.d. at the Supplement for the full report), participants did expect to gain more points in the OC compared to the CP condition (although not in the between-subjects comparison of the first block), and predicted points to-be-gained (in addition to enjoyment) did predict (a small) portion of PFC. As this was not the case in the former experiments, where participants experienced actual choice, this pattern of results is consistent with the notion that memory-based PFC is related to previously acquired associations of choice with better outcomes, while actual experience with choosing further elevate PFC due to factors that stem from the process of choosing.

6.4 Interim summary

To quantify the unique contribution of experiencing choices and memory-based PFC, we compared the combination of Experiments 1a & 1b to Experiment 2, when only the belief filter (Exp. 2) was applied. Importantly, the instructions and questions in these experiments were identical but for the inclusion of the money probe in Experiment 1a. The significant difference was whether participants answered the questions with (Actual-Choice; AC) or without experiencing the task (Simulated-Choice; SC). The full results of this analysis appear in the Supplement (S2) and are discussed here briefly.

A two-sample test of proportions revealed that Actual-Choice participants (n=163) preferred own-choice to a higher degree (83.44%, CI95% 77.73–89.14) compared to Simulated-Choice participants (n=199, 73.37%, CI95% 67.23–79.51), z=2.3, p=.02 (Figure 2). Thus, we estimate that actual experience with choice and no-choice situations adds ~10% to PFC, at least in the current context.

Participants' enjoyment was higher in the OC compared to the CP condition in both AC and SC experiments. Importantly, this difference was larger in the AC experiments and was lacking from the first block of SC experiments. Regarding the estimation of points gained, there was a main effect for experience: participants expected to gain more points in the SC

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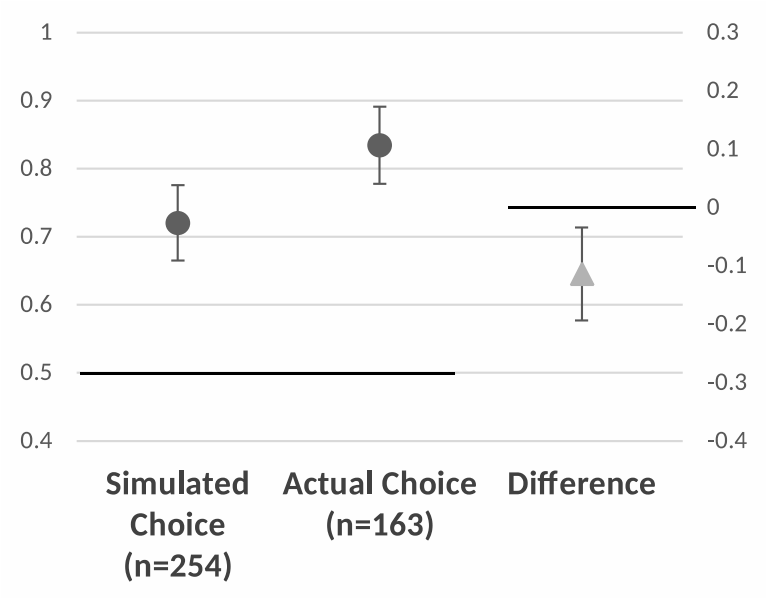

FIGURE 2: Means and 95% confidence intervals of the probability to choose given actually choosing in the task or merely simulating having chosen.

experiments compared to the points they thought they had gained in the AC experiments. But there was no difference between the OC and CP conditions.

Modeling PFC using the difference in enjoyment revealed that greater differences in enjoyment (in favor of the OC condition) predicted an increased probability that a person will further decide to choose for herself. Importantly, this effect was much stronger in the AC compared to the SC experiments. That is, the hedonic experience was more strongly associated with PFC when actual choices were made. Conversely, the difference in estimated points gained was not significantly associated with a person's PFC in either AC or SC experiments.

Taken together, the differences in enjoyment between conditions reliably predicted PFC. The fact that, after actual experience with the task, relative enjoyment had greater predictive power and the observed PFC increased, implies that the process of choice can be intrinsically reinforcing through hedonics and that enjoyment is a key factor that leads people to prefer own choice.

7 Experiment 3 – Testing the role of hedonics in causing PFC

Experiment 3 aimed to directly test the degree to which PFC is affected by choice-related factors. Our rationale was that, if there is a component in PFC that is causally driven by a hedonic response that arises from the process of choice, then targeting key aspects of choice (e.g., by inducing cognitive load) should reduce PFC. Since previous work has shown that

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feelings are reduced by cognitive load (e.g., DeFraine, 2016; Kron et al., 2010; van der Wal & van Dillen, 2013) it is possible that the hedonic feeling generated by choosing would be reduced. Conversely, to the degree PFC stems from a history of reinforcement, targeting key aspects of choosing should not affect it, or at least, affect it substantially less.

First, we reduced participants' ability to deliberate by employing our basic procedure with the addition of a simultaneous cognitive load. Second, we included another condition that targets another key aspect of the choice processes – the necessity of 'selecting based on one's preferences' (Ullmann-Margalit & Morgenbesser, 1977) – by instructing participants to "choose as randomly as possible", that is, to refrain from consulting their preferences.

7.1 Method

7.1.1 Participants and design

One hundred and eighteen students (76 females; Mean age=24.99, SD=4.01) participated in a mixed experimental design that included the two basic within-subjects conditions (OC and CP; counterbalanced) embedded within three between-subjects conditions (Dual-Task, Single-Task, and Random). As a stopping rule, we aimed for 20 participants per condition, but stopped unwittingly a bit short of that goal, having 3 conditions with 19 participants, 2 conditions with 20 participants, and one condition with 21 participants.

7.1.2 Procedure

Our basic procedure was again employed but this time with an additional 'executive' (cognitive load) task. While performing the OC and CP conditions, participants also performed a 1-trial back task – they had to constantly monitor, update, and remember the number of points they had gained in the previous trial, and were probed on this number seven times in each condition following a random number of trials. Then, participants responded to four fixed-order questions about their enjoyment, interest, difficulty of remembering the points from the previous trial, and boredom levels, using 1–9 point rating scales. (The sense of control and the perceived gained points measurements were not included, because we wanted to use a maximum of four questions and because these questions proved to be less informative.)

Regarding the three between-subjects conditions, the Dual-Task and Single-Task conditions differed only in the wording of the crucial PFC question at the end of the experiment. Participants had to decide whether to choose or let the computer choose in the third (ostensive) part of the experiment that will again include (Dual-Task) or will no longer include (Single-Task) the 1-trial back task. The Single-Task condition was included because PFC in the Dual-Task condition might be masked by participants wanting to reduce load and for that reason letting the computer choose. The Randon condition was identical to the Dual-Task condition but for the fact that in the OC block participants' task was to choose as randomly as possible. Crucially, this Random condition is as demanding as the Dual-Task

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condition but does not involve acting based on one's preferences. Thus, comparing the PCF portion between these conditions is an estimate for PFC that is induced by recent choice (as well as what constitutes choice in 'the mind's eye').

7.2 Results

Preference for choice. Most participants preferred choosing for themselves in the Dual-Task (68.29%) and the Single-Task (64.1%) conditions, but only 44.74% of participants preferred choosing for themselves in the Random condition (95% CI are presented in Figure 3a). The Dual-Task condition differed from the point of indifference (50%; z=2.34, p=.02) and from the Random condition (z=2.11, p=.03), while the Single-Task condition was only marginally different from 50% (z=1.76, p=.08, single-tailed p=0.04) and from the Random condition (z=1.71, p=.09, single-tailed p=0.04).[3] No other reliable differences were found.

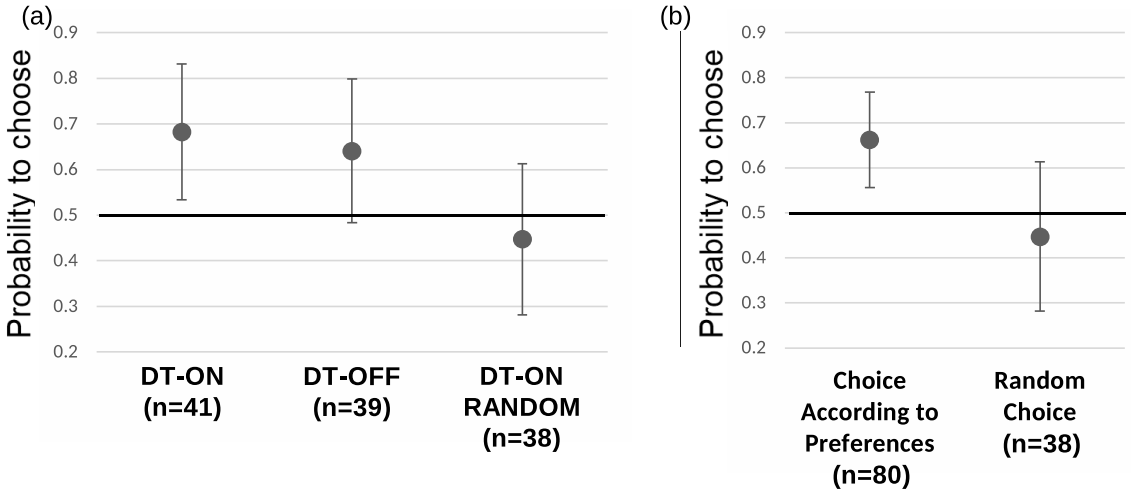

FIGURE 3: Means and 95% confidence intervals of the probability to choose pending on the experimental condition of Experiment 3 (a) and on the nature of choice in Experiment 3 (b).

In an additional test of PFC, the conditions in which participants chose according to their preferences (Dual-Task and Single-Task) were combined into one Preference-based Choice condition and compared to the Random condition. Among the Preference-based Choice group, 66.25% preferred choosing for themselves (Figure 3b). This result is different both from chance level (z=2.91, p<.01) and from the Random Choice condition (z=2.22, p=.03).

Subjective experience. As predicted, under cognitive load, there was no consistent difference between the OC and CP conditions in the great majority of the subjective experience measures (i.e., enjoyment, interest, sense of control, and the difficulty to perform the 1-back task; see Table 1; see S3 in the Supplement for the full report). The sole consistent difference

[3]Given the relatively small number of participants and the difficulty of interpreting a lack of difference using frequentist statistics we do not further interpret this pattern.

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was that participants in the Random condition reported that it was harder to perform the 1-back task during the OC compared to the CP condition. This may indicate that 'choosing' randomly may have created further cognitive load.

Predicting PFC using self-reported experiences. Three mixed logistic regressions were conducted to predict PFC separately with each Difference Variable (i.e., the difference in Enjoyment, Interest, and Boredom between the OC and CP conditions). In addition, the between-subjects condition (Dual-Task, Single-Task, and Random), and its interaction with the Difference Variables were added as input variables. These analyses revealed that boredom and interest predicted PFC with varying success for the two Preference-based and the Random conditions, while enjoyment similarly predicted PFC for all three between-subjects conditions (see S4 for the full regressions reports).

7.3 Discussion

As predicted, cognitive load lowered PFC (but did not eliminate it). Furthermore, differing from Experiments 1a & 1b, the difference in enjoyment between the OC and CP conditions was not significant. This is a strong indication that the cognitive load that accompanied the main task interfered with or otherwise dampened the hedonic feelings that choice generates as was previously shown for other feelings (Kron et al., 2010; van der Wal & van Dillen, 2013; van Dillen & van Steenbergen, 2018). Together, these findings support the notion that choice is self-reinforcing and highlight the potential causal role of exercising choice in creating PFC and of the feeling that drives it.

Eliminating a second defining factor of choice – selecting based on one's preference – led to the elimination of PFC, above and beyond the main effect of cognitive load. This finding again supports the conclusion that choice itself, conceptualized as performing preference-based selections but not merely selecting (not based on one's preferences) can be reinforcing and is necessary for generating PFC. Furthermore, it might be that the cognitively loading aspect of being random dampened PFC as well.

8 Experiment 4 – Testing whether preferences are necessary for PFC.

Experiment 3 suggested that PFC disappears when people are instructed to pick at random. Thus, a possible conclusion is that for choice to be reinforcing (or for "choice" to be 'choice') – selection among options must be based upon one's preferences (Ullmann-Margalit & Morgenbesser, 1977). Experiment 4 directly tested this idea by having participants select among task-relevant entities without having any preference regarding the outcome of their selection.

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8.1 Method

8.1.1 Participants and design

Here, we applied a Bayesian measure of strength of evidence and stopped the experiment when it became clear that PFC is either different or not-different from 50%. Accordingly, the experiment was stopped after twenty-one participants (17 females; Mean age=25.76, SD=2.93) completed two within-subject conditions (OC and CP; counterbalanced), when the computed Bayes factor crossed the conventional threshold of 1/3.

8.1.2 Procedure

Participants were seated in front of a desktop computer and pairs of boxes appeared onscreen. They were instructed to hold the mouse with their right hand and put two fingers of their left hand on the "n" and "m" keyboard keys. Their task was to click on one box using the mouse to open it. Once the box opened, a number (ranging from 1 to 9) appeared between the boxes with a simple arithmetic exercise appearing above it. Then, their task was to press the 'M' key if the number was the correct result of the arithmetic exercise or the 'N' key if it was not. Each trial ended only after participants correctly answered the question. All participants completed 50 trials per condition.

Thus, although the numbers 'revealed' by participants' key-presses were task-relevant as they were required to perform the arithmetic task, participants' selection of the box is seemingly not driven by any preference they might have towards the unboxed 'result'. In other words, while it is very likely that participants preferred attaining more points in the former experiments (due to their monetary value) and based their selections on that preference, it is unlikely that preference-based selection (i.e., choice) guided the decision of which box to open in this experiment.

As in our basic paradigm, in the OC condition participants freely chose which box to open, while in the CP condition a green rectangle indicated which box should be opened. Following each condition, participants answered questions about their experience in that part of the experiment using 1–9 scales: enjoyment, interest, sense of control, the difficulty of the arithmetic exercise. (The perceived gained points measurement was not included.) After both conditions were completed, participants indicated whether they prefer to choose for themselves or let the computer choose for them in a third part of the experiment (the binary PFC question from the previous experiments). Then, they were further informed that the third part will include 50 rounds and were asked to decide how many rounds they prefer choosing for themselves and how many they would like the computer to choose for them (a continuous PFC measure). The experiment ended at this point.

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8.2 Results

Preference for choice. Only 52.38% (CI95% 29.08-75.68, n=21) of participants preferred choosing for themselves in the third part of the experiment, not differing from the point of indifference (50%; z=.22, p=.83). A Bayesian Binomal Test (JASP Team, 2020) also supported this null hypothesis (BF01=3.7).

Analyzing the continuous PFC probe, which required participants to decide on how many future trials (out of 50) they would like to choose, produced a similar result. On average, participants decided to choose on 27.24 trials (54.48%) (CI95% 18.43-36.04), with a one-sample t-test showing that this result does not differ from chance level (25; t(20)=.53, p=.6).

Subjective experience. No consistent differences emerged between the OC and CP conditions on any of the subjective experience measures (i.e., enjoyment, interest, sense of control, and the difficulty of the arithmetic exercise; see Table 1).

8.3 Discussion

Experiment 4, together with the Random condition from Experiment 3, strongly suggest that merely selecting between options is not reinforcing and hence, does not generate PFC. Rather, for selecting to become a choice in 'the mind's eye', it must be based upon ones' preferences.

A possible alternative explanation is that Experiment 4 was aversive due to the inclusion of the arithmetic exercises and that this aversion lowered participants' PFC. However, comparing the enjoyment rating in Exp. 4 to the equivalent rating in Exps. 1a & 1b revealed no significant differences. Thus, the task was probably not more aversive.

9 General discussion

Consistent with previous studies, the current study documents a strong preference for choice even when individuals could refrain from the extra effort and receive identical outcomes. Further experiments capitalize on the robustness of this preference to understand what modulates and potentially generates PFC.

We found that for PFC to fully unfold participants should exercise their choice (Exp. 1). Conversely, just thinking about performing choices leads to a diminished PFC (Exp. 2). Furthermore, for greater PFC to emerge choices must be exercised under minimal (choice unrelated) cognitive load and should be based on the chooser's preferences. Selecting according to a different (i.e., preference-unrelated) rule (Exp. 3, Random condition) or not having preferences regarding the outcome of choice (Exp. 4), do not generate PFC, seemingly in contrast with the reported beneficial effects of so-called 'incidental choices'

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(Wulf & Lewthwaite, 2016). In this section, we review our interpretation of this pattern and the implications.

9.1 Choice is self-reinforcing

This pattern strongly suggests that the act of choosing is reinforcing, in and of itself, and that PFC is, to a substantial degree, dependent on exercising choice. Given that our participants consistently reported enjoying choice more – a pleasurable sensation that seemingly stems from the process of choice might be that reinforcing element. Still, the process of choice may be reinforcing even without involving a felt hedonic component, as has been suggested and shown for other responses (e.g., Berridge et al., 2009; Eitam et al., 2013). Hence further research is required to determine the necessity of felt pleasurable sensation in boosting PFC.

A possible avenue for exploring whether the pleasure from choosing has a causal role in generating PFC is to explore PFC with participants who suffer from a Major Depressive Disorder (MDD), a condition in which pleasure is muted (Mitterauer, 2020; Pizzagalli, 2014; Romaniuk et al., 2019). Initial work from our lab suggests that MDD does lead to lower PFC, lending further support for the role of enjoyment.

Be that as it may, this reinforcement-based explanation differs from an outcome-based explanation by which PFC is driven by lifelong acquired associations between choices and better outcomes, that is rewards (e.g., Delgado et al., 2000; Leotti et al., 2015; Leotti & Delgado, 2011). This is because the actual exercise of choice did significantly increase PFC compared to merely simulating choice.

Note that this explanation also differs from 'cognitive' explanations suggesting that choice is preferred because it increases the subjective sense of controlling the outcomes (e.g., Langer, 1975) or their valuation (e.g., Brehm, 1956). Here, exercising choice did not affect perceived outcomes. Only when participants simulated choice (and only after applying filters; Supplement S1.d), was there some evidence that people expected to gain more by choosing themselves (Exp. 2). Put differently, the current study suggests that the bona fide 'choice premium' (Cockburn et al., 2014; Niv et al., 2015) may be confined to the activity of choosing rather than added to or otherwise modulate the outcomes of choice.

Finally, the consistent pattern of results regarding the sense of control people reported raises the suspicion that it was driven by 'demand characteristics'. Moreover, we found no evidence that control, conceptualized as a response-driven sensorimotor prediction (Blakemore et al., 1998) is preferred in the context of decision making (see Karsh & Eitam, 2015). Specifically, PFC did not differ between the Active and Passive CP conditions in Exp. 1c. These finding suggests that previously reported relations between own-choice and control (e.g., Bobadilla-Suarez et al., 2017; Wang & Delgado, 2019) might not be subjectively felt and as a result do not guide a conscious preference toward choice situations (Karsh et al., 2016).

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9.2 Choosing to choose or not

The current study may also serve to explain an apparent contradiction in both lab and real-world results.[4] While preference for choice is indeed empirically robust, another seemingly opposite phenomenon exists – staying with the default (Anderson, 2003; Samuelson & Zeckhauser, 1988; see Jachimowicz et al., 2019 for a review). In a nutshell, when people are presented with options to choose from, one of which has been pre-selected, they will pick the prechosen (default) option at greater rates compared to when the same option is not the default. In other words, people choose not to choose, in the presence of a default.

Although decision-making involves multiple processes, each potentially affected by different factors; our conclusion that PFC stems to some degree, from the self-reinforcing nature of choosing, suggests several conditions that should modulate staying with default and lead to testable predictions. One such factor is exercising choice – if the choice process is self-reinforcing, people who have recently chosen will tend to exercise their choice even more thus reducing, on average, the tendency to stick to the default. If confirmed, this may provide a new form of 'nudge' to be applied when it is beneficial for individuals to move from the default.

A second factor is preferences – if people do not have clear preferences regarding the outcome of their choice they will stick to the default. This in itself may not be surprising, but the current study explains why this may be the case – because "choosing" without preferences is not reinforcing, and will not be reinforced even by previous, preference-based, choices – it is a different activity. This suggests that staying with the default can be reduced, on average, if the situation emphasizes acting upon one's preferences.

A third factor is the concurrent mental load. Note that here we are not referring to 'choice overload' (e.g., Iyengar & Lepper, 2000), where people feel overwhelmed by specific choice-related parameters (e.g., the number of options). Rather, as we predicted and Experiment 3 demonstrates, choice-irrelevant load reduces PFC and consequently should increase sticking to the default. More speculatively, it may be the case that 'choice overload' is but one instance of the more general effect of cognitive load on PFC reduction.

9.3 Choosing intensifies feelings through engagement?

In closing, we would like to raise a different explanation for our findings which leads to some surprising predictions. In Exp. 3 & 4 interest was positively correlated and boredom was negatively correlated with enjoyment. The casual relationship here is unknown – are people interested because they enjoy or vice versa? As subjective feelings were measured and not manipulated enjoyment cannot be firmly established as causing increased PFC. However, the robust effect of enjoyment in Exp. 1, as well as recent findings from our lab regarding the muted PFC of people suffering from anhedonia due to MDD point toward enjoyment as a leading candidate in boosting PFC.

[4]We are grateful to Professor Ido Erev for pointing out this interesting juxtaposition.

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Another explanation for PFC relates to Engagement theory (Higgins, 2006) and is that choosing increases engagement and thus, amplify the feelings generated in the situation. Relatedly, Beattie et al. (1994) suggested that the hedonic feelings that arise in a choice situation can be positive, but also negative, pending on the choice context. Thus, it is not that people will always prefer choosing or that choosing will always generate a positive experience. Rather, choosing increases engagement, which in turn would intensify enjoyment/interest (and decrease boredom) in a positive context of choosing between positive outcomes or performing an interesting or otherwise hedonically pleasant task. Conversely, in a negative context (e.g., choosing between two negative outcomes) choice should intensify negative feelings and PFC will decrease.

This interpretation can accommodate the current pattern of results. When profit could be made (Experiments 1–3) engagement should amplify PFC, when no profit but also no losses can be made (Experiment 4), engagement does nothing (hence no PFC) as there are no typical feelings to intensify. To determine the veracity of this theoretical alternative – future work should test the critical prediction that choosing in a negative context should reduce PFC.

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