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Does Mental Effort Avoidance Depend on the 'Type of Effort'?

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Abstract

The propensity for people to avoid mentally demanding tasks in the absence of reward is well documented. As a result, humans are often described as cognitive misers. This characterisation, while consistent with the psychological literature, contradicts everyday instances of effort being sought: reading, board games, and brain-teasing puzzles. Such examples however are markedly different from the types of tasks typically used in the mental effort literature (e.g., working memory tasks, demand selection tasks). The current set of experiments assessed whether the type of task (i.e., N-Back, Number Sequence Problems [NSP], or Anagrams) affects people's aversion to, or desire for, increased effort. On average, across 3 experiments, participants showed an aversion to effort regardless of whether the effort required was more attentional (N-Back) or cognitive (NSP and anagrams) in nature, and were willing to forgo financial reward in order to avoid more difficult tasks. A minority of participants, however, sought more effortful tasks for equal or lesser reward.

Keywords: mental effort; effort avoidance; effort seeking; cognitive misers; demand avoidance.

Introduction

Evidence that human beings are averse to engaging in mentally demanding tasks pervades the psychological literature (for review, Kool & Botvinick, 2018; Inzlicht, Shenhav, & Olivola, 2017), leading some to label us "cognitive misers" (Fiske & Taylor, 1984). In laboratory experiments, people prefer tasks which require less switching (Kool et al., 2010), tasks with lower working memory demands (Westbrook, Kester, & Braver, 2013), and will persist with "easier" strategies even with they incur a time or reward penalty (Kool et al., 2010). Anecdotally, people often opt for television over a book, social media over emails, or in academia, getting *another* coffee to avoid grading essays.

Despite this, it is obvious that humans occasionally seek out effort, even for leisure. If effort was ubiquitously aversive, the *New York Times* wouldn't have over one million subscribers to their games section, chess wouldn't have lasted thousands of years, and over two million people wouldn't play Wordle every day. Moreover, the rewards for engaging in such tasks appear minimal beyond the positive feedback for a correct answer or the social reward after beating a friend in a game. While such instances of effort seeking are commonplace in everyday life, they are scant in controlled laboratory settings. To our knowledge, experimental examples of effort seeking in the absence of extrinsic reward are only observed when the alternative is doing *nothing* – which arguably results in an aversive state of boredom (Bench & Lench, 2019; Wilson et al., 2014).

A successful theory of mental effort should account for both instances of effort avoidance and effort seeking. Firstly, however, instances of effort seeking need to be observed in a controlled environment to distinguish the factors which make effortful tasks intrinsically rewarding rather than aversive.

Defining Mental Effort

Inzlicht and colleagues' (2017) define mental effort as the phenomenon which modulates how well an individual could perform on some task and how well they actually perform. Typically, as effort increases, assuming difficulty is held constant, performance also increases. Furthermore, increased amounts of effort are required to maintain performance as external difficulty increases.

In addition, we also divorce the use of the term *effort* from the aversive experience felt when engaging in a demanding task (e.g., "grading undergraduate essays is *effortful*"). In theory, demarcating the expenditure of mental effort from a *sense of effort* (Kurzban, 2016) makes it possible for effort to increase independently from the aversive feeling often associated with it. For example, one could increase the difficulty level on their favourite computer game, and subsequently the amount of effort they need to exert, without it becoming less enjoyable.

Types of Mental Effort

Typical experiments investigating mental effort use tasks which could broadly be defined as *attentionally demanding*. For example, Westbrook and colleagues (2013) use the N-Back task (Kirchner, 1958) which places stress on working memory as the value of 'N' increases. Kool and colleagues (2010) used task switching games known as *Demand Select Tasks* (DST) where the rules of the game may change between trials: if a number displayed is blue, participants must respond as to whether it is greater or less than 5; if the number displayed is purple, participants must respond whether it is odd or even. Games which require greater switches between the two sets of rules (i.e., switches of colour) are considered more effortful. Other types of tasks are those employed by Caplin et al. (2020) which require participants to make distinctions between 7 and 10-sided polygons, or DellaVigna and Pope's (2018) experiment which required participants to press the *a* and *b* keys (on a keyboard) as fast as possible. Even without direct experience of such tasks, it is unsurprising that participants are unwilling to increase the difficulty (and subsequently their effort) without additional reward. In these instances, effort aversion is presumably driven by an increased sense of effort; as the amount of mental effort exerted increases, so too does the aversive sense of effort.

All challenging tasks require attention in order to succeed, but in *attentionally demanding* tasks, maintaining attention is the primary determinant of whether a

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participant succeeds or fails. Conversely, tasks which people engage in recreationally (e.g., board games, puzzles) often require effort which could be labelled *cognitively demanding* – types of tasks which often require abstract, problem-solving skills in addition to maintained attention. Before such potential differences – attentionally and cognitively demanding – are explicated however, it is important to establish whether this intuitive distinction maps onto different effort preferences. For instance, are people more willing to increase their effort in a cognitively demanding task (e.g., solve the missing number in a sequence) than an attentionally demanding one (e.g., N-Back tasks).

The current set of experiments assesses the cost of effort across three tasks – N-Back, Number Sequence Problems, and Anagrams – which we intend to require different types of effort. Specifically, the N-Back task requires attention and working memory, whereas the Number Sequence Problems and Anagrams require more abstract, problem solving skills which we argue more closely align with the tasks people partake in for fun (e.g., sudoku, Scrabble). Preferences and aversions to effort were assessed using an effort discounting task (COG-ED; developed by Westbrook et al., 2013). Analogous to a delay discounting task, the COG-ED allows an explicit financial cost to be placed on increasing (or decreasing) mental effort.

The COG-ED Task

Westbrook and colleagues (2013) first developed and employed the COG-ED using a N-Back task which had six levels of difficulty (N ranging from 1 – 6). The COG-ED task starts by asking participants to choose between a 1-Back task for $1.00 and a higher difficulty level for $2.00. For example, a 1-Back task or a 2-Back task. In this example, if participants chose the 2-Back task, the next offer for the 1-Back would rise $0.50 (i.e., 1-Back for $1.50 or 2-Back for $2.00). If the 1-Back was chosen, its value on the next offer would decrease by $0.50 (i.e., 1-Back for $0.50 or 2-Back for $2.00).

Participants made six choices for each comparison (1-Back or N-Back, where N ranged from 2 – 6) and the amount the offer changed would halve each time[1]. After six choices the final amount offered for the 1-Back task was taken as the indifference point. The lower the value of the indifference point the more participants were willing to lose in order to avoid the harder task (i.e., higher N-back task).

Their results showed that the harder the N-Back task, the lower the average indifference point. In other words, participants were willing to forgo greater financial reward as the N-Back difficulty increased.

Experiment 1

The first experiment aimed to replicate the work of Westbrook and colleagues (2013) with the addition of a 0-Back task. Here participants gained experience with various N-Back tasks (where N = 0 – 5) and then completed a COG-ED task which assessed their preferences and aversion to the varying difficulties. The 0-Back task was intended to elicit boredom, potentially inducing participants to prefer effort.

The design of our COG-ED task offered $2.00 for each option on the initial choice, allowing participants to show a preference for either the easier or harder N-Back difficulty (a feature not present in the original use of the COG-ED task).

Analogous to Westbrook et al. (2013) findings we expected participants, on average, would be willing to forgo greater reward as the difficulty level increased. We did however expect that some participants may show a preference for harder tasks (e.g., 1-Back and 2-Back) when the alternative was the potentially boring 0-Back.

Methods

Participants Thirty-nine students[2] enrolled in Psychology 1A or 1B courses at the UNSW, Sydney participated in the experiment in exchange for course credits. In addition, participants were paid a bonus (M = $5.11AUD).

Materials The experiment was coded in jsPsych (de Leeuw, 2015) and JavaScript. Participants completed the experiment on HP desktop computers in the lab.

N-Back Design The N-Back task consisted of six difficulty levels (N = 0 – 5) and drew from 10 consonants (Z, X, C, V, B, N, R, P, T, S). There were 30 sequential trials (letters displayed) in each run. Each letter was displayed for 2000 ms and there was a post-trial gap of 1500 ms. Participants were required to press 'm' (during the 2000ms trial) on their keyboard if the current letter matched the letter from N turns ago.

On a single trial, the chance of the current letter matching the letter from N trials ago was 33%. This was to ensure the experienced difficulty did not fundamentally differ between and within participants. During a 0-Back task letters were randomly drawn and participants were simply required to press 'm' for each letter.

COG-ED Design The COG-ED task consisted of nine different comparisons: 0-Back vs 1, 2, 3, 4, and 5-Back, and 1-Back vs 2, 3, 4, and 5-Back. The five 0-Back comparisons were presented first (in a random order) followed by the four 1-Back comparisons (in a random order).

On the initial choice of each comparison, both N-back tasks were offered for $2.00 (Figure 1). Whichever option was chosen first reduced by $1.00 on the next trial; this option then increased (decreased) by half of the last adjustment if the alternate (same option) was chosen; this titration occurred for seven trials and the final value (of the titrated option) was taken as the indifference point. It is important to note that whichever option was first chosen was the option which titrated over the remaining six choices. This was to ensure offers did not rise above $2.00, therefore participants forwent reward, rather than receiving greater reward to complete a task.

[1] The changes in the offered value (to 3 d.p.) across the six choices are $0.50, 0.25, 0.125, 0.062, 0.031, 0.015.

[2] The number of participants was lower than our intended sample of 50 due to a state-wide COVID-19 lockdown.

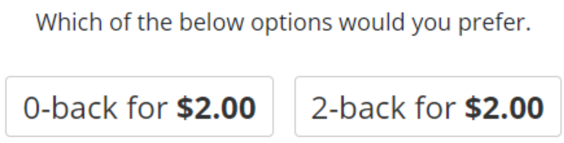

Figure 1. A participant's view for the first choice between a 0-back task and 2-back task.

Procedure Participants were given detailed instructions and a demonstration of how the N-Back task worked. Participants were also instructed that if they were unsure how the task worked they could ask the experimenter for help.

Following the instructions participants completed 12 training runs – two of each difficulty level – and were given feedback on their performance after each run. Feedback was in the following form: "*You correctly identified x of the X matching items. You incorrectly identified y of Y non-matching items. On average, you got z-percent correct.*"

Participants then moved onto the COG-ED task. They were told they would be choosing which option they would "*prefer to complete for the amount of money specified*" and that one of their choices would be randomly selected after the COG-ED phase and played out. Participants were also told their engagement and effort would be monitored during this final selected N-Back task and that they "will only be paid… if you maintain your effort during the task." It should however be noted that no such monitoring of participants performance or engagement took place, and payment was not contingent on their performance (following precedent – see Westbrook et al., 2013).

After a participant's choice was randomly selected from the COG-ED task (e.g., 1-Back for $1.25) they completed three runs of 30 trials of the selected difficulty level for the offered amount of money. Their performance on this phase did not affect their payment.

After completing the experiment participants were debriefed and received a bonus payment according to their randomly selected trial.

Results

Training phase performance Participants' performance generally decreased as difficulty level increased (Table 1). The one exception to this was the 0-Back task (M = 95.94% correct); this however was driven by four participants with comparatively low averages (< 80%). When these four participants are excluded the 0-Back average rises to 99.29%.

COG-ED Task Participants indifference points for each comparison were converted to a *subjective value* (SV) by dividing their indifference point by 2 (the amount initially offered for each choice) and then subtracting 1[3]. This conversion allowed indifference points to reflect the proportion of reward participants were willing to forgo in order to choose the alternate option: values between 0 and -1 indicate participants were willing to forgo reward to do the easier option (and the proportion of reward they were willing to forgo) and values between 0 and 1 indicate participants were willing to forgo reward to do the harder option (and the proportion of reward they were willing to forgo). For example, for the 1-Back or 2-Back comparison, an SV of -0.5 (+0.5) indicates a participant was willing to forgo 50% of the offered reward to do a 1-Back (2-Back).

On average, participants showed preferences for the easier option (Figure 2) and were willing to forgo greater proportions of reward as the difficulty disparity grew larger between the options ($F(8, 341) = 14.30$, $p < .001$). Exceptions were the 0-Back vs. 1-Back ($M = .02$, $t(38) = .62$, $p = .53$) and 0-Back vs. 2-Back comparisons ($M = -.07$, $t(38) = -.99$, $p = .33$) where participants were, on average, indifferent between the two options.

We also took a count of participants preferences when offered rewards were equal (i.e., both $2) across the nine comparisons (Table 2).

Table 1: Average performance per N-back level in the training phase of experiment 1.

N-Back	Percent Correct	Standard Error
0	95.94	0.02
1	98.72	0.42
2	93.72	0.94
3	82.10	1.38
4	75.99	1.29
5	72.77	1.35

Table 2: Number of participants who preferred the harder option for each comparison in Experiment 1.

Comparison	Prefer Hard	Comparison	Prefer Hard
0 or 1	16		
0 or 2	14	1 or 2	5
0 or 3	8	1 or 3	5
0 or 4	2	1 or 4	6
0 or 5	1	1 or 5	5

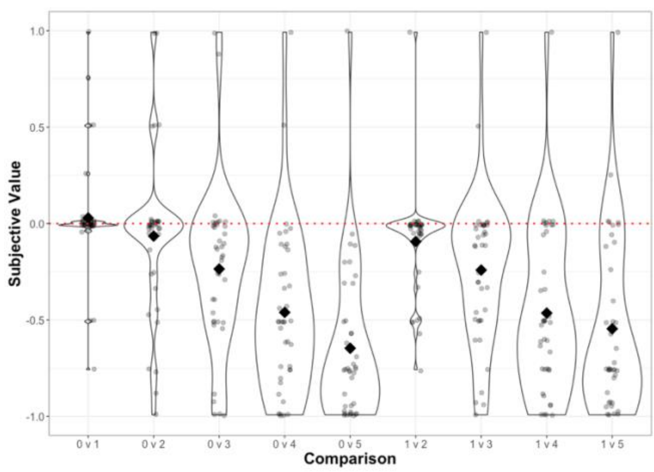

Figure 2. Average (diamonds) and individual (circles) SVs for each COG-ED comparison in Experiment 1.

3 If participants preferred the harder option their SV was inverted around 0 (i.e., it would lie between 0 and +1)

Discussion

The results of Experiment 1 largely replicate those of Westbrook et al. (2013) in that participants were willing to forgo reward in order to avoid harder difficulties. The addition of a 0-Back task, which requires minimal effort and was assumed to induce boredom, did not lead to effort seeking as was expected. However, in the 0-Back or 1-Back/2-Back comparisons participants were indifferent between the two options despite the 1-Back/2-Back tasks presumably requiring marginally more effort.

Experiment 2

Experiment 2 mimicked the design of Experiment 1, substituting the N-Back task for Number Sequence Problems (Figure 3; NSP) which we designed to more closely resemble the types of problem-solving tasks people play for fun (e.g., sudoku). NSPs consisted of a pie chart with six segments each containing a number except for the top segment. All of the problems followed a particular numerical rule which starts from the top right segment and moves clockwise around the circle. Participants were required to solve the numerical pattern and then input the missing number in a box below the problem.

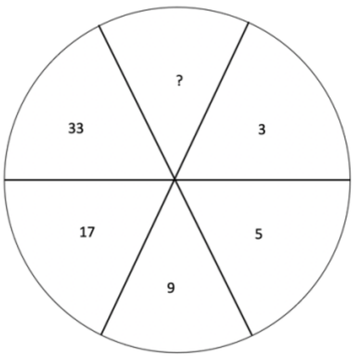

Figure 3. The rule for this problem (from the Medium set) is double the previous addition. The first addition is +2 (3 → 5), the following is +4 (5 → 9), the final addition is +32 (33 → 65). The solution is therefore 65.

Problems were categorised into three difficulty categories: Easy, Medium, and Hard. These categorisations were based on a separate pilot experiment of 50 participants. Participants were required to attempt each problem and give a rating from 0 – 100 how difficult they found each one. Average difficulty ratings were as follows: Easy (*M* = 4.04, *SE* = 2.02), Medium (*M* = 33.53, *SE* = 5.68), and Hard (*M* = 72.48, *SE* = 5.53).

Method

Participants Fifty-two participants completed the experiment via the Prolific platform. Participants were paid a flat rate of £3.25 and were also paid a bonus depending on their randomly selected choice from the COG-ED task (*M* = £1.54).

Materials The same as Experiment 1 except participants completed their experiment on their own desktop or laptop.

NSP Design Participants had two training blocks of each difficulty level (Easy, Medium, Hard) where each block lasted 3-minutes and a new problem appeared each time a participant entered their answer. Participants were also given feedback after each trial ("correct!" or "wrong!"), they were not however told the correct answer. The 3-minute timer only included time spent on a problem, not time spent on the feedback screen. The presentation order of the difficulty levels was randomised.

Difficulty levels were not presented to participants as "Easy", "Medium", or "Hard". Instead, participants were informed there were 3 different sets of number problems: "Blue", "Orange", and "Red". These colours corresponded to a particular difficulty which was randomised between participants.

COG-ED Design The COG-ED comparisons were Easy or Medium, Easy or Hard, and Medium or Hard – which were labelled as the corresponding colours for participants. The remainder of the COG-ED design was identical to Experiment 1.

Procedure After instructions, participants completed six, 3-minute runs of the coloured sets (two of each) in a random order.

After the training phase, participants completed the COG-ED task which was analogous to Experiment 1 (except there were only 3 comparisons). Participants were also given a reminder with an exemplar problem from each of the coloured sets. They were also told there was "no minimum percent correct or number of problems" they needed to solve in order to be paid, although we would monitor their effort to ensure "you are at least trying".

Following the COG-ED task we asked participants whether they used a calculator (which was allowed) and asked them to rate the difficulty (on a 0-100 scale, where 0 is labelled "Easy!" and 100 is labelled "Hard!") for each coloured set of problems.

Results

On average, in the training phase participants correctly solved 97.61% (*SE* = .37%; *M* = 32.15 attempted) of Easy Problems, 68.73% (*SE* = 2.07%; *M* = 9.65 attempted) of Medium Problems, and 17.16% (*SE* = 2.17%; *M* = 5.83 attempted) of Hard Problems.

Before analysing the COG-ED results, we removed participants whose post-task difficulty ratings did not align with our pre-determined difficulty categories (e.g., ranking Easy as 90, but Hard as 20). Nine participants were removed leaving 43 in the COG-ED analysis. In the COG-ED phase, comparable to Experiment 1, participants were willing to forgo reward in order to avoid harder difficulties (Figure 4): Easy vs Medium (M = -.17, $t(42) = -2.62$, p = .01), Easy vs Hard (M = -.42, $t(42) = -6.56$, $p < .001$), Medium vs Hard (M = -.26, $t(42) = -3.33$, $p < .01$). Participants, on average, were also willing to forgo more reward as the difficulty disparity increased between the two options ($F(2, 125) = 3.44$, $p = .04$) – that is, they were willing to forgo more to avoid Hard problems when the alternate was Easy compared to Medium.

We also counted participant's preferences when offered rewards were equal (i.e., both £2) across the comparisons (Table 3).

Table 3: No. participants who preferred the harder option in each comparison in Experiment 2.

Comparison	Prefer Hard (n = 43)
Easy vs Medium	8
Easy vs Hard	5
Medium vs Hard	11

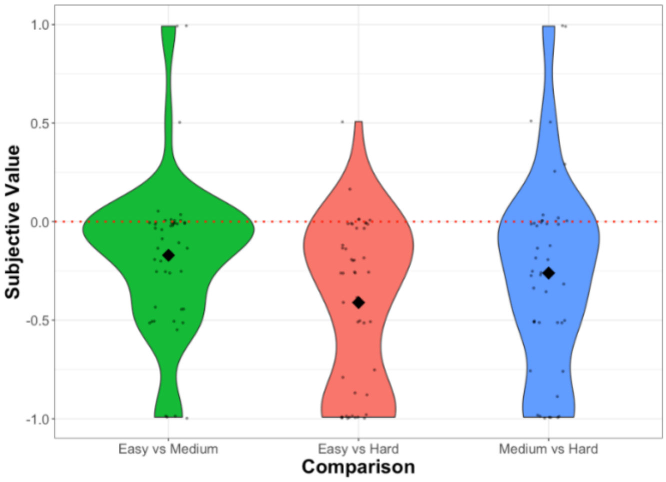

Figure 4. Average (diamonds) and individual (circles) SVs for each COG-ED comparison in Experiment 2.

Discussion

The results of Experiment 2 are similar to those in Experiment 1 in that participants generally avoid effort with only a minority of participants preferring a more difficult task when offered rewards are equal. These results contradict our hypothesis that a problem-solving task (i.e., NSPs) may be less aversive than the N-Back task and subsequently result in less effort avoidance.

Experiment 3

Experiment 3 was identical to Experiment 2 except anagrams, which also varied in difficulty, were used in place of NSPs. Like NSPs we hypothesised that anagrams would be more *cognitively demanding* and contrast with the *attentionally demanding* N-Back task.

Before conducting Experiment 3 a pilot experiment with 50 participants was conducted to assess the difficulty of 3, 5, and 7 letter anagrams. Analogous to the pilot experiment for Experiment 2 participants were asked to rate each anagram after they had attempted to solve it on a 0 – 100 scale. Difficulty ratings were as follows for the three categories: 3 letters (M = 6.63, SE = 2.71), 5 letters (M = 36.20, SE = 6.76), and 7 letters (M = 63.89, SE = 6.99).

Method

Participants Forty-Nine participants completed Experiment 3 and were paid £3.75 for the task. Participants were also paid a bonus depending on their randomly selected choice from the COG-ED task (M = £1.79)

Materials Same as Experiment 2.

Anagram Design Same as Experiment 2 except problems were 3, 5, and 7 letter anagrams. Sets of anagrams were labelled as “Blue”, “Orange”, and “Red”.

COG-ED Design Same as Experiment 2.

Procedure Same as Experiment 2. Participants were also asked whether they used a ‘word unscrambler/anagram solver’ which are available online (but were not allowed in the experiment).

Results

Three participants who said they used an anagram solver were removed, leaving 46 participants. In the training phase, participants, on average, correctly solved 95.37% (SE = .34%, M = 79.29 attempted) of 3 letter anagrams, 72.94% (SE = 2.03%, M = 22.74 attempted) of 5 letter anagrams, and 57.43% (SE = 1.37%, M = 12.87 attempted) of 7 letter anagrams.

Equivalent to Experiment 2, participants who ranked the difficulty of the sets (Blue, Orange, and Red) in an order that did not correspond with our pre-determined difficulties were removed (n = 9), leaving 37 participants in the COG-ED analysis. In general, like Experiments 1 and 2, participants were willing to forgo reward in order to complete easier sets of anagrams (Figure 5): Easy vs Medium (M = -.19, $t(36)$ = -3.54, p < .01), Easy vs Hard (M = -.26, $t(36)$ = -3.96, p < .001), Medium vs Hard (M = -.24, $t(36)$ = -3.98, p < .001). Participants however did not show any significant differences in willingness to forgo reward across the different COG-ED comparisons ($F(2, 107)$ = 0.37, p = .69).

The count of participants’ preferences when options were offered with equal rewards (i.e., £2) are displayed in Table 4.

Table 4: No. participants who preferred the harder option in each comparison in Experiment 3.

Comparison	Prefer Hard (n = 37)
Easy vs Medium	8
Easy vs Hard	7
Medium vs Hard	4

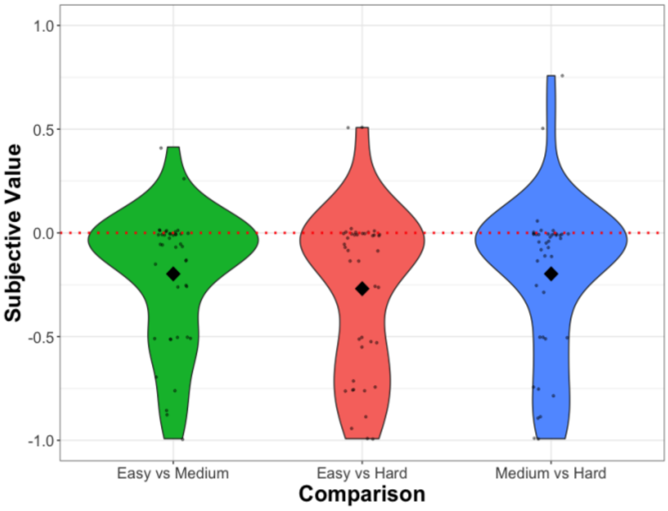

Figure 5. Average (diamonds) and individual (circles) SVs for each COG-ED comparison in Experiment 3.

Discussion

The results of Experiment 3 largely follow those of the previous two: participants are willing to forgo rewards in order to avoid harder tasks. In contrast to Experiment 2, however, we did not observe an increase in the amount participants were willing to forgo when the difficulty gap between two tasks increased. In Experiment 2 participants were willing to forgo more reward to solve Easy problems when the alternative was Hard problems compared to Medium problems; in Experiment 3, however, the willingness to forgo reward did not significantly differ between any of the COG-ED comparisons. We speculate, based on performance in the training phase (percent correct and number of problems attempted), that this is due to Hard NSPs being harder than 7 letters anagrams. In other words, the difficulty gap between 3 letter and 7 letter anagrams is smaller than the gap between Easy and Hard NSPs.

General Discussion

This collection of experiments aimed to assess whether varying the type of demand affected people's preference (or aversions) for performing various tasks. Experiments 2 and 3 used what we label *cognitively demanding* tasks (NSPs and anagrams) which we believe more closely resemble the problem-solving tasks people partake in for leisure (e.g., sudoku, Scrabble). Conversely, Experiment 1 used an *attentionally demanding* task (N-Back) often used in the mental effort literature.

Our hypothesis was that participants may have less aversion (or even a preference) for more difficult NSPs and anagrams when the alternative options were exceptionally simple (e.g., solve the next number: "1 2 3 4 5 _"; unscramble "NSU"). We hypothesised that although solving more difficult NSPs/anagrams would require more *effort,* the aversive experience of solving marginally harder problems may be less so than solving trivial, perhaps even boring, problems.

Our results however are coherent with previous work (for review, see Kool & Botvinick, 2018) which find scant examples of effort seeking in controlled environments. Participants in all three of our Experiments were willing to forgo reward (typically upwards of 25% of their potential earnings) to avoid more demanding tasks regardless of the task type. A small proportion of participants were willing to solve more difficult tasks for equal or less money – not everyone was seemingly effort averse – but these participants were always in the minority.

One explanation for this pattern may be the disparity between the number of problems solved (NSPs and anagrams) between difficulty conditions. While the length of time spent on a set was held constant across conditions (3 minutes), the number of problems participants could solve, on average, drastically differed between sets (e.g., participants solved over 6-times more 3 letter anagrams than 7 letter anagrams in the same time period). While the number of problems solved did not affect participants' financial reward, it did influence the amount of feedback they would receive. However, holding constant the number of problems per set presents its own problem: participants can solve easier problems significantly faster and therefore complete the experiment sooner.

Future work should examine whether effort aversion persists when participants are required to choose between varying task types. It is possible that tasks we categorise as *cognitively demanding* (e.g., NSPs, anagrams) do differ from *attentionally demanding* tasks in terms of how aversive increased effort is, but such differences cannot be observed by within task comparisons. An experiment comparing N-Back tasks, NSPs, and anagrams, of varying difficulties, could explicate this possibility. For example, whether participants would rather complete a 1-Back Task or a set of 5-letter anagrams.

Moreover, while these results cohere with the psychological literature, there remains a stark gap between such observations of effort avoidance (and seeking) in controlled laboratory environments and instances in day-to-day life: video gamers choose difficulties which match their ability; chess players, on average, choose a harder tournament when given the opportunity (Zak, Avrahami, & Kareev, 2019); and more than two million people now play the online game *Wordle* every day. Perhaps extraneous variables (e.g., prestige, social comparisons) are what drive such instances of effort seeking, but further research is required to determine what these variables, whether extrinsic or intrinsic, are and their impact on effort aversion.

Significant progress has been made on explaining the phenomenon of mental effort and its aversive nature since Galliot and Baumeister's (2007) blood glucose hypothesis: which postulated that a physical resource (i.e., glucose) underlies our sense of effort. For example, Kurzban and colleagues (2013) opportunity cost model, which argues the aversive sense of effort guides agents towards rewarding tasks (e.g., information); if the rewards received from a task are insufficient given the effort required, an aversive sense arises, which drives agents towards alternative tasks (for a summary, see Kurzban, 2016; for alternative computational accounts of mental effort, see Shenhav et al., 2017; Westbrook & Braver, 2015). Computational theories such as Kurzban and colleagues' (2013) have thus far performed well in explaining a multitude of observations in the relevant literature, there are however still gaps to be filled.

For example, such models should be able to account for instances of *effort seeking* should they be observed in a controlled setting (Inzlicht et al., 2017). Without observing instances of effort seeking (in the absence of extrinsic rewards) in controlled environments, however, it is difficult to assess how such theories of mental effort perform.

An experiment which gives participants the choice between performing a task again, immediately after completing it (e.g., a set of Easy anagrams), or completing a new, more difficult task (e.g., a set of Medium anagrams), may differentiate theories of mental effort. If the sense of effort exists to guide agents towards more fruitful tasks, participants should opt for the harder task as new information is attainable. If, however, increased effort is generally avoided in the absence of extrinsic reward, participants should opt to redo the same, easy task.

Future research will need to focus on these and related questions to determine whether our proposed distinction between attentionally and cognitively demanding tasks can help shed light on the effort paradox.

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