**We remember the past as more rewarding than it was: effects of temptation on cheating
and visual working memory**

Andrea Pittarello¹, Marcella Fratescu², & Sebastiaan Mathôt²

¹Virginia Tech

²University of Groningen

¹Corresponding author:

Andrea Pittarello

Virginia Polytechnic Institute and State University, Psychology Department

Blacksburg, VA, 24061, United States

Email: apittarello19@vt.edu

²University of Groningen, Psychology Department

Grote Kruisstraat 2/1 9712 TS Groningen, the Netherlands

Abstract

Here we report that participants' visual working memory of an ambiguous cue is biased towards stimuli that are associated with a high reward. Participants saw eight digits presented in a circular arrangement. On some trials, they were asked to report the digit ("Target Digit") indicated by a jittery cue that was slightly biased in the direction of another digit ("Second Cued Digit"), which was either higher, or lower than the Target Digit. Participants were paid based on the reported digit (higher digits meant higher pay) and not based on the accuracy of their report. In this setting, they could make self-serving mistakes by dishonestly reporting the Second Cued Digit when it was higher than the Target Digit. Replicating prior work, we found that participants frequently made such self-serving mistakes. On other trials, after the digits disappeared, participants were asked to reproduce the direction of the jittery cue, without receiving any pay. This allowed us to test whether participants' memory of the cue was biased toward high-rewarding digits, and our results showed that it was. We cautiously suggest that self-serving mistakes might result from automatic biases in working memory, which provides an important constraint for theories in behavioral ethics.

Key words: Ethical Blind Spots, Morality, Memory, Temptation, Attention

44 **Introduction**

45 Everyday life presents plenty of opportunities to profit from dishonesty, from academic
46 cheating to stealing and fraud (see Mazar & Ariely, 2006). Although people condemn these
47 behaviors and think of themselves as honest, they frequently bend the rules and lie (Bazerman &
48 Tenbrunsel, 2011). This contradiction motivated scholars from different disciplines such as
49 economics, psychology, and decision-making to further our understanding of what drives people
50 to bend the rules and still feel good about themselves. Bounded ethicality theory (Chugh,
51 Bazerman, & Banaji, 2005) argues that dishonesty results from ethical blind spots: attentional
52 biases caused by people's tendency to pay more attention to dishonest (yet profitable) information
53 at the expenses of honest (yet less profitable) information (see Bazerman & Tenbrunsel, 2011, for
54 a similar definition). That is, cheating may in part result from implicit biases, rather than from
55 explicit intentions to cheat.

56 A recent line of research (see Fiedler & Glöckner, 2015; Hochman, Glöckner, Fiedler, &
57 Ayal, 2016; Leib, Pittarello, Gordon-Hecker, Shalvi, & Roskes, 2019; Pittarello, Fratescu, &
58 Mathôt, 2019; Pittarello, Leib, Gordon-Hecker, & Shalvi, 2015; Pittarello, Motro, Rubaltelli, &
59 Pluchino, 2016) employed eye-tracking methodology and measured eye movements to investigate
60 what causes blind spots and when they emerge. For instance, Pittarello and colleagues (2015)
61 asked participants to report the outcome of a die roll appearing closest to a fixation cue, with higher
62 reports meaning higher payoffs (irrespective of participants' accuracy). On some trials, the die
63 second closest to the fixation cross was "tempting" in the sense that it was higher (and thus more
64 profitable) than the target die. On these trials, participants made 'self-serving mistakes' (an implicit
65 form of dishonesty) by reporting the tempting die roll instead of the correct one. In addition,
66 tempting dice captured visual attention and created ethical blind spots: Participants fixated at these

67 dice longer at the expense of fixations on the correct dice, and the strength of this effect in turn
68 predicted the extent of their dishonesty.

69 In another recent work, Pittarello and colleagues (2019) presented participants with a series
70 of digits on a screen and asked them to report the digit indicated by a jittery cue. There was some
71 ambiguity in the orientation of the cue, such that at times it was slightly biased toward another
72 digit, which was either higher or lower than the correct digit. Participants were paid more for
73 reporting higher digits (irrespective of whether they answered correctly) and were not penalized
74 for making mistakes. Conceptually replicating prior work, results showed that participants made
75 self-serving mistakes by reporting higher digits. Importantly, tempting digits captured participants'
76 gaze relatively quickly (for converging evidence see Hochman et al., 2016), suggesting that self-
77 serving mistakes result from an automatic bias, rather than from extensive deliberation. Taken
78 together, recent studies suggest that dishonest stimuli associated with high rewards capture
79 attention, which in turn shapes dishonesty.

80 While novel in the field of morality, the effect of reward on attention is well-established in
81 the literature on visual attention (for a review, see Failing & Theeuwes, 2018). The general idea is
82 that stimuli associated with rewards create an attentional template (Chelazzi, Duncan, Miller, &
83 Desimone, 1998; Reynolds, Chelazzi, & Desimone, 1999) that increases their accessibility much
84 like visual saliency does (see Theeuwes, 1991; 1992; 2010). Importantly, such accessibility
85 persists over time even when the same stimuli are no longer associated with rewards. For instance,
86 Della Libera and Chelazzi (2009) asked participants to engage in a shape-matching task in which
87 they were rewarded for their correct responses. During the first part of the experiment, certain
88 target and distractor shapes were associated with either a high or a low reward. In the second part
89 of the experiment, participants performed the same task but received no rewards. The main finding

was that performance in the second part of the task was affected by previously received rewards: Stimuli that were associated with high rewards acted as powerful distractors (and affected correct responses) even if they were no longer associated with rewards, and thus, were irrelevant (for a similar conclusion see Anderson, Laurent, & Yantis, 2011; Theeuwes & Beloposky, 2012).

Clearly, attention is biased by previously rewarded information (see Failing & Theeuwes, 2018), even when such rewards are obtained dishonestly (Pittarello et al., 2019). But is working memory also biased by reward? And could such working-memory biases be, at least in part, the driving force behind self-serving mistakes? Here, we test whether participants' memory is biased toward prior rewards that could be achieved dishonestly. Our prediction is based on prior research showing a connection between visual attention and working memory (see Awh, Vogel, & Oh, 2006; Fratescu, Van Moorselaar, & Mathôt, 2019; Gazzaley & Nobre, 2012; Zanto, Rubens, Thangavel, & Gazzaley, 2011). The main idea is that "attention serves as a gatekeeper for memory" (Lange, Starzynski & Engbert, 2012, p. 1179), meaning that an attended stimulus leaves a trace in memory that directs future tasks (see Gong & Li, 2014). For instance, Van der Stigchel and colleagues (2007) asked participants to remember the location of a target stimulus. On some trials, an irrelevant sudden distractor was presented in different parts of the screen shortly after a target stimulus. On other trials, no distractor was displayed. Results showed that participants' spatial recollection of the target was biased towards the location of the distractor, especially when the distractor appeared near the target stimulus, indicating that working memory affected attention. Finally, and crucial to our research question, reward also improves the memory representations of stimuli associated with rewards (Gong & Li, 2014).

To sum, previous research has shown that attention is biased towards rewarded stimuli, and that spatial working-memory representations are biased towards attended stimuli. We therefore

asked whether, in a task where participants frequently make self-serving mistakes by (mis)reporting rewarded stimuli, participants' memory is biased towards rewarded stimuli. To the best of our knowledge, this is the first work that combines research on dishonesty, attention capture, and memory.

The current experiment

We modified the task used by Pittarello and colleagues (2019). We presented participants with a series of digits (from 1 to 8) arranged in a circle and asked them to report the digit indicated by a jittery cue displayed in the center of the screen (i.e., the Target Digit). Participants were paid based on the reported digit (irrespective of whether the report was correct), with higher reports corresponding to higher rewards. On some trials the digit second closest to the cue, which we will refer to as the Second Cued Digit, was higher than the target (i.e., tempting), and on other trials it was lower (i.e., non-tempting). This setup gave participants the opportunity to make self-serving mistakes by reporting higher digits, in line with prior work (e.g., Pittarello et al., 2019; 2015; Leib et al., 2019).

To test whether working memory is biased towards tempting stimuli, we included trials in which participants first saw the digits, and then – after the digits had disappeared – rotated the cue (using the mouse scroll) to the position in which it originally appeared; in other words, participants performed a basic delayed-estimation task as is often used in visual-working-memory research (e.g., Wilken & Ma, 2004; Zhou, Lorist, & Mathôt, 2021). Participants did not receive any pay on these trials, meaning that the value of the digits was irrelevant. Importantly, at the moment when the digits were presented and encoded into working memory, participants did not yet know whether they would be asked to report the cued digit – and hence receive any payoffs – or to reproduce the direction of the cue. Because prior research showed that tempting and dishonest information

captures attention and that attention alters spatial working memory, it is plausible that in our setting temptation would also affect the recollection of the cue. Furthermore, because participants were not paid when asked to report the cue, they had no incentive to bias their responses toward the Second Cued Digit.

Materials and methods

Participants. Sixty participants took part in the study. Demographic information was collected for fifty participants (80% Females, $M_{age}=19.74$ years, $SD_{age}=2.61$ years). Ten participants were removed due to a programming error, and 19 for incorrectly answering the manipulation check at the end of the procedure. Thus, the final sample consisted of 31 participants, in line with that of Pittarello and colleagues (2015; 2019) who used a similar methodology. All participants had normal or corrected vision and earned an average of €2.16 (~\$2.41). The study lasted ± 20 mins, was approved by the local ethics committee of the University of Groningen and all participants read and signed a consent form before participation. All data and experimental materials can be found at https://osf.io/npbmg/?view_only=85d7c92db3da4c2da5e5014e1d8a7ca0.

Procedure. Participants saw 8 randomly presented digits (from 1 to 8) arranged on the circumference of an imaginary circle. One of these (the Target Digit) was indicated by a central jittery cue. After 2,500ms, the jittery cue disappeared, and participants were prompted to answer. Within-subjects, we manipulated two types of trials: On the “Report Digit” trials (75%; $N=7,221$), participants were paid according to the digit they reported, with higher digits corresponding higher payoffs (i.e., ‘1’ = €0.01, ‘2’ = €0.02, ‘3’ = €0.03, ‘4’ = €0.04, ‘5’ = €0.05, ‘6’ = €0.06, ‘7’ = €0.07, and ‘8’ = €0.08). On the “Report Rotation” trials (25%; $N=2,409$) participants were asked to rotate the cue – using the mouse scroll – to where it corresponded before it disappeared. Thus, the two types of trials were similar, with the only difference being that after seeing the eight digits on the

screen, on the “Report Digit” trials, participants had to report the digit that they thought was indicated by the cue (and were rewarded accordingly), whereas on the “Report Rotation” trials, they were asked to rotate the cue to how they thought it was its previously rotated without receiving any monetary payoff. For both trial types, we manipulated the ambiguity of the jittery cue such that it pointed slightly (10%) or moderately (40%) towards a second digit (i.e., “Second-Cued Digit”) (see Fig. 1 for a schematic representation of the procedure). To incentivize reports, we further varied the value of the Second-Cued Digit to be higher than the Target Digit (i.e., tempting on the “Report Digit” trials), or lower than the Target Digit (i.e., non-tempting on the “Report Digit” trials). Participants who wanted to dishonestly earn more money could report the Second-Cued Digit instead of the correct Target Digit more often when it was tempting – thus making self-serving mistakes – but not when not tempting –thus avoiding self-hurting mistakes.

The complete experimental design included three within-subject factors: Trial Type (“Report Digit” vs. “Report Rotation”), Cue Ambiguity (“low” vs. “moderate”), and Second-Cued Value (“Tempting” vs. “Non-Tempting”). Each participant completed 16 practice trials followed by 240 “Report Digit” and 80 “Report Rotation” trials. At the end of the experiment, participants answered the following manipulation check: “Please, pay attention! We want to make sure you understood how you earned money in this task. You received:”. Participants chose between: “More money for a correct than an incorrect answer (regardless of whether you reported a high or low digit)”, or “More money for reporting a high than a low digit (regardless of whether your answer was correct)”. Finally, for exploratory purposes, they were asked the following question “On a scale from 1 (not at all) to 7 (very much), to what extent do you think you accurately adjusted the cue?”. Since this question did not significantly correlate with any of the other variables of interest, it will not be discussed further.

Fig. 1. Schematic representation of the procedure. In this example, the Target Digit is ‘2’ and the Second-Cued Value a ‘6’. The jittery cue points moderately toward the tempting Second-Cued Value. In the Report Digit trials, participants reported the digit using the keyboard. In the Report Rotation trials, they reported the position of the cue using the mouse scroll.

Results

Report Digit trials. To test for self-serving mistakes, we conducted a generalized linear mixed model with Second-Cued Value, Cue Ambiguity, and their interaction as fixed effect predicting the probability of reporting the Second-Cued Digit (binomial). We included by-participant random intercepts for all fixed effects, but no random slopes. Results showed a main effect of Cue Ambiguity, $B=.27$, $SE=.07$, $p<.0001$, indicating that participants made more self-serving mistakes when ambiguity increased (this does not reflect cheating per se, but simply reflects that mistakes occur more often when task difficulty increases). We also found a main effect of Second-Cued Value, with participants reporting the Second-Cued Digit more often (33.33%) when it was higher (i.e., tempting) compared to when it was lower (6.18%) than the Target Digit, $B=.24$, $SE=.03$,

p<.0001, a pattern of cheating that replicates prior work (see Pittarello et al., 2015; 2019) (see Fig. 2). We also found, when looking at the data of individual participants, that some participants reported the highest digit ('8') on almost every trial, suggesting that they were not sensitive to the instructions at all, but simply maximized their profit (see Pittarello et al., 2019; Weisel & Shalvi, 2015 for a similar pattern). For robustness purposes, we repeated the same analysis removing these participants (whose average reported digit was ≥ 7.5). The main effects of Cue Ambiguity and Second-Cued Value did not change. However, their interaction was significant, $B=.28$, $SE=.12$, $p=.02$, indicating that, in this subset of the data, participants made more self-serving mistakes when ambiguity increased and the Second-Cued Value was tempting (vs. not tempting) (conceptually replicating Pittarello et al., 2015).

To sum, participants frequently cheated by making self-serving mistakes: Importantly, these mistakes are largely driven by temptation: When the Second-Cued Digit is tempting, participants are ~5 times more likely to report it compared to when it is not tempting.

Fig. 2. Proportions of reported outcome based on Second-Cued Value (tempting vs. non-tempting).

The bars labeled “highest” correspond to trials on which participants reported the “8”. In total, there were $N=7,221$ trials.

Report Rotation trials. We first normalized the Cue Report Error, such that an error of 0 correspond to a perfect reproduction of the cue orientation, whereas positive errors correspond to errors in the direction of the Second-Cued Digit and negative errors correspond to errors in the direction of the Target (the cue always pointed at an intermediate location, but closer to the Target than to the Second Cued Digit). A distribution of Cue Report Errors is shown in Fig. 3a,b.

Next, we applied a so-called “mixture model” to the Cue Report Errors (using the Biased Memory Toolbox; Zhou, Lorist, & Mathôt, 2021), a technique that is often used in visual-working-memory research (Zhang and Luck, 2008) to model responses in delayed-estimation tasks. The mixture model used here consists of a weighted mix of a Von Mises distribution (a normal distribution for rotational values) and a uniform distribution. The relative weighting of these distributions is determined by the Guess Rate parameter, such that a Guess Rate of 1 corresponds to a pure uniform distribution (random responses) and a Guess Rate of 0 corresponds to a pure Von Mises distribution (non-random responses). The width of the Von Mises distribution is determined by the Precision parameter, such that higher Precision values correspond to a narrower distribution (i.e., less variability in the responses). Finally, the shift of the Von Mises distribution along the x-axis is determined by the Bias parameter, such that positive Bias values correspond (in our case) to a bias towards the Second Cued Digit. Our main prediction concerns the Bias parameter, which we expect to be higher on tempting trials, where the Second Cued Digit is higher than the Target, as compared to non-tempting trials.

Figure 3. The distribution of Cue Report Errors for “tempting” trials where the Second Cued digit was higher than the Target (a) and “non-tempting trials” where the Second Cued digit was lower than the Target (b); here, an error of 0 corresponds to a perfect reproduction of the cue orientation, and positive errors correspond to an error in the direction of the Second Cued Digit. The red dotted line corresponds to the mean direction of the Second Cued Digit (relative to the cue). The green dotted line corresponds to the mean direction of the target (relative to the cue). c) The results of a mixture model applied to the tempting (orange) and non-tempting (blue) trials. The distributions shown here are based on the mean parameters across participants. For details about the model, see the main text. d) The difference in the Bias parameter between Tempting and Non-Tempting trials

(“temptation bias”; y-axis) for individual participants. A positive bias of 45° is a maximum bias in the sense that, on average, the cue was remembered as pointing towards the Second Cued Digit when it was higher than the Target, and as pointing towards the Target otherwise.

We fitted this model separately for each combination of participant and Second Cued Value (Tempting, Non-Tempting; Fig. 3c). Next, we used Bayesian paired-samples t-tests to test whether the model parameters differed between Tempting and Non-Tempting trials (using the default parameters of JASP 0.13.1). We found no evidence for a difference in the Precision ($BF_{10} = 0.56$) parameter between Tempting and Non-Tempting trials, and even some evidence against a difference in the Guess Rate parameter ($BF_{10} = 0.20$). However, as predicted, we found “strong evidence” for a difference in the Bias parameter, which was higher on Tempting trials than on Non-Tempting trials ($BF_{10} = 18.76$); that is, participants remembered the cue as pointing more towards the Second Cued Digit on those trials where the Second Cued Digit was tempting, as compared to when it was not tempting.

Discussion

Here we report that visual working memory is biased toward stimuli that are associated with reward, and we propose that this may be one of the mechanisms underlying the tendency for people to make self-serving mistakes. In our experiment, participants saw a series of digits associated with different payoffs (higher digits meant higher pay) preceded by a jittery cue. On some trials, which served to associate the different digits with different levels of reward, participants were asked to report the cued digit. There was some ambiguity in the direction of the cue, such that it was slightly tilted in the direction of another digit that could be either higher (i.e., tempting) or lower (i.e., non-tempting) than the cued digit. We successfully replicated prior work (e.g., Leib et al., 2019; Pittarello et al., 2015; 2019), and found that participants made self-serving

mistakes (an implicit form of dishonesty) by frequently reporting higher digits instead of cued and correct digits; participants rarely made self-hurting mistakes.

On other trials, which served to measure the effect of reward on visual working memory, after the digits and the cue disappeared, participants were prompted to rotate the cue back to how it was previously displayed. Importantly, at the moment that the digits were presented and encoded into working memory, participants did not yet know whether they would be asked to report a digit (and thus be rewarded), or to reproduce the orientation of the cue (with no chance of reward). On these trials, we found a clear bias towards tempting digits in the reported cue orientations. Phrased differently, we found that participants remembered the cue as being oriented more towards highly rewarded digits than it really was.

Our results are consistent with studies showing that reward affects visual attention (reviewed in Failing & Theeuwes, 2018), and that visual attention in turn affects visual working memory (e.g., Van der Stigchel et al. 2007). The novelty of the present study lies in linking these findings explicitly to research on morality, thus providing a concrete mechanism behind the notion that dishonesty results, at least in part, from automatic processes rather than from careful deliberation. This is an important contribution to the field of morality as Leib et al, (2019) recently wrote: “unlike outright lies that are by definition conscious, whether self-serving mistakes are conscious or not remains an open question” (p.10). Our results are also in line with the work of Hochman et al., (2016) who found that people are not always aware of their lies (see also Balci et al. & Dunning, 2006; Bazerman & Tenbrunsel, 2011; Welsh & Ordóñez, 2014).

A number of previous studies have looked at the relationship between memory and dishonesty. However, these studies all focused on episodic long-term memory rather than, as in our study, working memory. For instance, Kouchaki and Gino (2016) found that people are likely

to forget their past misbehaviors. However, a recent paper failed to replicate this result (Stanley, Yang, & De Brigard, 2018), suggesting that the link between episodic memory and dishonesty is unclear and deserves further attention. Our work – though using different measures of dishonesty and focusing on working memory – adds to this intriguing and unexplored area of research by cautiously suggesting that when cheating is possible, people remember the past as more rewarding than it was.

In summary, we instructed participants to report a target stimulus that was indicated by a central cue and found that participants tended to make self-serving mistakes by (mis)reporting non-target stimuli that were associated with a high reward. Crucially, we found that this tendency to ‘cheat’ was accompanied by a bias in visual working memory, such that participants remembered the cue as being oriented more towards high-reward stimuli than it really was. Finally, we propose that biases in visual working memory may be a mechanism that underlies some forms of implicit dishonest behavior, such as self-serving mistakes.

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