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DOI
10.1016/j.jesp.2024.104661

Publication date
2024

Document Version
Final published version

Published in
Journal of Experimental Social Psychology

Journal of Experimental Social Psychology 115 (2024) 104661

Contents lists available at ScienceDirect

Journal of Experimental Social Psychology

journal homepage: www.elsevier.com/locate/jesp

Choosing not to see: Visual inattention as a method of information avoidance☆

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ARTICLE INFO

Keywords:
Information avoidance
Visual attention
Eye-tracking
Suppression
Facilitation

ABSTRACT

People rely on a number of methods to avoid information that would compel them to change their beliefs or behaviors. However, it remains unclear whether people use visual inattention as a method of information avoidance. In three eye-tracking experiments, we test the hypothesis that people avoid visual information by strategically suppressing and facilitating visual attention depending on where desired and avoided information is likely to appear. Introducing a novel search task, we independently manipulate the probability of where desired and avoided information appear on the screen. Study 1 show that participants learn statistical regularities in information location and utilize this to gradually suppress attention to undesired information. Study 2 and 3 show that participants can simultaneously reduce and increase visual attention to areas where avoided and desired information are most likely to appear. The findings point to suppression of attention as a mechanism behind information avoidance through visual inattention and that reducing the predictability of where information appears could be a fruitful avenue for reducing it.

People generally seek information they consider relevant and ignore information they consider irrelevant. Yet at times, people actively avoid relevant information that is otherwise freely available to them, such as when patients avoid learning the results of their medical tests (Thornton, 2008) or when people avoid food calorie information despite acknowledging the importance of this information (Nordström et al., 2023; Reisch et al., 2021; Woolley & Risen, 2018).

Avoiding relevant information extends beyond personal consequences; it can also be costly for others. People, for example, avoid learning whether the products they buy were ethically manufactured, even though they claim to value this information (Ehrich & Irwin, 2005). Similarly, people who normally behave ethically may make mistakes that benefit them at the expense of others (Dana et al., 2007; Vu et al., 2023). Prior research indicates that such self-serving errors are more likely to occur when people can avoid paying attention to information that would have prevented them from making the mistake (Fosgaard et al., 2021).

Recent reviews define information avoidance as behaviors that prevent or delay the acquisition of information that is available, free, and relevant (Golman et al., 2017; Hertwig & Engel, 2016; Sweeny et al., 2010) and they identify a number of reasons why people avoid information, for example, because the information may require a change in beliefs, the information may require undesirable action, or the information itself may cause unpleasant emotions or diminish pleasant emotions (Sweeny et al., 2010). People can avoid information by physically avoiding and thereby not exposing themselves to information, a mechanism also known as selective exposure (Hart et al., 2009). If exposure is inevitable, people can still rely on other tactics to avoid information. They can, for instance, misinterpret information in a way that benefits them (Strachman & Gable, 2006) or they can misperceive information, a mechanism known as wishful seeing (Dunning & Balcetis, 2013). People can also purposefully forget information after exposure, a mechanism known as motivated forgetting (Anderson, 2020; Shu et al., 2011).

In a their review, Golman and colleagues suggest that inattention may be another method of information avoidance (Golman et al., 2017). In this article, we explore a potential form of inattention which is to avoid information by not looking at it that is, through visual inattention. For brevity, we will refer to information avoidance by means of visual inattention as *visual avoidance*. Despite idioms such as to "turn a blind

☆ This paper has been recommended for acceptance by Rachael Jack.

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https://doi.org/10.1016/j.jesp.2024.104661
Received 20 February 2024; Received in revised form 14 June 2024; Accepted 5 July 2024
Available online 17 July 2024

eye", past research does not provide an obvious answer to whether people use visual inattention as a method of information avoidance.

A number of past studies on visual attention in dishonesty exemplifies the challenge. In one study, participants were asked to report which of six dice was closest to a previously shown fixation cross (Pittarello et al., 2015). In one condition, participants were paid based on how accurately they located the correct die. In another condition, participants were paid based on the number of dots on the die they reported, which created an incentive for reporting an incorrect die if it had more dots. When participants were paid for accuracy, they made few mistakes and attended mainly to the correct die. On the contrary, when they were paid by the die value, they made more mistakes by reporting an incorrect but higher-paying die, and they also attended more to this incorrect die. Other studies using similar methods have replicated the finding showing a robust association between self-serving mistakes and increased attention to self-serving information and reduced attention to self-harming information (Hochman et al., 2016; Leib et al., 2019; Pittarello et al., 2019).

The dishonesty studies raise an important issue concerning the definition of visual avoidance. Since attention is a scarce resource, people mainly attend the most relevant information and ignore the less relevant (Orquin et al., 2021; Sims, 2003). In the dishonesty studies, participants could attend to two relevant pieces of information: the self-serving or the self-harming information. However, if participants perceived the self-serving information as more relevant than the self-harming information, they could have dedicated their scarce visual attention to the former at the expense of the latter. In their review, Golman and colleagues write: "inattention for the purpose of conserving scarce cognitive resources would not qualify as 'active avoidance' under our definition, since obtaining the information in these situations does incur an opportunity cost." (2017). This suggests a need to distinguish between visual avoidance from visual ignoring and we will define visual avoidance as visual inattention to relevant information independent of the presence of other information and visual ignoring as visual inattention to any (relevant or irrelevant) information dependent on the presence of more relevant information. Visual avoidance can thus be distinguished from visual ignoring as visual inattention that is not due to a lack of attention resources.

To the best of our knowledge, no studies so far have clearly distinguished visual avoidance from visual ignoring or identified the attention mechanisms behind visual avoidance. While the reasons for visual ignoring and avoidance differ (i.e., to conserve scarce cognitive resources vs. to preserve ignorance) they may share underlying attention mechanisms. Research on selective attention has identified two mechanisms that lead to visual ignoring of irrelevant information. The first mechanism is a competitive top-down advantage of task-relevant stimuli (referred to as targets) that leads to relatively stronger facilitation of attention to relevant stimuli compared to irrelevant stimuli (referred to as distractors). The mechanism is exemplified in the biased competition model (Desimone & Duncan, 1995) which assumes that when multiple objects are presented in the visual field at the same time, each one activates a neuronal representation in the visual cortex. Signals about task relevance and salient visual features influence the strength of the activation. Because cognitive capacity is limited, neuronal representations compete for activation in a mutually suppressive manner. The biased competition process results in the attentional selection of the target but not of the distractor.

Recently, there has been discussion about whether there is a second separate mechanism for suppressing visual attention to distractors (Antonov et al., 2020; Geng et al., 2019; Wöstmann et al., 2022). Findings from recent research indicate that people can learn to suppress locations with a high likelihood of task-irrelevant distractors (Geng et al., 2019). The learning process can occur without any awareness of the statistical regularity, and learning extends beyond spatial locations to predictable features in general. People can learn distractor colors as well as their distribution, and they are more likely to suppress high probability distractor colors (Chetverikov et al., 2017). Visual suppression results in attention below chance level towards areas where the distracting information is likely to appear, and people thus attend less to the suppressed stimuli than to any other stimuli, relevant or irrelevant (Gaspelin & Luck, 2018). Moreover, while suppressing attention to distracting stimuli, people can simultaneously facilitate attention towards relevant stimuli (Chang & Egeth, 2019; Couperus & Mangun, 2010). In other words, people can ignore irrelevant information by 1) facilitating attention to task relevant information thereby relatively enhancing attention to it compared to irrelevant information, 2) by suppressing attention to irrelevant information, or 3) by simultaneously facilitating and suppressing attention. Although past research has focused exclusively on the involvement of these mechanisms in ignoring irrelevant information, we propose that people may also use the ability to suppress attention to avoid relevant information.

In this article we aim to distinguish visual avoidance from visual ignoring and to examine whether people use visual avoidance as a method for information avoidance. We also examine facilitation and suppression as potential mechanisms behind visual avoidance. To this end, we conduct three eye-tracking studies. In Study 1, we develop a novel experimental task in which participants are instructed to search for two target objects. In one condition participants are instructed to and rewarded for identifying the same target, while in the other condition participants are instructed to identify one target and rewarded for reporting the other. This creates an incentive not to report the unrewarding target. Since most participants prefer not to be outright dishonest, such as by identifying the unrewarding target but not reporting it, they instead try to avoid identifying it.

In Study 2, we extend the experimental task by instructing participants to simultaneously search for two target objects. In one condition participants are rewarded for identifying either of the two targets while in the other condition participants are only rewarded for identifying one of them. The instructions mean that both targets are relevant but the reward structure implies that only one of the targets is rewarding which again creates an incentive not to report the unrewarding target. Thereby, we can test whether facilitation and suppression operates simultaneously when people avoid visual information. In Study 3, we replicate Study 2 on a larger sample.

A key feature of the experimental design in Study 2 and 3 is that we manipulate the probability of where the two targets appear on the screen independent of each other. The independent target locations allow us to distinguish visual avoidance from visual ignoring. If participants show decreased attention to the unrewarding target, they are engaging in visual avoidance because a) both targets are relevant due to the instructions and b) the two targets do not compete for scarce attention resources because participants can search for both targets at the same time. The independent and semi-predictable target locations also allow us to examine whether participants implicitly learn these statistical regularities and use this to suppress attention to locations with a high probability of information they wish to visually avoid.

1. Study 1

In Study 1, we aim to distinguish visual avoidance from visual ignoring and to examine whether people use visual avoidance as a method for information avoidance. We examine attention suppression as potential mechanisms behind visual avoidance. To that end, we develop a novel double-target search task that creates a conflict for participants by challenging them to balance the pursuit of personal rewards against following task instructions, ultimately incentivizing unethical behavior. Here, self-serving information refers to cues associated with gaining rewards, whereas self-harming information refers to cues associated with losses. A key feature of the task is that we manipulate the probability of where the two types of information appear on the screen semi-independently of each other. While the self-serving information is equally likely to appear in any of four possible areas on the screen, the self-harming information has different probabilities assigned to each area. If participants learn these probabilities and use suppression to visually avoid self-harming information this will result in more inattention (measured as a lower likelihood of fixating an area) to areas with a high probability of self-harming information.

1.1. Methods

1.1.1. Ethics and open science statement

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. This research complies with all relevant ethical regulations. The studies are approved by the Human Subjects Committee (#242) at Aarhus University. The data that supports the findings of all three studies, as well as the PsychoPy and R scripts used for power analysis, sensitivity analysis, data analysis, and running the experimental tasks are publicly available at: https://osf.io/8pk57/?view_only=2d4e0a261c8d4f4dbd0748f64 30d2692.

1.2. Participants

Twenty individuals (44% female, $M_{age} = 23.6$, $SD_{age} = 3.5$) with normal or corrected to normal vision took part in the experiment. The sample size was determined a priori based on a power analysis conducted through simulation in R. With an alpha level of 0.05, a small-sized effect of $d = 0.2$ (OR = 0.7) (Cohen, 1988) and a power of 80%, the power analysis indicated that for a within-subject design with two conditions and 320 trials per participants, a sample size of 20 is required. Notably, the repeated-measure design we utilize, commonly employed in vision science, enables a substantial number of samples per participant, thereby reducing the required sample size. Participants were recruited through Aarhus University's subject pool, and received a performance-dependent payment between DKK 50 (≈ $7) and DKK 160 (≈ $23) for their participation. Written and informed consent was obtained from all participants. The experiment was conducted at Aarhus University in February 2020. Two participants were excluded from the analysis since they did not complete all trials, resulting in a total sample size of 18 participants. A sensitivity analysis revealed 80% power to detect effects of $d = 0.19$ (OR = 0.71) or larger given a sample of 18 participants and 320 repetitions per participant.

1.2.1. Experimental design

Participants engaged in a visual search task in which they should locate a target object hidden on the screen among random visual noise. In 75% of the trials, a second target object would appear on the screen. The study used a within-subjects experimental design with two conditions (*ignore* vs. *report*). The two conditions were presented in two blocks in a counterbalanced order. In the *ignore* condition, participants were instructed to search for a geometric object (T1) and to ignore the presence of another object (T2) and that payment would be based on accurately locating T1. In the *report* condition, participants were instructed to search for T1 but report it if T2 was also present in a trial. That is, if both T1 and T2 were present, participants should only report the presence of T2 and not indicate the location of T1. If participants accurately reported the location of T1, they received the same payment as in the *ignore* condition, but if they reported seeing T2, the trial would be discontinued and the participants would not earn anything in that trial. Participants were explicitly and unambiguously instructed to report seeing T2, in such a way that it was clear to them that not reporting would be a violation of the instructions and thus cheating. See Fig. 1A for illustration of experimental flow.

1.2.2. Stimuli and apparatus

The stimuli were created and presented using PsychoPy3 and consisted of four squares with visual noise. T1 and T2 were geometric figures (e.g., triangles and stars), and were different in the *ignore* and *report* condition to minimize learning effects, but balanced so that effects were not attributable to distinct characteristics of the given object. T1 was present in all trials and was located in one of the four squares with equal probability. T2 was present in one of the four squares in 75% of the trials and its location was drawn from a multinomial distribution with probabilities (0.7, 0.25, 0.04, 0.01), resulting in an overall T2 probability of (0.525, 0.188, 0.028, 0.007). Across all participants, T2 appeared in the upper left square in 1008 trials, the upper right square in 1091 trials, the lower left square in 1239 trials, and in the lower right square in 999 trials. In the remaining 1423 trials, T2 did not appear on the screen. T2 location probabilities were randomly assigned in the beginning of each condition for each participant, and remained constant throughout the

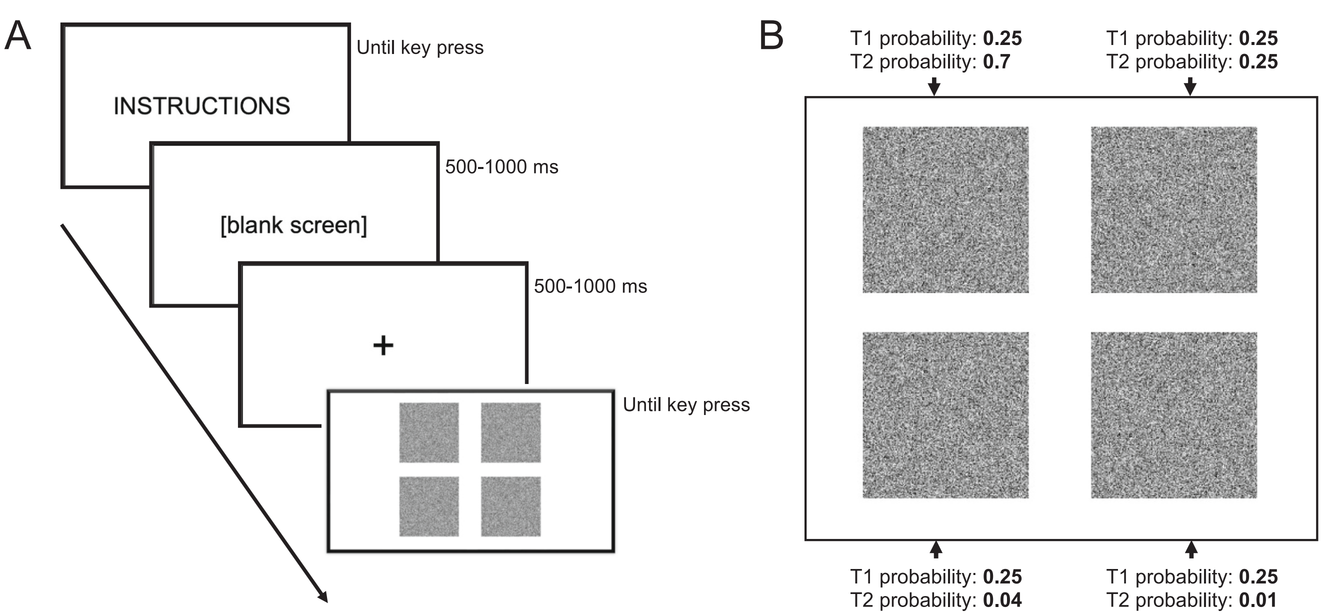

Fig. 1. A: Experimental flow for one trial. Participants went through 160 trials per condition. Instructions were displayed only at the beginning of each condition. B: Example of target probability structure. T1 was present in all trials and was located in one of the four squares with equal probability. T2 was present in one of the four squares in 75% of the trials and its location was drawn from a multinomial distribution with probabilities (0.7, 0.25, 0.04, 0.01). The stimuli was created in such way that T1 and T2 were not peripherally conspicuous; rather, partcipants needed to systematically search through the four squares to find the target objects.

condition. T1 and T2 could never coincide in one square. This means that the probabilities of T1 and T2 were not manipulated completely independently of each other, but only semi-independently, since we do not allow the targets to be located in the same square. An example of T1 and T2 probabilities is illustrated in Fig. 1B.

Eye movements were recorded using a table-mounted eye tracker (Eyelink 1000) with a 500 Hz sampling frequency, monocular accuracy of 0.5° of visual angle. Participant were seated 60 cm from a 20-in. screen with a resolution of 1680 × 1050 pixels. Fixation likelihood was used as measure of attention capture. Fixations were identified by the SR Research Dataviewer software, which relies on a velocity threshold algorithm (I-VT).

1.2.3. Procedure

Upon entering the lab, participants agreed to a consent form, and were seated in front of the screen. The eye-tracker was calibrated for each participant by completing a nine-point calibration and offset validation. A calibration offset below 0.5° was considered acceptable. Task instructions were displayed in the beginning of each condition, and each trial was preceded by a fixation cross, displayed for 500–1000 milliseconds, to control the location of the first fixation. Participants went through the experiment at their own pace, and stated their response by pressing one of five response buttons (“position 1”, “position 2”, “position 3”, “position 4” or “report presence of T2”). Participants went through 160 trials in each condition. After completing the task, participants were informed of their total earnings, and were paid accordingly.

1.3. Results

In the *ignore* condition, participants accurately indicated the correct T1 location in 98% of the trials. In the *report* condition, participants accurately indicated the correct T1 location (when T2 was not present) or the presence of T2 (when it was present) in 74% of the trials. Participants made self-serving errors (indicating the T1 location even though T2 was present) in 23% of the *report*-condition trials and self-harming errors (reporting T2 when it was not present or indicating the wrong T1 location) in only 3% of the *report*-condition trials.

To examine the effect of experimental condition on the likelihood of fixating T2, we ran a generalized linear mixed-effects regression on the likelihood of fixating a square depending on whether it contained T2. The outcome variable, *fixation likelihood*, was a binomial variable and the model included as fixed effects *condition* (ignore vs. report), *contain T2* (no vs. yes), and a two-way interaction: *condition*contain T2*. The model used a binomial response distribution and a logit link function, and random intercepts grouped by participant and random slopes for *condition*. Results revealed a significant interaction between the presence of T2 and the *report* condition, $OR = 0.51$, 95% CI [0.43–0.60], $p < .001$, indicating that when participants were instructed to report the presence of T2, the likelihood of fixating squares containing T2 decreased by 41%. See Appendix Table A1 for complete details on the model. Fig. 2A illustrates the effect of condition: when participants are instructed to ignore T2 there is a minor decrease in fixation likelihood for areas that contain T2 but when participants have an incentive to visually avoid T2, there is a large decrease in fixation likelihood for areas that contain T2.

To explore the effect of T2 probability on fixation likelihood, we ran a second model which included as fixed effects *condition* (ignore vs. report), *T2 probability* (0.01, 0.04, 0.25, 0.70), and a two-way interaction between *condition* and *T2 probability*. The model included a random intercept grouped by participant and random slopes for *condition* and *T2 probability*. Results from this model show that participants in the *report* condition were less likely to fixate a square when there was 25% chance that it contained T2 compared to 1% chance, $OR = 0.75$, 95% CI [0.60–0.95], $p = .015$, and even less likely when there was 70% chance that it contained T2, $OR = 0.70$, 95% CI [0.56–0.87], $p = .002$). See Fig. 2B for visualization and Appendix Table A2 for complete details on the model.

1.4. Discussion

The results show that participants were less likely to attend to areas that contained T2 when they had an incentive to avoid compared to ignore T2. The results also show that the likelihood of attending an area decreased when the likelihood of T2 being in that area increased. This means that participants learned T2 location probabilities and directed their attention away from high-probability locations. The findings suggest that visual avoidance leads to more visual inattention than visual ignoring does and this could be due to participants suppressing attention to avoided information. Study 1, however, does not allow for making inferences about whether participants can simultaneuously facilitate attention towards other stimuli. Building on the results that people can learn statistical structures in information location and utilize this to avoid undesired information, in Study 2 we focus on understanding the mechanisms influencing visual attention when people are confronted with equally relevant targets but conflicting goals.

2. Study 2

Study 2 builds on the insights from Study 1, while also incorporating a number of alterations. First, the target stimuli in Study 2 consist of letters presented among a number of distractor letters inside four squares, rather than geometric figures on a background of random visual

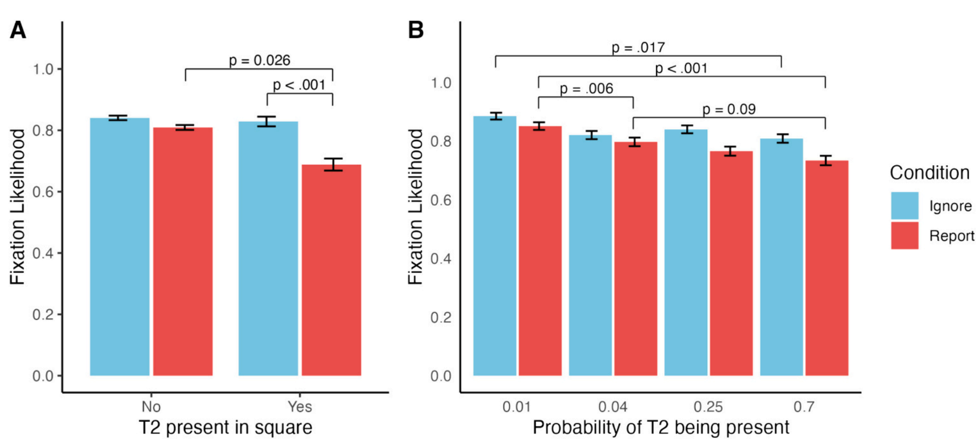

Fig. 2. A: Mean fixation likelihood based on whether T2 was present or absent in a square, derived from descriptive data. Error bars indicate 95% confidence intervals. B: Mean fixation likelihood based on the probability of T2 being present in a square, derived from descriptive data. Error bars indicate 95% confidence intervals.

noise. Second, whereas Study 1 uses a probability structure with four decreasing probabilities (0.7, 0.25, 0.04, 0.01), Study 2 uses a simpler probability structure where each target letter, T1 and T2, has two squares in which they are more likely to appear in and two squares in which they are less likely to appear in (0.4, 0.4, 0.1, 0.1). The probabilities of T1 and T2 are orthogonal, meaning that a square with low probability of T1 does not necessarily have a high probability of T2 (See Fig. 3B). Third, participants complete two conditions: *accuracy* and *report*. In both conditions participants are instructed to search for two different target letters (T1 and T2) and report the location of the first target they find. In the *accuracy* condition, participants are incentivized for reporting the location of T1 or T2, while in the *report* condition participants are only incentivized for reporting the location of T2. T1 thus represents self-serving information in the *accuracy* condition and self-harming information in the *report* condition. We expect that in the *report* condition, when there is a conflict between correct and incentivized behavior, participants will visually avoid areas that are likely to contain self-harming information. By comparing high vs. low T1 and T2 probability areas, we examine the potential mechanisms behind visual avoidance that is, facilitation of attention to self-serving areas (high T2 probability), suppression of attention to self-harming areas (high T1 probability), or a combination of both. Finally, by comparing participants who make more vs. less self-serving errors (failing to report T1 in the *report* condition), we can test whether self-serving errors are associated with more visual avoidance.

2.1. Method

2.1.1. Ethics and open science statement

This research complies with all relevant ethical regulations. We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. The studies are approved by the Human Subjects Committee (#249) and the Institutional Review Board (# 2021–0226144) at Aarhus University. The data that supports the findings of all three studies, as well as the PsychoPy and R scripts used for power analysis, sensitivity analysis, data analysis, and running the experimental tasks are publicly available at: https://osf.io/8pk57/?view_only=2d4e0a261c8d4f4dbd0748f6430d2692

2.1.2. Participants

Twenty-seven participants took part in the study (41% female, $M_{age} = 25.8$, $SD_{age} = 4.9$). The sample size was determined a priori based on a power analysis conducted through simulation in R, similar to that of study 1. For practical reasons, we decreased the number of trials from 320 to 200 per participants. With an alpha level of 0.05, a small-sized effect of $d = 0.2$ (OR = 0.7) (Cohen, 1988) and a power of 80%, this resulted in a required sample size 27. To achieve this sample, we again recruited participants from the Participant Pool at Aarhus University. Inclusion criteria were an age above 18, normal or corrected-to-normal vision, and a successful eye-tracking calibration. Participants received a performance-dependent payment between DKK 50 (≈ $7) and DKK 150 (≈ $22) for their participation, and were debriefed at the end of the experiment. Informed consent was obtained from all participants. The experiment was conducted at Aarhus University in October 2021. Two participants were excluded due to low task accuracy in conditions where they were incentivized for accuracy (accuracy <66%), resulting in a final sample of 25 participants. A sensitivity analysis revealed 80% power to detect two-way interaction effects of $d = 0.2$ (OR = 0.70) and three-way interaction effects of $d = 0.49$ (OR = 0.41) or larger given a sample of 25 participants and 200 repetitions per participant.

2.1.3. Experimental design

Participants engaged in the double-target search task where they searched for target letters that were flanked by non-target letters, inspired by the Eriksen Flanker Task (Eriksen & Eriksen, 1974). Participants went through two within-subject conditions in a counterbalanced order: *accuracy* vs. *report*. In both conditions, the two target letters, T1 and T2, were each present in each trial with a 0.75 probability. Each target letter could be positioned in one of four squares. Target letters were randomly drawn for each condition and for each participant. Each target letter had two locations in which it was more probable to appear and two locations in which it was less probable to appear (0.4, 0.4, 0.1, 0.1), making the target locations semi-predictable (see Fig. 3B). High-probability areas were always placed orthogonally to each other, in order to ensure that T1 and T2 probabilities were manipulated independently of each other (Wöstmann et al., 2022). This means that participants were presented with four squares: one with high chance of containing both T1 and T2, one with high chance of containing only T1, one with high chance of containing only T2, and one with low chance of

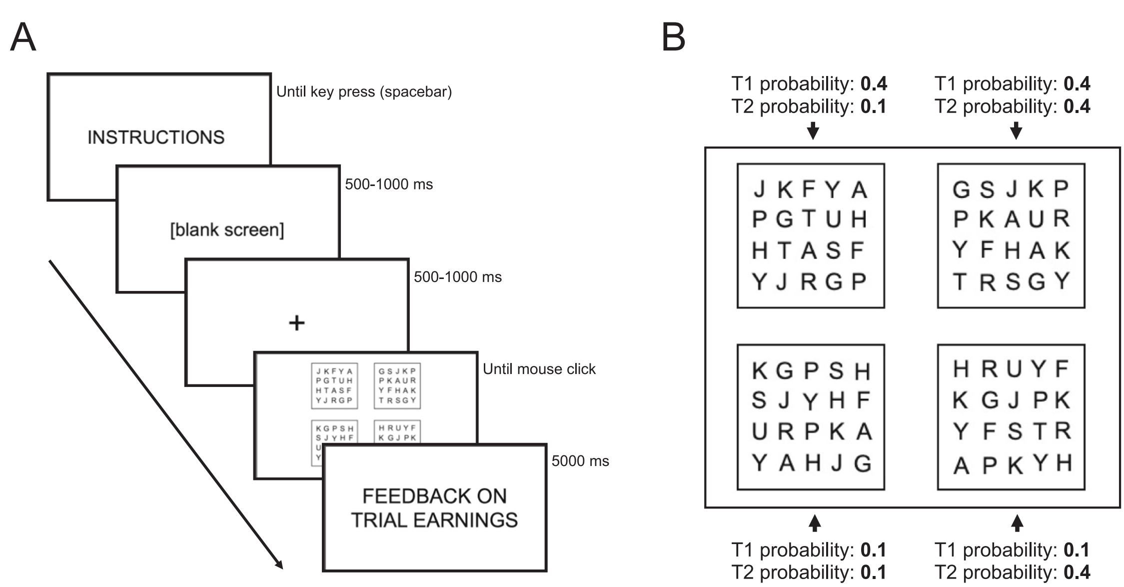

Fig. 3. A: Experimental flow for one trial. Participants go through 100 trials per condition and receive feedback on their earnings immediately after each trial. Instructions are displayed only in the beginning of each condition. B: Example of target probability structure. High T1-probability areas and high T2-probability areas are placed orthogonally to each other, in order to ensure that areas with high T1-probability do not per se have a low T2-probability and vice versa.

containing T1 or T2. In both conditions, participants were instructed to search for the target letter T1 if it was present. If T1 was not present, participants were instructed to search for T2. If none of the target letters were present, participants were instructed to press the skip-button on the keyboard. In the *accuracy* condition, payment was based on participants' accuracy in reporting which square contained the correct target letter. Participants received DKK 0.75 (≈ $0.11) for each correct trial. In the *report* condition, participants earned nothing if they pressed the skip-button or if they correctly reported T1, but received the same payment as in the *accuracy* condition if they correctly reported T2. Importantly, participants were explicitly and unambiguously instructed to always report on the location of T1 if it was present. T1 thus represents self-serving information in the *accuracy* condition and self-harming information in the *report* condition.

Before beginning the experiment, participants were informed that the study received funding to compensate them based on their performance, and any remaining funds would be donated to the charity organization Carbonfund.org. In this way, self-serving errors represented a benefit to the participant but a cost to a charity organization (similar to Gross et al., 2018).

2.1.4. *Stimuli and apparatus*

The stimuli were created using PsychoPy3 and consisted of randomly drawn letters placed inside four areas. Each area was 300 × 300 pixels and contained 20 letters (see Fig. 3A). T1 and T2 never appeared inside the same area. Eye movements were recorded using a table-mounted eye tracker (Eyelink 1000) with a 500 Hz sampling frequency and monocular accuracy of 0.5° of visual angle. Participants were seated 60 cm from a 22-in. screen with a resolution of 1680 × 1050 pixels. Fixation likelihood was used as the measure of attention capture, which enabled us to investigate whether a square had been fixated or not. Areas of interest were drawn around each of the four areas, and were 300 × 300 pixels each. Fixations were identified by the SR Research Dataviewer software, which relies on a velocity threshold algorithm (I-VT). Recordings of gaze began with stimulus presentation for each trial (after fixation cross) and ended when participants responded with a mouse click.

2.1.5. *Procedure*

Upon entering the lab, participants gave their consent to participate and were seated in front of the screen. The eye tracker was then calibrated for each participant by completing a nine-point calibration and offset validation. A calibration offset below 0.5° was considered acceptable. Once calibration was completed, task instructions were displayed at the beginning of each condition, and each trial was preceded by a fixation cross displayed for 500–1000 milliseconds in order to control for the location of the first fixation. Participants went through 100 trials in each condition at their own pace. They indicated their response by clicking with the mouse on the area containing the target letter (left click for reporting T1, right click for reporting T2), and received feedback on whether their answer yielded a payoff immediately after each choice was made. To avoid effects related to a sense of being observed, participants completed the task without others being present in the room. Participants were aware that their eye movements were being monitored. After task completion, participants were informed of their total earnings, paid accordingly, and fully debriefed.

2.2. *Results*

We modeled the data using a generalized linear mixed-effects model, implemented with the lme4 package (Bates et al., 2014) in R (R Core Team, 2022). We specified one overall model based on which we could test our hypotheses. The outcome variable, *fixation likelihood*, was a binomial variable and the model included as fixed effects *condition* (accuracy vs. report), *T1 probability* (low vs. high), *T2 probability* (low vs. high), and *self-serving error score* (proportion of self-serving errors in the report condition), two two-way interactions: *condition*T1 probability* and *condition*T2 probability*, and two three-way interactions: *condition*T1 probability*self-serving errors* and *condition*T2 probability*self-serving errors*. The model had a binomial response distribution and a logit link function and a random intercept grouped by participant and random slopes for *condition*, *T1 probability*, *T2 probability* and *self-serving errors*.

We tested all pre-registered hypotheses using the same model. To test the first hypothesis of whether participants avoid attending to self-harming information, we first examined whether participants' likelihood of fixating on areas with self-serving and self-harming information was different in the *accuracy* vs. *report* condition. Here, the T1 high-probability areas in the *report* condition represented self-harming information, since participants would miss out on the chance to earn money if they honestly reported T1. Based on estimated marginal means from the full model (for complete details on the model see Appendix Table A3), we specified planned contrasts using Tukey's test to examine differences in fixation likelihood for T1 high-probability areas between the two conditions and T2 high-probability areas between the two conditions. Note that the reference group in our regression model is the low-probability areas. This allows inferring the effects of both low and high probability areas from the T1 and T2 probability estimates. The planned contrasts revealed that participants were less likely to fixate on T1 high-probability areas in the *report* condition compared to *accuracy* condition, $z = -4.254$, $p < .001$ but more likely to fixate on T2 high-probability areas in the *report* condition compared to the *accuracy* condition, $z = 4.628$, $p < .001$. This means that participants paid less attention to self-harming stimuli compared with self-serving stimuli.

We then examined the regression coefficients in the full model for the *T1 probability* (0 indicating low and 1 indicating high probability), and *T2 probability* (0 indicating low and 1 indicating high probability) variables. A positive regression coefficient for *T1 probability* implies an increased fixation likelihood for areas with high probability of T1 appearing which suggests facilitation of attention towards T1. A negative regression coefficient for *T1 probability* implies a decreased fixation likelihood for areas with high probability of T1 appearing which suggests suppression of attention towards T1. The same interpretation of coefficients applies to the *T2 probability* variable. The direction of the regression coefficients is therefore indicative of whether participants facilitate attention, suppress attention, or both when avoiding information.

The results showed a significantly lower likelihood of fixating T1 high-probability areas in the *report* condition, $OR = 0.72$, 95% CI [0.62–0.83], $p < .001$, and a significantly higher likelihood of fixating T2 high-probability areas in the *report* condition, $OR = 2.13$, 95% CI [1.84–2.47], $p < .001$. This suggests that participants may have suppressed attention to high-probability T1 areas and facilitated attention to high-probability T2 areas in the *report* condition compared to the *accuracy* condition.

We then examined whether visual avoidance is associated with participants' propensity to make self-serving errors. We tested this with the three-way interaction in the model, where participants who make more self-serving errors should exhibit more visual avoidance of T1 in the report condition, and only in the report condition, since they were not motivated to make self-serving errors in the accuracy condition. According to our theorizing, participants in the accuracy condition had no incentive to avoid attending to information. Concretely, we expected that people who do not make self-serving errors fixate more on the T1 high-probability areas than T1 low-probability areas, and, conversely, that the effect would reverse for people who make more self-serving errors by fixating more on the T1 low probability areas than the T1 high-probability areas. The key result of interest for this analysis is therefore the effect of self-serving errors for T1 in the *report* condition. Results revealed a significant effect of *Self-serving error score* on the likelihood of fixating on T1 high-probability areas in the *report* condition, $OR = 0.01$, 95% CI [0.01–0.02], $p < .001$. We also found a significant effect of *Self-serving error score* on the likelihood of fixating on T2 high-probability areas in the *report* condition, $OR = 10.55$, 95% CI [5.08–21.95], $p < .001$. That is, people who make more self-serving errors not only avoid self-harming information, the self-serving behavior also results in more attention to the self-serving information. Taken together these result indicates that participants who make more self-serving errors exhibit stronger suppression of T1 and stronger facilitation of T2. See Fig. 4 for visualization.

2.3. Discussion

Consistent with Study 1, the findings revealed that participants faced with conflicting incentives fixated more on areas with self-serving information and less on areas with self-harming information. These results suggest that participants may be able to learn statistical regularities in the environment and use this information to simultaneously suppress visual attention to areas with a high probability of self-harming information and facilitate attention to areas with a high probability of self-serving information. The significant relationship between visual avoidance and proportion of self-serving errors suggests that people use facilitation and suppression strategically to maximize economic gains while minimizing ethical dissonance from overt dishonesty (i.e., directly misreporting T1 and T2).

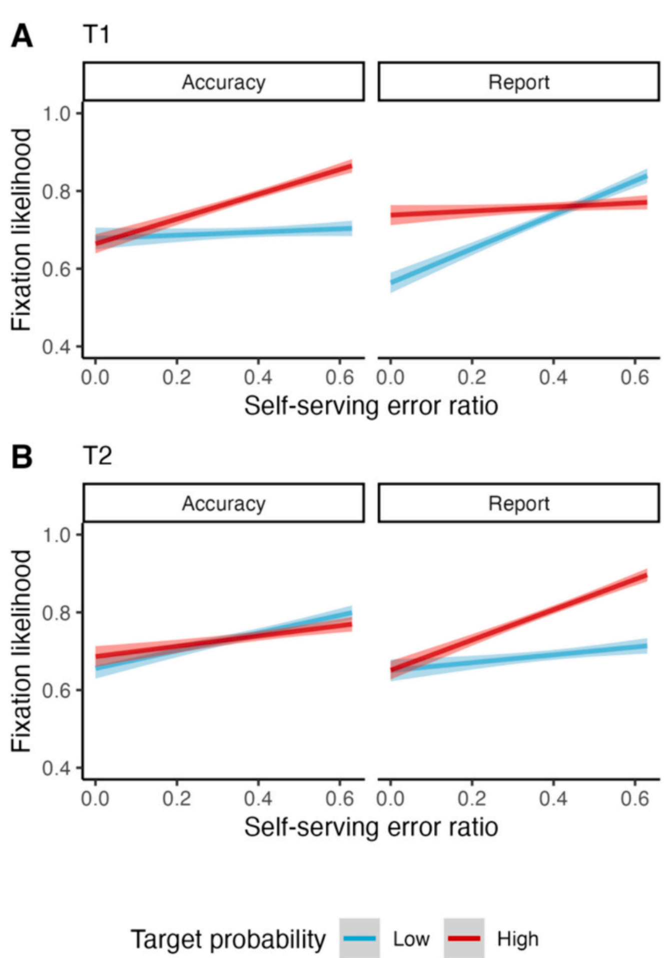

Fig. 4. A: Mean fixation likelihood based on whether there was a low vs. High probability that T1 was present in a square, as well as participants' ratio of making self-serving errors. Derived from descriptive data and error bars indicate 95% confidence intervals. B: Mean fixation likelihood based on whether there was a low vs. High probability that T2 was present in a square, as well as participants' ratio of making self-serving errors. Derived from descriptive data and error bars indicate 95% confidence intervals.

3. Study 3

To stengthen the robustness of our findings, we ran a third study replicating Study 2 on a larger sample. The full experimental protocol was preregistered at the Open Science Framework prior to data collection: https://osf.io/yue28/?view_only=aeda009b6af64848a07a43cea5ef8b8b.

3.1. Methods

3.1.1. Ethics and open science statement

This research complies with all relevant ethical regulations. We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. The studies are approved by the Human Subjects Committee (#249) and the Institutional Review Board (# 2021–0226144) at Aarhus University. The study is preregistered on the Open Science Framework: https://osf.io/yue28/?view_only=aeda009b6af64848a07a43cea5ef8b8b. The data that supports the findings of all three studies, as well as the PsychoPy and R scripts used to run the experimental tasks and analyze the data, are publicly available at: https://osf.io/8pk57/?view_only=2d4e0a261c8d4f4dbd0748f6430d2692.

3.2. Participants

Forty-four participants took park in the study (50% female, 48% male, 2% non-binary, $M_{age} = 25.23$, $SD_{age} = 5.64$). We determined the target sample size a priori based on a power analysis conducted through simulations in R (R Core Team, 2022). We used the data from the twenty-five participants in Study 2 to estimate the expected variance among participants, and increased the level of power to 95%. With an alpha level of 0.05, a small-sized effect of $d = 0.2$ (OR = 0.7), and a power of 95%, the power analysis indicated that for a within-subject design with two conditions and 200 trials per participants, a sample size of 40 is required. We oversampled with 10% to account for the attrition rate observed in the two previous studies. Following our preregistration, participants with low task accuracy (< 66% correct responses in the condition incentivizing accurate responses) were excluded ex-post data collection due to presumed lack of task understanding, leading to a total sample size of 39 participants. Participants received a performance-dependent payment between DKK 50 (≈ $7) and DKK 150 (≈ $22) for their participation, and were debriefed at the conclusion of the experiment. Informed consent was obtained from all participants. The experiment was conducted at Aarhus University in October 2022. A sensitivity analysis revealed 95% power to detect two-way interaction effects of $d = 0.17$ (OR = 0.74) and three-way interaction effects of $d = 0.48$ (OR = 0.42) or larger given a sample of 39 participants and 200 repetitions per participant.

3.2.1. Experimental design

The experimental design was identical to Study 2. The full experimental protocol was preregistered at OSF prior to data collection.

3.3. Results

We followed the same analysis plan as in Study 2, and ran a single model based on which we could examine regression coefficients and specify planned contrasts. The planned contrasts revealed that participants were less likely to fixate on T1 high-probability areas in the *report* condition compared to the *accuracy* condition, $z = -9.67$, $p < .001$. Additionally, people were more likely to fixate on T2 high-probability areas in the *report* condition compared to the *accuracy* condition, $z = 11.19$, $p < .001$. This means that participants paid less attention to self-harming stimuli compared with self-serving stimuli, as we observed in Study 2.

The results showed a significantly lower likelihood of fixating T1 high-probability areas in the *report* condition, $OR = 0.64$, 95% CI [0.57–0.71], $p < .001$, and a significantly higher likelihood of fixating T2 high-probability areas in the *report* condition, $OR = 2.98$, 95% CI [2.67–3.33], $p < .001$, as we observed in Study 2. This suggests that participants may have suppressed attention to high-probability T1 areas and facilitated attention to high-probability T2 areas in the *report* condition compared to the *accuracy* condition. The results further showed a lower overall fixation likelihood in the *report* condition compared to the *accuracy* condition, $OR = 0.76$, 95% CI [0.66–0.88], $p < .001$.

Finally, the two three-way interactions in the full model revealed a significant effect of *Self-serving error score* on the likelihood of fixating on T1 high-probability areas in the *report* condition, $OR = 0.07$, 95% CI [0.04–0.11], $p < .001$, and a significant effect of *Self-serving error score* on the likelihood of fixating on T2 high-probability areas in the *report* condition, $OR = 2.36$, 95% CI [1.39–4.01], $p < .001$. This suggests that participants who make more self-serving errors exhibit stronger suppression of T1 and stronger facilitation of T2. The key result of interest for this analysis thus replicate in Study 3 and is even more pronounced than in Study 2. See Fig. 5 for visualization. For complete details on the model see Appendix Table A4.

3.4. Discussion

Study 3 replicated the findings from Study 2 indicating that participants simultaneously facilitated attention to self-serving information and suppressed attention to self-harming information. Again, we also find that the facilitation and suppression patterns are stronger for participants who make more self-serving errors, suggesting that visual avoidance is used strategically to maximize economic gains while minimizing ethical dissonance from overt dishonesty.

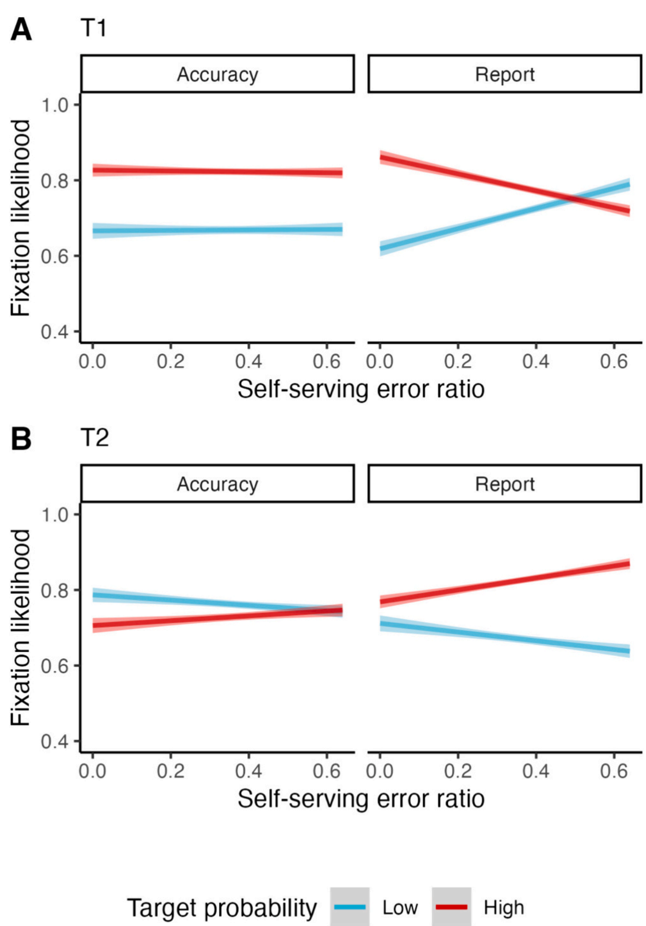

Fig. 5. A: Mean fixation likelihood based on whether there was a low vs. High probability that T1 was present in a square, as well as participants' ratio of making self-serving errors. Derived from descriptive data and error bars indicate 95% confidence intervals. B: Mean fixation likelihood based on whether there was a low vs. High probability that T2 was present in a square, as well as participants' ratio of making self-serving errors. Derived from descriptive data and error bars indicate 95% confidence intervals.

4. General discussion

Information avoidance is a common behavior for most people and research on this important topic is growing (Golman et al., 2017, 2022; Sharot & Sunstein, 2020). Despite the growing interest, it remains unclear whether people use visual inattetion as a method of information avoidance. One of the challenges to examine this topic is the difficulty in distinguishing visual avoidance from visual ignoring, both of which lead to visual inattention. Building on the definitions by Golman and colleagues (Golman et al., 2017), we propose that people igore irrelevant information to conserve scarce cognitive resources but avoid relevant information to preserve ignorance irrespective of cognitive resources. We define visual avoidance as 'visual inattention to relevant information independent of the presence of other information' and visual ignoring as 'visual inattention to any (relevant or irrelevant) information dependent on the presence of more relevant information'. In this article we aim to distinguish visual avoidance from visual ignoring and to examine whether people use visual avoidance as a method for information avoidance. We also examine facilitation and suppression as potential mechanisms behind visual avoidance.

In Study 1, we incentivize participants to either ignore or avoid a target object and find that when participants avoid the target they are much less likely to attend to areas that contain it. The higher the probability is of the target appearing in a given area, the less likely participants are to attend to that area. A possible explanation is that participants learn the statistical structures in the experiment and use this to suppress attention to areas that are likely to contain self-harming information. In Study 2 and 3, we extended the task so that participants were always required to search for both target objects. Results from Study 2 and 3 show that participants are more likely to attend to self-serving information and less likely to attend to self-harming information despite both types of information being equally relevant. Furthermore, the more inclined participants are towards self-serving mistakes the more pronounced these effects become. A possible explanation is that participants learn the statistical structures in the experiment and use this to suppress attention to areas that are likely to contain self-harming information while simultaneously facilitating attention to areas that are likely to contain self-serving information.

While vision research has mainly studied visual suppression in the context of irrelevant visual distractors, our findings suggest that people may be able to suppress attention to strategically avoid relevant information. A common assumption in vision science is that top-down control is determined along a single relevance-irrelevance axis with suppression of irrelevant information and facilitation of relevant information (Geng, 2014). While this description is useful for search tasks with unambiguous targets and distractors, our findings suggest facilitation and suppression are not necessarily couple to information relevance and irrelevance but are employed in complex situations where people strategically navigate task-defined relevance and incentives (self-serving vs. self-harming information).

Extrapolating from this, our findings suggest that people may be able to suppress visual attention to goal-relevant information when attending to this information is in conflict with another goal. This could, for instance, include situations where people are intensely motivated to attend to tempting food stimuli but on the other hand want to avoid consuming it (Mischel et al., 1972; Mischel & Ebbesen, 1970). It is also well-known that people have a strong motivation to attend to other people and faces, but in social situations people often avoid attending to others out of courtesy (Hessels et al., 2020; Holleman et al., 2020;

Laidlaw et al., 2011). Future research should therefore examine whether and how people use suppression of attention to navigate self-control and social situations.

Our findings shed light on basic attention mechanisms associated with information avoidance. Extending beyond basic visual search tasks, the work may have the potential to inform a variety of applied contexts. In health-related contexts, people may avoid looking at nutritional labels presented on food items they consume, in order not to observe the calorie content of food. Such behavior in turn may lead to poor dietary choices. Similarly, patients might avoid reading detailed medical test results to sidestep potential anxiety or stress, leading to delayed treatments or poor health management. To counteract visual avoidance, strategies could be employed to make relevant information less predictable. One approach could be to randomly vary the location or appearance of important information, thereby reducing the likelihood that people can easily anticipate and avoid it (Orquin et al., 2018). Another strategy might involve integrating interactive elements that require user engagement, thus making it harder to ignore the information.

Future research should also address some limitations in the current studies. First, the studies are limited to relatively simple visual stimuli comprising four information areas. Future research should aim to explore how the effects of facilitation and suppression generalize to more complex visual scenes that better represent real-world contexts. Second, it should also be explored whether visual avoidance can be based on other regularities than location, such as predictable features in color, saliency, size etc. Third, the generalizability of our results to other domains should be investigated, such as information avoidance in consumer and health-related contexts, such as avoidance of medical test results, nutrition information, or product warning labels. These areas present promising avenues for future research in order to better understand the extent and dynamics of visual information avoidance. As highlighted by Nordström et al. (2023), understanding the fundamental mechanisms that drive strategic information avoidance becomes crucial when the policy goal is to maximize welfare.

5. Conclusion

People frequently avoid information they believe is relevant but in conflict with self-serving incentives. People rely on a number of methods to avoid information, such as physical avoidance, misperceiving, misremembering, and forgetting information. We show that people also use visual inattention as a method of information avoidance and that they rely on statistical regularities in the environment to strategically avoid attending to locations that are likely to contain relevant but avoided information. In order to visually avoid information, people must therefore possess knowledge allowing them to anticipate where not to look. Our research suggests that making the location of avoided information less predictable may be an effective strategy to reduce visual avoidance.

CRediT authorship contribution statement

Caroline Kjær Børsting: Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Aleksandr Batuev:** Writing – review & editing, Software, Methodology. **Shaul Shalvi:** Writing – review & editing, Methodology, Conceptualization. **Jacob Lund Orquin:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

All authors declare no competing interest.

Acknowledgments

The authors would like to thank the Center of Integrated Business Psychology at Aarhus University for funding the study. The authors would also like to acknowledge research assistant Aleksandrs Baskakovs for his valuable help in data collection.

Appendix A. Appendix

Table A1
Study 1: Shift in fixation likelihood predicted by T2 presence and condition.

	Fixation likelihood		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	5.69	4.49–7.21	**<0.001**
Contain T2 [yes]	0.93	0.82–1.06	0.264
Condition [report]	0.89	0.54–1.48	0.663
Contain T2 * Condition	0.51	0.43–0.60	**<0.001**
Random Effects			
σ^2			3.29
$\tau_{00\ \text{Subject ID}}$			0.25
$\tau_{11\ \text{Subject ID. Condition}}$			1.16
$\rho_{01\ \text{Subject ID}}$			−0.55
ICC			0.14
$N_{\text{Subject ID}}$			18
Observations			23,040
Marginal R^2 / Conditional R^2			0.015 / 0.152

Table A2
Study 1: Shift in fixation likelihood predicted by T2 probability and condition.

	Fixation likelihood		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	10.39	6.34–17.03	**<0.001**
Condition [report]	0.94	0.55–1.61	0.816
T2 probability [0.04]	0.57	0.31–1.04	0.066
T2 probability [0.25]	0.55	0.34–0.88	**0.012**
T2 probability [0.7]	0.44	0.28–0.71	**0.001**
Condition * T2 probability [0.04]	0.92	0.73–1.16	0.489
Condition * T2 probability [0.25]	0.75	0.60–0.95	**0.015**
Condition * T2 probability [0.7]	0.70	0.56–0.87	**0.002**

Random Effects	
σ^2	3.29
τ_{00} Subject ID	1.06
τ_{11} Subject ID. Condition	1.21
τ_{11} Subject ID. T2 probability [0.04]	1.56
τ_{11} Subject ID. T2 probability [0.25]	0.92
τ_{11} Subject ID. T2 probability [0.7]	0.93
ρ_{01}	−0.21
	−0.66
	−0.88
	−0.86
ICC	0.22
N Subject ID	18
Observations	23,040
Marginal R^2 / Conditional R^2	0.035 / 0.245

Table A3
Study 2: Shift in fixation likelihood predicted by T1 and T2 probability, condition, and proportion of self-serving errors.

	Fixation likelihood		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	2.44	1.21–4.95	**0.013**
T1 probability [high]	1.62	1.10–2.39	**0.016**
T2 probability [high]	0.94	0.68–1.30	0.714
Condition [report]	0.83	0.66–1.05	0.117
Self-serving error score	3.68	0.27–49.48	0.325
T1 probability * Condition	0.72	0.62–0.83	**<0.001**
T2 probability * Condition	2.13	1.84–2.47	**<0.001**
T1 probability * Self-serving error score	5.42	0.95–30.87	0.057
Condition * Self-serving error score	6.03	1.73–21.02	**0.005**
T2 probability * Self-serving error score	0.46	0.09–2.26	0.338
T1 probability * Condition * Self-serving error score	0.01	0.01–0.02	**<0.001**
T2 probability * Condition * Self-serving error score	10.55	5.08–21.95	**<0.001**

Random Effects	
σ^2	3.29
τ_{00} Subject ID	3.20
τ_{11} Subject ID. T1 probability	0.89
τ_{11} Subject ID. T1 probability	0.59
τ_{11} Subject ID. Condition	0.22
ρ_{01}	−0.65
	−0.46
	0.07
ICC	0.43
N Subject ID	25
Observations	20,000
Marginal R^2 / Conditional R^2	0.056 / 0.466

Table A4
Study 3: Shift in fixation likelihood predicted by T1 and T2 probability, condition, and proportion of self-serving errors.

	Fixation likelihood		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	2.46	1.91–3.17	**<0.001**
T1 probability [high]	2.27	1.78–2.91	**<0.001**
T2 probability [high]	0.80	0.65–0.97	**0.024**
Condition [report]	0.76	0.66–0.88	**<0.001**
Self-serving errors	0.57	0.18–1.80	0.335
T1 probability * Condition	0.64	0.57–0.71	**<0.001**
T2 probability * Condition	2.98	2.67–3.33	**<0.001**
T1 probability * Self-serving errors	0.98	0.32–3.00	0.971
Condition * Self-serving errors	3.00	1.53–5.86	**0.001**
T2 probability * Self-serving errors	2.50	0.98–6.37	0.056
T1 probability * Condition * Self-serving errors	0.07	0.04–0.11	**<0.001**
T2 probability * Condition * Self-serving errors	2.36	1.39–4.01	**0.001**

Random Effects	
σ^2	3.29
$\tau_{00\ \text{Participant}}$	0.61
$\tau_{11\ \text{Participant. T1 probability}}$	0.55
$\tau_{11\ \text{Participant. T2 probability}}$	0.34
$\tau_{11\ \text{Participant. Condition}}$	0.12
ρ_{01}	−0.79
	−0.62
	−0.26
ICC	0.10
$N_{\text{subject\_id}}$	39
Observations	31,200
Marginal R^2 / Conditional R^2	0.067 / 0.160

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesp.2024.104661.

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