Age Effects on Inattentional Blindness: Implications for Driving

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Abstract. We may fail to notice things in our environment because our attention is directed somewhere else, a phenomenon called inattentional blindness. Our susceptibility to inattentional blindness increases as we age. We explored three potential moderators of the age and inattentional blindness relationship: (1) the spatial proximity of the unexpected object to our focus of attention; (2) the match between the features of the unexpected object and those we have prioritized—our attention set; and (3) the salience of the unexpected object. Using a large sample of participants, we found no evidence that any of these moderate the effect that age has on inattentional blindness; the effect of age is robust. We discuss the implications for older drivers.

Keywords: Aging · Attention · Inattentional blindness · Attentional breadth · Attention set · Salience

1 Introduction

We may fail to notice an object or event in our environment because our attention is directed elsewhere—a phenomenon called inattentional blindness [1, 2]. Even very consequential events such as a pedestrian walking in front of our car or a car merging into our lane may go unnoticed when our attention is directed elsewhere. In fact, we may miss something in front of us even if we're looking directly at it [3]; visual fixation does not guarantee detection.

We are less likely to notice an unexpected object as we age. When counting the number of ball passes made by a team of players in white shirts while ignoring the passes made by a team in black shirts, 60 % of younger participants, but only 10 % of older participants, noticed when a woman in a gorilla suit walked through the game [4]. And, when visually tracking white shapes while ignoring black ones, every 10 years of age predicted a 1.3-fold increase in the probability of missing a gray cross that traversed the display [5].

What moderates this age effect? One moderator that has been explored is spatial proximity; we are more likely to notice something the closer it appears to our focus of

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attention [6, 7]. Given that our breadth of attention declines with age [8], are older adults exceptionally more likely to miss unexpected objects that appear away from their focus of attention? A large online study found no evidence of this: When tracking moving objects on a screen, the effect of age did not depend on how far away from an attended line the unexpected object appeared (see Fig. 1) [5].

Another possible moderator is attention set—the features we prioritize [9]. We're more likely to notice something when it matches our attention set. For example, attending blue makes blue things more noticeable. Attention sets also help us ignore irrelevant objects. If we're attending white while ignoring black, we're more likely to notice white things, but less likely to notice black things. Given that our working memory capacity—something that helps us ignore irrelevant information—declines as we age [10], older adults may be less able to maintain an attention set than younger adults. Only one study has so far explored this [11]. When tracking black shapes while ignoring white ones, the difference in noticing between white and black unexpected objects was 63 % for older participants, but only 25 % for younger participants. Despite these differences, the interaction between age and attention set was not significant. Further exploration is warranted, however, as the sample size used in the study was relatively small (∼20 per cell).

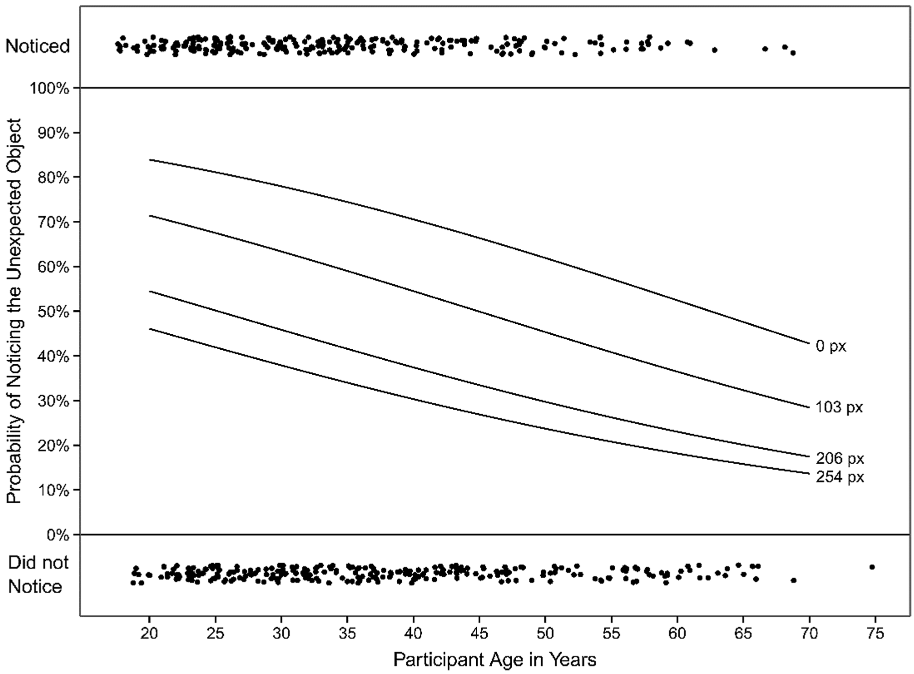

Fig. 1. The probability of noticing the unexpected object as a function of age and distance from the focus of attention. Originally appeared in Stothart et al. [5]. By Cary Stothart, Walter Boot, and Daniel Simons. Available under creative commons attribution 3.0 unported (http://creativecommons.org/licenses/by/3.0).

In an exploratory analysis, we assessed the interaction between attention set and age using a larger sample of participants. We also explored the interaction between age and spatial proximity using an unexpected object that appeared at a distance further away from the farthest distance used in Stothart et al. [5]. Finally, we explored a novel interaction: age by salience. We are less likely to notice salient unexpected objects than ones that match our attention set [9]. Given that our vision deteriorates with age [12], would older adults be exceptionally less likely to notice a distinctive unexpected object than one that matches their attention set?

In order to rapidly recruit our sample and collect data from a population more diverse than the typical undergraduate one, we crowdsourced data collection online using Amazon Mechanical Turk. Using a large sample also allowed us to use age as a continuous variable.

2 Method

The experiment took place online and participants completed it using their personal computers. The experiment was programmed in JavaScript, PHP, and HTML/CSS.

2.1 Participants

The analysis included data from 618 participants who were recruited and tested on Amazon Mechanical Turk (425 females, Mean Age = 33.74, *SD* = 11.30, Median Age = 30, *Min* = 18, *Max* = 71; Fig. 2 shows the age distribution). All participants lived in the United States, had normal or corrected-to-normal vision, were not color blind, passed an attention check test, and had not participated in a previous inattentional blindness experiment.

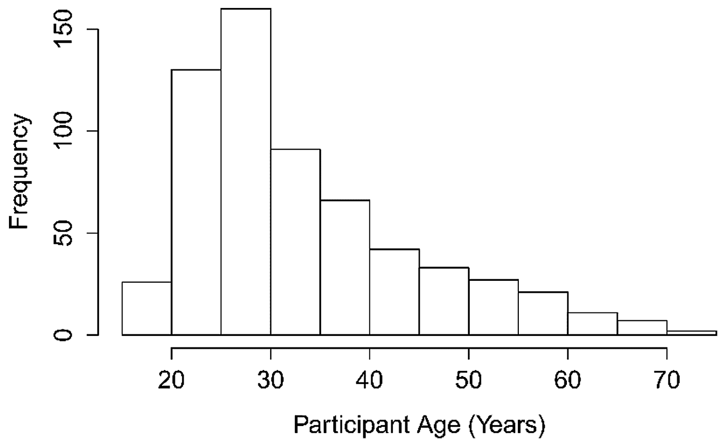

Fig. 2. Age distribution of the sample

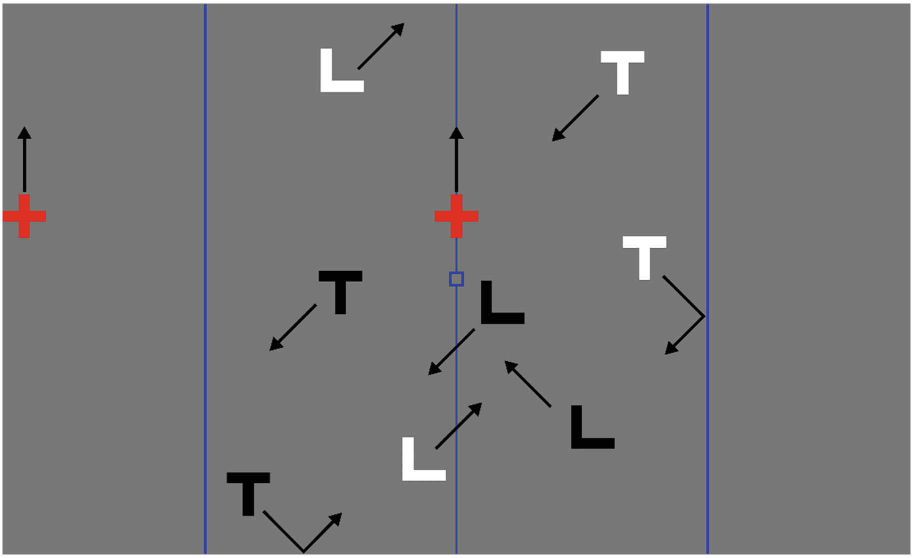

Fig. 3. The inattentional blindness task. The unexpected object was either a red, black, or white cross, and it could appear either on the attended line or away from it. Both paths are shown in the figure. (Color figure online)

2.2 Inattentional Blindness Task

Figure 3 shows the inattentional blindness task. Participants viewed a gray (#777777) 900px by 546px display that featured three vertical blue lines that spanned it (#0000FF; thickness = 2px). One line was positioned in the center of the display and the two others were positioned on opposite sides of the center line at a distance of 250px. In each of the three, 15-second-long trials, participants counted the number of times 4 white letters (2 L's and 2 T's; #FFFFFF) crossed the central blue line while ignoring 4 black letters (2 L's and 2 T's; #000000; 43px by 43px; thickness = 11px). The letters moved in a randomly-chosen direction (45, 135, 225, or 315 degrees relative to vertical) at speeds ranging from approximately 90px/s to 180px/s. The speed and direction of each letter changed randomly and independently every 1 to 4 s, making the trajectories unpredictable. Each letter was assigned a unique change interval, meaning that the letters changed speeds and directions at different times. Five seconds into the third trial, a white (#FFFFFF), black (#000000), or red (#FF0000) unexpected object (a 43px by 43px cross with a line thickness of 11px) appeared from the bottom of the display, moved toward the top of the display at a speed of 90px/s, and disappeared at the top of the display. The unexpected object either moved on a vertical path 157px to the left of the left-most blue line or along the central blue line. The color and path of the unexpected object was randomly chosen for each participant.

2.3 Procedure

Participants first completed the inattentional blindness task. They were then asked if they noticed the unexpected object. Regardless of their answer, they were asked if the unexpected object was moving, what direction it was moving in, what shape it was, and what color it was. Participants then answered a number of questions about their computer and demographics. Finally, they completed an attention check task where they chose the middle number in a list of numbers and entered it on the next screen.

3 Results

Participants were coded as having noticed the unexpected object if they reported noticing it and correctly answered one of the questions about its features. Using this scheme, 55 %, [95 % confidence interval: 51 %, 59 %] of participants noticed the unexpected object. We report the results using age as both a continuous and categorical variable.

3.1 Age as a Continuous Variable

Replicating previous experiments, older participants were less likely to notice the unexpected object, $B = -0.02$, $SE = 0.01$, *Odds Ratio* = 0.98, 95 % CI [0.97, 0.99], $p = .005$.

Attention Set. Replicating previous studies, the attention set participants adopted predicted noticing: Whereas 69 % [62 %, 75 %] of participants noticed the unexpected object when it matched attended items (the white letters; $n = 215$), only 17 % [12 %, 22 %] of participants noticed it when it matched ignored items (the black letters; $n = 200$), $B = 2.41$, $SE = 0.24$, *Odds Ratio* = 11.18, 95 % CI [7.05, 18.15], $p < .001$. This effect, however, was not moderated by age, $B = 0.01$, $SE = 0.02$, *Odds Ratio* = 1.01, 95 % CI [0.97, 1.06], $p = .650$.

Salience. The unexpected object was slightly more noticeable when it had a distinctive color (red; 78 % [72 %, 83 %], $n = 203$) than when it shared the same color with attended items (white; 69 % [62 %, 75 %], $n = 215$), $B = 0.46$, $SE = 0.22$, *Odds Ratio* = 1.59, 95 % CI [1.03, 2.48], $p = .039$. Age did not moderate this effect, $B = 0.01$, $SE = 0.02$, *Odds Ratio* = 1.01, 95 % CI [0.98, 1.05], $p = .469$.

Spatial Proximity. Noticing depended on whether or not the unexpected object appeared near the focus of attention: 62 % [57 %, 68 %] of participants noticed it when it appeared near the focus of attention ($n = 307$) and 48 % [42 %, 53 %] of participants noticed it when it appeared away from the focus of attention ($n = 311$), $B = 0.60$, $SE = 0.16$, *Odds Ratio* = 1.81, 95 % CI [1.32, 2.50], $p < .001$. This effect was also not moderated by age, $B = 0.01$, $SE = 0.02$, *Odds Ratio* = 1.01, 95 % CI [0.98, 1.04], $p = .411$.

Table 1. Noticing as a function of age group

Factor	Younger adults	Older adults	Y, O *n*
Attention set (Tracking White)			
White unexpected object	77 % [64 %, 87 %]	65 % [52 %, 76 %]	49, 60
Black unexpected object	18 % [10 %, 31 %]	7 % [3 %, 19 %]	50, 51
Spatial proximity			
Near	67 % [57 %, 77 %]	57 % [46 %, 68 %]	83, 82
Far	53 % [42 %, 65 %]	36 % [27 %, 47 %]	73, 80
Salience			
Salient unexpected object	84 % [72 %, 92 %]	65 % [51 %, 77 %]	57, 51
Set-matching unexpected object	77 % [64 %, 87 %]	65 % [52 %, 76 %]	49, 60

3.2 Age as a Categorical Predictor

Table 1 shows the noticing rates for each moderator. The youngest 25 % of participants were coded as younger adults (n = 156, Mean Age = 22.64, SD = 2.03, Median = 23, Min = 18, Max = 25) and the oldest 25 % of participants were coded as older adults (n = 162, Mean Age = 49.72, SD = 8.19, Median = 49, Min = 39, Max = 71). Participants between the ages of 25 and 39 were excluded from the analysis. Using this coding scheme, 61 % [53 %, 68 %] of younger participants and 47 % [39 %, 55 %] of older participants noticed the unexpected object, B = 0.57, SE = 0.22, *Odds Ratio* = 1.76, 95 % CI [1.13, 2.76], p = .013.

Attention Set. The difference between white and black unexpected objects was 58 % for older participants and 59 % for younger participants. This difference was not significant, B = 0.33, SE = 0.77, *Odds Ratio* = 1.39, 95 % CI [0.31, 6.79], p = .672.

Salience. The difference between salient and attention-set-matching unexpected objects was 0 % for older participants and 7 % for younger participants. This was also not significant, B = 0.45, SE = 0.64, *Odds Ratio* = 1.56, 95 % CI [0.45, 5.54], p = .484.

Spatial Proximity. The difference between near and far unexpected objects was 21 % for older participants and 14 % for younger participants. This difference was not significant, B 0.27, SE = 0.46, *Odds Ratio* = 1.31, 95 % CI [0.53, 3.24], p = .564.

4 Discussion

We are less likely to notice unexpected objects the more we age. And, we are more likely to notice unexpected objects the closer they are to our focus of attention and when they match the features we prioritize—our attention set. Although we replicated these three effects, we found that the effect of age on inattentional blindness is pretty robust—it does not depend on either the color of the unexpected object or its spatial proximity to the focus of attention. Furthermore, the pattern of results did not change depending on if we used age as a categorical or continuous predictor.

We found this despite using a much larger sample than ones previously used—the benefit of this being greater power to detect an effect and more confidence about the effect sizes. Although we collected our data online using Amazon Mechanical Turk, we replicated three in-lab findings. Additionally, Mechanical Turk has been validated on a number of other measures, including behavioral [13] and clinical ones [14]. Given this, it's unlikely that our results depended on the use of an online sample.

The topic of inattentional blindness is very relevant to driver safety; we can't respond to something on the road if we don't notice it. Indeed, "looked-but-failed-to-see" accidents—where a driver looks at, but fails to notice something on the road—may account for 69 % to 80 % of intersection crashes [15] and inattentional blindness is likely the cause of many of these. Therefore, the factors that predict inattentional blindness can likely be used to reduce traffic accidents [16]. For example, the attention set we adopt can substantially change our chances of getting into an accident. When looking for a yellow road sign, 36 % of participants collided with motorcycle when it was blue, but only 7 % of participants collided with it when it was yellow. As most drivers likely adopt an attention set for "car," making other roadway objects look similar to cars (e.g., motorcycles) may reduce collisions [16].

Although we know that age predicts inattentional blindness, there are likely additional individual differences that can tell us which older adults are more likely to get into a crash. One candidate is working memory capacity. In younger adults, working memory capacity may only predict noticing in specific contexts [17, 18] and for certain subsets of people [19]. However, it may predict overall noticing in older adults [20]. Indeed, studies finding lower inattentional blindness rates among those with higher working memory capacities tend to use samples with larger variabilities in age [21, 22]. Therefore, age's moderating effects on working memory capacity should be explored further.

In summary, the effect of age on inattentional blindness is robust to both attention set and spatial proximity to the focus of attention. In order to reduce roadway accidents, future research should explore additional factors that may moderate the age and inattentional blindness relationship.

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