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Forgotten or never consciously processed? A comparison of immediate and delayed recall of driving details

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ABSTRACT

After driving a familiar route, people often have a poor memory of the drive. To investigate how quickly people forget information from an everyday drive we asked participants ($n = 38$) to take a 20-min simulated drive on familiar local roads and after a delay, answer questions about what happened and what they saw at four locations. We questioned drivers either immediately (<1 s), 20 s or 45 s after driving through each location, or at the end of the drive. Recall accuracy remained high when drivers were questioned immediately and at delays of 20 s and 45 s, but was significantly poorer when drivers were questioned at the end of the drive. Recall accuracy for stopping at a location did not decrease regardless of delay. The results add to our knowledge about the role of attention and memory for highly practised and largely automatic skills, such as everyday driving.

1. Introduction

After driving a familiar route, where nothing out of the ordinary occurs, people typically have poor memory for details from the drive (Charlton and Starkey, 2018). This amnesia for everyday driving may be accompanied by feelings of large time gaps in attention, which raises concerns about driver safety (Galpin et al., 2009). But why is memory for everyday driving so poor? Is it because drivers are not paying attention? Or could it be that much of the information about the drive is quickly forgotten?

From one perspective, it makes sense that memory for everyday driving is so poor, because most of the time, driving on familiar routes is sufficiently predictable that it can be completed safely with only brief periods of conscious, focused attention (Charlton and Starkey, 2018). While it is understood that little is remembered from everyday drives, the literature is unclear about what *is* remembered from everyday driving, and whether some types of information from a drive are remembered better than others. A small number of studies have attempted to discover what is remembered after a drive is complete.

In one early study, when tested at the end of a drive, drivers showed good memory for whether or not they had stopped at specific intersections, whether or not a vehicle was ahead of them, and whether or not other vehicles crossed their path (Groeger, 2000). In comparison, drivers showed poorer memory for sightings of pedestrians or cyclists. The authors suggested that drivers' incidental memory of the driving environment is best for potential hazards, for example other vehicles or intersections that were rated as more difficult or dangerous. The authors went on to conclude that increased arousal at encoding (with danger and difficulty) increases the durability and vivid nature of memories (Groeger, 2000). Another study tested this idea that the experience of risk plays a central role in memories for driving (Chapman and Groeger, 2004). Drivers' memories after viewing films of driving scenes were found to be poor overall, with drivers giving correct answers for an average of between 66% and 72% of situations. Situations involving higher risk were generally remembered better than situations rated as low risk. The authors concluded that drivers typically remember the information which is attended to most closely, in particular, “central information from dangerous situations” (Chapman and Groeger, 2004, p. 1247).

In a more recent study, participants drove familiar local roads (in a driving simulator or on-road) and were asked to rate their perceived risk, difficulty and anxiety during the drive (Charlton and Starkey, 2018). After the drive, the participants were prompted to recall everything they remembered from the drive. Participants in this study had an average recall accuracy of 58.22%. Participants' recollections were dominated by memories of other vehicles, pedestrians and traffic control devices. Poor driving behaviour of other motorists was also frequently mentioned. Participants were also asked cued-recall questions about what happened and what was seen at specific locations in the drive. Memories of stopping at a particular location had the highest accuracy. However, when considering the types of recall errors made by drivers, memories of stopping and vehicles immediately ahead of the driver had a high number of false alarms, suggesting that participants were reconstructing what usually happened at a particular location rather than recalling what actually happened during the experiment.

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Participants often failed to recall sightings of pedestrians or vehicles at side roads, which suggested driver inattention to these types of information. No significant correlation was found between recall accuracy and driver ratings of risk, difficulty or anxiety. However, the predominance of memories of poor driver behaviour was consistent with prior research that indicated higher durability and accuracy of recollections of events associated with increased arousal or consequentiality (such as hazards or risky situations) (Groeger, 2000; Chapman and Groeger, 2004). The authors concluded that drivers' memories for everyday drives are poor due to a general lack of attention to the driving task, and the intrusion of false recollections of what typically happens at familiar locations (Charlton and Starkey, 2018).

The degree to which inattention is a factor influencing drivers' poor memory for everyday drives has been called into question by two sorts of studies. In one recent study participants drove three familiar routes and at the end of each they were asked a series of questions about events from the drive (Dua and Charlton, 2019). The researchers manipulated the type of recall and recognition cues used (auditory and visual) and found that recall accuracy ranged from a high of 81.34% when a sample of music played during the drive was reinstated to a low of 33.34% when part of a radio documentary was re-played. The authors suggested that memories for an everyday driving trip were available for recall, and accessible with a good recall cue.

A separate line of research comes from studies that have examined the time course of incidental memory. For example, memory for taped audio passages of speech is good when tested immediately after hearing the passage. However, when tested after a delay of 80 syllables (27 s), recognition of syntactic changes, or changes to the form of the original sentence, decreased to near chance levels (Sachs, 1967). In contrast, recognition of semantic changes, or changes in the meaning of a sentence, remained high when tested after a delay of 160 syllables (46 s). These results suggest that the original form of a sentence is only held in memory long enough for the sentence to be comprehended. In a similar way drivers' memory for recently passed road signs has been tested when they were stopped at a police roadblock (Luoma, 1993). Roadblock studies have shown that memory for road signs is often poor; between 18% and 39% correctly recalled a general warning sign, whereas between 69% and 80% of drivers correctly recalled a speed limit sign (Luoma, 1993). There are, however, several difficulties with this paradigm, not the least of which is the potential for emotional disturbance associated with the unexpected police roadblock to interfere with recall (Luoma, 1993).

One study modified the roadblock paradigm by having the researcher hitchhike on a busy road (Fisher, 1992). Once picked up by a passing driver, the researcher waited until drivers drove past a road sign. Approximately 100 m after passing the sign, the researcher asked the driver if they remembered the last road sign they passed. Results showed that memory for signs was poor, with only 56% of drivers correctly recalling the sign (Fisher, 1992). In another modification of the roadblock paradigm, drivers were joined in their vehicle by an experimenter (Luoma, 1993). This study differed from previous studies because the delay between passing a road sign and inquiry was varied, to measure the influence of forgetting. Inquiry occurred either immediately after passing the sign, or after the driver stopped the vehicle 670 m down the road (a delay of between 49 s and 56 s). When questioned immediately, drivers had similar recall accuracy for both speed limit signs and animal crossing signs. After a delay, drivers had good memory for speed limit signs, but recall accuracy of animal crossing signs decreased significantly when inquiry was delayed. These results suggest that the effect of recall delay may differ depending on the type of sign, or perhaps the subjective importance of the sign. However, the presence of other traffic was found to significantly decrease recall of a sign, which limited interpretation of the results (Luoma, 1993).

The goal of the present study was to measure the information drivers remember from familiar routes at several short delays, while attempting to address some of the methodological difficulties of prior studies. Whereas previous studies have tested drivers' memory only at the end of a drive (Charlton and Starkey, 2018), and others have interrupted a drivers' progress to ask about a preceding object or event (Fisher, 1992; Luoma, 1993), there has not been a controlled study examining the time course of driver memory. To do this we used a driving simulator to implement a roadblock style method, as a simulated drive can be quickly and discretely paused to allow driver questioning. A simulated drive also allowed control of traffic levels, and a familiar local road was chosen to better approximate an everyday drive. Specifically, we wanted to measure how quickly people forget information about an everyday drive, and see whether some types of information from a drive are remembered better than others.

To answer these questions, we tested drivers' memory for different types of information at varying delays during a simulated drive on familiar local roads. If quick forgetting influences memory for everyday driving, we might expect memory for an everyday drive will be better when drivers are questioned at shorter delays. If driver memory is better for information that commanded conscious attention, we might expect that memory will be more durable for information of importance to the driver, such as their own behaviour (e.g., stopping at an intersection) or the presence of other vehicles. Conversely, we might expect that more peripheral information, such as sightings of cyclists or pedestrians, would be quickly forgotten.

2. Method

2.1. Participants

Participants were recruited from the local community through email, posters, social media posts, and referral from another study, and received a $20 voucher to thank them for their participation. Thirty-eight fully licenced drivers completed the experiment (22 female). The average age of participants was 37.92 years ($SD = 13.80$). The average amount of driving reported by participants was 198.19 km per week but varied considerably between participants ($SD = 423.44$). The average rating of familiarity with the local road driven in the simulator was 6.78 out of 10 ($SD = 2.17$), and participants reported that they drove all or part of this road an average of 3.26 times per week ($SD = 3.07$).

2.2. Procedure

Once informed consent was obtained, participants were read a list of instructions for how they were to complete the experiment. Participants then took a seat in a high-fidelity driving simulator (see Charlton and Starkey, 2018 for a detailed description of the simulator). As shown in Fig. 1, the simulator consisted of a full-size vehicle (Toyota Prius) positioned in front of a projection surface (2.32 m from the drivers eye position). High-definition video (HD resolution, 100 Hz frame rate) of roads surrounding the university were displayed on the projection surface. The videos used contained only typical and familiar driving scenes and nothing potentially hazardous or absorbing to drivers. Participants used the accelerator and

Fig. 1. Transport Research Group driving simulator at the University of Waikato.

brake pedal to control the speed of the video (and therefore the vehicle). The steering wheel produced a sensation of apparent steering by adjusting the position of the central part of the scene, as with normal road driving. The interior light was left on, so participants could more easily read and answer written questions.

The researcher informed the participants that they would answer questions about specific locations in the drive, but participants were unaware of which specific locations they would answer questions about. Because drivers were somewhat alerted to the purpose of the experiment, it was necessary to prevent drivers from visually searching and memorising the driving environment more than they usually would. The researcher read the following instruction to participants: “While we are asking you about parts of the drive, the drive has far too much information for you to try and think about everything you see while you are driving. So just relax and drive as you normally would, in your everyday life”.

The experiment began with a short (approximately 5 min) practice drive. At the end of the practice drive, participants answered a set of practice questions. The practice drive was included to familiarise participants with the controls of the simulator and the procedure with which they would answer questions. Practice questions were the same questions asked in the test drive to ensure all groups had exposure to these questions before the test drive. These questions are explained in further detail below. After the practice drive was complete, participants were reminded about their task to answer questions about specific locations in the drive and were given the opportunity to ask questions. The researcher then informed the participant that the test drive would begin.

The test drive video was a 14 km circuit of predominantly suburban and residential roads with a 50 km/h speed limit, with the exception of a 4 km section of road with a 60 km/h and then an 80 km/h speed limit. The test drive took approximately 20 min to complete. Four locations in the test drive were designated as targets. Drivers answered questions about what happened, and what they saw at these four locations. Two locations were traffic-light-controlled intersections, where the participant stopped. One location was a roundabout that participants' drove through. The other was a straight section of road with a pedestrian crossing that participants drove through.

Each participant was randomly assigned to one of four groups. These groups differed in the delay between driving through each location, and when they answered questions about that location. Participants in the “Immediate recall” group answered questions less than 1 s after driving through each location. Participants in two “Delayed recall” groups answered questions either 20 s or 45 s after driving through each location. Participants in a fourth “Post-drive” recall group completed the drive uninterrupted, answering questions about all four locations at the end of the drive (around 5 min after driving through the final location). All four groups answered questions while seated in the simulator.

Questions were located on five separate clipboards, which were numbered (according to location order) and stacked in order on the passenger seat. A cover page obscured the questions. After driving through each of the predetermined locations, the researcher paused the simulator and communicated a number to the participant through the simulator's intercom system. The participant then picked up the clipboard corresponding to that number and answered the questions on the question sheet, by circling and writing answers in pen. The possible responses to questions in which an answer needed to be circled, were either “yes”, “no” or “can't recall”.

At the top of each question sheet was a clear description of the location, as well as a full-colour photo (taken on a different day to the simulation video) to provide context. Below the photo was the phrase “*At this location…*”, followed by the list of questions. Participants answered the same six questions about each location. Questions appeared in a different order for each location, but each participant received the same questions in the same order. Questions asked about stopping, vehicles immediately ahead, sightings of cyclists and pedestrians. At each location, participants were also asked two familiarity (rather than memory) questions, asking about either street/landmark names, or the speed limit at that location. These questions were designed to make the list of questions appear to differ each time. At the bottom of the question sheet was a space for participants to free-recall anything else they remembered from that location. After the drive and questioning was complete, participants completed a brief demographic questionnaire and received a $20 voucher to thank them for their participation.

2.3. Analysis

We excluded data from two participants who misunderstood the instructions of the experiment. These participants thought questions were asking about the drive as a whole, instead of about the specific locations. Misunderstanding was determined through the low mean percentage accuracy, and free-recall responses which mentioned things that were seen previously in the drive, but not at the specific location. The driving simulator collected data showing the driver's speed and brake force applied at each location. These data were examined to determine whether any drivers applied extreme brake force at a location (more than three standard deviations above the mean), which resulted in the video simulation slowing down to an inappropriate level. The data of two participants from location one was excluded; one because the participant applied excessive brake force, the other because the participant misplaced the pen. The data of two participants from location four were excluded because both of these participants applied excessive brake force at this location.

Of the questions that drivers were asked, the responses to four main question types were used for analysis: whether the participant had stopped their vehicle (stop questions), whether there was a vehicle immediately ahead of them (vehicle ahead questions), whether there was a cyclist present (cyclist questions), and whether there was a pedestrian present (pedestrian questions). “Stop” questions were included as an example of the driver's own behaviour. “Vehicle ahead” questions were included as an example of stimuli related to vehicle control. “Cyclist” and “pedestrian” questions were included as examples of more peripheral elements of the driving environment.

Answers to the four main question types were scored according to signal detection theory; hit (the stimuli was present and the participant answered “yes”), correct rejection (the stimuli was not present and the participant answered “no”), miss (the stimuli was present and the participant answered “no”) and false alarm (the stimuli was not present and the participant answered “yes”). Participants also had the opportunity to answer with “can't recall”. Correct answers were analysed as the sum of hits and correct rejections. Incorrect answers were analysed as the sum of misses, false alarms and “can't recall” responses.

3. Results

The main result of interest was the comparison of recall accuracy at each of the four delays, immediately, after 20 s, 45 s or after the completion of the simulated drive. As shown in Fig. 2, participants in the post-drive delay group showed the lowest recall accuracy, with only slightly above 50% accuracy totalled across all of the recall questions ($M = 50.58\%$, $SD = 12.99\%$). The other three delay groups showed similar levels of accuracy to one another, ranging from 68.40% to 69.94%. A one-way between-subjects analysis of variance (ANOVA) showed that the delay groups were significantly different in their overall recall accuracy, $F\,(3,32) = 5.86$, $p = .003$, $\eta_p^2 = 0.354$. Post-hoc pairwise comparisons (Bonferroni adjusted) indicated that participants in the post-drive delay group had significantly lower overall recall accuracy than the immediate ($p = .007$), 20 s delay ($p = .013$) and 45 s delay ($p = .014$) groups. Overall recall accuracy for the immediate, 20 s delay and 45 s delay groups did not differ significantly ($p = 1.00$ for each comparison).

In order to examine the potential for different types of information from the drive to be more or less memorable than others, we calculated the recall accuracy for the four main types of information: whether the participant had stopped their vehicle, whether there was a vehicle immediately ahead of them, whether there was a cyclist present, and whether there was a pedestrian present. The average percent recall for each type of information, at each recall delay is shown in Fig. 3.

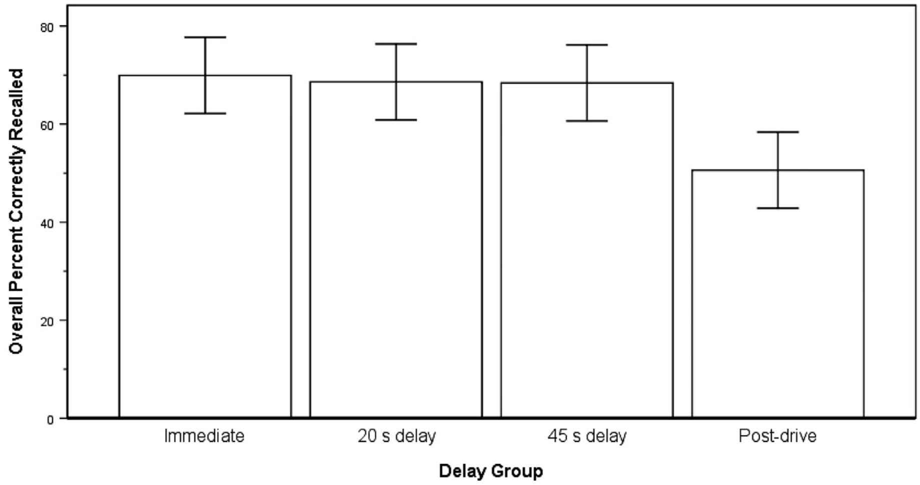

Fig. 2. The mean percent of items correctly recalled for each group. Error bars show 95% confidence intervals.

As can be seen in Fig. 3, there is a different pattern of results for each type of information; it appears that the post-drive group's memory for everything, except whether they stopped, is worse than the other three groups'. In order to assess the degree of these differences, we performed a 4 × 4 repeated measures ANOVA (4 delay groups × 4 information types). That result showed a significant main effect of delay (F (3,32) = 2.579, p < .001, $\eta_p^2 = 0.463$). The main effect of information type approached significance, with a small effect size (F (3,96) = 2.497, p = .064, $\eta_p^2 = 0.072$). A significant interaction between information type and delay group was found (F (9,96) = 2.579, p = .011, $\eta_p^2 = 0.195$), meaning that the effect of delay depends on the question type.

Exploring this interaction, we failed to find any reliable differences in recall accuracy for "stop" questions; all four groups showed a similar percent correctly recalled, ranging from 82.40% to 88.89% accuracy. For "vehicle ahead" questions, drivers in the immediate (M = 91.66%) and 20 s delay groups (M = 94.45%) showed similarly high recall accuracy, whereas the 45 s delay (M = 77.78%) and post-drive (M = 59.26%) delay groups showed much lower accuracy. For "pedestrian" questions, the immediate, 20 s delay and 45 s delay groups showed relatively high recall accuracy, ranging from 75.00% to 80.56%, with the post-drive group showed the lowest recall accuracy (M = 61.11%). Similarly, for the "cyclist" questions, drivers in the immediate (M = 94.45%), 20 s delay (M = 77.78%) and 45 s delay groups (M = 80.56%) showed high accuracy and the post-drive group showed lower accuracy (M = 48.19%).

Of course, accuracy is only part of the story; we also examined the different types of recall errors; the rates of misses, false alarms and "can't recall"

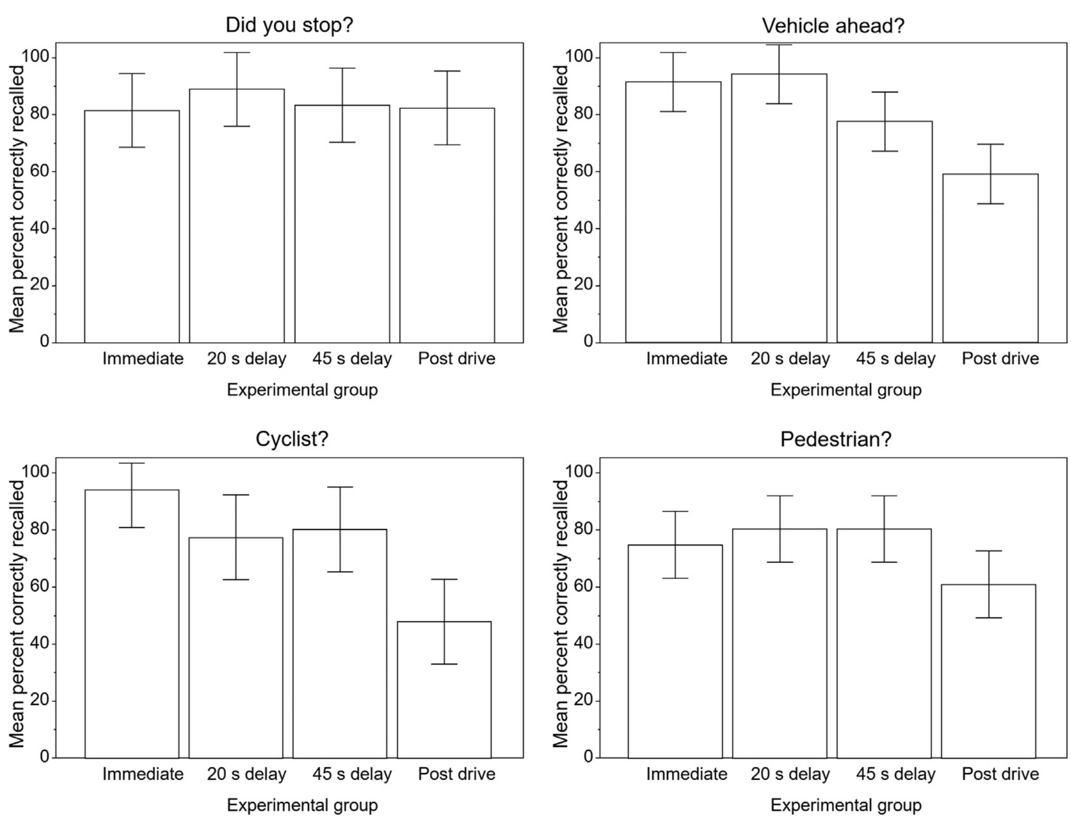

Fig. 3. Percent correctly recalled for stop, vehicle ahead, cyclist and pedestrian question types, for immediate, 20 s delay, 45 s delay and post-drive recall groups. Error bars show 95% confidence intervals.

responses for each question type. Multiple one-way MANOVAs were calculated to identify the nature of the interaction between information type and recall delay. These analyses enable us to see the percentage of correct answers (hits & correct rejections), misses, false alarms, and "can't recall" responses that were given for each of the four information types.

Fig. 4 shows the percentage of each response type for each of the four groups, the answers for "Stop" questions are at top left. A one-way MANOVA (including misses, false alarms and "can't recall" responses) failed to reveal any significant differences between the four groups (F (9, 73.163) = 0.406, p = .928, Wilks' ∧ = 0.888, η_p^2 = 0.039).

At the top right of Fig. 4 shows the percentage of each type of response for "vehicle ahead" questions, for each of the four groups. In contrast to the recall of vehicle stops described above, the one-way MANOVA (including misses, false alarms and "can't recall" responses) indicated that there was a significant difference between delay groups for "vehicle ahead" questions (F (9, 73.163) = 3.575, p = .001, Wilks' ∧ = 0.412, η_p^2 = 0.256). Post-hoc multiple comparisons (Bonferroni adjusted) indicated that there were significantly more "can't recall" answers for drivers in the 45 s delay and post-drive groups compared to the immediate and 20 s delay groups (which had zero "can't recall" responses) (ps = .016). No other comparisons were significant.

The lower left panel of Fig. 4 shows the percentage of each response type for "cyclist" questions, for each of the four groups. Similar to the recall of vehicles immediately ahead (described above), a one-way MANOVA (including false alarms and "can't recall" responses) indicated a significant difference between delay groups (F (6, 62) = 3.236, p = .008, Wilks' ∧ = 0.580, η_p^2 = 0.238). Post-hoc multiple comparisons (Bonferroni adjusted) indicated that there were significantly more "can't recall" answers for drivers in the post-drive group compared to the immediate group (which had zero can't recall responses) (p = .006). Differences in percentage "can't recall" answers between the post-drive and both the 45 s delay and 20 s delay groups approached significance (ps = 0.052).

Finally, the lower right of Fig. 4 shows the percentage of each answer type for pedestrian questions, for each of the four groups. In contrast to sightings of vehicles ahead and cyclists, a one-way MANOVA (including misses, false alarms and "can't recall" responses) failed to indicate any significant differences between the four delay groups (F (6, 62) = 1.380, p = .237, Wilks' ∧ = 0.778, η_p^2 = 0.118). There were, however, more misses for this type of information compared to the other three information types. When drivers were questioned after the drive, an average of 25% of their responses to pedestrian questions resulted in a miss (SD = 23.26%), with drivers in the immediate (M = 14.78%, SD = 14.24%), 20 s delay (M = 11.11%, SD = 13.18%) and 45 s delay group (M = 16.67%, SD = 12.50%) also showing a high percentage of misses.

These relatively high percentages of misses are in contrast to zero misses for "stop" questions for drivers in the immediate, 20 s delay and 45 s delay groups, and a relatively low percentage of misses in the post-drive group (M = 2.28%, SD = 8.33%). The percentage of misses for "vehicle ahead" questions were slightly higher compared to "stop" questions, with drivers in the immediate (M = 8.33%, SD = 12.50%), 20 s delay (M = 5.56%, SD = 11.02%), 45 s delay (M = 2.78%, SD = 8.33%) and post-drive groups (M = 12.89%, SD = 15.54%) showing moderate percentages of miss responses for "vehicle ahead" questions.

4. Discussion

Consistent with prior research, our results showed that memory for everyday driving is relatively poor. When questioned after the drive, drivers' overall recall accuracy was near chance level, at 50.58% correctly recalled. When questioned at shorter delays, recall accuracy was better, ranging from 68.40% to 69.94%, but this still shows that drivers could not remember one-third of the information that we asked them about. This poor memory was reflected in conversations with participants after the experiment was complete. Participants from all four groups commented that they felt their memory was very poor, and many drivers commented that they had been "driving on autopilot".

One purpose of this study was to find out how quickly information from an everyday drive is forgotten. We predicted that memory would be better

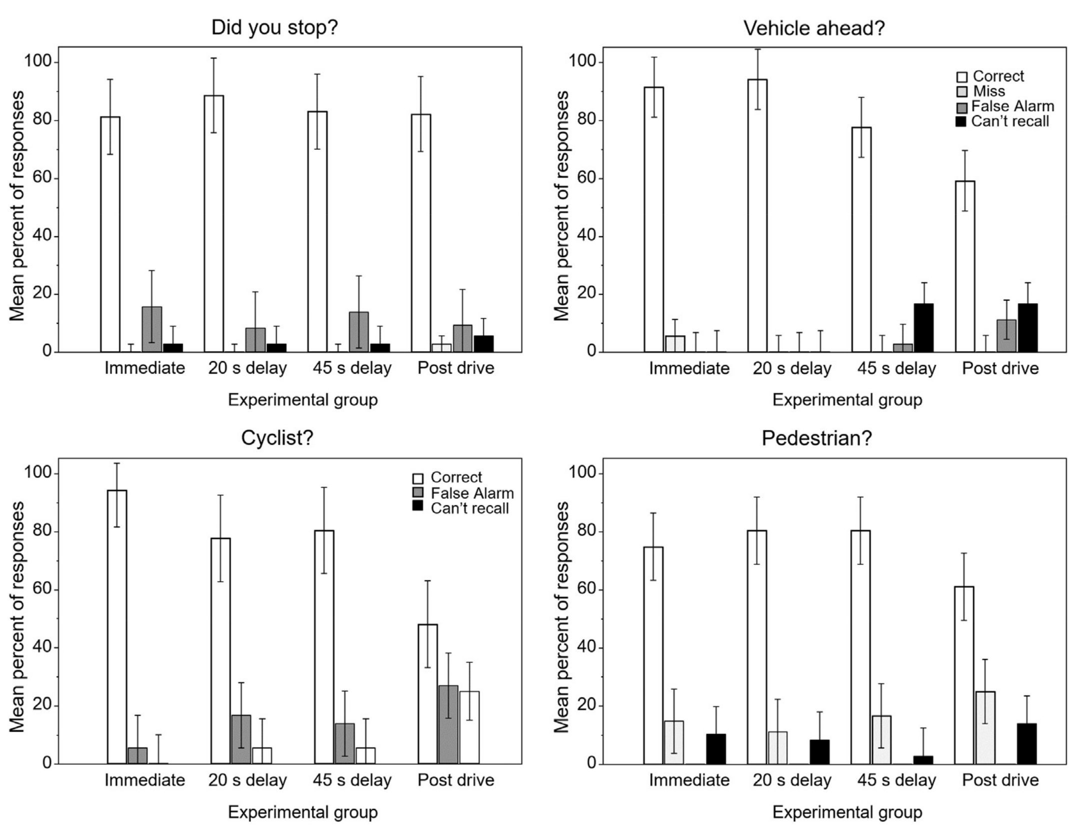

Fig. 4. Percent of correct, miss, false alarm and can't recall responses for each question type. Error bars show 95% confidence intervals.

when tested at shorter delays and our results showed partial support for our prediction. Drivers' overall accuracy was fairly consistent across delays of up to 45 s, but was significantly poorer when tested after the drive was complete. Although we predicted that recall accuracy would decrease with each increasing delay, we instead found that recall accuracy decreased after 45 s. These results are somewhat at odds with the prior studies that suggest unimportant information is often quickly forgotten (Luoma, 1993; Sachs, 1967), but future research could test driver memory at longer delays, to try and to better map the time course of forgetting of information from an everyday drive.

A second purpose of this study was to find out whether some types of information are forgotten more quickly than others, and as expected, the results showed a significant interaction between information type and recall delay. Accurate recall for stopping at a location was consistent across all four delays, whereas delay did have an effect on drivers' ability to correctly recall sightings of vehicles immediately ahead, cyclists, and pedestrians. This finding replicated the results of prior studies which have also found drivers have good memory for whether they stopped at intersections or not (Charlton and Starkey, 2018; Groeger, 2000). Interestingly, this pattern was also reflected in post-drive conversations with participants, who often mentioned that unimportant information from the drive was quickly forgotten if it was no longer needed for moment-to-moment vehicle control.

The durability of memory for stopping at an intersection was further illustrated in our analysis of recall errors. There was no significant difference in misses, false alarms and “can't recall” responses across the four delay groups. “Can't recall” responses could be seen as reflecting a driver's confidence in the accuracy of their memory. By responding with “can't recall”, they were acknowledging that their memory was below their threshold of confidence that they could give an accurate response, to the point where they did not even offer a guess. In contrast to memory for stopping, it was found that drivers who were questioned at longer delays gave more “can't recall” responses to questions asking about vehicles ahead and cyclists, compared to drivers who were questioned at shorter delays. In fact, drivers who were questioned immediately never responded “can't recall” to questions about vehicles ahead or cyclists. This result suggests that after a delay, drivers' confidence in their ability to correctly recall unimportant information (such as sightings of other road users) is significantly decreased.

Analysing the recall errors for questions asking about pedestrians yielded different results. “Can't recall” responses and misses were relatively high for “pedestrian” questions compared to the other question types, and was consistently high across all four delay groups. These results may reflect the peripheral location of pedestrians in the driver's vision, and the lack of necessity for drivers to pay attention to pedestrians. One of the locations in the drive was a straight section of road going through a small shopping district including several pedestrians on the footpaths. Participants drove through this location without stopping and their relatively high rate of “can't recall” answers suggested that drivers had little confidence in their ability to correctly recall whether pedestrians were present or not, as they had not paid attention to them.

A surprising finding was that drivers who were questioned immediately after driving through a location only correctly recalled whether they stopped an average of 80% of the time. It was expected that because of the salience of the drivers' own behaviour, that memory for stopping at a location might be close to 100% correct when drivers were questioned immediately. These drivers, however, gave false alarm responses approximately 16% of the time. This finding aligns with one study, which also found that memories of stopping had a high number of false alarms (Charlton and Starkey, 2018). False alarms also predominated recall errors for “cyclist” questions. For drivers who were questioned after the drive, a relatively high 26.86% of responses were false alarms. The high percentage of false alarms is surprising, since a cyclist was never present at any of the four locations. The high amount of false recollections of cyclists was likely due to the presence of cyclists at other points in the drive.

It must be noted that one limitation of this study was the small sample size of participants and limited number of test locations in the drive. The substantial effect sizes obtained with 36 participants suggested there were some important differences between the different recall delays, particularly the poorer post-drive recall accuracy. Advances in technology, allowing the use of multiple screens in the simulator, or replication with some form of on-road testing will allow future research to examine memory for objects further to the side of the driver and in the mirrors. The administration of the recall questions could also be improved to limit interference with driving and allow more precise measurement of recall delay. For example, the methodology we used may have had an inadvertent alerting effect and contributed to the superior performance of the mid-drive delays over the end of drive recall condition.

This study has shown how memory for everyday driving is poor and suggested that it may be due to both driver inattention and forgetting of unimportant information. Overall recall accuracy suggested that the information that drivers do acquire persists in memory for up to 45 s, but forgetting occurs sometime afterwards. Analysis of recall accuracy for different types of information suggested that drivers form durable memories of information of subjective importance, such as their own behaviour, but quickly forget information of little subjective importance, such as sightings of vehicles ahead, cyclists and pedestrians. The importance of understanding the cognitive processes involved in everyday driving was highlighted in another study which found that the “driving without awareness” that occurs during everyday drives on familiar roads may pose an increased risk for injury-involving crashes (Burdett et al., 2017). The inaccuracy of post-drive recall has implications for future research that relies on post-drive questioning as a method for measuring driver information acquisition. Further, knowing how and when to present important information to drivers has been shown to be crucial for increasing situation awareness and safety relevant driver behaviour (Starkey et al., 2020). Understanding the time course and contextually-bound characteristics of drivers' memory is of both theoretical interest as well as of value to road safety practitioners.

Author contributions

The research described in this manuscript was undertaken by the first author (DSR) in partial fulfilment of a Bachelor of Social Sciences with Honours degree in Psychology and was supervised by the second author (SGC). The manuscript was jointly prepared by the two authors.

Data availability

The data analysed during this study are not publicly available due lacking participant consent for open data-sharing, but are available from the corresponding author on reasonable request.

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Ethical approval

All participant recruitment and test procedures were approved by the School of Psychology Human Research Ethics Committee at the University of Waikato and were in accordance with the 1964 Declaration of Helsinki. Informed consent Informed consent was obtained from all of the participants in the study.

Declaration of competing interest

The authors declare that they have no competing interests.

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