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Temporal Expectancy in Driving : An Automated Future

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ABSTRACT

The difference in temporal expectancy between participants who are experienced in driving automated vehicles, and participants who are experienced in using only manually driven vehicles, is measured. The period in seconds between the change in stimulus, or in this case, the signal changing from green to red, and the onset of the action, in this case, the muscle tension generated in the ankles before pressing the brake, measures temporal expectancy. This exercise is carried out for each participant through a driving simulator of either manually driven features or auto-pilot features, based on the type of driving experience of the participant. The mean temporal expectancy of each participant is calculated through the cumulation of a definite number of trials. Thus, the means are used to derive the average temporal expectancy of each of the two groups based on auto-pilot or manual drivers. The group tabulated to have lesser seconds as a measure of temporal expectancy, is inferred to have better temporal expectancy.

Keywords : Temporal Expectancy, Manually Driven Vehicles, Auto-Pilot Vehicles

I. INTRODUCTION

In Australia, road trauma costs are increasing over those of the defense budget, comprising 70 million Australian Dollars. On the other hand, extensive research conducted by the Department for Transport and the Centre for Connected Autonomous Vehicles in the United Kingdom, claims that a burgeoning percentage of automated vehicles is directly proportional to roadway efficiency, reducing delays by 40% and periods of a journey by 11%.

Herein, the solution to tackling a fast- pace world requiring transport of a similar nature, is evident. Automated vehicles are being increasingly availed of, primarily due to their efficiency and cost-effective service. Shortly, one can expect to encounter an increasing amount of mixed traffic, consisting of both automated and manually driven vehicles. Consequently, nations are increasingly investing in this form of transport, enhanced by the latest technological developments. The general expectation is for reduced road risks, lives lost, and efficient conduction of transport and commutation.

However, one factor remains unchanged, at least for the near future: the drivers of each type of vehicle remain the same. In a typical situation, an average person would be behind the wheel, with the same physiological, psychological, and social characteristics. This would be unchanging, irrespective of the number of automated vehicles on the street. Moreover, rather than solely automated vehicles, an increasing amount of mixed traffic, consisting of both manually driven and automated vehicles, will gradually become a common scenario in a wider range of populations.

Hence, our innate characteristics may arise as an unforeseen loophole in this ingeniously devised system of a safe future- we, as drivers, remain who we are. As humans, we have definite internal characteristics, which may impact the situation on a typical roadway with mixed traffic, just as it does now with that of mostly manually driven vehicles.

One aspect of human perception and reaction is temporal expectancy, which is the expectation of an individual for an action or occurrence, based on the perceived time period of a stimulus. This may impact the precision with which a driver presses the brake by seeing a red traffic signal, or when a pedestrian starts to cross the road when the pedestrian- sign turns green. Hence, this aspect governs most of our actions on a roadway- be it pedestrian or driver.

As such, this study explores the impact of an automated or AI- adaptive vehicle on the temporal expectancy of the driver, through methods further investigating the role of possible training on behaviour requiring temporal expectancy. Herein, this study is a novel attempt to determine the impact of the usage of an automated vehicle on the temporal expectancy of the driver, using a driving- simulator.

II. Review of Literature

Temporal expectancy refers to the expectation of an event of occurrence, based on its timing. This allows an individual to react with better motor readiness in situations where the action will be determined by a particular stimulus, or a definite set of stimuli only. Hence, the expected timing of occurrence for the stimulus, followed by the action, is determined by temporal expectancy.

Schmalbrock and Frings (2022) measured temporal expectancy as the ability to predict an impending event by using information acquired from the passage of time. If the time before an occurrence varies, responses to that event become faster as the waiting period increases. In response-speed investigations, this variable-foreperiod effect was reported frequently. Various action control frameworks presume that the response and stimulus features are merged into an event file that is later retrieved if features recur. However, the importance of foreperiods in action control is yet to be addressed. As a result, researchers looked into the impact of

the foreperiod on the combining of action-perception elements. Participants went through a conventional distractor-response binding paradigm, in which they produced two consecutive responses to target symbols while distractor symbols were shown. They concluded that distractor-response binding heightened with foreperiod duration, which they infer is facilitated by an increase in motor readiness driven by temporal expectancy.

Another study conducted by (Anderson & Sheinberg, 2008) employed a cued visual categorization task to examine how shifts in temporal context alter neural responses in

the inferior temporal cortex, an extrastriate visual region considered to be involved in object processing. In every trial, the first picture cued a temporal interval before a second target image was displayed. The animal's task was to categorize the second image by hitting one of two previously assigned buttons. All of the pictures served as both cues or signals and targets. The first or second picture in a trial controlled whether an image cued a delay time or indicated a button press. They could compare neural activity in the inferior temporal cortex, to the same picture segmented by temporal context and expectation, by using this paradigm. For target presentations, neuronal spiking was stronger, and visually induced local field potentials (LFPs) were bigger than cue presentations. When targets came unexpectedly early on invalidly cued trials, the amount of the evoked LFP was lowered and delayed, and neuronal spiking was inhibited. For predicted targets, spike field coherence increased in the beta-gamma frequency range. Finally, depending on temporal attention manipulations, multiple neural responses in the higher-order ventral visual cortex may arise for the same visual picture.

Some scholarly articles further illustrating temporal expectancy, the dependent variable of this study, are attached below:

- Anderson, B., & Sheinberg, D. L. (2008). Effects of Temporal Expectancy and Temporal Context on Neural Activity in Inferior Temporal Context. Neuropsychologia, 46(4), 947-957. https://doi.org/10.1016/j.neuropsychologia.2007.11.025
- Schmalbrock, P., & Frings, C. (2022). Temporal expectancy modulates stimulus– response integration. Attention, Perception and Psychophysics, 84(1), 221-230. doi:https://doi.org/10.3758/s13414-021-02361-7
- Amer, T. S., & Johnson, T. L. (2016). Information technology progress indicators: Temporal expectancy, user preference, and the perception of process duration. International Journal of Technology and Human Interaction, 12(4), 1. https://doi.org/10.4018/IJTHI.2016100101

The independent variable for this study will be whether a participant uses an AI- adaptive or automated vehicle, which will be introduced through a driving simulator. The probable (extraneous) variable of training will be manipulated. Herein, a participant irrespective of whether they use either type of driving simulator might have an improved precision of action, due to sharpened temporal expectancy driven by unintentional training through numerous trials. A driving simulator would be used to introduce the two types of “vehicles,” with features pertaining to each type. The temporal expectancy of each participant would be measured through the seconds it took for them to press the brake after seeing a visually presented traffic signal turn red.

This will be tested using a quasi-experimental, in-between participants design in which participants who drive automated vehicles, are tested against a group of participants who use manually driven vehicles. The temporal expectancy of each participant will be measured in seconds. This may be defined as the time period between the onset of the change of stimulus- the change of traffic signals from green to red, and the tensing of ankle muscles of the participants to push the brake.

Hence, the present study hypothesizes that drivers who do not use automated driving methods, display better temporal expectancy than those who do while responding to roadway stimuli. This informed assumption has been made due to the common presence of alerting effects while using a manually driven vehicle, as each mechanism has to be adjudged by the driver instead of an auto-adaptive system. As such, drivers using manually driven vehicles experience temporal expectancy as well as focused attention (Dalmaijer & Nijenhuis, 2016).

III.Method

Participants

Participants will be recruited using the following steps:

A convenience sampling method is used, wherein a flyer or a social media post will be sent to the available contacts.

The flyer will be advertising recruitment for a research study, for individuals who have experience with driving an auto-pilot adaptor and those who are experienced in manually driven vehicles but not in using auto-pilot adaptors.

Each participant will be required to have a total driving experience of at least 10 years.

Participants would be reimbursed with an incremental payment, that is, a transaction made as an appreciation for their dedication of time, irrespective of whether they complete the study. However, it may also be disclosed that a slightly higher amount would be provided to those who complete the study. A group of 30 participants would be allocated to each type of driving simulator, based on their driving experience. Hence, a total of 60 participants would be involved in the study. Essentially a quasi-experimental design, the study will use a between- participants method to measure the variable. I expect the sample to comprise participants who are mostly older than approximately 35 years of age, as relatively few young people have sustained access to automated vehicles.

IV. Materials

I will divide the two groups A and B based on driving experience for automated and manually driven vehicles, respectively. Accordingly, each participant will be allocated to either type of driving simulator. Each participant will be subject to numerous trials for the simulator. A trial comprises a roadway featuring numerous intersections and randomly allocated traffic signals (meaning that there may be trials without any traffic signals). This feature curtails the impact of training as an extraneous variable. This manipulation further enables one to investigate the probable role of training in temporal expectancy.
Furthermore, a capped speed- limit to prevent the interplay of additional variables such as speed.

Hence, the independent variable is whether participants use an auto-pilot adaptor or a manually driven vehicle; the dependent variable is the temporal expectancy displayed by the participants.

Measures

Each participant is subject to numerous trials with the outlined features. The temporal expectancy, which is the expectation of a change in the stimulus based on timing, is measured in each trial for every participant.

This is measured by the difference in time from the onset of the signal changing from green to red, and the time taken to press the brakes, measured through electrodes recording muscle tension in the ankles. The measurement is conducted for each red-light instance.

Better temporal expectancy is defined by a relatively lesser number of seconds of the time period between the onset of the change in stimulus, and the generation of muscle tension to apply the brake. The mean temporal expectancy (in seconds) is calculated for each participant, which is averaged for each of the two groups. Comparing the means and observing which group has "fewer" seconds allows to us infer that the said group has better temporal expectancy. As such, this hypothesis is tested.

The following table represents an example of the tabulation of the data garnered from these trials, for this between-subjects design:

SUBJECT ID	TEMPORAL EXPECTANCY/ seconds between the onset of the change in stimulus and muscle tension	TRIAL	RED LIGHT
1.	1.3	1	1

	1.2	1	2
	1.4	2	3

The above table may be used for each participant of each of the two groups. Since the occurrence of red lights at visually projected intersections is randomized, the red lights are coded for tabulation. As such, there may be multiple intersections in a trial or no intersections at all.

Using such a table, the mean temporal expectancy is calculated for each participant.

Subsequently, the scores of each participant are averaged to represent the mean temporal expectancy of each group. The group with lesser seconds is said to have better temporal expectancy. The general trend of the data indicated whether training plays a role in bettering temporal expectancy. For example, if it is observed that the time period for each participant generally decreases with successive trials, the impact of training is manifested as improved precision in action, due to better temporal expectancy.

Design

The research- design used is quasi-experimental, as there is no random assortment of participants in an experimental and control group; moreover, there is no control group.

Participants are allocated to groups based on their type of driving experience. The between- subjects design is employed, wherein the variable is measured based on scores of different groups comprising different sets of participants.

Procedure

A pilot test is conducted before the actual procedure.

Participants are welcomed into the research chamber. Each participant is welcomed similarly, and their consent is sought, without revealing the aim of the research. This takes approximately five minutes.

Basic refreshments such as water and a light snack are provided, which the participant may consume, which takes approximately two to five minutes.

This is followed by furnishing them with an instruction sheet, with detailed instructions from the researchers instead of directly communicating the same. These measures standardize the procedure and prevent experimenter expectancy effects or context effects, if any. Carrying out this process would take approximately five minutes for each participant, as he or she is directed to the respective driving simulator.
The participant engages in calibrating the driving-simulator for approximately 10 minutes, followed by practicing basic maneuvering for five minutes.

The participant engages in 15 trials, each trial lasting for a minute. This would take approximately 15 minutes.

Finally, the participant is brought back to the chamber for a debriefing, followed by the sharing of any thoughts or queries which the participant may have. Approximately 10 minutes is required for this step.
Hence, the process lasts for approximately 45 minutes, to an hour.

V. REFERENCES

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