

An experimental paradigm proposal for perception-action coupling during driving on a winding road while sitting or standing: Preliminary results on gaze, head and center of pressure displacements

**Sérgio Tosi Rodrigues¹, Vinícius de Paula Rodrigues¹,
Gustavo de Andrade Silva^{2,3}, Paula Fávaro Polastri¹,
Fábio Augusto Barbieri⁴, Cédric T. Bonnet⁵,
José Angelo Barela³**

¹São Paulo State University (UNESP), Department of Physical Education, Faculty of Sciences, Laboratory of Information, Vision and Action (LIVIA), Bauru, São Paulo, Brazil.

²Federal University of Southern Bahia, Center for Training in Public Policies and Social Technologies, Ihéus, Bahia, Brazil.

³São Paulo State University (UNESP), Department of Physical Education, Laboratory of Movement Studies, Institute of Biosciences, Rio Claro, São Paulo, Brazil.

⁴São Paulo State University (UNESP), Department of Physical Education, Faculty of Sciences, Human Movement Research Laboratory (MOVI-LAB), Bauru, São Paulo, Brazil.

⁵Univ. Lille, CNRS, UMR 9193 – SCALab – Sciences Cognitives et Sciences Affectives, F-59000 Lille, France

DOI 10.52050/9788579177101-3

Abstract

Heading perception is a fundamental component of spatial navigation through the environment, necessary to succeed in driving. It is achieved through the coordination of gaze, head, and whole-body posture. This chapter offers a novel approach to characterize this complex coordination process in response to standardized visual input and motor task requirements, while driving a car through a simulated winding road, allowing a protocol to test perception-action coupling among gaze, head, and posture elements in distinct populations and conditions. As a first step of investigation towards such approach, exploratory analyses on gaze, head and posture sway were conducted. Eighteen young adults, all licensed drivers, divided into expert and novice groups had their center of pressure, head, and gaze displacements in the anterior-posterior and medio-lateral axes recorded while driving for two minutes on a highway with a sinusoidal path, at a constant speed of 100 km/h, avoiding committing traffic violations, in body positions of standing and sitting. The dependent variables of standard deviation of car lateral position, mean amplitude, coherence, and gain of center of pressure, head, and gaze displacements in both axes were preliminarily discussed in terms of perception-action coupling.

Introduction

The perception of locomotion direction (i.e., self-motion) through the environment is a fundamental component of spatial navigation, so-called heading perception (Ali, Decker, & Layton, 2023; Bradley *et al.*, 1996; Warren & Hannon, 1988), necessary to succeed in tasks such as driving, cycling, and walking. Heading

perception is achieved through the coordination of gaze, head, and whole-body posture (Gibson, 1979) and is affected by a variety of interrelated factors, such as the role of gaze behavior in the perception of optical flow (Jörges, Bansal, & Harris, 2024; Sun *et al.*, 2024; Warren & Hannon, 1990) and the effects of sitting or standing on postural and cognitive performance (Cherigui *et al.*, 2025; Hua *et al.*, 2025). This chapter offers a novel approach to characterize this complex coordination process in response to standardized visual input and motor task requirements, while driving a car through a simulated winding road, allowing a protocol to test perception-action coupling among gaze, head, and posture elements in distinct populations and conditions. As a first step of investigation towards such approach, exploratory analyses on gaze, head and posture sway were conducted. In the present book chapter, we briefly present foundations of this experimental paradigm and its method, followed by preliminary results.

Vision and heading perception while driving a car in curves

When navigating a winding road, the control processes that facilitate vehicle conduction are often overlooked; the driver's contribution appears so effortless and automated that the task rarely penetrates conscious awareness. However, its significance becomes immediately apparent when drivers close their eyes, even for a moment, as a collision can occur rapidly.

The appropriate control of vehicle heading requires highly precise information regarding the future course of the road, obtained more or less continuously on a short time scale. While a general impression of the scene is insufficient, a complete three-dimensional reconstruction of the environment ahead is rarely necessary (Land, 1998). A variety of relevant questions arise from such a context: What information does vision

extract from the road ahead? From which part of the road or surrounding scenery does this information originate? How is this information transformed into muscular commands to control vehicle steering? What are the latencies in this transformation?

Land (1998), based upon the models of Donges (1978) and Godthelp (1986), suggested that driving involves a double control system, as illustrated in Figure 1. This double control comprises a feedback system for error correction and an anticipatory (feedforward) control based on the view of the road further ahead, spanning a time and distance greater than the half-second interval involved in feedback. The anticipatory signal refers to the future curvature of the road, which is directly transformed into the steering wheel angle, as it can be converted into the curvature of the vehicle's trajectory. However, since the anticipatory signal pertains to road curvature well ahead of the vehicle, it is necessary to delay the steering response by an appropriate interval. In Donges' model, this delay was approximately 1 second. Similarly, MacAdam's 1988 model (cited by Land, 1998) presented more varied delays between 0.8 and 3.0 s, while Land (1998) reported delays between 0.8 and 0.9 s.

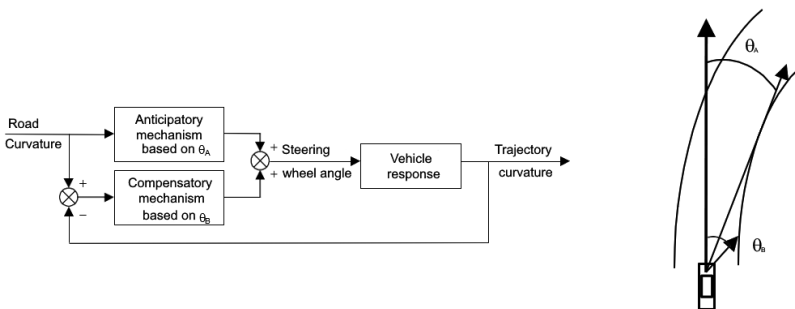


Figure 1. Control diagram of the driving mechanism proposed by Land (1998). Road curvature is determined by the difference between a road feature and the current trajectory direction at a convenient look-ahead distance (θ_A), serving as a *feedforward* signal. Deviations from the appropriate lane position are measured by the near-angle between the lane edge and the vehicle (θ_B), which serves as a *feedback* signal to correct residual errors from the *feedforward* subsystem.

In short, while driving in a winding road, continuously steering to the right and to the left, both mechanisms of feedback-based compensations and anticipations of road information ahead account for controlling the desired trajectory of the vehicle. This requires collective contributions of gaze, head, and posture to the heading perception simultaneously to proper arm movements to control the driving wheel, the topic under investigation in the present research proposal.

Perception-action coupling in postural control applied to driving context

Within this general framework of driving and in addition to the questions above, what are the role of eye movements, head and postural sway in this process? A possibility of integrating all these elements arises from an approach resulting from manipulating visual information to study postural control. Lee and colleagues (Lee & Aronson, 1974; Lee & Lishman, 1975; Lishman & Lee, 1973) experimentally manipulated visual information by moving a suspended “room”. This apparatus, known as the “moving room” consisted of side walls, a ceiling, and a front wall, and can be moved anteriorly and posteriorly (Barela, 2000). In their study, Lee and Aronson (1974) showed that when this moving room was in motion, adults and children stood within this room produced corresponding body sway. Even more strikingly, for abrupt displacements of the moving room, the maintenance of upright stance was compromised, occasionally resulting in falls (Lee & Aronson, 1974). This manipulation of visual information to produce alterations in the maintenance of postural orientation was adopted and refined to analyze posture more systematically within a dynamical systems approach (Warren, 2006), particularly when participants are not aware

of the visual manipulation, characteristic of a sub-threshold stimulation (Schoner, 1991).

In a similar vein, the present proposal uses an oscillatory visual stimulus generated by the sinusoidal trajectory of the vehicle in the winding road created by the driving simulator environment in order to analyze the relationship between this visual input and movements of the eyes, head and the center of pressure, when participants are conscious of visual stimuli. The descriptions of this perception-action coupling are made in terms of measures of coherence, the strength of the relationship between visual pattern and motor component involved, and gain, ratio between amplitudes of visual stimulus and motor response.

Influences of sitting or standing on body sway, cognition, and attention

Although conventional automotive transport is predominantly associated with a seated posture, some classes of vehicles allow a standing position (e.g., electrical scooters, offshore fishing boats). This standing configuration often serves to enhance the operator's field of vision, maneuverability, balance control among other aspects.

The debate on sitting or standing positions while driving a vehicle or other behaviors is also associated with more general health issues. For instance, office work usually involves long hours in the seated position, exposing workers to sedentary behavior, which may lead to various health hazards, such as increased mortality risk and cardiometabolic disorders (Lavie *et al.*, 2019; Van Uffelen *et al.*, 2010). Several interventions can be employed to mitigate sedentary behavior; one strategy that yields favorable outcomes is the implementation and utilization of sit-stand desks (Bonnet & Cheval, 2023; Commissaris *et al.*, 2016). Occupational

productivity is central to this debate on performance when sitting vs. standing. On one hand, relevant literature has shown that the level of performance in a variety of desk-based tasks was equivalent when sitting vs. standing (Karakolis & Callaghan, 2014). In these studies, the research method usually involved the use of binary variable such as failure/success (Karakolis & Callaghan, 2014). On the other hand, when task performance was measured with subtle, continuous variables, such as the reaction time, literature has indicated that the level of task performance was better when standing than when sitting (Cherigui *et al.*, 2025; Rosenbaum *et al.*, 2017; Smith *et al.*, 2019). Shorter reaction times when standing has been found in Attention Network Task (ANT) (Abou Khalil *et al.*, 2023; Barra *et al.*, 2015) and the Stroop test (Rosenbaum *et al.*, 2017; Smith *et al.*, 2019). We still need to mentioned that equivalent reaction times between standing and sitting were found in other studies (Bantoft *et al.*, 2016; Caron *et al.*, 2020, 2022). Cherigui *et al.* (2025) focused on determining the effect of alternating the body position between standing and sitting on task performance and visual attention in the ANT as compared to a sitting-only condition. Their results showed that the proportion of blinks was lower in the alternating condition than in the sitting-only condition and revealed shorter reaction times when standing than when sitting. Authors interpreted these findings as indicative that humans may be more effective and have greater visual attention in an alternating condition than in a sitting-only condition.

Manipulating postural requirements in combination with perceptual-motor tasks may further reveal complexities of heading perception and control. Higher complexity of postural sway while standing is predictive of perception of action possibilities (Masoner *et al.*, 2020). Thus, the implementation of more complex environments for the study of postural control

appears advantageous, as it allows for a deeper understanding of the postural stabilization process. In this regard, perceptual-motor tasks, such as driving, may assist in further elucidating this process and its effects.

A novel experimental paradigm for perception-action coupling in driving

The current research proposal brings novelty to both the debate on the comparison between sitting and standing postures and the complexity of driving behavior, emphasizing the perception-action coupling among gaze, head, and balance components. Our new paradigm applies a very simplified version of a simulated driving task, involving solely the driving wheel adjustments under constant velocity, while having visual input from a sinusoidal road trajectory, with no need of regulating clutch, brake, and gas pedals, but preserving fundamental perception and action characteristics of natural context. The aim of our study was twofold: (i) to introduce this experimental paradigm proposal for perception-action coupling during driving on a winding road while sitting or standing; (ii) to present preliminary results on gaze, head and center of pressure displacements, as well as results on driving performance. Although driver's experience and body position are relevant and well-established factors to affect, respectively, driving behavior and postural control, these variables were exploratorily manipulated within this set of preliminary results, with no hypotheses defined in terms of effects on amplitude, coherence, and gain of the relationship between center of pressure, head, and gaze displacements with visual input.

Methods

Participants

Eighteen young adult volunteers, all licensed drivers, participated in this study. All participants had normal or corrected-to-normal vision (glasses or contact lenses), without any sensorimotor or neurological deficits. Approval from the local ethics committee was obtained (CAAE: 67952423.0.0000.5398), and participants signed an Informed Consent Form before beginning their participation in the study. Participants were divided into two experimental groups (Expert, Novice), with mean age of 29.2 (SD = 2.7) years and 25.0 (SD = 5.0), respectively. The classification of drivers was adapted from the study by Lehtonen *et al.* (2014). A participant who reported driving up to 15,000 kilometers was considered a novice driver, and a participant who reported driving more than 15,000 kilometers was considered an expert driver. The mean distances driven by expert and novice groups were, respectively, 79,416 (SE = 33,456) and 4,653 (SE = 4,233) kilometers.

Equipment and software

An eye tracker (SMI Glasses, 120 Hz) was used to record the gaze location and a head tracker (Ascension, model Flock of Birds, 60 Hz) was used to record tri-dimensional head position and orientation of the participants during the driving task, which was performed in the STISIM Drive M100 simulator (version 3.14.01) equipped with a Logitech G29 steering wheel. A height-adjustable table (Office DT900 Table) was used, where the TV monitor (46" LED) was positioned in front of the participant, along with the force platform (AMTI, 60Hz), positioned under

participant's feet in order to record the center of pressure (COP) during the simulation in the sitting position (on a seat on the platform) and standing position (directly on the platform), as shown in Figure 2.



Figure 2. Representative pictures of the experimental setup with a participant in the positions of standing (left) and sitting (right)

Experimental Design and Tasks

After a period of familiarization with equipment and task, experimenting with basic control mechanisms while driving for three minutes, participants of expert and novice groups were required to drive for two minutes on a highway with a sinusoidal path, at a constant speed (100 km/h), avoiding committing traffic violations (e.g., not using turn signals when overtaking, colliding with other vehicles), in two conditions of body position (standing and sitting), totaling two trials per participant. The order of the experimental conditions was counterbalanced to avoid order effects.

Procedures

Data collection was carried out at the Information, Vision and Action Laboratory (LIVIA), located in the Department of Physical Education at UNESP – Bauru. Upon arrival, participants were greeted by the experimenter and instructed to carefully read and sign the Informed Consent Form. Visual acuity was assessed by the Snellen test, followed by the experimental tasks as previously described.

Data Analysis

Raw data regarding the participants' center of pressure (COP), head, and gaze displacements in the anterior-posterior (AP) and medio-lateral (ML) axes were obtained and processed through a script in a Matlab environment (The Mathworks Inc., 2010 – version 7.10.0.499) specifically written to calculate the following dependent variables: standard deviation (SD) Car lateral position (cm), mean amplitude, coherence, and gain of COP, head, and gaze displacements (all in AP and ML axes). Coherence indicates the dependency (“strength”) between body oscillation and visual stimuli; coherence values vary between 0 and 1, indicating none or full dependency. Gain the ratio between the amplitude of visual stimuli and body oscillation amplitude; gain values close to 1 indicates a stronger coupling between visual stimuli and postural oscillation. Raw data regarding the participants' lateral vehicle position were obtained through the driving simulator, that provided the calculated value of variability (standard deviation) of the vehicle's lateral position throughout the entire trial.

Statistical analysis

Data of each dependent variable were subjected to analysis of variance (ANOVA) of Group (Expert, Novices) by Position (Standing, Sitting), repeated measures for the last factor. SPSS software (IBM SPSS Statistics, version 25) was used for the necessary statistical analyses. The significance level adopted was 0.05 for all analyses. Pairwise comparisons (post-hoc) were performed using Tukey's LSD test. Bonferroni probability adjustments and Greenhouse-Geisser degrees of freedom adjustments were used as needed (Maxwell & Delaney, 1990).

Results

The SD of the car lateral position was not affected by group, position or group by position interaction. Mean SD of car lateral position was .459 (SE = .034) cm (Figure 3). In the AP axis, COP mean amplitude was higher in the sitting position ($M = .230$, $SE = .031$) than in standing position ($M = .128$, $SE = .013$), $F(1,16) = 12.15$, $p = .003$, $\eta_p^2 = .432$. COP mean amplitude was higher for the novice group ($M = .219$, $SE = .026$) than the expert group ($M = .139$, $SE = .026$), $F(1,16) = 4.91$, $p = 0.042$, $\eta_p^2 = 0.235$ (Figure 4 top, left). In the ML axis, COP mean amplitude was higher in the standing position ($M = .208$, $SE = .020$) than in sitting position ($M = .156$, $SE = .012$), $F(1,16) = 12.15$, $p = .003$, $\eta_p^2 = .432$ (Figure 4 top, right). In the AP axis, head mean amplitude was higher for the novice group ($M = .413$, $SE = .040$) than the expert group ($M = .287$, $SE = .040$), $F(1,16) = 4.97$, $p = 0.040$, $\eta_p^2 = 0.237$ (Figure 4 middle, left). In the ML axis, group by position interaction affected head mean amplitude, $F(1,16) = 7.46$, $p = 0.015$, $\eta_p^2 = 0.318$. Post-hoc analyses revealed that, in the standing position,

head mean amplitude was higher for the novice group ($M = .377$, $SE = .031$) than the expert group ($M = .282$, $SE = .031$). In the sitting position, head mean amplitude was also higher for the novice group ($M = .428$, $SE = .042$) than the expert group ($M = .235$, $SE = .042$) (Figure 4 middle, right). In both axes, gaze mean amplitude was not affected by group, position or group by position interaction (Figure 4 bottom, left and right).

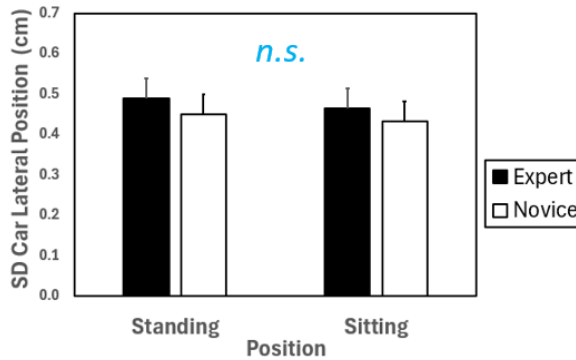


Figure 3. Standard deviation (SD) of the car lateral position (cm) in the standing and sitting positions for the expert and novice groups.

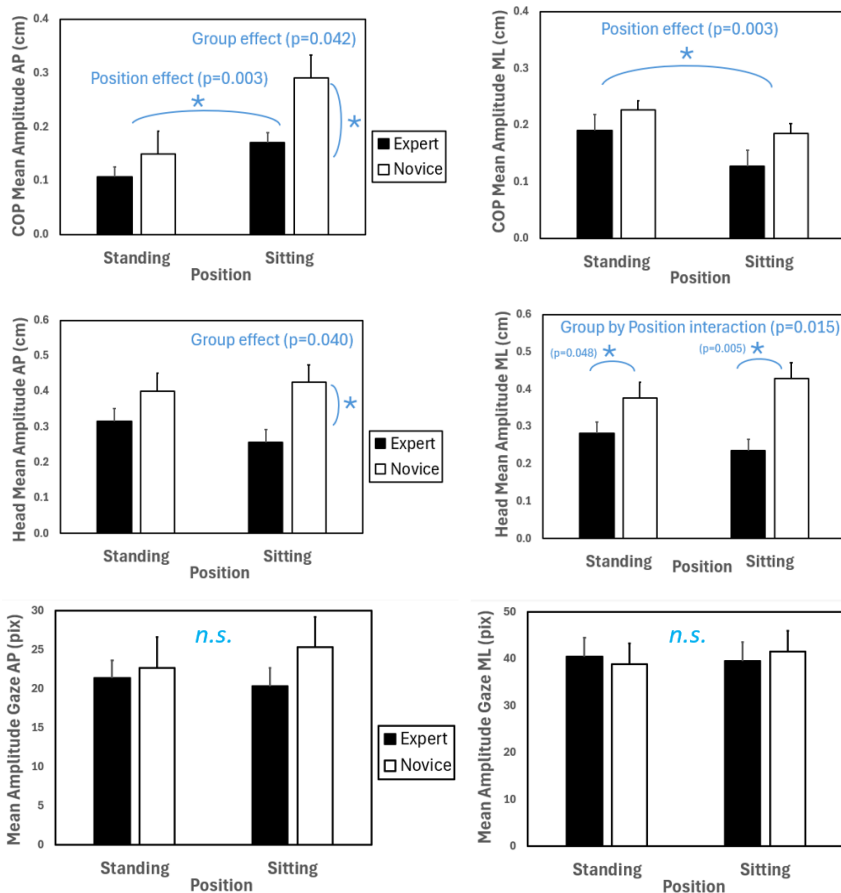


Figure 4. Anterior-posterior [AP] (left column) and medio-lateral [ML] (right column) mean amplitude (cm) of center of pressure [COP] (top row), head (middle row), and gaze (bottom row) in the standing and sitting positions for the expert and novice groups.

In the AP axis, COP coherence was higher in the sitting position ($M = .836$, $SE = .051$) than in the standing position ($M = .663$, $SE = .066$), $F(1,16) = 8.25$, $p = 0.011$, $\eta_p^2 = 0.340$ (Figure 5 top, left). COP coherence in the ML axis and head and gaze coherence in both axes were not affected by group, position or group by position interaction (Figure 5). In the AP axis, COP gain was higher in the sitting position ($M = .012$, $SE = .003$) than in standing position ($M = .005$, $SE = .001$), $F(1,16) = 11.09$, $p = 0.004$, $\eta_p^2 = 0.409$ (Figure 6 top,

left). In the ML axis, COP gain was not affected by group, position or group by position interaction. In the AP axis, head gain was higher for the novice group ($M = .022$, $SE = .003$) than expert group ($M = .010$, $SE = .003$), $F(1,16) = 6.11$, $p = 0.025$, $\eta_p^2 = 0.276$ (Figure 6 middle, left). In the ML axis, head gain was higher for the novice group ($M = .022$, $SE = .003$) than expert group ($M = .009$, $SE = .003$), $F(1,16) = 8.96$, $p = 0.009$, $\eta_p^2 = 0.359$ (Figure 6 middle, right). In both axes, gaze gain was not affected by group, position or group by position interaction (Figure 6 bottom, left and right).

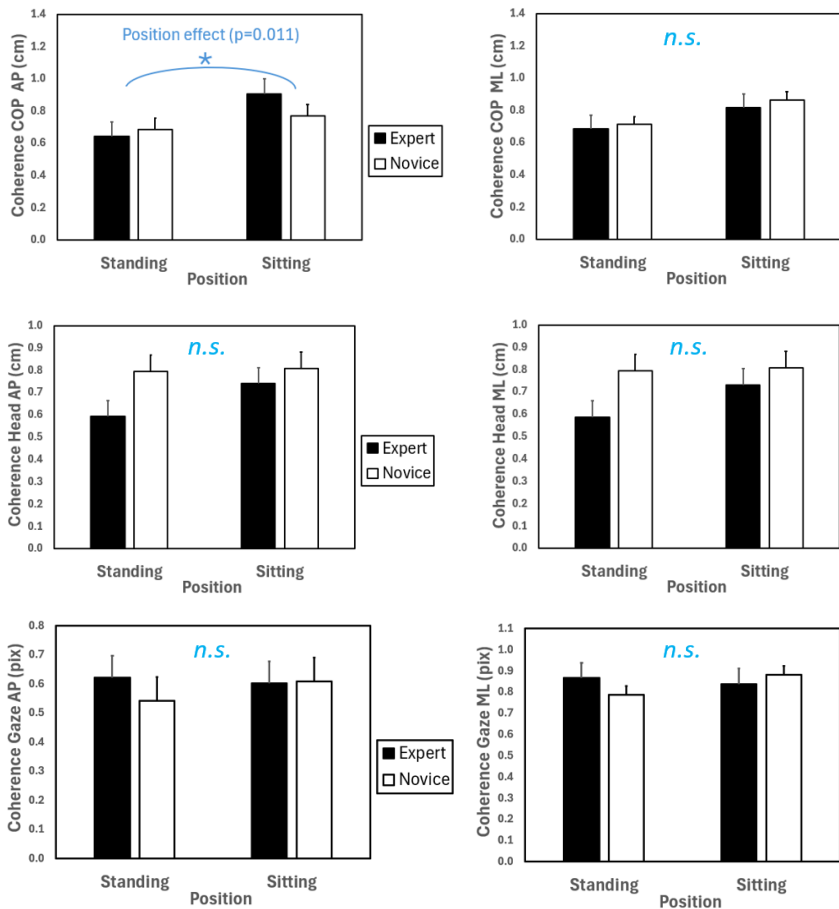


Figure 5. Anterior-posterior [AP] (left column) and medio-lateral [ML] (right column) coherence of center of pressure [COP] (top row), head (middle row), and gaze (bottom row) in the standing and sitting positions for the expert and novice groups.

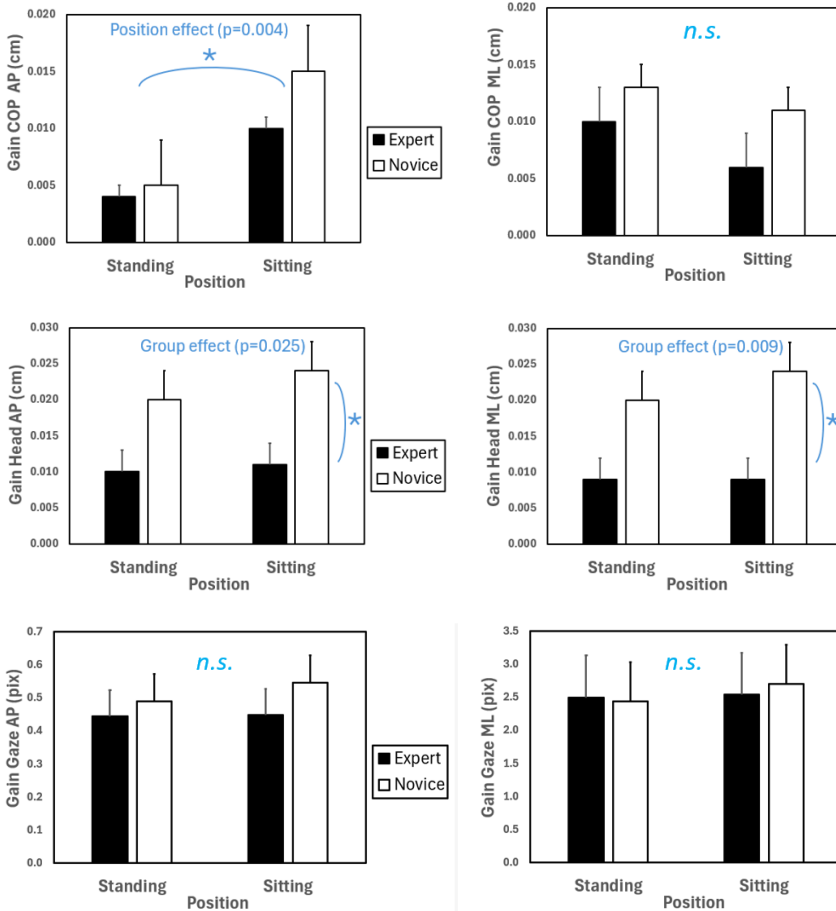


Figure 6. Anterior-posterior [AP] (left column) and medio-lateral [ML] (right column) gain of center of pressure [COP] (top row), head (middle row), and gaze (bottom row) in the standing and sitting positions for the expert and novice groups.

Discussion

The first purpose of this study was to present an experimental paradigm proposal for perception-action coupling during driving on a winding road while sitting or standing. We wanted to offer theoretical and methodological organization to future research. Similarly to the present context, Schoner (1991) brought

the moving room paradigm to a dynamic view of perception-action patterns, emphasizing the importance of the theoretical concept of temporal stability of coordination patterns, which means “the ability to return to a coordinated movement pattern after perturbations and to sustain the coordination pattern in the face of a fluctuating environment” (Schoner, 1991, p. 455). In terms of the presented driving paradigm, new investigations could manipulate a variety of dependent variables (e.g., driver’s experience and body position, as done in the present study, or distinct aspects of visual stimuli such as velocity and frequency, applied to different populations, as people with Parkinson’s disease, dyslexic children, or diabetic elderly) to consistently test the adaptation to particular perturbations of interest to the coordination of posture, head, and gaze patterns. Additionally, Schoner (1991) highlighted the concept of behavioral information (Schoner & Kelso, 1988) which was used to express “the ability of coordination systems to adapt to environmental, memorized or intended constraints in terms of required coordination patterns” (Schoner, 1991, p. 456). For our driving paradigm, to set stimulus conditions in terms of behavioral information, we assume that our perceptual system provides a relevant parameter of the optic flow, the expansion rate of a perceptual scene (Lee, 1976), arriving from the sinusoidal path of the vehicle throughout the road curves in our case.

The second purpose of this study was to present preliminary results on gaze, head and center of pressure displacements, as well as results on driving performance. Here, results are discussed in terms of exploratory analyses conducted. Driving performance was not affected by driver’s experience and body position in this study. The variability of the lateral position of the vehicle is a landmark of driving performance (Land & Tatler, 2009). The magnitude of the observed SD seemed not exaggerated,

considering the sinusoidal road trajectory as drivers usually attenuate the trajectory of vehicle with respect to the road curvature (Land, 1998). The relatively low level of difficulty of the driving task (visually detecting the road curvature and moving the driving wheel accordingly in constant velocity) justifies the absence of significant effects on this variable.

COP amplitude was affected by body position in both axes. The results showed that the amplitude of AP COP sway was higher in the sitting condition while the amplitude of ML COP sway was higher in the standing condition. This finding is probably related to the lateral direction of the driving wheel rotations, affecting the COP response when standing with additional freedom to move laterally. Additionally, novices presented larger COP displacements than experts in the AP axis, in accordance with the expected effects of expertise on postural performance (Paillard, 2019). A similar trend of higher displacements of less experienced participants was found for head movements in challenging postural contexts due to driving skill level (e.g., Rodrigues, Gotardi, & Aguiar, 2024).

Coherence measures, in general, were not affected by driving experience or body position. Exception was the significantly higher coherence of COP in the AP axis during sitting, as compared to standing position. Coherence measures express the level of dependency between body movement and visual stimuli, varying between 0 and 1. All coherence observed values were closer to 1 (around .6 and .9), revealing a relatively high dependency of the movement responses to visual input. Head and gaze coherence values seemed higher than those from COP; also, coherence values appeared higher in the ML axis, as compared to AP axis.

In terms of gain measures and independently of group and body position, very weak coupling for COP and head

measurements, in both AP and ML axes (values lower than .1). Gaze gain measurements revealed considerably stronger perception-action coupling in the AP axis (mean values around .5) than in the ML axis (mean values higher than 1, around 2.5).

Furthermore, gaze measures of amplitude, coherence and gain were not affected by group, body position or interaction, presenting a more invariant pattern with respect to visual stimuli. Independently of group and body position, it is worth of note that drivers exhibit a gaze strategy towards the tangent point in a curve while driving (Paschoalino *et al.*, 2019). This may reflect particularities of gaze behavior constraints due to the need of higher visual acuity for specific visual cues in the environment (Land & Tatler, 2009).

In summary, these preliminary results provide an initial analysis of distinct contributions of COP, head, and gaze controls to the coordination process. The proposed experimental paradigm for studying perception-action coupling in driving and its initial results bring a variety of aspects of complexity to debate, considering the temporal stability of coordination patterns due to the proposed continuous driving task on a winding road; also, it accounts for the need for behavioral information as created visual input meaningful for the perceiver, making available time to contact or other information in a curvilinear trajectory from the optical flow, following the bases suggested by Schoner (1991).

References

- Abou Khalil, G., Doré-Mazars, K., & Legrand, A. (2023). Is better selective attention while standing possible without cost on postural sway? *Quarterly Journal of Experimental Psychology*, 76, 1852–1861.
- Ali, M., Decker, E., & Layton, O. W. (2023). Temporal stability of human heading perception. *Journal of Vision*, 23(2), 8.

- Bantoft, C., Summers, M. J., Tranent, P. J., Palmer, M. A., Cooley, P. D., & Pedersen, S. J. (2016). Effect of standing or walking at a workstation on cognitive function: A randomized counterbalanced trial. *Human Factors*, *58*, 140–149.
- Barela, J. A., Polastri, P. F., & Godoi, D. (2000). Controle postural em crianças: oscilação corporal e frequência de oscilação. *Revista Paulista De Educação Física*, *14*(1), 55-64.
- Barra, J., Auclair, L., Charvillat, A., Vidal, M., Pérennou, D. (2015). Postural control system influences intrinsic alerting state. *Neuropsychology* *29*, 226–234.
- Bonnet, C. T. & Cheval, B. (2023). Sitting vs. standing: an urgent need to rebalance our world. *Health Psychology Review*, *17*(4), 673-694.
- Bradley, D. C., Maxwell, M., Andersen, R. A., Banks, M. S., & Shenoy, K. V. (1996). Mechanisms of heading perception in primate visual cortex. *Science*, *273*(5281), 1544–1547.
- Caron, E. E., Marusich, L. R., Bakdash, J. Z., Ballotti, R. J., Tague, A. M., Carriere, J. S. A., Smilek, D., Harter, D., Lu, S., & Reynolds, M. G. (2022). The influence of posture on attention. *Experimental Psychology*, *69*, 295–307.
- Caron, E. E., Reynolds, M. G., Ralph, B. C. W., Carriere, J. S. A., Besner, D., & Smilek, D. (2020). Does posture influence the Stroop effect? *Psychological Science* *31*(11), 1452-1460.
- Cherigui, W, Guillaume, M., Rodrigues, S. T., Bonnet, C. T. (2025). Success in goal-directed visual tasks: the benefits of alternating sitting and standing instead of only sitting. *Applied Ergonomics*, *129*, 104611.
- Commissaris, D. A. C. M., Huysmans, M. A., Mathiassen, S. E., Srinivasan, D., Koppes, L. L. J., & Hendriksen, I. J. M. (2016). Interventions to reduce sedentary behavior and increase physical activity during productive work: A systematic review. *Scand J Work Environ Health*, *42*(3), 181-191.
- Donges, E. (1978). A two-level model of driver steering behavior. *Human Factors*, *20*(6), 691-707.
- Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.
- Godthelp, J. (1986). Vehicle control during curve driving. *Human Factors*, *28*, 211-221.
- Hua, A., Guillaume, M., Rodrigues, S. T., Barbieri, F. A., & Bonnet, C. T. (2025). Benefits of swaying while standing to higher selective attention in goal-directed visual tasks. *Human Movement Science*, *99*, 103318.

- Jörges, B., Bansal, A., & Harris, L. R. (2024). Precision and temporal dynamics in heading perception assessed by continuous psychophysics. *PLOS One*, *19*(10).
- Karakolis, T. & Callaghan, J. P. (2014). The impact of sit-stand office workstations on worker discomfort and productivity: A review. *Applied Ergonomics*, *45*(3), 799-806.
- Land, M. F. (1998). The visual control of steering. In L. R. Harris & M. Jenkin (Eds.), *Vision and action* (pp. 163-180). Cambridge University Press.
- Land, M., & Tatler, B. (2009). *Looking and acting: Vision and eye movements in natural behaviour*. Oxford University Press.
- Lavie, C. J., Ozemek, C., Carbone, S., Katzmarzyk, P. T., & Blair, S. N. (2019). Sedentary behavior, exercise, and cardiovascular health. *Circulation Research*, *124*(5), 799-815.
- Lee, D. N. (1976). A theory of visual control of braking based on information about time-to-collision. *Perception*, *5*, 437-459.
- Lee, D. N., & Aronson, E. (1974). Visual proprioceptive control of standing in human infants. *Perception & Psychophysics*, *15*(3), 529-532.
- Lee, D. N., & Lishman, J. R. (1975). Visual proprioceptive control of stance. *Journal of Human Movement Studies*, *1*(2), 87-95.
- Lehtonen, E. et al. (2014). Effect of driving experience on anticipatory look-ahead fixations in real curve driving. *Accident Analysis & Prevention*, *70*, 195-208.
- Lishman, J. R., & Lee, D. N. (1973). The autonomy of visual kinaesthesia. *Perception*, *2*(3), 287-294.
- Masoner, H. et al. (2020) Complexity of postural sway affects affordance perception of reachability in virtual reality. *Quarterly Journal of Experimental Psychology*, *73*(12), 2362-2375.
- Maxwell, S. E. & Delaney, H. D. (1990). *Designing experiments and analyzing data: A model comparison approach*. Wadsworth.
- Paillard, T. (2019). Relationship between sport expertise and postural skills. *Frontiers in Psychology*, *10*, Article 1428.
- Paschoalino, G. P. et al. (2019). Driving experience in a natural context of racing video game players does not affect gaze strategy towards tangent point during simulated curve negotiation, but the curvature angle does. *Brazilian Journal of Motor Behavior*, *13*(4), 113-123.
- Reisenegger, R., Bansal, A., Harris, L. R., & Bremmer, F. (2025). Conflicting heading biases explained by different reference frames. *Journal of Vision*, *25*, 2595.

- Rodrigues, S. T., Gotardi, G. C., & Aguiar, S. A. (2024). Effects of vision on postural control in neurologically healthy individuals. In F. A. Barbieri, R. Vitório, & P. C. R. Santos (Eds.), *Locomotion and posture in older adults: The role of aging and movement disorders* (2nd ed., pp. 293-312). Springer.
- Rosenbaum, D., Mama, Y., Algom, D. (2017). Stand by your Stroop: Standing up enhances selective attention and cognitive control. *Psychological Science*, *28*, 1864–1867.
- Schöner G., & Kelso J. A. S (1988). Dynamic pattern generation in behavioral and neural systems. *Science*, *239*, 1513-1520.
- Schöner, G. Dynamic theory of action-perception patterns: the moving room paradigm. *Biological Cybernetics*, *64*, 455–462.
- Smith, K. C., Davoli, C. C., Knapp, W. H., Abrams, R. A. (2019). Standing enhances cognitive control and alters visual search. *Attention, Perception, & Psychophysics*, *81*, 2320–2329.
- van Uffelen, J. G. Z. et al. (2010). Occupational sitting and health risks: A systematic review. *American Journal of Preventive Medicine*, *39*(4), 379-388.
- Warren, W. H. (2006). The dynamics of perception and action. *Psychological Review*, *113*(2), 358–389.
- Warren, W. H., & Hannon, D. J. (1988). Direction of self-motion is perceived from optical flow. *Nature*, *336*(6195), 162–163.
- Warren, W. H., & Hannon, D. J. (1990). Eye movements and optical flow. *Journal of the Optical Society of America A*, *7*(1), 160–169.