Análisis de la Percepción de Peligros y la Estimación del Riesgo para definir un perfil del conductor seguro

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Editor: Universidad de Granada. Tesis Doctorales
Autor: Andrés Augusto Gugliotta
ISBN: 978-84-9163-786-8
URI: http://hdl.handle.net/10481/49718

UNIVERSIDAD DE GRANADA

FACULTAD DE PSICOLOGÍA

CIMCYC: Centro de Invesgigación

Mente, Cerebro y Comportamiento

La tesis ha sido realizada bajo la co-dirección de los doctores Cándida Castro Ramírez y José Luis Padilla García quienes avalan la calidad de la misma y la formación del doctorando para aspirar al grado de doctor.

En Granada a 11 de Diciembre de 2017

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Esta tesis ha sido realizada gracias a la financiación de Proyectos de Investigación: Proyecto Motriz de la Junta de Andalucía, (Proyecto Motriz P11-SEJ-7404 y BS-14-164 I+D+I CEI-Biotic, Granada) de la Dirección General de Tráfico (Exp: 0100DGT21263 and SPIP2015-01782) y del MICINN (PSI2013-42729-P y PSI2016-75086).

Gracias Candi por ayudar a sacar todo esto adelante. Gracias José Luis y Pablo por tenerme paciencia. Gracias Petya, Carlos, Alex y Ada por estar ahí cuando me hizo falta. Gracias Sara por escucharme y animarme todo este tiempo. Gracias a mis padres por confiar en mí, y especialmente a mi madre, por todos los consejos que me empujaron a seguir adelante. A todos los que me ayudaron en este largo camino, a todos los que me ayudasteis a llegar hasta aquí, os dedico este trabajo y os doy las gracias.

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1 RESUMEN

En la conducción, como en la actividad deportiva, no sólo influye la habilidad del que la práctica, sino también el riesgo que asume al practicarla (McKenna Horswill y Alexander, 2006). Por un lado, la "habilidad para percibir peligros" podría considerarse como "un estado" del conductor (aprendiz, novel o con experiencia), que sería sensible a programas de entrenamiento específico y a la práctica, per se, de la conducción. Esta habilidad consiste en poder detectar y responder a eventos de la carretera que tienen alta probabilidad de producir una colisión (Crundall et al., 2012). Sin embargo, la estimación del riesgo -o probabilidad de que una vez percibido un obstáculo, se considere peligroso-, y la toma de decisiones arriesgada podrían relacionarse con ciertos "rasgos" de personalidad (e.g., búsqueda de sensaciones, impulsividad, ira, agresividad, insensibilidad al castigo, etc.), con estilos de conducción (Elander, West y French 1993; Evans, 1991; Summala, 1987; Taubman-Ben-Ari y Katz Ben-Ari, 2013), y otras variables como, por ejemplo, el consumo de alcohol u otras sustancias. La meta de esta tesis ha sido contribuir a identificar qué características definen a los conductores seguros, bien porque han desarrollado habilidades para percibir peligros del tráfico, bien porque realizan una buena estimación del riesgo.

En un primer estudio (Gugliotta et al., 2017), basado en Castro et al. (2014), se desarrolló una nueva versión de la tarea de predicción de peligros, con la que exploramos si existen diferencias tanto en consciencia situacional (i.e.: percepción, comprensión y predicción), como en la toma de decisiones entre conductores aprendices noveles y con experiencia, así como entre conductores reincidentes y no reincidentes. La tarea se basaba en la presentación de vídeos de situaciones reales de conducción que se cortaban ante la aparición incipiente de un peligro. Esta nueva versión del Test de Predicción de

Peligros mostró buenas propiedades psicométricas. Los resultados de este estudio mostraron que los conductores aprendices tenían una ejecución significativamente peor que la de los conductores experimentados identificando y localizando los peligros. Curiosamente, los conductores fueron más certeros a la hora de responder la pregunta de toma de decisiones que a las preguntas correspondientes a la consciencia situacional, lo que sugiere que cuando deciden qué maniobra deben realizar, los conductores no muestran necesidad de poseer un conocimiento consciente completo del peligro exacto que está ocurriendo.

En un segundo estudio, Castro et al. (2016), nos propusimos explorar la posibilidad de entrenar la habilidad de predicción de peligros de los conductores incluyendo comentarios instructivos entre un primer y un segundo bloque de evaluación. Los comentarios dirigían la atención del participante a las regiones más relevantes de la escena, donde podían aparecer los peligros, y se presentaban los vídeos completos desvelándose así el final del vídeo cortado previamente en el primer bloque. El entrenamiento mostró efectos positivos en todos los participantes. No se encontraron diferencias entre los grupos de reincidentes y no reincidentes. Sin embargo, mientras que el rendimiento en los vídeos en los que la aparición del peligro era gradual mejoraba, tanto en el grupo entrenado como en el no entrenado (probablemente por efecto de la práctica), en el caso de los vídeos donde la aparición del peligro era abrupta, sólo el grupo entrenado mejoró su rendimiento.

El objetivo del tercer estudio (Ventsislavova et al., 2016) fue profundizar en la disociación de la conciencia situacional y la toma de decisiones. Para ello, recurrimos a una versión del Test de Percepción de Peligros *"What Happen Next?"* (WHN) de alternativas múltiples, que mediante la disociación de situaciones peligrosas y cuasi-peligrosas nos permitió aplicar la técnica de la Teoría de Detección de Señales (TDS; Green y Swets, 1966; Stanislaw y Todorov, 1999). Encontramos diferencias significativas en el índice de discriminación del peligro y en la prudencia en la toma de decisiones, tanto en función del nivel de experiencia, como del perfil de reincidencia de los conductores. De este modo, los conductores con experiencia eran más cautos que los noveles, a la vez que los conductores reincidentes daban respuestas más arriesgadas que los no reincidentes pese a no diferenciarse en consciencia situacional.

El último estudio pretende desenmascarar por qué los hombres jóvenes que conducen están sobrerrepresentados en la población de conductores reincidentes y averiguar qué otras variables relacionadas con algunos hábitos adquiridos, los atributos de personalidad o los estilos de conducción, podrían ayudar a comprender este fenómeno. Los participantes contestaron a una batería de instrumentos en la que se recogieron datos sociodemográficos (género y edad), hábitos de consumo de alcohol, estilos de conducción, estimación general del riesgo en la vida cotidiana, sensibilidad al castigo y al refuerzo, e ira en conducción. Los resultados mostraron que el mejor predictor de la reincidencia es un consumo de alcohol de riesgo seguido por la conducción incauta y, en menor medida, la infraestimación del riesgo recreacional y la mayor sensibilidad al refuerzo. Por tanto, si se quisieran realizar intervenciones eficaces para reducir la reincidencia en tráfico deberían centrarse tanto en el establecimiento de programas de desintoxicación alcohólica, como en la posibilidad de plantear políticas "reforzantes".

2 INTRODUCCIÓN

En toda la Unión Europea (UE) alrededor de 26.000 personas murieron por accidentes de tráfico en 2014, de los cuales un 14% eran jóvenes (European Comission, 2016ab). Según estos informes, en la última década las víctimas mortales de tráfico de entre los 18 y 24 años ascendieron a 57.000 jóvenes. En este período, los avances en políticas de seguridad vial han logrado disminuir la siniestralidad en las carreteras en un 43% en toda la UE., un 62% en España. Aún queda trabajo por hacer, el objetivo propuesto por la UE es reducir a la mitad el número de accidentes para el año 2020 ("*Road Safety Programme 2011-2020*"). El éxito de las medidas estratégicas que toman los gobiernos puede depender de estudios científicos. Desde la Psicología, podríamos aportar el conocimiento sobre las características del conductor que lo hacen más proclive a cometer infracciones que amenazan la conducción segura.

Parker, Reason, Manstead y Stradling (1995) se plantearon que ambos constructos, percepción de peligros y toma de decisiones arriesgada, podrían ser conceptualmente distintos y empíricamente separables, que tuvieran orígenes psicológicos diferentes, y que la intervención pudiera requerir distintos remedios. En este sentido, la adquisición de la habilidad para percibir peligros podría considerarse como "un estado" del conductor (aprendiz, novel o con experiencia), susceptible de ser entrenado de forma específica o mediante la práctica, per se, de la conducción. Sin embargo, la estimación del riesgo -o probabilidad de que una vez percibido un obstáculo, se considere a éste como peligroso-, y la toma de decisiones arriesgada, podrían relacionarse con "rasgos" de personalidad como la búsqueda de sensaciones, impulsividad, ira, agresividad, insensibilidad al castigo, etc. (Elander et al., 1993; Evans, 1991; Summala, 1987). La Figura 1 presenta un modelo inicial sobre la relación entre las variables que pueden estar relacionadas con en el perfil del conductor seguro.

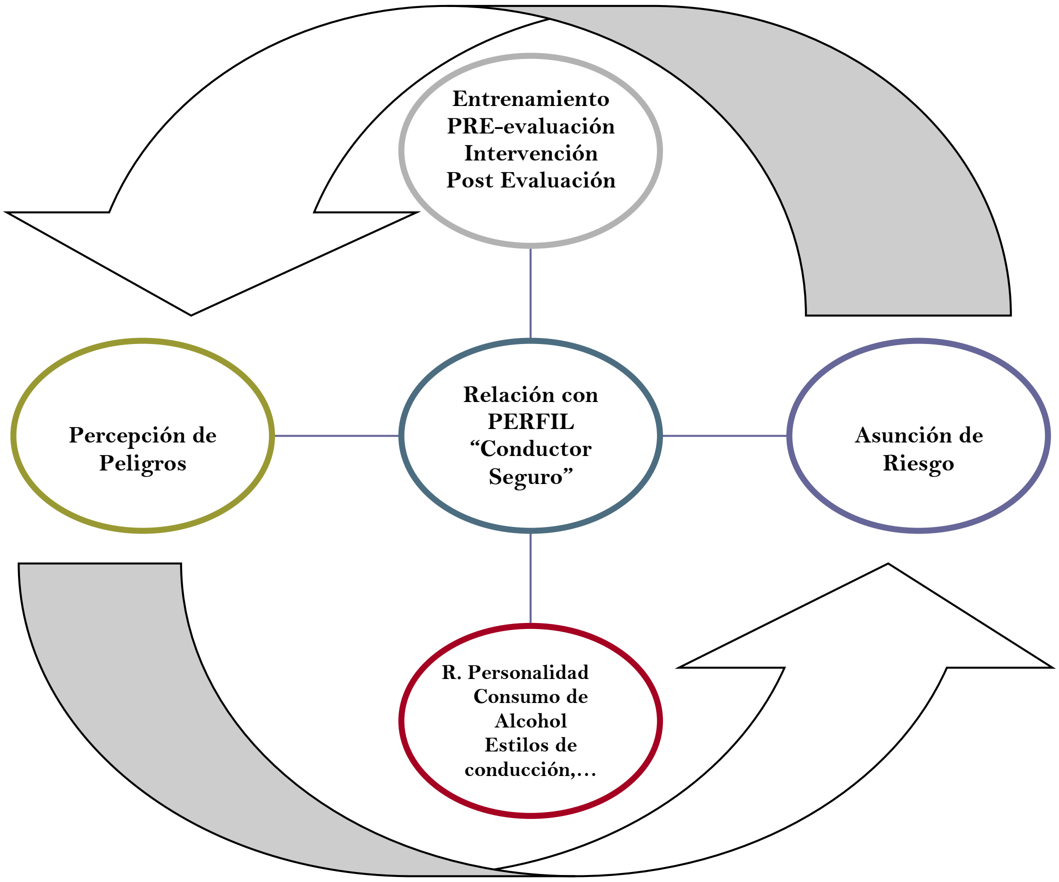

Figura 1. *Diagrama que relaciona el perfil del conductor seguro con la Percepción de Peligros y la Asunción de Riesgos.*

2.1 Habilidad de Percepción de Peligros del tráfico

La habilidad de percepción de peligros (PdP) es crítica en conducción. Según Horswill y McKenna (2004), es la única habilidad que se ha demostrado que correlaciona con la implicación en accidentes. Se trata de la habilidad para detectar y responder a eventos de la carretera que tienen alta probabilidad de producir una colisión (Pradhan y Crundall, 2016; Crundall et al., 2012; Crundall, Andrews, van Loon, y Chapman, 2010; McKenna y Crick, 1991). Dichos eventos a los que podríamos llamar "peligrosos", no incluyen las características del conductor del vehículo, sino que se refieren a obstáculos potencialmente peligrosos de la carretera, que se pueden cruzar en la trayectoria del mismo, por ejemplo, peatones, ciclistas u otros vehículos, tanto en circulación como estacionados (Wallace, Haworth y Regan, 2005). Podemos entender la habilidad de PdP como la habilidad de incorporar la información clave del entorno del tráfico para así poder anticipar lo que va a pasar o de leer la carretera (McKenna y Crick, 1991; Mills, Hall, McDonnald y Rolls, 1998).

2.1.1 Test de Percepción de Peligros: Tiempo de Anticipación

Según McKeena y Crick (1991) es posible analizar la PdP a través del estudio de vídeos que muestran escenas de tráfico filmadas desde la perspectiva del conductor de un vehículo en movimiento, en los que aparezcan obstáculos con los que se podría colisionar, tomando como a medida la discriminación simple basada en la detección del peligro y el tiempo de reacción. Así, se obtendría un aceptable control experimental de la situación de estudio, sin la necesidad de poner al participante o al experimentador en riesgo en una tarea de conducción real, y sin renunciar a gran parte de la validez ecológica. Además, las repuestas a los peligros se miden objetivamente al capturar el tiempo de respuesta, en vez de que tengan que basarse en las valoraciones subjetivas, realizadas por los evaluadores, sobre la ejecución de los conductores noveles (Sagberg y Bjørnskau, 2006). Por ello, en noviembre 2002, el *Department of Transport* de UK, incorporó el *Hazard Perception Test*, como parte de sus exámenes para conseguir la licencia de conducción y, desde entonces, forma parte de la selección (*o screening*), de nuevos conductores que realiza la *Driving Standard Agency* (Horswill y McKenna, 2004).

Un asunto por resolver por parte de los Test de PdP, deriva de la idea de que distintos conductores utilicen distintos umbrales de decisión para clasificar qué "incidentes" constituyen un peligro. Farrand y McKenna (2004) encontraron que proporcionando a los participantes instrucciones de ser más laxos o más estrictos, alteraban sus latencias de respuesta en el Test de PdP. Por ello, comentaron que la mejor forma de evitar dicho sesgo sería utilizar las medidas de los parámetros de sensibilidad (d') y de criterio (B) de la Teoría de Detección de Señales (TDS; Green y Swets, 1966; Stanislaw y Todorov, 1999). Según Farrand y McKenna (2004**),** se podría discernir qué parte de las diferencias se deben al sesgo de respuesta, y cuáles son realmente debidas al grado de experiencia del conductor. Sin embargo, encontraron dificultades para poder implementar de forma práctica la TDS en los Test de PdP, ya que creían que era difícil poder presentar la condición de "no peligro". Por ejemplo, ellos comentaban que durante la creación del primer Test de PdP (McKenna y Crick, 1991), algunos expertos (policías) decían que había peligro en algunas escenas en las que los investigadores pensaban que no lo había, ya que los policías eran capaces de reconocer que había algo de aceite en la carretera que podría provocar que los conductores frenaran. Este problema del sesgo de respuesta de los Test de PdP ha seguido vigente hasta nuestros días y, en parte, el surgimiento de los nuevos Test de Predicción de Peligros tiene como motivación intentar paliarlo.

2.1.2 Test de Predicción de Peligros: Precisión en la Predicción

Horswill y McKenna (2004) consideraron que la detección de peligros implica la toma de "consciencia situacional" (*Situation Awareness*, SA, por su nombre en inglés); de incidentes potencialmente peligrosos en el contexto del tráfico. Endsley (1995) define la SA como la percepción de los elementos del ambiente en función de magnitudes temporales y espaciales, la comprensión de su significado y la proyección de su estado en el futuro próximo. Así, existen tres etapas esenciales en este modelo de la SA: 1) la percepción de la escena; 2) Su comprensión; y 3) La proyección de escena en el futuro inmediato. La Figura 2 ilustra el modelo.

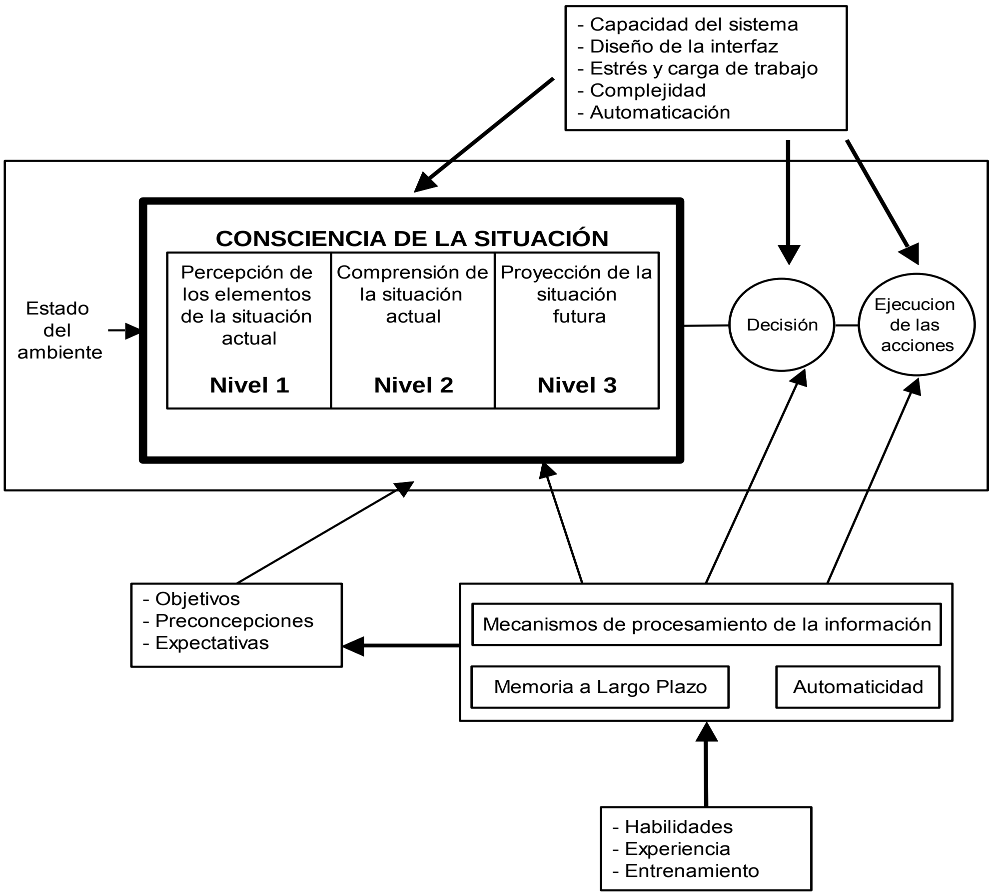

Figura 2. *Diagrama del procesamiento de la información según Endsley (1995).*

Según este modelo, percibir el peligro no se limita sólo a la mera capacidad perceptiva, sino que incluye la comprensión de la situación en su conjunto, y su proyección en el futuro inmediato para generar una adecuada predicción de los eventos que ocurrirán en la escena. Endsley (1995) destaca la naturaleza dinámica de la conducción, donde los estímulos y condiciones ambientales cambian constantemente, requiriendo una continua toma de decisiones. Para llevar a cabo esta tarea de manera eficiente, los conductores han de tener modelos mentales del entorno que les permitan hacer predicciones con las que anticipar los eventos potencialmente peligrosos. Los conductores que tienen una buena predicción del peligro, desarrollan modelos mentales más sofisticados que pueden utilizar para anticipar situaciones peligrosas de manera más eficaz (Horswill, 2016).

A diferencia de la tarea de PdP clásica, la tarea de predicción de peligros (*What Happen Next?*, *WHN*?), no sólo explora la PdP, sino también la comprensión que el conductor hace de la escena del tráfico, a partir de las cuales (percepción y comprensión), es posible planear y predecir lo que va a pasar (proyección de la situación). Castro et al. (2014) validaron el primer Test de PdP en el contexto español, que mide la precisión en la estimación de los peligros, utilizando la tarea WHN. Además, estas pruebas se basan el supuesto de que una predicción adecuada del peligro será determinante para tomar decisiones acerca de las maniobras que se van a ejecutar.

Sin embargo, Groeger (2000) señalaba que era preciso dotar de basamento teórico a estos estudios. Kinnear, Kelly, Stradling y Thomson (2013) también destacaban que aún no están claros los principales mecanismos que subyacen a la habilidad de PdP.

2.1.3 Capacidad del Test de Percepción de Peligros para distinguir entre grupos de conductores

Crundall y Underwood (1998) y Crundall (2016) mostraron que los conductores con experiencia desarrollaban estrategias flexibles de búsqueda visual cuando se enfrentan a diferentes escenas de conducción, donde los conductores sin experiencia mantenían siempre el mismo patrón. También los conductores noveles tienen una peor anticipación del comportamiento de los demás conductores de la vía (Bjørnskau y Sagberg, 2005).

Desde el 2002 hasta ahora, la DSA (Driving Standard Agency, U.K) ha demostrado que el *Hazard Perception Test* (Department of Transport, 2017), puede discriminar entre conductores en función de los distintos niveles de experiencia. En concreto, los estudios de pruebas de PdP mostraron que esta prueba cognitiva provee un modo robusto de discriminación entre conductores seguros e inseguros (Horswill y

McKenna, 2004), y entre conductores seguros y aquéllos que han muerto en un accidente de tráfico en los 12 meses posteriores a la realización del test HP (Drummond, 2000).

Además, según Jackson, Chapman y Crundall (2009), existen condiciones en los vídeos de predicción de peligros que provocan que distintos tipos de conductores: noveles vs. con experiencia, con accidentalidad vs. conductores seguros, tengan peor o mejor ejecución en el test. Esta es la razón por la que, en distintas manipulaciones posteriores, los investigadores incluyeron al menos algunos vídeos en los que algún factor del ambiente, asociado con conocimiento previo, pueda favorecer la detección del peligro. Por ejemplo, según Crundall et al., (2010) y Jackson et al., (2009), es posible establecer las categorías denominadas: "Predicción Conductual" (*Behavioural Prediction, BP*), en las que un elemento del ambiente que ya estábamos viendo (i.e., un peligro potencial), se convierte en un peligro real; y las situaciones denominadas Predicción Ambiental (*Environmental Prediction, EP*), en las que un elemento del ambiente (precursor), puede ayudar a predecir la aparición de un peligro real. También recientemente, Underwood, Ngai y Underwood (2013) plantean otra posible clasificación de los vídeos en función de la forma de aparición del peligro en la escena (abruptos o graduales), ya que aunque en un vídeo se muestren claves precursoras del peligro, si la aparición de la clave y del peligro es simultánea, de nada servirá la clave.

2.1.4 Utilidad de la Percepción de Peligros para el Entrenamiento.

Ya en 1986, Quimby y Watts destacaban que, aunque la habilidad de PdP es importante para la seguridad vial, presenta un problema clave y es que requiere décadas de experiencia al volante antes de alcanzar su máximo desarrollo. Por ello, acortar el tiempo de adquisición de esta habilidad podría ayudar a disminuir el riesgo de accidentes para muchos conductores, al menos en sus primeros años tras la obtención del carné, que es cuando son más vulnerables. Según Horswill (2016) esta idea no es nueva, cuando países como Inglaterra, Australia o los Países Bajos implantaron los Test de PdP, establecieron unos estándares que garantizaran unos mínimos en esta habilidad antes de poder obtener el permiso de conducir. Así se motivó a los conductores principiantes a entrenarse en esta habilidad, a la vez que adquirían el resto de las habilidades necesarias para la conducción (Horswill, 2016).

McKenna y Crick (1997) usaron originalmente los vídeos *What Happen Next?* como forma de entrenamiento, parando el videoclip justo antes de la aparición de un peligro, y preguntándoles a los participantes que creían que ocurrirá después del corte. Tras responder los participantes, un experto comentaba lo que podría haber ocurrido después.

También se han usado comentarios instructivos para entrenar a los conductores noveles. Se presentan vídeos de situaciones de tráfico y se les pide a los participantes que generen comentarios sobre lo que estaban observando en el vídeo, o que atiendan a un experto que imparte dichos comentarios (Horswill, Taylor, Newman, Wetton y Hill, 2013; Isler, Starkey y Williamson, 2009; McKenna et al., 2006; Wetton, Hill y Horswill, 2013). Wetton et al. (2013) compararon el efecto del entrenamiento mediante comentarios instructivos vs. con vídeos *What Happen Next*, encontrando que si bien ambos eran efectivos, el procedimiento de emitir o recibir comentarios instructivos era más eficaz como técnica de entrenamiento.

Otra forma de entrenar la habilidad de PdP consiste en exponer al participante a un gran número de vídeos de peligros del tráfico, instruyéndolos previamente sobre cómo identificar todos los posibles peligros (Meir, Borowsky y Oron-Gilad, 2014). Otra variación consiste en ir enseñándoles, a medida que transcurre el vídeo, dónde deben mirar en la escena de tráfico, indicándoles que estén atentos a las zonas por las que puede aparecer un peligro (Pradhan, Pollatsek, Knodler y Fisher, 2009). .

En 2016 Horswill se preguntaba en qué medida mejoras en la habilidad de PdP peligros, producen necesariamente una reducción en el riesgo de sufrir accidentes. En este sentido, Wells et al. (2008) compararon los participantes que realizaron el *Hazard Perception Test* británico y los que no, comprobando que el grupo entrenado redujo en un 11,3% los accidentes de tráfico relacionados con no conducir despacio, comportamiento mas frecuente entre los conductores noveles y mayores. También Thomas, Blomberg, Peck y Korbelak (2016), utilizando 17 minutos del entrenamiento similar al de Pradhan et al. (2009) (i.e., enseñando a mirar priorizando las zonas en las que puede aparecer un peligro), encuentran que los hombres conductores que recibieron el entrenamiento tuvieron un 23.7% menos de accidentes frente a los no entrenados.

2.2 El perfil del conductor inseguro

Para mejorar la comprensión del problema de la conducción insegura, es preciso explorar qué variables permiten predecir e identificar al conductor de riesgo. Su evaluación precisa puede permitir mejorar la eficacia de los diagnósticos, así como de las intervenciones que se realizan para su modificación, hasta ahora en España, casi centrada mayormente en cursos de sensibilización y reeducación para la recuperación de puntos.

No todos los conductores calibran por igual el riesgo de una situación o sus propias habilidades para afrontarlo. Por ejemplo, se ha visto que los motoristas son más cautos que los conductores de automóvil, detectando vídeos de peligro cuando su aparición es gradual, aunque esto implique cometer mayor número de falsas alarmas (Underwood et al., 2013). Sin embargo, también existen conductores que simplemente no son conscientes del riesgo de algunas situaciones peligrosas (Armsby, Boyle y Wright, 1989).

En la literatura previa, la conducta infractora había sido relacionada ya con algunas variables demográficas como el género masculino, la edad de los jóvenes, algunas características de personalidad y el consumo de sustancias como el alcohol, y las drogas.

En cuanto al género, los conductores varones jóvenes con menores habilidades en la conducción podrían infraestimar el riesgo potencial de situaciones peligrosas (Castellà y Pérez, 2004; Deery, 1999). Los hombres aceptan más comportamientos arriesgados en la conducción que las mujeres (Sarkar y Andreas, 2004; Boufous et al., 2009), y es más probable que los primeros sufran un accidente de tráfico (Williams y Shabanova, 2003). Los hombres jóvenes comenten más conductas de riesgo como conducir bajo los efectos del alcohol, hablar por teléfono (Delhomme, Chaurand y Paran, 2012; Ivers et al., 2009; Deffenbacher, Oetting y Lynch., 1994), sobrepasar los límites de velocidad, salirse de su carril o realizar conductas temerarias (Swedler, Bowman, y Baker, 2012), y son menos sensibles que las mujeres, a las medidas punitivas que pueden recibir por realizar dichos comportamientos (Castellà y Pérez, 2004).

También muestra la literatura la relación entre la personalidad y la conducción de riesgo (Dahlen y White, 2006; Machin y Sankey, 2008; Ulleberg y Rundmo, 2003). En concreto, un mayor riesgo se relaciona con rasgos de personalidad como la búsqueda de sensaciones (Constantinou, Panayiotou, Konstantinou, Loutsiou-Ladd y Kapardis, 2011), la agresión y la extroversión, así como con bajos niveles de altruismo y bajos niveles de aversión al riesgo (Machin y Sankey, 2008; Taubman-Ben-Ari, Mikulincer y Gillath, 2004; Ulleberg y Rundmo, 2003).

2.3 Estudios

En este trabajo se exploran algunos aspectos relacionados con la habilidad del conductor para predecir peligros del tráfico. En el Capítulo I, se inicia el análisis del funcionamiento de los procesos cognitivos que están a la base de la habilidad de PdP (consciencia situacional y toma de decisiones). Una predicción de peligros adecuada es imprescindible para tomar decisiones acertadas. Nos preguntamos en qué medida este proceso de predicción de peligros requiere un esfuerzo, y si este fuera el caso, si puede llegar a automatizarse mediante la práctica.

El objetivo del Capítulo II consiste en diseñar una forma de entrenamiento rápida basada en comentarios instructivos, presentando de nuevo los vídeos que previamente habían sido evaluados en su forma cortada. Ahora bien, en el entrenamiento su presentación se hacía de forma completa, de tal manera que el participante podía ver el desenlace del vídeo, al mismo tiempo que un experto iba verbalizando e indicando a dónde debían mirar en la escena de tráfico, dirigiendo su atención hacia la zona donde aparecería el peligro.

En el Capítulo III analizamos los parámetros de la TDS para conocer el funcionamiento de los procesos de discriminación y decisión que subyacen a la de detección de peligros. La forma de operacionalizar estos procesos ha sido a través de la inclusión de dos tipos de situaciones de peligro. Se presentan como señal peligros que finalmente acabarán desarrollándose y sería preciso realizar una maniobra evasiva; y como ruido, cuasi-peligros o peligros potenciales que no llegarían a necesitar la realización de una maniobra evasiva.

Por último, en el Capítulo IV nos planteamos que para mejorar la comprensión del problema de la conducción insegura, es preciso explorar qué variables permiten predecir e identificar el perfil del conductor de riesgo. Entre ellas, analizamos la función que desempeñarían algunos factores como el género, la edad, el consumo de sustancias, medido con el AUDIT *(Alcohol Use Disorders Identification Test*, Castellà y Pérez, 2004), los estilos de conducción adaptativos (estilo cauteloso) y desadaptativos (temerario, agresivo, reducción de estrés), medidos con el MDSI, (*Multidriving Style Inventory*, Taubman-Ben-Ari, Mikulincer y Gillath, 2004, adaptación de Padilla et al., enviado), y factores de personalidad: propensión al riesgo, medida a través del DOSPERT (*Domain-specific risk-taking*, Blais y Weber, 2006; adaptación española: Horcajo, Rubio, Aguado, Hernández y Márquez, 2014); sensibilidad al castigo y al refuerzo, medida con el SPRQ-20 (*Sensitivity to Punishment and Sensitivity to Reward Questionnaire*, Castellà y Pérez, 2004) y la ira al volante, medida con la DAS, (*Driving Anger Scale*, Deffenbacher, Lynch, Oetting y Yingling, 2001; Richer y Bergeron, 2012, adaptación española de Herrero-Fernández, 2001).

2.3.1 ¿Son totalmente conscientes los procesos de Consciencia Situacional y Toma de Decisiones en conducción? Resultados de una tarea de Predicción de Peligros. (Capítulo I)

Detectar el peligro en entornos de conducción es una medida para garantizar la seguridad en la carretera. Nos preguntamos si una buena predicción da lugar a una respuesta adecuada. En este estudio se avanza en la comprensión de la habilidad de PdP investigando la conexión entre una predicción exitosa y la selección de la respuesta adecuada ante el peligro. El objetivo de este trabajo era desarrollar una versión mejorada del test español de predicción de peligros, a la vez que exploramos las diferencias en la consciencia situacional y la toma de decisiones entre conductores aprendices, noveles, y conductores experimentados, así como entre conductores reincidentes y no reincidentes. La contribución de este trabajo no es solo teórica; el Test de Predicción de Peligros es una manera validada de evaluar la habilidad de PdP. Este test puede ser útil como parte del sistema para obtener el carnet. También puede ser útil para evaluar a aquellos conductores que han de renovar la licencia después de haber sido revocada, o como una manera de entrenar a los conductores.

2.3.1.1 Método

Se reclutaron tres grupos de conductores (aprendices, noveles y conductores con experiencia). Parte de estos conductores noveles y con experiencia eran reincidentes, y parte no reincidentes. En concreto, 121 participantes observaron una serie de vídeos que concluían con una pantalla negra inmediatamente antes de la aparición del peligro. Después los participantes respondieron a una serie de preguntas que evaluaban su consciencia situacional: "¿Cuál era el peligro?" "¿Dónde se encontraba?" "¿Qué va a pasar después?"; y su toma de decisiones: "¿Qué maniobra realizarías si fueras el conductor que lleva la cámara?

2.3.1.2 Resultados y Conclusión

Esta alternativa a los Test de PdP mostró una consistencia interna satisfactoria (Alfa de Cronbach = .75), con once vídeos que consiguen índices de discriminación superiores a .30. Los conductores aprendices tuvieron un rendimiento significativamente peor que los conductores con experiencia identificando y localizando el peligro. También fue interesante encontrar que los conductores respondieron mejor a la pregunta de toma de decisiones que a las preguntas que evaluaban su conciencia situacional, lo que sugiere que los conductores pueden hacer una elección apropiada de la maniobra a realizar, sin contar con un conocimiento consciente completo del peligro exacto al que se enfrentan.

2.3.2 La Escucha Proactiva de Comentarios instructivos mejora la Predicción del Peligro (Capítulo II)

El objetivo de este trabajo fue explorar el efecto de la escucha proactiva a comentarios instructivos, utilizando la versión española del Test de Predicción de Peligros desarrollado recientemente.

2.3.2.1 Método

En un primer bloque de evaluación se utilizaron 16 vídeos en su versión corta, detenidos justo antes de la aparición del peligro (Ver Figura 3). Durante este pre-test se generaron expectativas sobre el desenlace de la situación de conducción. Después, al grupo entrenado se les mostró la versión completa de los 16 vídeos utilizados en la primera sesión, revelando el desenlace del peligro, al mismo tiempo que escucharon una voz en off que aportaba información relevante sobre dónde alojar la atención durante la visualización de los vídeos, con el objeto de entrenar el reconocimiento y la anticipación.

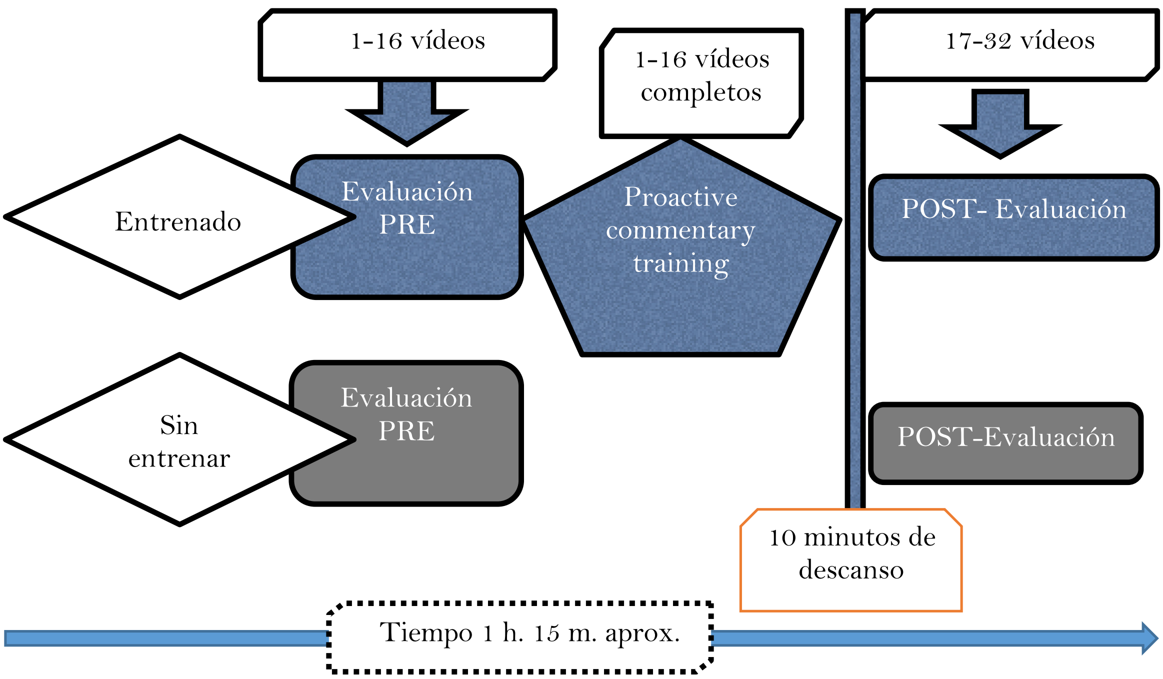

Figura 3. *Procedimiento seguido en este estudio.*

En total, 121 participantes formaron parte del estudio. La muestra incluía conductores aprendices nóveles y con experiencia, entre ellos conductores reincidentes y no reincidentes. Los participantes fueron divididos en dos grupos: uno entrenado y otro no entrenado. Se realizaron dos sesiones de evaluación: un pre-test (16 vídeos) y un pos-test (otros 16 vídeos).

2.3.2.2 Resultados y Conclusión

El test presentó unos altos índices de consistencia interna (Alfa de Cronbach = .87). Y el entrenamiento mostró efectos significativos positivos para todos los grupos de participantes. No se encontraron diferencias entre los conductores reincidentes y no reincidentes. El rendimiento en los vídeos graduales puede ser mejorado después del entrenamiento, pero también mediante la mera práctica. Sin embargo, el entrenamiento es esencial y especialmente beneficioso para entrenar la habilidad de detectar peligros que aparecen de manera abrupta (los cuales parecen ser difíciles de mejorar mediante la práctica por sí sola).

2.3.3 ¿Qué ocurre cuando los conductores se enfrentan a los peligros de la carretera? Un análisis de los procesos cognitivos implicados en la tarea de Predicción de Peligros (Capítulo III).

Este estudio tiene por objetivo obtener conocimiento sobre la naturaleza de los procesos involucrados en la PdP, utilizando para ello técnicas de medida que separen y cuantifiquen de manera independiente dichos subprocesos. En concreto, este estudio aporta medidas cuantitativas de los procesos involucrados en la percepción y predicción de peligros: discriminación, consciencia situacional (reconocimiento, localización y proyección), y toma de decisiones (ver Figura 4). Esto es posible, al menos en parte, debido a la aplicación del análisis de los parámetros de la Teoría de Detección de Señales para analizar la tarea de predicción y PdP.

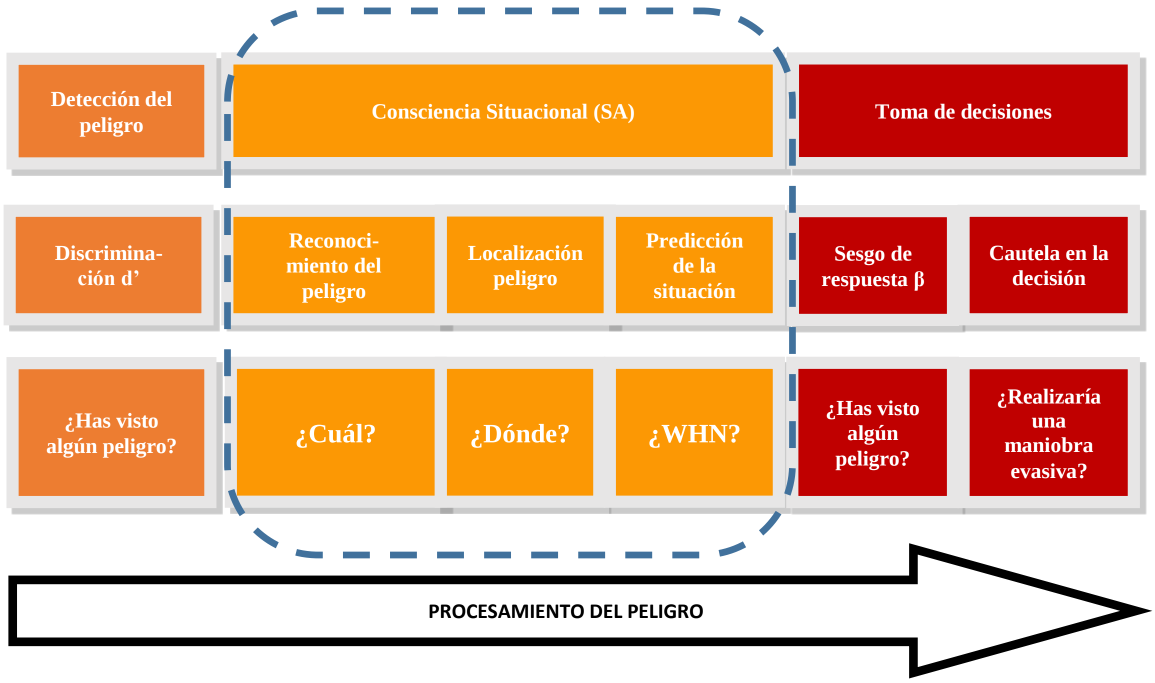

Figura 4. *Variables empíricas simples con las que se pretende estudiar el funcionamiento de estos procesos cognitivos.*

2.3.3.1 Método

Para poder calcular los parámetros de la TDS, se presentaron a los participantes situaciones peligrosas y cuasi-peligrosas. Las situaciones peligrosas fueron aquellas en las que era necesario realizar una maniobra evasiva, como frenar o dar un volantazo, mientras que en las situaciones de cuasi-peligro no se requería realizar ninguna maniobra evasiva, sino seguir conduciendo manteniendo la misma velocidad y trayectoria.

En este contexto los peligros se consideran la señal y los cuasi-peligros el ruido. Los cuasi-peligros son obstáculos (peligros potenciales) que se parecen a los peligros, pero que finalmente no llegan a desarrollarse, es decir, no es preciso realizar una maniobra evasiva (ni frenar, ni cambiar de trayectoria). La similitud entre señal y ruido genera cierto grado de incertidumbre necesaria para el cálculo de la Teoría de Detección de Señales (ver Tabla 1).

Tabla 1. Manipulación realizada de peligros y cuasi-peligros del tráfico.

	Respuesta del Participante	
	Sí	No
Señal (Peligro)*	Aciertos (Hits)	Fallos (Misses)
Ruido (Cuasi-Peligro)**	Falsas Alarmas	Rechazos Correctos

*Peligro: Contiene un peligro desarrollándose que requiere la realización de una maniobra evasiva.
**Cuasi-Peligro: Contiene un peligro potencial que finalmente no se desarrolló, por lo que no requiere que se realice ninguna maniobra evasiva.

Se creó por primera vez una versión del Test de Percepción y Predicción del Peligro mediante alternativas múltiples para medir el rendimiento de los participantes en una tarea de tipo *What Happen Next?* La muestra estaba constituida por 147 participantes, 47 mujeres y 94 hombres. Se reclutaron grupos de conductores reincidentes (noveles y experimentados), y no reincidentes (aprendices, noveles y experimentados). Los vídeos fueron divididos en dos tipos: situaciones peligrosas y situaciones cuasi-peligrosas.

2.3.3.2 Resultados y Conclusión

El Test de Predicción de Peligros con preguntas de alternativas múltiples tuvo éxito a la hora de encontrar diferencias entre conductores con distintos niveles de experiencia. Mediante el análisis de la TDS, se encontraron diferencias asociadas al nivel de discriminación del peligro (d’ prima), entre conductores con diferentes perfiles (reincidentes y no reincidentes). Además, se encontró que los conductores experimentados tenían una mayor consciencia situacional que los conductores noveles o aprendices. Por otro lado, pese a que los conductores reincidentes tuvieron un peor rendimiento que los conductores no reincidentes en las preguntas de identificar si había un peligro, su ejecución global en la prueba que mide la conciencia situacional fue igual para los conductores reincidentes y no reincidentes (de hecho, eran tan conscientes de cuáles eran los obstáculos en la carretera, de dónde se encontraban y de qué pasaría después, como los conductores no reincidentes). Sin embargo, cuando se consideraron las respuestas al respecto de la prudencia, los conductores experimentados fueron más cautos que los conductores noveles, y los conductores no reincidentes fueron más cautos que los conductores reincidentes. O lo que es lo mismo, fue mayor el número de conductores experimentados y no reincidentes que decidieron la respuesta de "tomar una maniobra evasiva o frenar progresivamente".

2.3.4 Estatus infractor en conducción: ¿Quién está en riesgo? Rol del Consumo de Alcohol, el Estilo de Conducción Incauto, la Sensibilidad al Refuerzo y la Infraestimación del Riesgo en el Ocio, en la predicción de la Reincidencia (Capítulo IV)

Encontrar herramientas de predicción de la conducta del conductor reincidente, que sean precisas, es una tarea difícil que no está exenta de riesgo y puede ser peligrosa. A veces, se ha justificado dicha identificación para castigar a los reincidentes con medidas punitivas más que para tratarlos con programas de intervención psicológica eficaces. Para comprender mejor el problema es preciso saber cuáles son los factores más relevantes en el modelo de predicción de estas conductas. Este estudio pretende desenmascarar por qué los conductores jóvenes y hombres están sobrerrepresentados en la reincidencia y en qué medida el consumo de alcohol, los estilos de conducción, la infraestimación del riesgo, la sensibilidad al castigo o al refuerzo, y la conducción agresiva o con ira, podrían ayudar a comprender este fenómeno.

2.3.4.1 Método

En este estudio, 296 conductores: 86 reincidentes (7 mujeres y 79 hombres) y 206 no reincidentes (105 mujeres y 101 hombres), contestaron a una batería de instrumentos en la que se preguntaron datos sociodemográficos (género y edad), hábitos de consumo de alcohol, estilos de conducción, estimación general del riesgo en la vida cotidiana, sensibilidad al castigo y al refuerzo, e ira en conducción.

2.3.4.2 Resultados y Conclusión

Los resultados aportan un modelo de regresión logística capaz de predecir la reincidencia y de explicar el 34% de la variabilidad, clasificando exitosamente al 77.6% de los participantes. En dicho modelo, el mejor predictor de la reincidencia es el consumo de alcohol de riesgo, seguido por la conducción incauta (pues el estilo de conducción precavido correlaciona negativamente con la reincidencia) y, en menor medida, la infraestimación del riesgo recreacional (tal vez podría asociarse a la búsqueda de sensaciones y la impulsividad), y la mayor sensibilidad al refuerzo (lo que haría pensar acerca de la baja efectividad de las medidas punitivas que se adoptan para intentar corregir la reincidencia).

3 CAPITULO I: Are Situation Awareness And Decision-Making In Driving Totally Conscious Processes? Results of A Hazard Prediction Task

Gugliotta, A., Ventsislavova, P., Garcia-Fernandez, P., Peña-Suarez, E., Eisman, E., Crundall, D., & Castro, C. (2017). Are situation awareness and decision-making in driving totally conscious processes? Results of a hazard prediction task. *Transportation research part F: traffic psychology and behaviour*, *44*, 168-179. doi: 10.1016/j.trf.2016.11.005

3.1 Abstract

Detecting danger in the driving environment is an indispensable task to guarantee safety, which depends on the driver's ability to predict upcoming hazards. But does correct prediction lead to an appropriate response? This study advances hazard perception research by investigating the link between successful prediction and response selection. Three groups of drivers (learners, novices and experienced drivers) were recruited, with novice and experienced drivers further split into offender and non-offender groups. Specifically, this works aims to develop an improved Spanish Hazard Prediction Test and to explore the differences in Situation Awareness, (SA: perception, comprehension and prediction) and Decision-Making ("DM") among learners, younger inexperienced and experienced drivers and between driving offenders and non-offenders. The contribution of the current work is not only theoretical; the Hazard Prediction Test is also a valid way to test Hazard Perception. The test, as well as being useful as part of the test for a driving license, could also serve a purpose in the renewal of licenses after a ban or as a way of training drivers. A sample of 121 participants watched a series of driving video clips that ended with a sudden occlusion prior to a hazard. They then answered questions to assess their SA ("What is the hazard?" "Where is it located?" "What happens next?") and "DM" ("What would you do in this situation?"). This alternative to the Hazard Perception Test demonstrates a satisfactory internal consistency (Alpha = .75), with eleven videos achieving discrimination indices above .30. Learners performed significantly worse than experienced drivers when required to identify and locate the hazard. Interestingly, drivers were more accurate in answering the "DM" question than questions regarding SA, suggesting that drivers can

choose an appropriate response manoeuvre without a totally conscious knowledge of the exact hazard.

3.2 Introduction

Situation Awareness (SA) can be a useful term to describe drivers' understanding of the relationship between themselves and other objects within the driving environment, with the ultimate aim of avoiding hazards on the road (e.g. Wetton, Hill & Horswill, 2013). These authors define hazard perception as 'the ability to predict dangerous situations on the road' (p65), which elegantly encapsulates the final output of the linear, three-stage model of Situation Awareness popularised by Endsley (e.g. Bolstad & Cuevas, 2010; Endsley, 1988, 1995). In this model, *perception* of the environmental elements precedes *comprehension* of their qualities and relevance to oneself, which allows one to project their future status (e.g. predicting their future locations). While good SA is not *sufficient* to guarantee an appropriate response, it could be argued that SA is at least necessary in order to decide upon the most suitable manoeuvre: whether to brake sharply, make a turn to avoid a hazard, or overtake. While the necessity of good SA seems obvious in support of selecting the correct behavioural response, this has not been tested in the field of driving. Furthermore, while there is much evidence to suggest that hazard prediction discriminates between drivers on the basis of experience, there is no research that has followed these predictions through to the response selection. It is a possibility that adding response selection to a hazard prediction test may enhance (or even degrade) the discriminative function of such tests. For this reason, the current study explores the link between SA and Decision-Making ("DM") using a hazard prediction methodology.

Pradhan and Crundall (2017) have defined hazard prediction as the extraction of hazard evidence from the potential hazard precursors in the scene, and then prioritising these precursors for iterative monitoring. They argue that this is a vital sub-process in the whole behaviour chain (from hazard searching to response selection) which they term *hazard avoidance*. In contrast they argue that the term *hazard perception* is often imprecisely used to refer to varying collections of sub-processes within the *hazard avoidance* process (including both perceptual and post-perceptual processes).

Despite the inexact terminology of *hazard perception*, the majority of research over the last five decades has focused upon the use of *hazard perception tests*. Traditionally these tests require participants to watch video clips from a driver's perspective and press a button as soon as they spot a developing hazard (though some also include a measure of location-based accuracy; e.g. Wetton, Hill & Horswill, 2011). Evidence suggests that safer and more experienced drivers respond faster to such hazards (e.g. Horswill & McKenna, 2004; McKenna & Crick, 1991; Wetton et al., 2011), and that performance on these tests can be linked to likelihood of collision (e.g. Boufous, Ivers, Senserrick & Stevenson, 2011; Horswill, Anstey, Wood & Hatherly, 2010). Indeed the introduction of the UK hazard perception test in 2002 has been directly linked to a significant decrease in on-road crashes (Wells, Tong, Sexton, Grayson & Jones, 2008). It should be noted however that not all studies have had success separating safe from less-safe drivers (Borowsky, Shinar & Oron Gilad, 2010; Chapman & Underwood, 1998; Sagberg & Bjørnskau, 2006; Underwood, Ngai & Underwood, 2013).

The Hazard Prediction Task (also known as the "What happens next?" test) is a variant on the traditional Hazard Perception task that assesses the predictive component of situation awareness for on-road hazards, asking participants to answer three questions that probe SA: "*What* is the hazard?" "*Where* is the hazard?" "*What happens next?" (WHN)*. Following the methodology of Jackson, Chapman and Crundall (2009), these questions are asked following occlusion of the video clip, which occurs just as the hazard begins to develop. In comparison with a traditional hazard perception methodology, evidence suggests that this hazard prediction test format is also good at discriminating between experienced, safer drivers and inexperienced, less-safe drivers (e.g. Castro et al., 2014, 2016; Crundall, 2016). However, one benefit of the hazard prediction test over the hazard perception test is that it removes post-perceptual biases from the measure, such as response criterion (where participants may delay responding to a perceived hazard because they feel it falls within their skill level to avoid it). Thus this prediction test is a potentially purer measure of one's ability to spot hazards. It is presumed that a correct prediction of the hazard is needed in order to make appropriate decisions about the manoeuvres to be performed (Endsley's, 1995, Horswill & McKenna, 2004; Jackson et al., 2009), but to date this has yet to be tested in a hazard prediction paradigm.

3.2.1 In-time critical Decision-Making processes and Situation Awareness

Individuals' ability to acquire SA has an impact on their decision-making. According to Smith (2013), making the right decision in a short period of time is crucial in driving. The accuracy of the decision made by the driver is based on his/her knowledge of the driving environment applied to the present context. However, the role that SA plays is not constant even in time-critical situations (SA). That is, it seems more crucial in non-standard situations or when anticipating hazards to have good SA, such as a high level of information about traffic, extraneous activity and unforeseeable events. Therefore, the analytical process of quantifying and qualifying SA should involve integrating "DM", and equally, SA should be analysed in order to discover in what form it could be used at the critical time, in order to make the right decisions.

Making a decision whether to keep the same speed and trajectory or make an avoiding manoeuvre may be considered a simple aspect of the driving task that could be carried out in a controlled way but also be primed by automatic processing. However, Groeger and Clegg (1998, page 145) stated that they were very doubtful indeed that the performance of any complex aspect of the driving task (e.g. changing gear) was automatic.

3.2.2 Driving Experience, Offender status and Hazard Prediction

It has been widely documented that differences in Hazard Prediction are found between different groups of drivers on the basis of experience and crash record (see Horswill, 2017, for a review). There is less evidence however regarding the impact of offender status on traditional hazard perception tests. We know that offenders are more likely to be involved in a collision (Laapotti, Keskinen, Hatakka & Katila, 2001; Simon & Corbett, 1996; Yahya & Hammarstroöm, 2011), and repeat offenders are especially dangerous (Lapham, Ring-Kapitula, C' de la Baca & McMillan, 2006). There has been some suggestion that drivers with multiple convictions score worse in Hazard Perception than non-offenders (e.g. Pelz & Krupat, 1974), but it seems more likely that the increased crash risk of offenders is driven mostly by high level of risk propensity (e.g. Hatfield & Fernandes, 2009) and perhaps alcohol/drug intake (e.g. Beirness, Simpson & Mayhew, 1991; Fell, 1993, 1995; Solnick & Hernenway, 1994). So why might violators have worse HP skills? It is possible that this could reflect a risk estimation bias: Perhaps violators see the obstacles but decide they are not hazardous to them because they overestimate their own skills. In other words, violators' poorer skills in hazard estimation could be due to a criterion bias, which the hazard prediction test should remove. This provides an additional potential benefit for using the prediction-based variant of the hazard perception test.

3.2.3 Research aims

The purpose of this study is to assess the relationship between drivers' SA and "DM" when performing a Hazard Prediction task, with the ultimate aim of further developing our Spanish Hazard Prediction Test (Castro et al., 2014), modified to suit the different driving context found in Spain and to determine its psychometric properties. We are hoping to improve the internal consistency of the test and to evidence validity, by discriminating between groups Specifically, we predict that learner and novice drivers should perform worse on this prediction test than experienced drivers, and this difference may become greater when one considers their decision making in regard to response selection. We may also find that offenders are worse at hazard prediction than non-offenders, though if previous results from hazard perception studies are due to criterion bias in their responding, we may find that offenders are equally good at predicting hazards as non-offenders.

3.3 Method

3.3.1 Participants

The number of participants in the current study was 121:69 male and 52 female. They were divided into three experience groups: (a) 20 young learner drivers (16.5%), aged between 18 and 37, taking lessons in order to pass their driving test, (b) 62 novice drivers (50.4%) aged between 18 and 39, already qualified but with no more than eight years' driving experience and (c) 40 drivers with experience (31.1%), aged between 26 and 53, who had driving licenses of various kinds. Of those already possessing driving licenses, 20 in the novice group and 20 in the experienced group were repeat offenders.

The average age of the novice drivers was 23 years, with between 3 and 7 years of post-licensure driving experience (*M* = 4.54 years, *SD* = 2.75). All novices reported driving on a weekly basis. In contrast, experienced drivers' average age was 38 years, with 8 or more years of post-licensure experience (*M* = 20.97 years, *SD* = 8.14).

Significant differences were found in number of kilometres driven between learners (280.20 km/year), younger inexperienced drivers (11318.82 km/year) and experienced drivers (27975.67 km/year), taking into account the complete sample $F(2, 95) = 5.578$, $p = .004$ (with repeated contrasts showing differences between all levels) . Also, significant differences were found in years of driving experience between learners (1 year), younger inexperienced drivers (4.54 years) and experienced drivers (20.97 years) taking into account the complete sample, $F(2, 103) = 108.353$, $p = .001$, with repeated contrasts again confirming differences at each level comparison). In the current research, the experienced group of drivers was recruited from beyond the student population to ensure sufficient experience, though learner and novice drivers included students.

Offender drivers were recruited from different driving schools in Granada (La Victoria, Luna and Genil, Granada, Spain). These participants were attending a driving education course following a succession of violations, resulting in a loss of license points (opposite to the UK system where drivers gain points due to violations).

3.3.2 Design

Mixed ANOVAs were performed. The repeated measures factor was the type of question (4) (SA questions ["What", "Where", "WHN"] and the "DM" question). The between subjects factors were: driving experience (3) and offender status (2). As the assumption of sphericity was violated, we used the Greenhouse-Geisser correction. Here the *dependent variable* is the accuracy mean for the 4 questions (ranging from 0 to 2 points).

3.3.3 Equipment

3.3.3.1 Videos

During late 2012 and early 2013, a total of 300 videos, recorded from the driver's viewpoint, were made in the city of Granada, Spain, by two members of the research team who were also experienced drivers. Recording conformed with the Nottingham protocol (Crundall, 2016; Jackson et al., 2009). Sixteen of the 300 high definition (HD) video-clips, with a resolution of 1920 X 1080, were selected for use in the test. Hazards consisted of cars, motorcycles, trucks and pedestrians that entered the path of the film car and would have caused a collision without the driver making an avoidance manoeuvre. The film clips were edited to cut to a black screen just as the hazard began to develop. In Table 1 can be seen a description of the videos used.

It is worth noting that the participant's point of view was passive (as the driver of the car from which the videos were recorded). There was no active involvement of the driver in the unfolding hazard situation. All hazards, therefore, could be considered passive hazards. There were no accidents during the video recording of naturalistic driving. This research followed the ethical principles required for researching with human beings (Declaration of Helsinki).

Participants were shown the videos in the following way: a blank screen with the corresponding numerical code was presented initially and then immediately replaced by the driving scene, which lasted for between 6 and 25 seconds.

Table 1. Description of these hazard situations.

Video Code	Length (Sec)	Discrimination (inclusion)	Vehicle	Type of road	Visibility	Description of the video content	Expected Driver Response to the Decision Making Question	
							Manoeuvres performed by the real driver: 2 points Score	Other appropriate avoiding manoeuvres 1 point Score
9	16.09	Yes	Car	Highway	Clear	A car stops in the middle of a junction between two exits, and changes direction	Swerve to the left	Move forward Speed up
28*	11.49	Yes	Car	Highway	Clear	The red car in the left lane suddenly invades our lane while trying to dodge another car that has stopped	Sharp brake	Gradual brake
31*	12.04	Yes	Car	Minor Road	Less clear	A car is joining the road at an intersection	Sharp brake	Gradual brake
32	15.08	Yes	Car	Urban Road	Less clear	A car suddenly joins the road and moves into the left lane	Gradual brake	Sharp brake
84	12.04	Yes	Car	Urban Road	Less clear	A car is approaching an intersection in reverse	Maintain same speed and direction	-
95	20.27	Yes	Car	Urban Road	Hindered by other vehicles	A car that was parked is reversing into the road	Gradual brake	-
103	24.48	Yes	Car	Urban Road	Hindered by other vehicles	A car hidden behind other cars in a car park is reversing into the road	Gradual brake	-
118	11.02	Yes	Car	Urban Road	Clear	A car, that suddenly starts indicating, is moving into our lane from the left-hand lane	Gradual brake	Sharp brake
130*	20.48	Yes	Car	Urban Road	Hindered by other vehicles	A towed car has moved into our lane in front of us	Sharp brake	-
169	19.04	Yes	Motorcycl e	Urban Road	Clear	A motorcycle appears in front of us and performs a manoeuvre that is not allowed in order to join the left lane, invading our lane	Gradual brake	Move forward Swerve to the left
197	18.05	Yes	Pedestrian	Urban Road	Hindered by other vehicles	A pedestrian is about to cross the road	Gradual brake	Sharp brake
205*	19.54	No	Car	Highway	Clear	The car that is ahead of us slows down due to the heavy traffic	Swerve to the right	Gradual brake
215	14.08	No	Truck	Minor Road	Less clear	A butane truck suddenly appears in the opposite lane, heading towards us	Gradual brake	Sharp brake
216	6.11	No	Car	Urban Road	Hindered by other vehicles	A car suddenly joins the road at an intersection	Sharp brake	Gradual brake
226	15.04	No	Car	Urban Road	Hindered by other vehicles	Overtaking a double-parked ambulance is another car that is trying to reverse into its lane	Sharp brake	Swerve to the right
230*	19.46	No	Pedestrian	Urban Road	Hindered by vegetation	A pedestrian is about to cross on a zebra crossing	Gradual brake	-

*Videos that does not discriminate (Alpha value under .30)

3.3.3.2 Questionnaire

For the study, a questionnaire was used to collect participants' answers to the three SA questions and the "DM" question. Following initial pages for instructions and demographic questions, 16 pages repeated the four questions for each clip: (SA Q1) "What is the hazard?" (SA Q2) "Where is it located?" (SA Q3) "What happens next?", and (DM Q) "What would you do in this situation?".

Scoring was as follows. For "What is the hazard?" two points were obtained if the description of the hazard was correct (e.g. "The green car!"), one point if the answer was partially correct but lacking detail about its characteristics that might distinguish it from other exemplars in the scene (e.g. "A car…?"), and zero if the answer given was incorrect.

For "Where is the hazard?" participants were asked to mark a cross on a pictorial representation of the last frame (but without any hazard elements included). This picture was similar to a line-drawing of the scene in blank ink, though it was actually created using Adobe Photoshop and then edited to remove all potential hazards, (see the drawing in Figure 1). The sketch contained enough detail to enable the participants to identify the location without hesitation if they had correctly spotted the imminent hazard before occlusion. Each answer sheet had a picture that was specific to a particular clip. Participants drew an X on the picture where they anticipated the hazard to be immediately after the video was cut. If this cross fell within an invisible target square that matched the extreme boundaries of the hazard, the participant was awarded two points. If the cross fell within a one cm boundary around the target square, the participant was awarded a single point. Zero points were obtained if the cross was drawn in any other position.

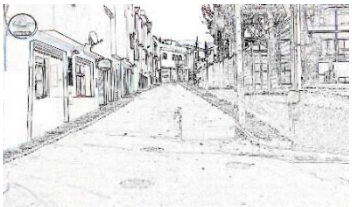		
Figure 1a. Example of the sketch that was used (the relevant objects and possible obstacles (pedestrians, cars, bicycles, etc.) were removed)	Figure1b. The sketch that was not used.	Figure1c. Example of the restricted areas. Restricted area Near-Restricted area

Figure 1. Example of an edited sketch of the last photogram (with all the relevant obstacles removed) displayed in each video, printed on each answer sheet (a). The original schematic drawings of the road frame with all the relevant objects and possible obstacles (pedestrians, cars, bicycles, etc.). This was not used (b). An example of the restricted and the near-restricted areas on the photogram is provided (c). This was used for correction of the "Where is the hazard?" question.

For the "What happens next?" question, participants obtained two points if they described exactly what would happen, e.g. "The car ahead will have to brake sharply to avoid colliding with the red car merging from the right", one point if the answer was incomplete but pointed towards the answer, and zero if the description was incorrect.

The fourth question regarding their decision of how to respond ("What would you do in this situation?") was presented with eight possible answers, of which the first seven were possible manoeuvres (i.e. "sharp brake", "gradual brake", "maintain same speed and direction", "speed up", "move forward", "swerve to the left" and "swerve to the right") and the last alternative was left as an open answer (i.e. other), where the participant could suggest an alternative manoeuvre.

For the DM question, two points were given if the exact manoeuvre performed by the film driver was provided. Other appropriate avoiding manoeuvres 1 point score. And zero points if the answer was incorrect. Expert drivers' judgments were taken into account to establish the correct and incorrect answers. The manoeuvres are described in the right-hand columns of Table 1.

In order to distinguish the question about what would happen next in the driving environment from the DM process, a clarification was added to the "What happens next?" question (SA Q3) explaining that this answer should be independent of what the participant would actively do if he/she was the driver of the car filming the traffic scene.

3.3.4 Procedure

The 121 participants in this experiment comprised drivers from different experience groups (learners, novices and experienced drivers) and profiles of offending (offenders/non-offenders), grouped accordingly. Before beginning, a researcher gave them instructions on how to follow the task and respond to the questionnaire and they filled in the demographic information form. The time required to carry out the entire study was around 90 minutes. The task was performed in groups (with group size averaging 15). Participants sat between 3 to 5 m from a projection screen measuring 1.53 y 2.44. All video clips were presented in a fixed (though initially random) order, matching the order of the answer sheets in the response booklet.

3.3.5 Data Analysis

The participants' answers were corrected by a first evaluator, but 50% of the questionnaires were corrected by a second evaluator, independently. The degree of agreement between the two was assessed for each question. Cohen's Kappa was calculated. The level of agreement between the two evaluators was considered high s: κ

= .95 for “What is the hazard?” and κ = .94 for “What happens next?” These data confirmed the consistency of the corrections

The scores were subjected to classic item analysis, calculating the discrimination indices; and reliability analyses, estimated with Cronbach’s (1951) Alpha coefficient. All group comparisons were based on mixed between- and within-subjects analysis of variance.

The differences that achieved a level of .05 were considered statistically significant (Cohen, 1988; Richardson, 2011). Levene’s test was calculated to evaluate the assumption of homogeneity of variance and the KS test to check assumption of normality. All the post-hoc analyses (i.e. planned and pairwise comparisons) were subjected to Bonferroni’s adjustment. The program used for the statistical analyses was SPSS (version 19), IBM Statistics.

Finally it should be noted that the same participants also contributed data to a recent publication (Castro et al., 2016), though the other paper was concerned with the impact of a training intervention (listening to a driving commentary) on hazard prediction scores. The current paper reports a novel focus and analysis.

3.4 Results

3.4.1 Internal consistency

This Hazard Prediction Test was first tested with 16 videos and the initial value obtained for Cronbach’s Alpha coefficient was .73. Following this, 5 of the videos were removed because they showed a low index of discrimination (less than .30). The final test was composed of eleven videos. They showed indices of discrimination higher than 0.30 and the final Cronbach’s Alpha Coefficient of the test was .75.

3.4.2 Main Results

3.4.2.1 Non-offender drivers: Analysis of type of question (SA and "DM") and experience

A 4×3 mixed ANOVA was performed: 4 questions ("What?", "Where?", "WHN?" and "DM") X 3 levels of driving experience in the non-offender drivers' sample, with question type being the within groups factor. Question type produced a main effect [$F(3,75) = 31.726$, $p < .001$, $\eta^2_p = .56$]. Pairwise comparisons showed significant differences between all questions, except between the "What?" and "DM" ones. The "What?" question (M = 0.89) (SA Q1) was more correctly answered than both the location question ("Where?") (M = 0.77) (SA Q2) or the prediction question ("What happens next?") (M = 0.56) (SA Q3). Interestingly, the "DM" question (M = 0.87) was answered correctly more often than the "Where?" and "What happens next?" questions (see Figure 2).

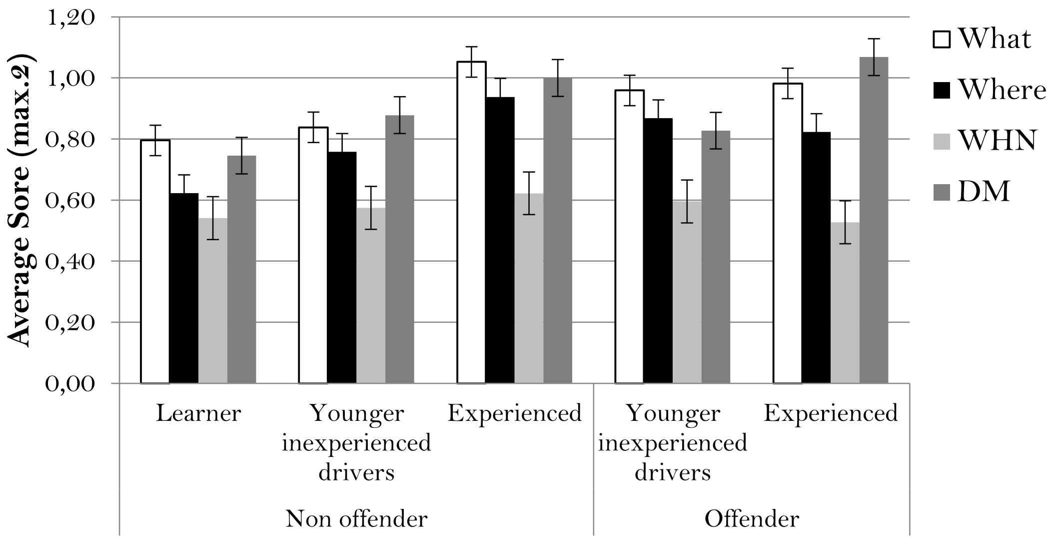

Figure 2. Accuracy mean total for the 4 questions: SA [Q1"What is the hazard?" (What?), Q2 "Where is it?" (Where?) "What happens next?" (WHN?)] and Decision-Making ("DM"); by non-offender (learner, younger inexperienced and experienced) drivers and offender (younger inexperienced and experienced) drivers; and showing error bars.

A main effect of experience was also found [$F(2,77) = 6.20$, $p = .003$, $\eta^2_p = .14$], though the interaction was not significant [$F(6,150) = 1.27$, $p = .270$, $\eta^2_p = .05$].

3.4.2.2 Offender drivers: Analysis of type of question (SA and "DM") and experience

A 4×2 mixed ANOVA was performed: 4 questions ("What?", "Where?", "WHN?" and "DM") X 2 levels of driving experience in the offender drivers' sample. Question type was the only repeated measures factor manipulated. Question type was found significant [$F(3,369 = 27.019$, $p < .001$, $\eta^2_p = .69$]. Paired comparisons revealed the same pattern of results to those in previous analyses with a decrease in mean accuracy across the three SA questions ($M = 0.96$ Vs. $M = 0.83$ vs $M = 0.55$ respectively), while mean accuracy to the "DM" question ($M = 0.94$) was significant better than both the "where?" question (SA Q2) and the "what happens next?" question (SA Q3).

While the experience effect was not significant [$F(1,38) = .285$, $p = .597$], a significant interaction between the two factors was noted [$F(3,38) = 5.56$, $p = .020$, $\eta^2_p=.13$]. Planned comparisons identified that inexperienced offenders ($M = 0.83$) only differed to the experienced offenders (M=1.07) in the "DM" question [$t(97) = 2.83$, $p = .010$].

3.4.2.3 Analysis of the type of question by experience and offender status

A 4x2x2 mixed ANOVA was performed across the 4 questions ("What?", "Where?", "WHN?" and "DM") X 2 levels of driving experience X 2 offender status of drivers (non-offender and offender). Question type was the only repeated measures factor manipulated.

Question type produced a significant main effect [$F(3,94) = 50.33$, $p < .001$, $\eta^2_p = .62$]. Paired comparisons revealed the same pattern of results to those in previous analyses with a decrease in mean accuracy across the three SA questions (*M* = 0.92 vs. *M* = 0.79 vs *M* = 0.57 respectively), while mean accuracy to the "DM" question (*M* = 0.90) was significantly better than both the "where?" question (SA Q2) and the "what happens next?" question (SA Q3). In addition, a significant experience effect was found [$F(1,96) = 3.99$, $p = .040$, $\eta^2_p = .04$]. Experienced drivers (*M* = 0.88) obtained higher scores than younger inexperienced drivers (*M* = 0.79). No significant effect of offender status was found.

3.4.3 Subjective estimates of driving skills

Participants estimated their driving skills, their awareness of other drivers and their self-confidence in driving. They used a 6-point scale (1=No, 6=excellent). Significant differences in the three questions were found between the experience groups (learners, novice and experienced drivers). In fact, learners showed significantly lower scores than experienced drivers in all the questions. In addition, younger inexperienced drivers showed significantly lower scores than experienced drivers in self-rated driving ability (see Table 2). Differences were also found between non-offenders and offenders, excluding learner drivers, particularly in the self-reported measures of driving ability and self-confidence in driving, where the offender group showed higher scores than the non-offender group.

These self-reported measures were correlated with the SA questions. A Pearson correlation between these variables showed that self-reported measures were correlated with each other ($p < .001$), as were the SA questions ($p < .001$). Only the "What?" question was correlated with self-rated driving ability and self-confidence in driving ($p < 0.05$) (see Table 3).

Table 2. Comparisons of driving skills for experience condition and offender status.

	Learner *M*(*SD*)	Novice *M*(*SD*)	Experienced *M*(*SD*)	*F* (*df*)	*p*	η^2
Driving Ability	2.94 (1.73)	4.79 (1.02)	5.33 (.66)	31.93 (2.12)	<.001	.36
Awareness of Others	3.56 (1.59)	5.10 (.91)	5.45 (.68)	22.61(2.12)	<.001	.28
Self-confidence in Driving	3.38 (1.82)	5.05 (1.06)	5.40 (.63)	20.68(2.11)	<.001	.27
		Non-offender *M*(*SD*)	**Offender** *M*(*SD*)	*t*	*p*	η^2
Driving Ability		4.82 (.99)	5.28 (.75)	-2.474	.015	.06
Awareness of Others		5.20 (.77)	5.30 (.94)	-.604	.550	.00
Self-confidence in Driving		5.02 (.95)	5.45 (.85)	-2.337	.021	.05

Note: *M* = Mean; *SD* = Standard Deviation; *F* = One-way between-groups ANOVA (top) t= Independent Samples t-test (bottom); *df*= degrees of freedom *p*= significance level ; η^2= Size Effect.

Table 3. Correlations between the Hazard Prediction questions and driving skills (self-estimations)

	What	Where	WHN	"DM"	Driving ability	Awareness of others	Self-confidence in driving
What	1	**.62****	**.39****	**.30****	**.23***	.11	**.19***
Where		1	**.55****	**.35****	.17	.08	.10
WHN			1	**.19***	.12	.01	.07
"DM"				1	.16	.14	.077
Driving ability					1	**.72****	**.81****
Awareness of others						1	**.78****
Self-confidence in driving							1

Note.. WHN? = What Happens Next?; DM = Decision Making

**=The correlation at $p < 0.01$ (2-tailed) was considered significant.

*=The correlation at $p < 0.5$ (2-tailed) was considered significant

3.4.4 Socio-demographic and driving variables

In addition to the above analyses we analysed whether socio-demographic variables affected the answers provided by the participants to the four questions for each clip. Regarding gender, it was found that men were more likely to be correct (*M* = 9.31, *SD* = 2.81) than women (*M* = 8.02, *SD* = 2.73) when answering "Where is the hazard?"

[t(116) = 2.493, p = .014, η^2_p = .12]. However, age and educational level did not show significant differences in test performance.

Among the participants, 17.5 % (N = 21) worked as professional drivers. This sample obtained better results than the rest in the "Where is the hazard?" question (M = 8.56, SD = 2.82 for non-professional drivers; M = 9.57, SD = 2.87 for professional drivers) [t(1189) = -2.411, p = .017, η^2_p = .05] and for "What would you do in this situation?" (M = 9.53, SD = 2.97 for non-professional drivers; M = 11.38, SD = 3.61 for professional drivers) [t(118) = -2.487, p = .014, η^2_p = .05]. Additionally, people whose work involved driving (N = 36) showed significantly better results in both identifying [t(117) = -3.06, p = .003, η^2_p = .08] and locating [t(116) = -2.63, p = .010, η^2_p = .06] the hazard, when compared with other groups. Finally, no relationships were found between the efficacy of test performance and type of accident or near misses, nor for withdrawal of license or fines.

Regarding subjective estimates of driving skills, the socio-demographic characteristics in these variables were compared. Results indicated that men (M = 5.10, SD = 1.42) obtain higher scores in driving ability than women (M = 4.25, SD = 1.93) [t(115) = 3.924, p < .001, η^2_p = ,12] and men show more self-confidence in driving than women [t(112) = 3.004, p < .003, η^2_p = ,07]. Furthermore, age is correlated with the three driving skills (driving ability: r = .335, p < .001; awareness of others: r = .257, p < .001; self-confidence in driving: r = .242, p < .001] and there are statistically significant differences between educational levels in self-confidence in driving [F(5,114) = 2.337, p = .047, η^2_p = .10]. Tukey tests isolated these differences between two educational levels: drivers with Higher Education (non-compulsory) studies show higher levels of self-confidence in driving than drivers with a vocational degree (M = 4.69 SD = 1.34).

Professional drivers gave higher ratings of their driving ability (M = 4.57, SD = 1.38) than non-professional drivers (M = 5.29, SD = 0.644; t(116) = -2.320, p = .022, η^2_p=.04). Additionally, people whose work involves driving gave significantly higher ratings on all three subjective scales. People whose work involves driving gave a mean of 5.50 (SD = .56), while people whose work does not involve driving gave an average of 4.34 (SD = 1.39) in driving ability [t(116) = -4.823, p < .001, η^2_p = 0.18]; people whose work involves driving (M = 5.42, SD = 0.77) present higher scores than people whose work does not involve driving (M = 4.83, SD = 1.21) in awareness of others [t(115) = -2.683, p = .008, η^2_p = .06]; and people whose work involves driving (M = 5.47, SD = 0.61) present higher scores than people not involved in driving for work (M = 4.70, SD = 1.39) in self-confidence in driving [t(115) = -3.191, p = .002, η^2_p = .08]. In addition, the driving experience (nº years with driving license) correlated with the driving skills (r = .358, p < .001; r = .295, p < .001; r = .244, p = .013, respectively). Finally, no relationships were found between the efficacy of test performance and types of accident or near misses, nor for withdrawal of license or fines.

3.5 Discussion

3.5.1 Experience affects hazard prediction

The target of this research was to further develop our Hazard Prediction test for driving in a Spanish setting and to determine its psychometric properties, exploring the effect of driver experience and driving profile on the detection and prediction of various hazardous situations displayed on video, and to assess the relationship between SA and DM. The test showed sufficient psychometric reliability and discrimination indices. An acceptable Cronbach's Alpha coefficient was achieved (α = .750). Cronbach's Alpha coefficient is dependent on the items' sample size. While the current study only used a small sample of video-items, the test still achieved good internal consistency.

The skill of correctly predicting "What will happen next?" in a hazardous situation was found to depend on the driver's experience. This extends beyond research that has previously compared novice and experienced drivers (Crundall, 2016, Jackson et al., 2009; Lim, Sheppard & Crundall, 2014) and demonstrates that this skill develops across a wider spectrum of experience than we may have first thought, from learner, through to highly experienced (see also Castro et al., 2014; 2016; Ventsislavova et al., 2016). As this predictive skill underlies the whole hazard avoidance process (Pradhan & Crundall, 2017), and is therefore crucial to safe driving (Horswill & McKenna, 2004), it follows that authorities should make efforts to improve hazard prediction in novice and learner drivers.

Spanish government needs to bring in a test to encourage training. Hazard prediction assessment and training is essential to detect hazards that appear abruptly at the driving environment. In addition, performance in gradual-onset obstacles can be improved after training, teaching drivers where to look, identifying and prioritising potentially hazardous areas of the visual scene (Castro et al., 2016).

3.5.2 Offender status does not affect hazard prediction

In relation to offender and non-offender status, there were no significant differences between them, which supports the previous results of Castro et al., (2014). This previous study suggested that multiple driving offenders obtained similar results to non-offender drivers in the Hazard Prediction test. Thus the source of their increased crash risk does not appear to come from offenders' inability to perceive hazardous precursors and predict imminent hazards. It is more likely that their increased crash propensity derives from risk taking which is, at least partly, linked to their self-confidence in their own driving skills. Perhaps their overconfidence decreases safety margins in responses to hazardous stimuli? If this is the case, one might expect an effect of offender status upon accuracy to the "DM" question, yet no effect was found. It remains possible however that the options provided for the "DM" question were not sensitive enough to detect risky behaviours in hazard responding. For instance both offenders and non-offenders may choose the "swerve to the right" option for a particular clip, but these responses do not identify the fact that offenders might choose to swerve to the right at the very last instant, whereas non-offenders might swerve much sooner. It remains an interesting research challenge to develop future options that might have a greater chance of discriminating between offenders and non-offenders.

3.5.3 Complete SA is not required to select the most appropriate response

Perhaps the most striking result of the current study comes from comparing the scores for the three SA questions to response accuracy for the "DM" question, with the latter introduced for the first time on comparable scales of measurement. While the three SA questions appear progressively more difficult (as predicted by a linear SA process, and as noted by Jackson et al., 2009, though see Endsley, 2015), the results suggest that drivers are more accurate in identifying the most appropriate manoeuvre to be performed than in locating the hazard and predicting what happens next in the driving environment. It seems that it is possible to ascertain how to behave appropriately without having complete SA to support the decision. This could be a useful survival mechanism. While drivers are able to use controlled processes to make the decisions necessary to perform accurate manoeuvres, in time-critical moments unconscious processing, or automatic responding, could also influence their performance. In support of this, other researchers (Creswell, Bursley, & Stapute, 2013; Langsford & McKenzie,

1995) have suggested that decision making tasks can be influenced by both implicit (unconscious) and explicit (conscious) processes.

Inference processes vary. Some of them are more automatic, rapid and easier, while others seem controlled, slower, more difficult and demanding (Evans, 2008; Sloman, 1996, 2002). They depend on different cognitive systems: automatic vs. controlled. In addition, the number of alternatives to think about (or "the contrast class") affects the grade of difficulty in reasoning (Barrouillet & Lecas, 1998, Oaksford & Stenning, 1992, Schroyens, Schaeken & Y'dewalle, 2001; Wason, 1961). That is, different conclusions are reached when we negate a binary class such as 'it is not a man' than when we negate a non-binary class, e.g., 'it is not red'.

In our case, initial mental models can be considered easy for the questions "What is the hazard?" and "Where is it?" but they may also be important when asked '*"What would you do in this situation?"*. We believe that all the potential alternatives can be encapsulated in just two ways of manoeuvring. The two main alternatives available after perceiving a hazardous driving situation are: a) keeping the same speed and direction (when an almost-hazard is perceived), b) performing an avoidance manoeuvre (when a hazard is perceived; e.g. braking progressively or abruptly or changing direction).

Those inferences that require thinking of a greater number of alternatives (see Johnson-Laird, 2006, 2008), such as with the "What happens next?" question, could be considered harder and more time-consuming. They require a prediction to be made about the future of the driving situation, based on the information previously processed, which involves considering a greater number of alternatives.

While the conclusion that complete SA is not necessary for "DM" is appealing, there is a caveat. The fact that the "DM" question provided 8 options to choose from meant that there was a 12.5% chance that the participants could guess the answer without even seeing the accompanying video, let alone correctly predicting the hazard. Furthermore, some answers are more likely than others (e.g. 'braking' might appear a more natural answer than 'swerving'), and if these popular answers matched the correct answers this could inflate the "DM" score over and above the free response required for the SA questions. This possibility needs to be explored in future research.

3.5.4 Modest novices and boastful offenders

Participants were asked to estimate their driving skills, such as driving ability, awareness of others and self-confidence in driving. According to Horrey, Lesch, Mitsopoulos-Rubes and Lee (2015) drivers estimations of their abilities are often inflated or erroneous. They also state that such misjudgments in calibration result in poor decision making, or risky behavior (e.g. younger inexperienced drivers may over-estimate their misperceived their skills and drive too fast on slippery surfaces).

In the current study, significant differences were found between those with different driving experience in all three self-rated scales relating to driving skills, though in the current study our inexperienced drivers claimed less driving ability and self-confidence than experienced drivers, as well as less awareness of others. This apparent contradiction of Horrey et al. (2015), suggests that if younger inexperienced drivers travel at high speed on a slippery surface, it could have more to do with their ability to judge the demands of the roadway. Thus inexperience in calibrating their perceived skills to the apparent demand of the roadway, rather than overconfidence in their skills per se, may be a greater cause of collision.

Furthermore, significant differences were found between offender and non-offender drivers: the offender group showed higher scores than the non-offender group in all three driving skills when self-reported. It is the offender group who shows greater overconfidence. If we assume that at least experienced offenders are as good at predicting hazards as non-offenders, then any miscalibration between perceived skill and roadway demands is more likely to come from the former rather than the latter (i.e. they may accurately judge the danger in a situation, but mis-judge their ability to deal with it).

In regards to other demographic factors, age and educational level showed no significant differences in test performance. Conversely it was found that professional drivers, and people whose work involved driving, performed significantly better at both identifying and locating the hazard when compared with other groups. Therefore, we can conclude that when it comes to differences, only experience can be considered as a determining variable.

Finally, the results showed relationships between socio-demographic characteristics and subjective driving skills (driving ability, awareness of others and self-confidence in driving). In the main, men showed greater self-confidence in driving than women; there were positive correlations between age and the three subjective driving skills, and also in the number of years since passing the driving test. Professional driving and work that involves driving are significant indicators of higher subjective driving skills.

3.5.5 Future research and implications

As this is the first attempt to link hazard prediction with decision making regarding response selection, it is inevitable that future research questions will be raised. While, the SA questions have been used several times previously (e.g. Jackson et al., 2009), this is the first time that a "DM" question has been used in this context. Accordingly while we feel confident in the (albeit null) conclusion that the current study does not suggest a difference between offender and non-offender hazard prediction, we are less confident that offenders might choose the same response option as non-offenders. As noted above, this may be affected by the sensitivity of the response options to the underlying dimensions in which offenders differ in their real world behaviour (e.g. offenders may choose the same response as non-offenders but may choose to trigger this response later than non-offenders when in the real world. Alternatively one could argue that the location of testing (during a driver re-education course), and the nature of the tasks, may have led to demand characteristics contaminating the measure. Further research varying the nature of the "DM" question and response method is required.

Another route for future research is to compare offenders' performance to non-offenders performance across both a hazard prediction test and a hazard perception test. If the traditional hazard perception methodology suggests offenders to be worse than non-offenders, but the hazard prediction test does not, then we can conclude that the hazard perception group differences are more likely due to post-perceptual processes, such as criterion bias, rather than perceptual problems.

While correct "DM" may not be entirely dependent on the ability to articulate SA completely within this current methodology, the strong correlations between SA questions and "DM" demonstrate a significant relationship which benefits from driving experience. The implications are clear. If hazard prediction is a key element in avoiding collisions, policy makers need to provide the conditions under which inexperience drivers can develop their prediction skills in safe environment. Two options are possible. First, governments might opt for a graduated licensing system which gently increases exposure to difficult driving situations, rather than the step-change in difficulty that many new drivers face after passing their test. This would allow them to develop their predictive powers in relative safer environments, before moving to more demanding types of driving. A more targeted intervention however might be for governments to introduce a hazard perception (or hazard prediction task) as part of the national licensing procedure as has happened in the UK, the Netherlands, and in some states of Australia. Wells et al., (2008) reported the beneficial effects of having introduced the UK hazard perception test, with a significant reduction in collisions. This was presumably due to a mixture of preventing the worst drivers from obtaining a license, and from a change in training practices, with driving instructors focusing more upon the higher order skills relating to the detection of hazards, in order to ensure that their pupils pass the test. On this basis we recommend that policy makers in different countries consider the introduction of some form of hazard perception test as a requirement for all learner drivers to pass. This will hopefully accelerate the usual experiential development of drivers' predictive powers, and help reduce collisions involving inexperienced drivers.

3.6 Acknowledgments

We are grateful to the Spanish participants who volunteered for the tests as well as to the two anonymous reviewers whose comments enabled us to improve the manuscript and to our English editor Barbara Lamplugh for revising and improving the English. We are also indebted to the Junta de Andalucía (Proyecto Motriz P11-SEJ-7404), and the Spanish Government, MICINN (PSI2013-42729-P), all of whom gave us financial support. This research was supported by the Spanish Dirección General de Tráfico – DGT (0100DGT21263 and SPIP2015-01782) and the three driving schools in Granada (Autoescuelas la Victoria, Luna and Genil) from whom we obtained our sample of participants. We much appreciate their contribution to the study. We gratefully acknowledge support from the resources supplied by the Centro de Servicios de Informática y Redes de Comunicaciones (CSIRC) and by the Facultad de Comunicación y Documentación, both from the University of Granada. The study design, data collection, analysis and interpretation were carried out independently of the

funding bodies, as were the writing up of the experiment and the decision to seek publication.

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4 CAPITULO II: Proactive Listening To A Training Commentary Improves Hazard Prediction

Castro, C., Ventsislavova, P., Peña-Suarez, E., Gugliotta, A., Garcia-Fernandez, P., Eisman, E., & Crundall, D. (2016). Proactive listening to a training commentary improves hazard prediction. *SafetyScience*, *82*, 144-154. doi: 10.1016/j.ssci.2015.09.018

4.1 Abstract

The aim of this work was to explore the effect of Proactive Listening to a Training Commentary, using the recently developed version of the Spanish Hazard Perception test. Firstly, 16 videos were used in the pre-test session in its short version, cut to black just before the hazard appearance. The What Happens Next Assessment (at the pre-test stage) generates expectations about the outcome of the traffic situation. Then, the training (8 minutes in length) uses the complete version of the same 16 videos, revealing the hazards unfolding. It involves listening to a voice with relevant information about where to allocate attention in the complex driving scene in order to recognise and anticipate the hazard successfully. A total of 121 participants were included in this study. The sample consisted of learner, novice and experienced drivers, including re-offender and non-offender drivers. The participants were divided into 2 groups: a trained and an untrained group. Two assessment times were used: pre-test (16 videos) and post-test sessions (another 16 videos). The test presented a high internal consistency (Alpha = .875). This training shows significant positive effects for all types and groups of participants. No significant differences were found between the non-offender and the offender groups. Performance in gradual-onset hazard events can be improved after training but also by practice; however this training is essential and especially beneficial for training the ability to detect hazards that appear abruptly (which seems to be difficult to improve just by practice).

4.2 Introduction

The ability to perceive hazards while driving is a factor that reduces the risk of having accidents (Wells, Tong, Sexton, Grayson & Jones, 2008; Horswill, Anstey, Hatherly & Wood, 2010a). A hazard in the traffic context is any permanent or temporary object which remains in the road environment and has the potential to increase the risk of an accident (Jackson, Chapman & Crundall, 2009). Hazard perception is the skill of detecting, evaluating and reacting to events on the road that have a high probability of producing a collision (Crundall et al., 2012) and is the only specific driving ability that correlates with a lower crash risk (Wells et al., 2008; Horswill et al., 2010a). Therefore, it is considered that improving the skill of hazard perception through training could decrease the crash risk. Beanland, Goode, Salmon & Lenné (2013) assert that the training of higher-order cognitive skills, such as hazard perception, addresses the broader driving context, particularly anticipating or avoiding hazardous situations. Recognition of the importance of these cognitive skills has led to a proliferation of driver training programmes that directly target these skills.

In fact, it seems worth questioning whether training improves the ability to detect hazards of only learner drivers and drivers with less experience. It is possible that training could be effective for all groups of drivers, including those with considerable driving experience, safe drivers and re-offenders. However, training may not be equally effective when drivers are exposed to different types of hazard. It would also be interesting to find out whether practice in itself, using *What Happens Next* exercises (WHN) (McKenna & Crick 1997), would be enough to improve hazard perception test scores. In each of these exercises, trainees had to view video footage of a traffic situation, which was freeze-framed at a given point (usually just before a hazard was encountered) and at that point trainees were asked "what might be about to happen".

Nevertheless, as Wetton, Hill & Horswill (2013) explained, the WHN exercises did appear to have a significant immediate training effect, independent of the expert commentary exercises, but the magnitude of this effect was reduced. That is, if one had to choose between using either WHN exercises or expert commentary exercises, then one would choose the latter. According to Endsley (1995), Situation Awareness operates at three levels that support hazard perception and make it possible to answer the three main questions: "What is the hazard?", "Where is the hazard?" and "What happens next?" which means perceiving and understanding the hazardous situation and anticipating future driving events (Jackson et al., 2009).

Specifically, Wetton et al. (2013) investigated what type of training would be most useful to improve hazard perception by using video-based tests featuring real driving footage at three points: immediately prior to the test (pre-); immediately post-test (post-); and after a one-week delay. They created four types of video training. The first was WHN, based on McKenna and Crick (1997) as referred to above. The second video was expert commentary training. The third type was hybrid commentary training (i.e., expert plus self-generated commentaries); and the fourth consisted of a full training package (i.e., WHN plus hybrid commentary training). All four types of training presented significant results compared with results from untrained groups. However, full training resulted in the greatest improvement and *WHN* Training the least. The addition of self-generated commentaries to the expert commentary training (hybrid commentary condition) did not significantly improve response times. All training effects decayed considerably after the delay, but the effect of full training remained significant. Although no benefit was found in adding self-generated commentaries to expert commentaries, the possibility remains that the *WHN* exercises may provide an additional benefit when combined with commentary training.

In another study, Isler, Starkey & Williamson (2008), taught drivers how to identify hazards by detecting clues from the environment using commentary training while concurrently performing a secondary tracking task, simulating the steering of real driving. After the training, novice drivers detected a higher percentage of hazards and had faster response latencies compared to a baseline than those without training.

Crundall, Andrews, Van Loom & Chapman (2010) investigated whether learner drivers would benefit from being trained to produce a commentary drive. They compared one group of commentary-trained learner drivers to a control group. The results showed that the trained group had fewer crashes, reduced their speed sooner on approaching hazards and applied pressure to the brakes sooner than untrained drivers.

There is also evidence that training in hazard perception benefits both novice and older drivers as they both reduce their significantly speed when approaching hazards (Horswill, Kemala, Wetton, Scialfa & Pachini 2010b). For instance, Horswill et al. (2010a) used a video of a driver's eye view of hazardous traffic situations. The participants in the trained group heard an expert driving instructor giving a running commentary on the footage, indicating what he was paying attention to and giving general advice about anticipating hazards. The following excerpt from the commentary is typical: *"Scanning ahead. Looking over the crest of the hill. Car turning left. Approaching traffic. More cars coming towards us. Cars on the right. Checking amongst the trees."*

On the other hand, Meir, Borowsky & Oron-Gilad (2014) explored the formulation and evaluation of a new HP training test –the Act and Anticipate Hazard Perception Training (AAHPT) in young novice-drivers. There were three types of test mode (*Active*, *Instructional and Hybrid*) and a Control group. *Active members* observed video-based traffic-scenes and were asked to press a response button each time they detected a hazard. *Instructional members* underwent a tutorial which included both written material and video-based examples regarding HP. *Hybrid members* received a condensed theoretical component followed by a succinct *Active* component. The Control group was presented with a road safety tutorial. According to their results, one week later, the *Instructional* mode demonstrated inferiority in comparison to the other two modes; the *Active* and the *Hybrid* mode members were more aware of potential hazards relative to the control group.

However, the *Instructional* mode of training could be carried out as an active mode of training too. As McKenna, Horswill & Alexander (2006) pointed out, commentary training improved drivers' situational awareness and led them to a better appreciation of the risks, by encouraging them to actively search for hazards. Although commentary training doesn't necessarily require a simulator response, it still provides an active search guide to the participants. The fact that commentary training based on instructions can be applied without using a simulator means that a less expensive tool is available that doesn't require great amounts of time, money or effort and that could be just as effective. During the hazard perception exercise and when the video footage is cut, the driver generates a process which consists of selection of information and decision making. Once commentary training begins (visualizing the complete driving scene), drivers initiate an active listening process, which directs the top-down allocation of attention and generates expectations in drivers as to what may happen in the immediate future. Participants are eager to find out *WHN*, or in other words, they expect feedback from their performance, which is the best guide they could have. Indeed, these sequences of action assume an active role by drivers that culminates in expectations. It can also guide their attention as well as arousing expectations of receiving feedback on their performance.

Moreover, it seems worth exploring whether the training has a different effect on the improvement in their perception according to the kind of hazard. Underwood, Ngai & Underwood (2013) suggested the following classification of hazard situations: those where hazards appeared gradually vs. those where hazards appeared abruptly. The gradual onset hazard videos are those that show events unfolding (for example, a football flying out of a driveway can predict that children are nearby). (Horswill &

McKenna, 2004; Underwood, 2007). However, the abrupt onset hazards are those that involve the abrupt capture of attention and exogenous events (for instance, a pedestrian appearing suddenly). This type of hazard is under consideration for inclusion in driving tests, but it could be considered that what they are testing is the viewer's speed of reaction rather than their ability to assess a scenario and anticipate how the situation will develop. Experienced drivers gained an advantage in those situations where the hazard appeared gradually. This is probably due to the fact that gradual onset provides clues that allow experienced drivers to figure out how the situation will develop. So, it is expected that experienced drivers may have a more developed awareness of events on the motorway and of the behaviour of other road users.

Furthermore, according to White, Cunningham & Crundall (2011) young drivers show an optimism bias for their driving skills and accident risk perceptions. In addition, when comparing their driving self-assessment with their actual behaviour, there are indications that they overestimate their driving skills (De Craen, Twisk, Hagenzieker, Elffer & Brookhuis, 2011). On the other hand, multiple road offenders obtain different hazard prediction scores from normal/safe drivers (see the classic study by Pelz and Krupat, 1974). The implication is that good drivers are more likely to avoid accidents than are drivers with a record of offending. According to Simon and Corbett (1996), results of accident history are positively related to offending. The number of accidents and offences is higher among young men and their index of accidents is higher than those of women or older drivers (Laapoti, Keskinen, Hatakka & Katila, 2001; Yahya & Hammarstroöm, 2011). Lapham, Ring-Kapitula, C'de la Baça and McMillan (2006) stated that repeat offenders are more likely to be involved in fatal motor vehicle crashes, hit and run collisions with pedestrian fatalities and to have a high blood alcohol concentration (BAC) when driving (0.15 mg/dl and above) than first-time DUI offenders (Beirness, Simpson & Mayhew, 1991; Fell, 1993, 1995; Solrick & Hernenway, 1994).

4.2.1 Research Aims

The first research aim was to assess the effect of the video-based Proactive Listening to a Training Commentary (PLTC)on participants' hazard prediction performance, and secondly, to compare the improvement of performance in hazard prediction skills of groups of different driving experience (,learner, novice and experienced drivers) and non-offenders vs. re-offenders, in various types of hazardous situation. That is, in order to check whether different hazardous situations distinguish between drivers, two hazardous situations were manipulated: hazards that appeared gradually (where the hazard could be predicted by using clues from the environment) and hazards that appeared abruptly (the abrupt hazards appear a few milliseconds before the video stops, requiring direct detection).

For these purposes, a new and improved version of the Hazard prediction Test adapted to a Spanish driving context (HP-WHN, Castro et al., 2014) was used to measure the targets, emulating the *WHN* test (McKenna & Crick, 1997; Jackson et al., 2009) for the assessment. Clips between 6 and 26 seconds long were presented to the participants and were stopped immediately prior to the hazardous situation and then three questions were asked for each video: What is the hazard? Where is it located? and WHN? The primary task was to detect and identify the impending hazardous traffic scenarios and following this, participants were exposed to the commentary training guidance provided by an expert, while watching the complete version of the pre-test videos and carrying out an active listening task. The commentary training had a guide function for participants, leading their attention to what was relevant, i.e. where to look and how to use the visual information to make predictions.

4.3 Method

4.3.1 Design

Different mixed ANOVA designs were used in this study. The dependent measure was accuracy of the participants in the test (i.e. average in the HP test, max. 6). The 3 repeated measures independent variables were session (pre-test; post-test) and type of question (What is the hazard?, Where is the Hazard? and What Happens next?), and two types of hazard (gradual and abrupt onset hazards). The 3 independent variables measured between groups were training condition (trained group; untrained group), experience of the drivers (learner, novice and experienced drivers) and recidivism condition (non-offenders vs. re-offenders). The sphericity assumption was not achieved; therefore, the Greenhouse-Geisser correction was used.

4.3.2 Participants

A total of 121 drivers took part in the current study; 69 participants were men and 52 were women. Three experience groups were considered (see Table 1, top): (a) 20 (16.5%) learner drivers (18-37 years) who were attending lessons to obtain a driving licence for the first time, (b) 62 (50.4%) novice drivers (18-39 years) who were in possession of a driving licence and had less than eight years' driving experience, (c) 40 (31.1%) experienced drivers (26-53 years) who possessed different types of driving licence. Specifically, 20 of the novices and 20 of the experienced drivers were re-offenders. Re-offender drivers was recruited from collaborating driving schools in Granada (Spain) while they attended a driving re-education and recidivism prevention course (i.e., the course known as "*Re-obtaining the total number of points*", which is compulsory in Spain for drivers who have been banned from driving after losing all the available points of their driving licence); their socio-demographic characteristics are shown in Table 1, bottom.

All participants were recruited from either collaborating driving schools in Granada (Autoescuela la Victoria, Autoescuela Luna and Autoescuela Genil-Ogíjares, Granada, Spain) or the School of Psychology of the University of Granada. Ethical principles in the declaration of Helsinki for research involving human participants were followed in the current study.

4.3.3 Materials

4.3.3.1 Videos

Thirty-two HD (high definition) videos with a resolution of 1920 X 1080, taped from the driver's viewpoint, were used for the test. For the recording of the videos, the protocol developed by the University of Nottingham, UK was used in order to control the bias involved in recording (see Wetton, Hill & Horswill, 2011). A total of 300 videos were recorded in the city of Granada (Andalucía, Spain), during the autumn of 2012 and spring of 2013, by two experienced drivers who are part of the research team. Driving routes were chosen according to the Accidents Report of 2011 (National Department of Traffic, 2012). The videos included different road types, comprising 11% motorway outside the city (A-44 and A-92 highway) and 89% urban roads (the neighbourhoods of Sacromonte, Almanjayar and Zaidin, which are typical Andalusian). Hazard situations consisted of 50% cars, 25% pedestrians, 7% motorcycles, 11% trucks and 7% buses. These hazards appeared out of side streets, at junctions etc.

All videos were preserved in their original version and have not been retouched. There were no accidents during the recordings. Ethical principles in the declaration of Helsinki for research involving human participants were followed.

Table 1. Socio-demographic information for the three experience groups of drivers and drivers' profile (recidivist or not recidivist)

Non recidivist drivers	**Learner drivers**					**Novice drivers**					**Experienced drivers**				
Socio-demographic information	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
Age	20	18	37	20,30	4,23	41	18	29	21,93	2,61	20	27	53	37,10	8,37
Gender[a]	18	1	2	2	--	41	1	2	2	--	20	1	2	1	--
Level of education[b]	20	3	6	4	--	41	3	6	4	--	19	2	6	4	--
Years driving regularly[c]	20	1	1	1	--	41	2	3	2	--	20	4	4	4	--
Years since obtaining driving license	5	0	4	1,00	1,73	40	0	10	3,55	2,90	20	11	37	20,35	7,85
Driving frequency[d]	16	1	5	5	--	41	1	5	2	--	20	1	2	1	--
Kilometres driven last 12 months	10	0	1000	280,20	435,69	35	0	60000	4922,06	10956,90	20	150	100000	35087,50	34305,39
Accidents last 12 months	13	0	1,00	0,08	0,28	37	0	2,00	0,19	0,52	20	0	2,00	0,20	0,52
Quasi-accidents last 12 months	15	0	3	0,60	0,99	41	0	20	2,37	3,84	20	0	26	7,40	7,47
Traffic incidents- Insurance company	16	0	0	0	0,00	41	0	3	0,17	0,54	20	0	2	0,30	0,57
Nº of times losing driving license	10	0	0	0	0,00	41	0	1	0,02	0,16	20	0	0	0,00	0,00
Traffic tickets received	14	0	0	0	0,00	41	0	2	0,10	0,37	20	0	2	0,35	0,67
Multiple Offenders															
Age	--	--	--	--	--	19	21	39	25,32	4,498	20	26	51	38,70	8,50
Gender[a]	--	--	--	--	--	20	1	2	1	--	20	1	2	1	--
Level of education[b]	--	--	--	--	--	20	1	6	3	--	20	1	6	3	--
Years driving regularly[c]	--	--	--	--	--	20	3	3	3	--	20	4	4	4	--
Years since obtaining driving license	--	--	--	--	--	19	4	12	6,68	2,110	20	10	33	20,55	8,62
Driving frequency[d]	--	--	--	--	--	20	1	5	1	--	19	1	5	1	--
Kilometres driven last 12 months	--	--	--	--	--	14	0	150000	27310,71	41096,08	19	0	130000	20489,53	32467,94
Accidents last 12 months	--	--	--	--	--	18	0	2,00	,2778	0,57	18	0	2	0,17	0,52
Quasi-accidents last 12 months	--	--	--	--	--	18	1	17	5,17	4,61	17	0	7	2,59	1,70
Traffic incidents- Insurance company	--	--	--	--	--	17	0	2	,47	0,80	17	0	2	0,18	0,53
Nº of times losing driving license	--	--	--	--	--	19	0	2	1,00	0,58	18	0	2	0,94	0,59
Traffic tickets received	--	--	--	--	--	19	0	3	1,42	1,22	18	0	3	1,11	1,08

Median valued reported: (a) 1 = Female. 2 = Male. Median value reported.
(b) 1 = Primary. 2 = Secondary (compulsory). 3 = Secondary (non-compulsory). 4 = Vocational. 5 = Grade. 6 = Master.
(c) 1 = Learning to drive. 2 = Up to 2 years. 3 = Between 3-7 years. 4 - 8 or more years. Median value reported.
(d) 1 = Daily. 2 = Weekly. 3 = Monthly. 4 = Never.

The presentation of each video was as follows: First, a black screen with the corresponding numerical code of the video appeared and then immediately following this, one of the driving scenes was presented at random. The clips' duration ranged between 6 and 26 s. and they were stopped immediately prior to the hazardous situation, immediately cutting to a black screen which concluded the trial.

4.3.3.2 Proactive Listening to a Training Commentary (PLTC)

For the training session, a full version of the first 16 videos (pre-test) was developed, which included a voice that described in detail the complete traffic scene. The guide revealed the most important clues from the environment that would help to detect the hazards. An example of the PLTC that guided the participants' eye movements and visual search was as follows: *"We are on the A-92 heading towards Guadix at the height of Loma Verde, where it crosses the motorway from Granada to Jaen. The truck in front of us has just left the highway to Jaen. A red car on the motorway access lane is trying to join our lane. ATTENTION, perhaps we cannot facilitate its access to the lane because another vehicle behind us is approaching fast, so we would not be able to perform the manoeuvre."*

4.3.3.3 Questionnaire

For the study, a new and improved version of the HP-WHN test (Castro et al., 2014) was used. This new version of the HP-WHN test contains a brief demographic questionnaire and a total of 32 response forms (1 page per video) for all 32 video clips, including instructions on how to complete it. Participants were required to complete the response form at the end of each video clip by responding: (1) What is the hazard? (2) Where is it located? and (3) WHN?

For 'What is the hazard?' participants obtained 2 points if they gave an exact description of the hazard (e. g. red car in the left lane), 1 point if they gave a partially correct answer (e.g. a car on the left, but without giving any details of its characteristics or location or if there was more than one) and 0 points for an incorrect answer. For 'Where is the danger?' 2 points were given if the cross was marked in the restricted area where the hazard appeared, 1 point if the cross appeared near or around the restricted area and 0 points if the cross was outside the two previous areas. Finally, to score the 'WHN?' question, 2 points were given if an exact description of what would happen was provided: "The car yielded because it could not change lane and allow the red car to merge smoothly with the traffic", 1 point if the description was not complete, and 0 points if the answer was incorrect.

4.3.4 Procedure

A total of 121 participants took part in this study and all of them were pre-assigned to different groups: groups that were exposed to the PLTC and Control groups. Prior to the experiment, participants were provided with instructions and at the same time, an experimenter explained to them how to answer the questionnaire. They all completed a demographic information form before the beginning of the experiment.

Participants completed the test in group sessions. They filled in the socio-demographic questionnaire individually. Then the video clips were presented in groups while the participants were seated at a distance of between 3 and 5 metres from a projection screen. The videos were shown on the screen at a 1920 x 1080 resolution using a video projector connected to a standard computer. After each clip, participants were required to complete the response booklet following each video, answering 'What is the hazard?', 'Where is the hazard?' and 'WHN?

The study consisted of two experimental parts: During the first part, both trained and untrained groups were presented with the 16 Session A clips. Each clip started from a black screen and ended on a black screen immediately prior to the hazardous event, with a self-paced progression dependent on the amount of time participants required to fill in the questions between clips. Following the pre-test clips, the trained group were presented with the complete version of these videos (the guide voice described the complete version of the first 16 traffic scenes used for the assessment), providing all the details that lead the attention to what is relevant in the traffic scene, in order to detect the hazard easily, and also the outcome of the traffic environment providing delayed feedback. Participants had to carry out an active listening task, paying closer attention to the guide and the traffic scene. The control group took a break of 10 minutes. The trained group also took a break of 10 minutes after the intervention.

During the second part of the study and after the break, the post-intervention assessment was undertaken. Both groups (Trained and Untrained) had to watch the 16 Session B video clips (videos 17 to 32) and the procedure was identical to the first part. At the end of the experiment, both groups were asked whether they had any doubts or wanted more details about the study. For ethical reasons, when the Untrained group asked for an explanation, they were allowed to watch the PLTC videos too, and in that way they received the training at the end of the experiment, once the pre and post-session measures had been taken.

4.3.5 Data analysis

Once data collection was completed, to confirm the consistency of marking, 50% of the score sheets (randomly chosen) were scored by an independent researcher, and agreement was measured using Cohen's Kappa for each question. According to these analyses, the two evaluators generally agreed on the response correction $\kappa = .95$ for 'What is the hazard?', 'Where is the hazard?' $\kappa = 1$ and $\kappa = .94$ for 'WHN?'

Disagreements were discussed and a conclusion was reached on each occasion. Given the high level of agreement, a single researcher scored the remaining scripts.

The scores obtained from pre-test and post-test clips were jointly submitted to classic item analysis and reliability analysis. In particular, a minimum acceptable item-total correlation was set at .30 and a high Cronbach's Alpha of .875 for each total scale was expected.

Only the videos that achieved discrimination indices greater than .30 were taken into account in the analysis. That is, 11 videos out of 32 (5 from the pre-test and 6 from the post-test) that did not accomplish this criterion, were withdrawn from further analysis. The final version of the hazard prediction test was composed of the 21 remaining hazardous situation video clips (11 videos are pre-test and 10 are post-test). Average scores were calculated for all 21 videos and then separately for the 11 pre-test and 10 post-test sessions. Average score was calculated separately for the 9 gradual-onset hazard events and 12 abrupt-onset hazard events. It should be noted that the scores obtained with these two types of video clip were also divided into pre-test and post-test. This distinction was intended to measure separate issues and the interpretation of the scores was actually different for gradual-onset hazard events and abrupt-onset hazard events.

Effect size is listed as partial Eta squared (η^2_p), demonstrating the proportion of the total variance explained by a variable that is not explained by other variables in each mixed model ANOVA specified. Effect sizes (η^2_p and η^2) of mixed model and paired-samples would be considered as follows: .01 a small effect size, .06 a medium effect size and .14 a large effect size (Cohen, 1988; Richardson, 2011). The level of statistical significance was set at .05 in all analyses Planned comparisons were used as a post hoc test with Bonferroni correction. All statistical analyses were performed using IBM SPSS Statistics v19 for Windows.

4.4 Results

4.4.1 Psychometric properties

Taking into account the discrimination indices of the items are greater than .30, this version of the Hazard prediction Test consists of 21 videos (11 videos are pre-test and 10 are post-test), with an Alpha coefficient of .875. Table 2 shows the descriptive statistics of the test items and the discrimination indices.

Table 2. Descriptive Statistic of the items in the new Hazard prediction Test.

Video	Mean	Standard Deviation	Discrimination Index
1	2.75	1.61	.62
5	3.61	1.41	.39
6	3.25	1.21	.44
8	1.02	1.75	.46
10	0.47	1.08	.40
11	3.80	1.55	.42
13	1.66	2.05	.38
14	3.49	1.08	.43
15	2.74	1.60	.50
16	2.50	1.73	.36
17	4.64	1.39	.75
18	4.36	1.51	.58
19	3.53	1.61	.53
20	2.80	1.96	.46
21	2.83	1.98	.55
22	3.37	1.46	.53
23	3.05	1.89	.47
27	4.04	1.62	.73
30	2.97	1.17	.32
31	3.22	1.52	.45
Total	3.00	1.56	

4.4.2 Training effects

A (2)×2 mixed-model ANOVA was conducted with session (pre-test and post-test) as the repeated measures factor and training (trained and untrained) as the between subjects factor. A significant main effect between pre versus post-test [Wilks' Lambda

= .67, $F(1,119) = 59.654$, $p = .001$, $\eta^2_p = .33$] and significant interaction between pre- versus post-test and training group was found [Wilks' Lambda = .92, $F(1,119) = 10.642$, $p = .001$, $\eta^2_p = .08$]. Paired-samples t-tests indicated that the HP scores of the trained group in PLTC improved between pre-test (2.19; average scores out of 6) and post-test (3.05) [$t(60) = -7.532$, $p = .001$, $\eta^2_p = .49$] and the untrained group also improved between pre-test (2,3) and post-test (2.6), [$t(59) = -3.265$, $p = .002$, $\eta^2_p = .15$]. The trained group (3.05) outperformed the untrained group (2.6) in post-test [$t(119) = 2.008$, $p = .047$, $\eta^2_p = .03$] (Figure 1).

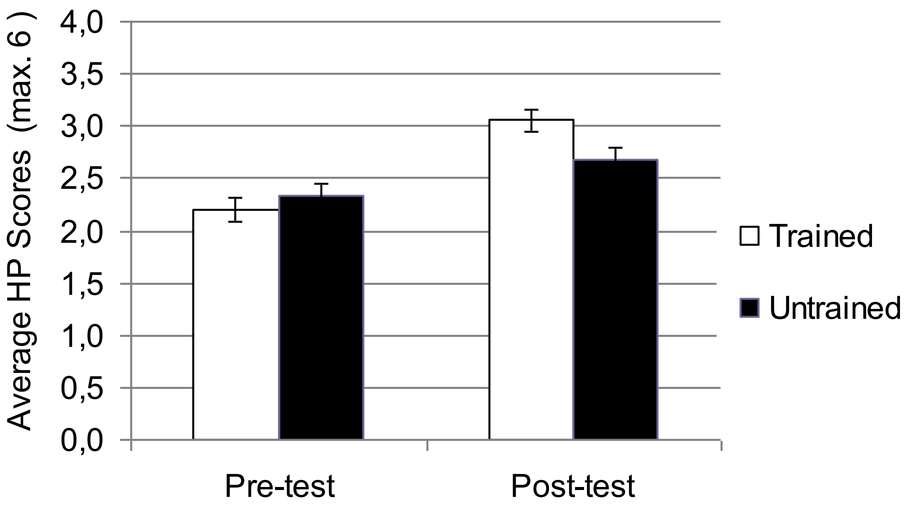

Figure 1. Mean hazard prediction scores (the scale was composed of six points) pre-test and post-test for the trained and untrained groups. Error bars represent standard errors of the mean

4.4.2.1 Effect of the training and type of stimulus

A (2)×(2)×2 mixed-model ANOVA was conducted, where the repeated measures independent variables were session (pre- and post- session) and type of stimulus (gradual and abrupt hazards) and the independent variable measured between groups was training condition (trained and untrained).

The 3-way interaction between session, type of stimulus and training was not significant [Wilks' Lambda=1.00, $F(1,118) = 0.007$, $p = .934$, $\eta^2_p = .00$]; for this reason one 2x2 mixed model ANOVA per type of stimulus was conducted.

The 2-way interaction between the session (pre- and post- session) and training condition (trained and untrained) was found to be significant [Wilks' Lambda = .913, $F(1,118) = 11.188$ $p = .001$, $\eta^2_p = .09$].

The 2-way interaction between the session (pre- and post- session) and type of stimulus (gradual and abrupt hazards) was also found to be significant [Wilks' Lambda = .891, $F(1,118) = 14.424$, $p = .001$, $\eta^2_p = .11$]. These were the only significant interactions found.

The main effect of type of stimulus was significant [Wilks' Lambda = .657, $F(1,118) = 61.489$, $p = .001$, $\eta^2_p = .34$]. Gradual-onset hazard events ($M = 2.18$) are more difficult to detect than abrupt-onset hazard events ($M = 2.87$). It was for this reason that a specific analysis for each type of hazard (abrupt and gradual) was performed, in order to compare the results of the different groups of drivers.

The main effect of session was also significant [Wilks' Lambda = .532, $F(1,118) = 103.744$, $p = .001$, $\eta^2_p = .47$].

No more main effects were found to be significant.

4.4.2.1.1 Training gradual hazards

A (2)×2 mixed-model ANOVA was conducted with session (pre-test and post-test of gradual-onset hazard events) as the repeated measures factor and training (trained and untrained) as the between subjects factor. The results showed a significant main effect between pre- versus (1.74) post-test (2.62) in gradual-onset hazard events [Wilks' Lambda = .635, $F(1,118) = 67.947$, $p = .001$, $\eta^2_p = .37$] and a significant interaction between pre- versus post-test and training group was found [Wilks' Lambda = .954, $F(1,118) = 5.731$, $p = .018$, $\eta^2_p = .05$]. Paired-samples t-tests indicated that the scores of the trained group in gradual-onset events improved between pre-test (1.6) and post-test (2.8) [$t(59) = -7.639$, $p = .001$, $\eta^2_p = .50$] although the untrained group also improved between pre-test (1.8) and post-test (2.4) [$t(59) = -4.074$, $p = .001$, $\eta^2_p = .22$], (See Figure 2).

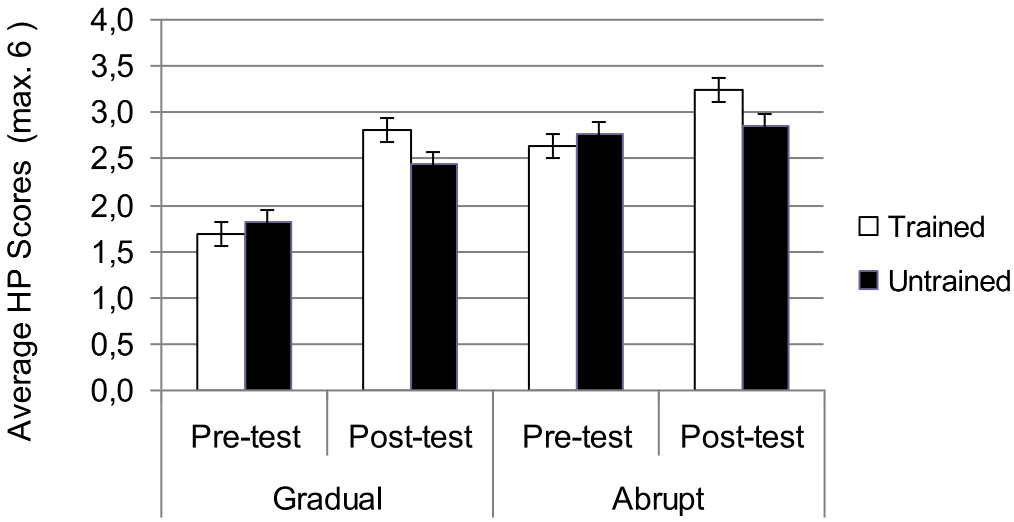

Figure 2. Mean gradual and abrupt-onset hazard events (the scale was composed of six points) pre-test and post-test for the trained and untrained groups. Error bars represent standard errors of the mean

4.4.2.1.2 Training abrupt hazards

A (2)×2 mixed-model ANOVA was conducted with session (pre-test and post-test of abrupt-onset hazard events) as the repeated measures factor and training (trained and untrained) as the between subjects factor. A significant main effect between pre-test (2.6) versus post-test (3.2) was found in abrupt-onset hazard events [Wilks' Lambda = .91, $F(1,119) = 11.751$, $p < .001$, $\eta^2_p = .09$] and a significant interaction between pre- versus post-test and training group was found [Wilks' Lambda = .94, $F(1,119) = 7.113$,

$p = .009$, $\eta^2_p = .06$]. Paired-samples t-tests indicated that the scores of the trained group in abrupt-onset hazard events improved between pre-test (2.6) and post-test (3.2) [$t(60) = -4{,}255$, $p = .001$, $\eta^2_p = .23$] but there was no significant difference between pre-test (2.7) and post-test (2.8) in the untrained group [$t(59) = -.545$, $p = .587$, $\eta^2_p = .01$], Figure 2.

4.4.3 Experience effects

4.4.3.1 Effect of training and driving experience

A (2)×2×3 mixed-model ANOVA was used to examine the differences between session (pre-test and post-test) as the repeated measures factor, training (trained and untrained) and the groups of drivers with different traffic experience (learner, novice and experienced drivers) as the between subjects factors. Significant main effects between pre- versus post-test [Wilks' Lambda = .72, $F(1,115) = 44.683$, $p = .001$, $\eta^2_p = .28$] and the interaction between session and training group were found [Wilks' Lambda = .94, $F(1,115) = 6.928$, $p = .010$, $\eta^2_p = .06$]. A significant main effect of experience was found [$F(2,115) = 5.915$, $p = .004$, $\eta^2_p = .09$]. Paired comparisons showed that experts (3.24) outperform learner drivers (2.34) in the post-test. All the experience groups improved their performance after training, but this improvement was greater for those drivers who already held a driving license: novices and experts. The biggest improvement was found for the trained group of experienced drivers, who improved their performance between pre-test (2.3) and post-test (3.3). The trained group of novice drivers also improved their performance between pre-test (2.2) and post-test (3.0) but not as much. And finally, the trained group of learner drivers improved their performance the least between pre-test (1.8) and post-test (2.3), Figure 3.

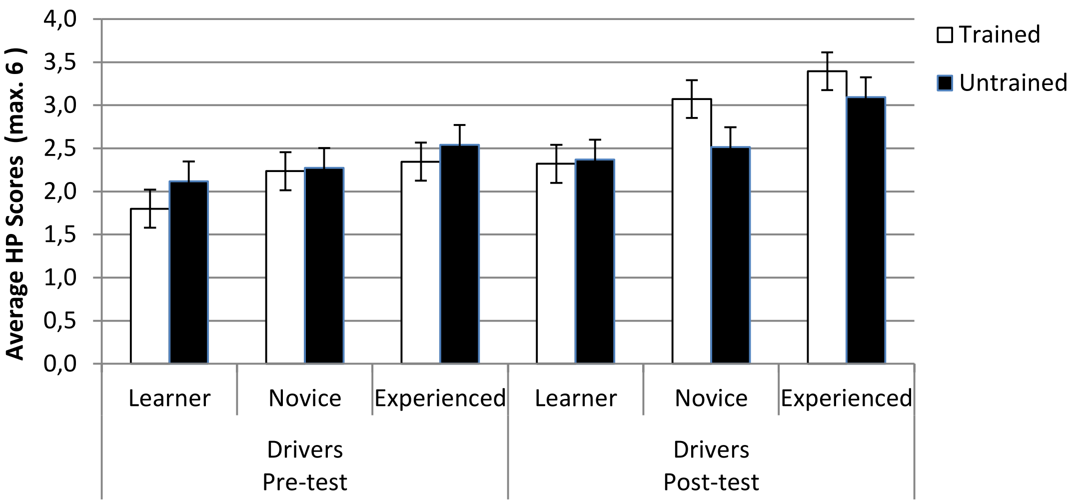

Figure 3. Mean hazard prediction scores (the scale was composed of six points) of learner, novice and experienced drivers in the pre-test and post-test for the trained and untrained groups. Error bars represent standard errors of the mean.

4.4.4 Effect of the training and recidivism

A (2)×2×2 mixed-model ANOVA was used to examine the differences between session (pre-test and post-test) as the repeated measures factor and, training (trained and untrained) and the groups of drivers with different driving records, recidivism (multiple road offenders and non-offender drivers)) as the between subjects factors. To conduct this analysis, learners were excluded. Significant main effects between pre- versus post-test [Wilks' Lambda = .64, $F(1,97) = 54.456$, $p = .001$, $\eta^2_p = .36$] and the interaction between session and training group were found [Wilks' Lambda = .89, $F(1,97) = 11.788$, $p = .001$, $\eta^2_p = .18$]. The main effect of recidivism was not significant [$F(1,97) = 0.101$, $p = .752$, $\eta^2_p = .00$], the averages of multiple road offenders were 2.38 in pre-test and 2.98 post-test; and the averages of non-offender drivers were 2.21 in pre-test and 2.81 post-test.

4.4.5 The effect of experience and type of question vs. type of hazard

A (3)×(2)×3 mixed-model ANOVA was used to explore the differences between the repeated measures type of question (What, Where and WHN) and type of stimulus (gradual and abrupt hazards) and the between groups measure of experience condition (learner, novice and expert).

The 3-way interaction between the three factors was not significant [Wilks' Lambda = .97, $F(2,116) = 1.638$, $p = .199$, $\eta^2_p = .03$]

The 2-way interaction between the type of question and the type of stimulus was significant [Wilks' Lambda = .54, $F(1,116) = 17.902$, $p = .001$, $\eta^2_p = .13$]. It was for this reason that a specific analysis for different types of hazard (abrupt and gradual) was performed.

No more interactions were found to be significant.

Three main effects were significant: The main effect of type of question [Wilks' Lambda = .44, $F(1,116) = 20.486$, $p = .001$, $\eta^2_p = .15$] was significant. The main effect of type of stimulus [Wilks' Lambda = .51, $F(1,116) = 109.39$, $p = .001$, $\eta^2_p = .48$] was significant. The main effect of experience [$F(2,116) = 6.21$, $p = .003$, $\eta^2_p = .10$] was significant.

4.4.5.1 Experience and type of question in gradual hazards

A (3)×3 mixed-model ANOVA for the gradual-onset hazards was used to examine the differences between type of question (What, Where and WHN) as the repeated measures factor and the groups of drivers with different traffic experience (learner, novice and experienced drivers) as the between subjects factors. Significant differences were found for gradual-onset hazards related to the type of question/hazard [Lambda Wilks = .785, $F(1,117) = 3.355$, $p = .050$, $\eta^2_p = .03$] and significant main effects for the type of experience [$F(2,116) = 3.915$, $p = .023$, $\eta^2_p = .06$]. Planned comparisons showed significant differences between learners ($M = 0.57$ maximum 2 points) and experts ($M = 0.77$ maximum 2 points), $p = .020$. Specially, significant differences were found in 'What is the hazard?' ($p = .013$) and in 'Where is the hazard?' ($p = .028$) questions. In addition, a significant difference between learners and novices was found ($p = .028$) in 'What is the hazard?' and a marginal significance between these groups (learners and novices) in 'Where is the hazard' ($p = .073$) (Figure 4 top).

4.4.5.2 Experience and type of question for abrupt hazards

A (3)×3 mixed-model ANOVA for the abrupt-onset hazards was used to examine the differences between type of question (what, where and WHN) as the repeated measures factor and the groups of drivers with different traffic experience (learner, novice and experienced drivers) as the between subjects factors.

Similar results were found for abrupt-onset hazards: there were significant differences for type of question related to the type of hazard [Lambda Wilks = .38, $F(1,117) = 30.582$, $p = .001$, $\eta^2_p = .21$] and significant main effect for the type of experience [$F(2,117) = 6.811$, $p = .002$, $\eta^2_p = .10$]. Planned comparisons showed significant differences between experts ($M = 1.09$ maximum 2 points) and learners (.82 maximum 2 points), $p = .002$; and between experts and novice drivers (.93 maximum 2 points), $p = .021$. Specially, these significant differences were found in 'What is the hazard?' and 'Where is the hazard?' questions (Figure 4 bottom).

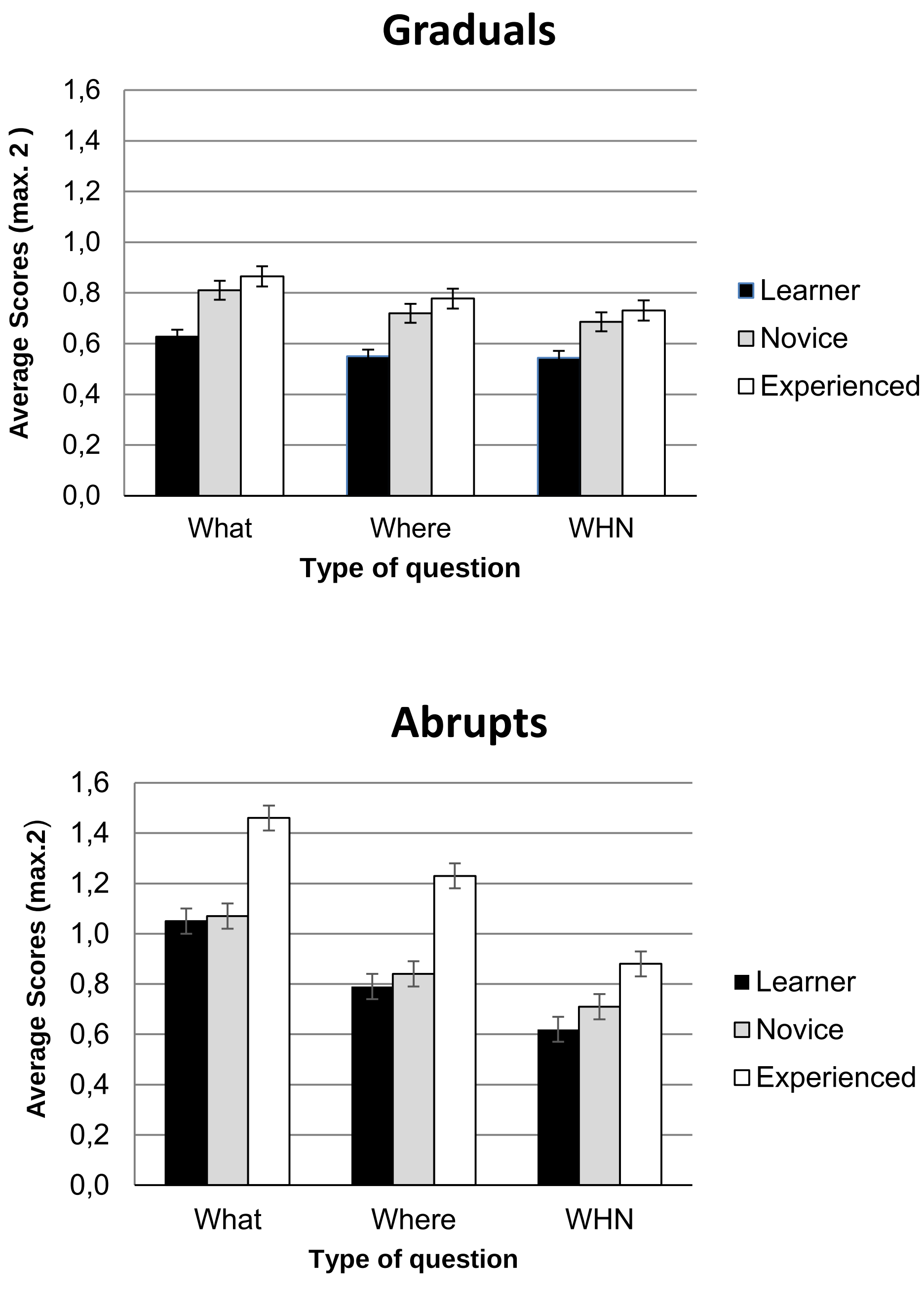

Figure 4. (Top/Down) Mean hazard prediction scores of gradual and abrupt onset hazards (average max. 2) per question, for learner, novice and experienced drivers. Error bars represent standard errors of the mean.

4.5 Discussion

For the current research, a new and improved version of the Hazard prediction Test was created for a Spanish sample. The first research aim was to assess the effect of the video-based PLTC on participants' hazard prediction performance, and the second was to compare the improvement of performance in hazard prediction skills of groups with different driving experience (experts, novices, learner drivers), in various types of hazardous situation. That is, in order to check whether different hazardous situations discriminate between safe and unsafe drivers, two hazardous situations were manipulated: hazards that appeared gradually (where the hazard could be predicted by using clues from the environment) and hazards that appeared abruptly (requiring direct detection).

A new version of the video clips was developed, considering previous literature (e.g., Crundall et al., 2010, 2012; Jackson et al., 2009; Wetton et al., 2011) and previous work of this research team (Castro et al., 2014).

We have improved the selection of videos (which ended with a sudden occlusion prior to the hazardous situation starting, yet with enough information for the viewer to predict or at least make an educated guess as to what might happen next). The video photograms were cut precisely, in the exact millisecond when the hazards started to unfold, set it up in different hazard categories (abrupt and gradual appearance) and improved the formulation of 'Where is the danger?' and 'What happens next?' questions. We asked participants to answer the questions immediately after each video (Jackson et al., 2009), in order to analyse hazard detection, situational awareness and the projection they had of the future traffic scene. For the training sessions a full version of the first 16 videos (pre-test) was developed, adapted to the Spanish driving context, including a voice that described in detail the complete traffic scene.

The results showed an acceptable psychometric reliability of the new version of the Hazard prediction Test HP-WHN in the Spanish driving context and it appears to be a useful tool for studying hazard prediction. The original version of the test was composed of 32 videos (16 pre-test and 16 post-test). However, taking into account the videos that achieve the criterion of a discrimination index higher than 0.30, the final version of the test used for the analysis was composed of 21 video clips (11 pre-test and 10 post-test sessions). This cleaned up version showed a Cronbach's Alpha of .875. The PLTC is effective for improving hazard prediction performance. The trained group showed higher means in comparison to the untrained group in a post-test session, and these results support the conclusions of Wetton et al., (2013) and Underwood et al., (2013): commentary training can improve drivers' hazard prediction response. Specifically, it appears that PLTC somehow guides the attention as well as arousing participants' expectations of receiving feedback on their performance. That is, this training provides useful feedback on whether the participants were right or wrong in the pre-test session, which then helps them improve their performance in perceiving the oncoming hazard.

One crucial theory that explains how we perform visual search tasks efficiently is Guided Search (Wolfe, 1994). According to this theory, both bottom-up (stimulus-driven) and top-down (goal-driven) factors may contribute to the topography of this activation. In many studies, participants are instructed to view scenes without any particular task in mind so that stimulus driven (bottom-up) processes guide visual attention (Hwang, Higgins & Pumplun, 2009). However, whenever there is a search task, goal-driven (top-down) processes tend to dominate guidance. In other words, during visual search tasks, in which subjects are asked to find a particular target in a display, top-down processes play a dominant role in the guidance of eye-movement (e.g.

Henderson, Brockmole, Castelhano & Mack, 2007; Petter & Itti, 2007; Pomplum, 2006; Zelinsky, Zhang, Yu, Chen & Samaras, 2006).

The PLTC helps drivers not only by providing knowledge but also by increasing sensitivity to hazards. Learning becomes easier when expectations are involved. Drivers received the expected information (feedback) about the hazard occurrence and could appreciate whether their performance succeeded or failed, which results in affective value. All these facts would provide drivers with useful patterns of visual search that could enable them to predict more accurately the appearance of possible hazards by gathering clues from the traffic scenes.

Specifically, gradual-onset hazard events seem to be more difficult to detect than abrupt-onset hazards and these results are similar to those of Underwood et al., (2013) who found better results for abrupt onset hazards (that gained faster responses) than gradual onset hazards. He found that the abrupt-onset hazards (attention-capturing hazards) certainly attracted faster responses (mean of 1.79 s) than the gradual-onset hazards (3.87 s). The gradual appearance of the hazard precursor seems to be more difficult to detect than the abrupt appearance of the real hazard, even when the clip cuts to black just as the hazard starts to emerge.

However, in the current study, training and practice improves prediction of gradual hazards more than it improves detection of abrupt hazards. Results for gradual-onset hazards always appeared better in the post-test sessions than in the pre-test sessions. For the gradual onset hazards, both the trained and the untrained groups showed an improvement in their performance after the post-test sessions, which indicates that the detection of gradual hazards could also be improved merely by practice. Gradual hazards have more precursors and therefore are more likely to benefit from practice and training. Nevertheless, as Wetton et al. (2013) explained, the WHN practice did appear to have a significant immediate training effect, independent of the expert commentary exercises, but the magnitude of this effect was less and it would possibly not endure over time. That is, if one had to choose between using WHN exercises or Proactive Listening to a Training Commentary, then one would choose the latter or even better, the combination of both methods as we did.

On the other hand, abrupt-onset hazards seem to be easier for drivers to detect. However, to achieve a better performance for abrupt hazards, the implementation of PLTC is required. For the abrupt onset hazards, after the post-test session, only the trained group showed an improvement in their performance, which indicates that the detection of gradual hazards could not be improved merely by practice. That is, for the abrupt-onset hazards, the trained group showed a significant improvement in performance after the post-test session whereas the untrained group did not show a significant improvement. This could be due to the fact that abrupt hazards capture the attention rapidly and there is not enough time to take advantage of the environmental clues. It is likely that either there is not enough time to perceive these clues or there is not enough time to process and consider them (Vargas, Moreno-Rios, Castro & Underwood, 2011). As a result, it is much more difficult to improve detection of abrupt hazards merely with practice, without the aid of the environmental clues provided in advance of the hazard's appearance. The PLTC seems to play a crucial role, mainly when the danger appears abruptly, in helping drivers to anticipate where it is worth allocating their attention (the most relevant part of the complex traffic scene).

As expected, learner drivers obtained lower average scores in comparison with novice and experienced drivers (e.g. Pollatsek, Fisher & Pradhan, 2006; McKnight & McKnight, 2003; Fisher, Pollatsek & Pradhan, 2006).

All driving groups benefit from the Proactive Listening to a Training Commentary, but the greatest improvement post-test was found for the experienced drivers, followed by the novice drivers and finally the learner drivers.

One the one hand, the fact that experienced drivers proved to be the group benefitting most could be due to the advantage they have in experience in comparison with the other groups. The importance of the "observer features" should be noted: a solid base of experience makes learning easier and, for that reason, novice and learner drivers, who haven't yet been exposed to the same number of traffic situations, obtained inferior results. Novice drivers process traffic situations more slowly than experienced drivers; therefore, if the situation becomes very complex, contains many cues or there is not enough time to process them, novices will be at a greater disadvantage. However, the last two groups also showed improvement, which means that the improvement in detecting hazards using PLTC is effective, albeit at different levels.

Nevertheless, it can be considered a counter-intuitive finding that learner drivers show the least benefit from PLTC. Assuming a plateau in HP skills, one would imagine that learners/novices have more 'room for improvement'. This finding is important because novices are at greater risk and we need to devise training strategies that target them rather than their parents. But could PLTC be used as a tool to help learner and novice drivers reach an acceptable level of understanding of the driving situation and, at the same time, develop their sensitivity to hazards, taking advantage of their expectations to benefit from the full length videos provided in the training session? Or could it be that the experts benefit most because the commentary is pitched at them? Imagine a chemistry class of first year and third year undergraduates. If the guest lecturer talks in terms more familiar to the third year students, they will gain more than the first years. Or could it even be that actually processing a commentary is a secondary task – it might help at one level, but at another level it might hinder performance.

According to a paper accepted in JEPA, listening to commentaries can negatively affect eye movements (Young, Chapman & Crundall, 2014). Perhaps the benefit to experts of the extra information outweighs the costs, but is the opposite true for novices? Should commentary driving only be an advanced training tool (as it currently is in the UK)?

In addition, a peculiar pattern of learning was found with regard to the performance of novice drivers. When abrupt-onset hazards were presented, the performance of novices was similar to that of the learner drivers and significantly worse than that of experts. Conversely, for gradual-onset hazards, the performance of novice drivers approached that of experts and was significantly different to that of learners. Novices (as they are acquiring some expertise) benefit most because the commentary is now beginning to be pitched at them. They seemed to be able to make use of the environmental clues that help to anticipate the hazard, and so improved their performance. However, novice drivers have not yet registered enough memory records of traffic situations that could help them explore the traffic scene or inform them when hazard anticipation is needed for abrupt-onset hazards. Learner and novice drivers find it more difficult to guide their visual search intentionally (top-down). For this reason, we consider that these groups would need to develop their search strategies more because they would probably fail to perceive the source of the hazard or not perceive it quickly enough to allow an understanding of the future situation (Jackson et al., 2009).

In any case, learner drivers showed the worst performance when compared with the other groups. According to Box and Wengraf (2013), once drivers have driven 1000 kilometres, their abilities can be considered equal to those of drivers with 3 or more years of driving experience and experience reduces the risk of accidents for all driving groups. Drivers need more practice in order to develop their skills and become expert in more complex tasks. And, in previous research (Castro et al., 2014), it was discovered that novices find it more difficult to detect complex driving situations, for example, differentiating between quasi-dangerous situations and dangerous situations. In this study, we observed parallel results: novices have difficulty in situations of greater uncertainty or those in which there are no clues or insufficient time to understand the traffic scene (e.g. abrupt hazards). Lack of experience makes the anticipation of hazards more difficult. Both novice and learner drivers strive more when driving and this implies more errors (Logan, 1988). This is because these drivers have fewer records in memory to use while driving; only driving experience would make possible the use of successful solutions, previously learned. As a result, the performance of experienced drivers seems to involve less effort. Therefore, there is less disruption caused by distraction and more consistent execution.

Experts outperformed the other groups particularly when the response to type of stimulus vs. type of question was measured. Specifically, there were differences between experts, novices and learners in detecting both gradual and abrupt onset hazards, so the best results were obtained for the "What is the hazard?" and "Where is the hazard?" questions. These results are similar to those of Jackson et al. (2009), regarding the pattern of responding to the questions, indicating that identifying the hazard was easier than noting the location and predicting what would happen next and, at the same time, support the idea that driving training increases Situation Awareness (Walker, Stanton, Kazi, Salmon & Jenkins, 2009). Experienced drivers are more aware of the information concerning both types of hazard whereas learners, due to their inexperience, may need more time to process the hazard and get used to being alert on the road. Also, learner and novice drivers might have assigned fewer intentional resources to the task.

It should be noted that there is little recent literature focusing on training re-offenders and non-offenders in hazard prediction tasks. We compared the performance of offenders to that of non-offender drivers and the results indicated that commentary training was equally effective for both. Offenders did not obtain better results in comparison to the non-offender group, which indicates that probably the re-offenders had similar patterns of processing, understanding the information and performing the Hazard prediction task but different decision-making and execution to those of non-offenders when driving on their own. Further research is required to ascertain the differences between these two groups, considering cognitive processes, decision-making and execution of the manoeuvres in real driving. It should be noted that both groups are quite singular and this fact could affect and impair the perception process in real driving, e.g. driving under the influence of alcohol, or at very high speeds.

For instance, recently Yahya and Hammarstroöm, (2011) analysed a total of 1,995 records with the aim of determining to what extent differences exist between drunk and sober drivers. They found that 88% of the offenders were men and 12% women. The proportion of drunk drivers is 25% for men and 20% for women. The group of drivers below the age of 35 is over-represented in the register in relation to the population register. Due to this last fact, it would be a complex task to achieve equivalence for these groups. Richard et al. (2013) pointed out that driving at excessive speed still remains an unsolved problem. Speed is a contributory factor for accidents and even though there have been attempts to solve this problem; there has been no significant reduction in traffic accidents produced by speed.

Finally, complementary analyses were made to evaluate potential differences between the two groups of drivers recruited (see also Table 2). Results showed that the multiple offender group included more males. In addition, as expected, they had previously lost their driving licenses more times, had received more tickets during the last 12 months and had more traffic incidents reported to an insurance company. They also tended to drive more kilometres per year and to have been involved in more accidents during the last 12 months (it should be noted that the multiple offender drivers had been banned from driving for some months before attending the re-education course). In consequence, the differences in these and other socio-demographic variables should be carefully considered in future studies. However, no differences were found between the ability of the non-offender and the re-offender drivers to correctly identify hazardous situations in the video clips.

4.5.1 Future research

It is necessary to continue this research in order to determine the effect that different hazards have on learners, novices and experienced drivers. In fact, even experienced drivers failed when accurate anticipation of what would happen next was required, for both abrupt and gradual-onset hazards. Therefore, we consider that all groups of drivers could benefit from using PLTC. However it must be considered the potential for repeated training sessions over time. For instance, gradual onset HP performance didn't exceed 50% even for trained participants.

Our participants' performance in this HP-WHN test is quite poor, specifically in the case of gradual onset HP. This could mean that our task is quite difficult. Anyway, the task seems to be sensible and significant differences can be found between groups of participants of different driving experience. It can therefore be used as a discrimination tool. It would be interesting to compare this level of performance with the results found in other research. For instance, Underwood et al. (2013) also used gradual and abrupt onset videos and they obtained a better performance. However the thei task requirements were quite different. Underwood's participants performed the traditional Hazard Perception task that measures Reaction Time and Accuracy. And the videos were displayed in their complete form. The task required participants to respond to any potential hazards by tapping the spacebar on the computer keyboard, as soon as they were detected. This meant the results could not really be compared.

On the other hand, the ability of the experienced participants had not reached a ceiling despite decades of driving. According to Horswill, Taylor, Newman, Wetton and Hill (2013), even highly experienced drivers benefit from a brief hazard perception training intervention. (i.e. police drivers significantly outperformed highly experienced drivers in a validated video-based hazard perception test).

It has been shown that drivers can improve their scores in video-based hazard perception tests following training interventions. Horswill, Falconer, Pachana, Wetton and Hill (2015) and Horswill et al. (2013) found that after training, significant improvements in hazard perception are seen for even highly experienced drivers and drivers over 65 years. Horswill et al. (2015) showed that the effect of brief training in Hazard Perception remains after the intervention, and approximately 1 month and 3 months later without a significant decay in the training effect over this time period. Future studies may also include a prospective design. For instance, it could be ascertained by monitoring the frequency of driving "mishaps/motor vehicle collisions" between trained and untrained groups for monthly follow-ups for 6 or 12 months. Moreover, including driving "mishaps" (e.g., failing to notice merging traffic) in addition to actual incidents would also provide more data.

In conclusion, it appears that PLTC, using video-based training tests, is effective: the active training improves hazard prediction. However, further research should explore whether this kind of training would be effective long term and whether transfer occurs in hazard prediction during real driving.

In addition, the trade-off between PLTC and other concurrent driving tasks should be evaluated in order to implement effective training methods that could be widely used and affordable to all those drivers who need to improve their hazard prediction abilities.

Future research could also look at the possibility of achieving a more affordable version of the *Hazard prediction Test* that would allow a more effortless and factual correction, using closed questions with different response alternatives. Finally, we are looking forward to comparing the results obtained in this test with reaction time data and eye movement recordings.

4.6 Acknowledgements

We thank the Spanish drivers who were volunteers in the trials. We are grateful to the anonymous reviewers for their helpful comments to improve this paper. Financial support was also provided by the Junta de Andalucía (PO7-SEJ-02613, and Proyecto Motriz P11-SEJ-7404; and BS-14-164 I+D+I Research project from the CEI-Biotic, Granada, Spain and the Spanish Government, MICINN (PSI2013-42729-P). Ph.D. Psychology Program, University of Granada. Also, we would like to thank the Spanish Dirección General de Trafico –DGT, (Exp: 0100DGT21263) for supporting the present research, and the Autoescuelas la Victoria, Luna and Genil (Granada) for providing the sample of participants. None of the funding sources had direct involvement in the study design, in data collection, analysis or interpretation, in the writing of reports or in the decision to submit the paper for publication.

4.7 References

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5 CAPÍTULO III: What Happens When Drivers Face Hazards On The Road?

Ventsislavova, P., Gugliotta, A., Peña-Suarez, E., Garcia-Fernandez, P., Eisman, E., Crundall, D., & Castro, C. (2016). What happens when drivers face hazards on the road?. *Accident Analysis and Prevention*, *91*, 43-54. doi: 10.1016/j.aap.2016.02.013

5.1 Abstract

The current study aims to obtain knowledge about the nature of the processes involved in Hazard Perception, using measurement techniques to separate and independently quantify these suspected sub-processes. This study provides quantified measures of the processes involved in Hazard Perception and Prediction: Sensitivity, Situation Awareness (recognition, location and projection) and Decision-Making. It applies Signal Detection Theory analysis to Hazard Perception and Prediction Tasks. To enable the calculation of Signal Detection Theory parameters, hazardous vs. quasi-hazardous situations were presented to the participants. In the hazardous situations it is necessary to perform an evasive action, for instance, braking or swerving abruptly, while the quasi-hazardous situations do not require the driver to make any evasive manoeuvre, merely to carry on driving at the same speed and following the same trajectory. A first Multiple Choice Hazard Perception and Prediction test was created to measure participants' performance in a What Happens Next? Task. The sample comprised 143 participants, 47 females and 94 males. Groups of non-offender drivers (learner, novice and experienced) and offender drivers (novice and experienced) were recruited. The videos were divided into two types of situation: hazardous situations and quasi-hazardous situations. The Multiple Choice Hazard Perception and Prediction test succeeded in finding differences between drivers according to their driving experience. In fact, differences exist with regard to the level of hazard discrimination (d' prime) by drivers with different experience (learner, novice and experienced drivers) and profile (offenders and non-offenders) and these differences emerge from Signal Detection Theory analysis. In addition, it was found that experienced drivers show higher Situation Awareness than learner or novice drivers. On the other hand, although

offenders do worse than non-offenders on the hazard identification question, they do just as well when their Situation Awareness is probed (in fact, they are as aware as non-offenders of what the obstacles on the road are, where they are and what will happen next). Nevertheless, when considering the answers participants provided about their degree of cautiousness, experienced drivers were more cautious than novice drivers, and non-offender drivers were more cautious than offender drivers. That is, a greater number of experienced and non-offender drivers chose the answer "I would make an evasive manoeuvre such as braking gradually".

5.2 Introduction

Traditional Hazard Perception (HP) tests are used to discriminate between safe and less safe drivers on the basis of their ability to respond quickly to developing hazards in video clips of driving and now form a part of the driver-licensing procedure for the UK and parts of Australia. Many studies have explored the ability of Hazard Perception tests to discriminate between safe and less safe drivers across a wide range of road users, including novice and learner drivers (e.g. Horswill & McKenna, 2004), older drivers (e.g. Horswill et al., 2008), motorcyclists (Crundall, Van Loon, Stedmon & Crundall, 2013; Vidotto, Bastianelli, Spoto & Sergeys, 2011), emergency vehicle drivers (Crundall, Chapman, Phelps & Underwood, 2003; Crundall, Chapman, France, Underwood & Phelps, 2005; Johnston, 2014), driving offenders (Castro et al., 2014; Castro et al., 2016) and even pedestrians (Rosenbloom, Mandel, Rosner & Eldror, 2015). Materials have also been developed into training interventions (e.g. Helman, Palmer, Delmonte & Buttres, 2012; Horswill, Taylor, Newman, Wetton & Hill, 2013; Horswill et al., 2015; McKenna, Horswill & Alexander, 2006).

Many studies have demonstrated the ability of hazard perception tests to discriminate safe from unsafe drivers, despite using very different tests created in different laboratories across the world. While there have also been some studies which have failed to replicate these successes (see Horswill & McKenna, 2004 for a review), the body of evidence suggests that Hazard Perception tests do indeed tap into an essential skill for safe driving. One study even found that drivers who performed poorly on an Hazard Perception test were more likely to have died as a result of a traffic collision in the subsequent 12 months (Drummond, 2000). Certainly the introduction of the Hazard Perception test into the UK driver-licensing procedure appears to have had a demonstrable affect upon traffic collisions (Wells, Tong, Sexton, Grayson & Jones, 2008). This positive reduction in collisions could be due to two factors: 1) the capacity of this test to filter out “unsafe drivers” before they obtain their driving licenses, and 2) the inclusion of Hazard Perception skills in the training required to obtain a driving license, though in all likelihood, both factors contribute.

However, despite the myriad of studies using hazard perception tests, few studies have attempted to unpack the skill to identify its underlying components (cf. Crundall, 2016). It is important to gain a better understanding of the cognitive processes which underpin HP as this knowledge will allow us to better refine driver education and testing. .

5.2.1 Sensitivity and Decision-making: Signal Detection Theory

Brown and Groeger (1988) defined Hazard Perception as the process of identifying hazards and quantifying their potential for danger. However in addition to identifying hazards, the driver also needs to reject possible hazards for continued inspection, so as to better prioritise the most dangerous aspects of the scene. This approach draws parallels with Signal Detection Theory (Green & Swets, 1966; Swets, 1998; Macmillan & Creelman, 2005). Signal Detection Theory (SDT) changed our way of thinking about the performance of sensory tasks by explaining that performance depends not only on sensory information, but also on biases inherent in the decision-making processes.

Signal Detection Theory provides a framework to describe and analyse decisions that are made in uncertain or ambiguous situations (Wickens, 2001). The person must decide whether or not a target is present or a condition is met. For simple tasks such decisions may be easy to make: the alternatives are obvious and the evidence is clear. Other tasks, however, are not so simple. While alternatives may remain distinct, the evidence on which to base the decision may be ambiguous, or the situation presents a high level of noise compared to the target signal. Judging the danger present in a driving situation is one example of a complex task that can be beset by a weak signal-to-noise ratio.

Signal Detection Theory models two important aspects of the decision-making process in such ambiguous scenarios: sensitivity to the signal embedded within the noise, and the bias or criterion that guides one's decisions. The first aspect of the decision-making process is captured in the measure of sensitivity (d-prime), which is essentially the number of hits (correct identifications) minus the number of false alarms (reporting a target when no target is present). This reflects the intensity of the signal in comparison to background 'noise'. A 0 value means an inability to distinguish signal from noise, while increases in d' reflect a greater ability to distinguish signals from noise.

In the second stage, this signal is evaluated and compared to a threshold of evidence above which one accepts the presence of a target. This threshold differs from person to person and across time and tasks. It is often called the response bias of criterion and is represented as *B*. A low criterion reflects a liberal tendency to always report that the target is present, while a high criterion represents a more conservative stance. Some tasks may even encourage both criteria to be used sequentially. For instance, radiologists can be instructed first to examine all images, using a liberal criterion (tendency to say Yes, there is a tumour), and then to reexamine positive images, using a conservative criterion (tendency to say No). A neutral criterion, $B= 1$, is found when participants favour neither the Yes response nor the No response. However, values less than 1 can be interpreted as a bias towards responding YES (liberal criterion), whereas values of B greater than 1 indicate a bias towards the NO response (conservative criterion).

The traditional method of conducting a Signal Detection analysis takes measures of correct hits (when a participant correctly identifies a hazard) and false positives (when a participant incorrectly identifies a non-hazard as being a hazard), which are entered into formulae to determine separate measures of sensitivity (d-prime) and response bias in decision-making (B or criterion) (Stanislaw & Todorov, 1999).

Wallis and Horswill (2007) stated that there are a number of reasons why this approach is both conceptually inappropriate and practically difficult for HP-like tasks. They believe that in the Hazard Perception domain, there is no way to objectively measure whether a scene is "a hazard" or "not a hazard" as it lacks the objectively measurable assessment of a binary true state. They argue that traffic environments can be considered to vary in their potential for hazard with context and over time. Accordingly all traffic situations can be better conceptualised as potentially hazardous *to some degree.* They used ratings of the traffic scenes by driving experts to perform a Fuzzy Signal Detection Theory analysis. They argued that ratings of a domain authority might be appropriate. For example, instructors were used as a benchmark for the level of risk present in a traffic situation (Crundall et al., 2003; McKenna & Crick, 1991; Mills, Parkman, Smith & Rosendhal, 1999), against which risk judgments by less experienced drivers could be compared.

These fuzzy rates are then used to calculate sensitivity and response bias as in traditional Signal Detection Theory (Parasuraman, Masalonis & Hancock, 2000), for example, a response of 80% 'yes' to an event that is 60% signal-like. The event is somewhat signal-like so warrants a response (hit = 60%), but the individual over-responds so is assigned a proportion of false alarm (20%) and of correct rejections (20%). These fuzzy rates are then used to calculate sensitivity and response bias as in traditional Signal Detection Theory (Parasuraman et al., 2000).

Wallis and Horswill's (2007) results did not identify any sensitivity differences between experienced drivers and novices in the Hazard Perception test (the Signal Detection analysis) or in the hazard-rating task (the Fuzzy Signal Detection analysis). Similarly, the trained and untrained drivers did not differ in sensitivity in either task. Sensitivity in the Hazard Perception test and the hazard-rating task did not correlate with latency in the Hazard Perception test for all groups. However the untrained novice group was significantly more conservative than both the trained novice group and the experienced group in the Hazard Perception test, though these differences did not carry over to the hazard-rating task. Response bias in the Hazard Perception test correlated significantly with latency, so that more liberal responses were associated with faster latencies for trained novices, untrained novices and experienced drivers.

One explanation for these results is that the subjective estimation of a reduced number of experts can contaminate the analysis and bias the results obtained. A similar criticism of the use of expert or experienced drivers' judgments was made by Wetton, Hill and Horswill (2011) of the staged driving situations used to create the Hazard Perception Test. The authors believed that this practice of manoeuvring vehicles in front of a car with a camera so as to deliberately create a dangerous situation from the point of view of expert or experienced drivers (McKenna & Crick, 1991; Catchpole & Leadbeatter, 2000, for instance) could contaminate the criterion. They explained that if expert or experienced drivers inadvertently create scenes that favour individuals who are more like themselves (and not necessarily in terms of Hazard Perception ability alone), then this may explain why those scenes sometimes appear to distinguish between novice and experienced drivers more effectively than scenes featuring unstaged hazards (Crundall et al., 2003).

Recent work published by Sanocki, Islam, Doyon and Lee (2015) also shows that it is possible to study Hazard Perception in terms of the classic Signal Detection Theory (Green & Sweets, 1966), which separates sensitivity, the overall ability to differentiate the presence or absence of vulnerable road users (VRU pedestrians, cyclists, etc.), from bias when interpreting the stimulus information (the amount of perceptual evidence needed for detecting the VRU). They explored how crowded environments decrease sensitivity and thereby increase errors.

An alternative way to apply Signal Detection Theory to hazard perception is to conceptualise the hazard from a functional point of view. If a developing driving situation would cause a collision without an atypical avoidance response (i.e. gradual braking towards traffic lights would not count) then this could be termed a hazard requiring a response. We are still left with the problem of *when* the driving situation is considered to have become hazardous. This is a problem that has taxed all researchers who have attempted to measure response times to hazards. One potential way to reapply Signal Detection Theory to hazard perception is to remove speeded responses completely, instead adopting a simple binary probe question (e.g. did you see a hazard?). This approach to hazard perception has been the focus of recent research that has attempted to link Hazard Perception with situation awareness (Situation Awareness), but these studies have so far failed to combine this technique with an Signal Detection Theory analysis. The following section will introduce this methodology and discuss its compatibility with Signal Detection Theory.

5.2.2 Situation Awareness: Hazard Recognition, Hazard Location and Prediction of the Future Situation

Endsley (1987) proposed the Situation Awareness Global Assessment Technique (SAGAT) as a viable method for measuring Situation Awareness. This technique requires the task to be suddenly paused, at which point probe questions are presented to the participant to assess their understanding of the situation at that instant. To have Situation Awareness, one must pass through Endsley's three stages: perception of the environment, comprehension, and finally prediction of future stages. If a driver can correctly perceive, comprehend and predict the environment while driving (and moreover, do this constantly on an iterative basis), then s/he should be less likely to have a collision (though excellent Situation Awareness does not necessarily predict the quality of the ultimate choice of behaviour).

McKenna and Crick (1997) applied the SAGAT technique to hazard perception clips, exploring the training potential of the methodology for improving hazard perception skill. Participants were first given instruction in active search strategies before they were presented with a series of clips that were paused just when a hazard was about to occur. Participants were then asked "what might be about to happen?" The pausing of the video (the paused frame was still available to view on the screen) gave participants more time to process the imminent events. This training significantly reduced response latencies to hazards in a subsequent hazard perception task.

Jackson, Chapman and Crundall (2009) revisited the SAGAT methodology with their 'What Happens Next?' task, employing the test for assessment purposes rather than for training. The clips were paused immediately prior to the appearance of a hazard, but crucially, they only discriminated between novice and experienced drivers if the clips were occluded during the pause. Similarly, Castro et al., (2014; 2016) developed a

Spanish version of the 'What Happens Next?' test. A series of questions probed the participants' perception, comprehension and prediction abilities during the occluded pauses: *What is the hazard?*, *Where is the hazard?* and *What happens next?* An adequate response to these questions could be "A pedestrian… on the left sidewalk… is about to step out in front of my car". Two different driving situations were explored, according to the driver's experience: hazardous and quasi-hazardous situations. The results demonstrated that learner drivers and re-offenders are less able to identify quasi-hazardous traffic situations than experienced drivers. Regarding hazardous situations, the findings are consistent with previous literature (Jackson et al., 2009 and Crundall, Andrews, Van Loon & Chapman, 2010; Crundall, Crundall, Clarke & Shahar, 2012): experienced drivers outperform novice and learner drivers in identifying hazardous situations. This reinforces the finding that experience is an important factor in identifying hazardous situations.

From the current perspective, this type of occluded hazard prediction task lends itself perfectly to a standard, non-fuzzy, Signal Detection Theory analysis. If the findings of Wallis and Horswill are robust, we should be able to replicate them with this simpler approach to analyzing d' and *B*.

5.2.3 The Current Study

To measure and quantify different factors to explore the processes involved in Hazard Perception, we built a Multiple Choice Hazard Perception and Prediction Test. It was developed to measure both Sensitivity and Response bias (Signal Detection Theory parameters) and Situational Awareness (Endsley, 1995) through different driving situations, using the following questions: *What is the hazard? Where is the hazard? What happens next?* For this purpose, two types of driving situation are explored: hazardous and quasi-hazardous situations. A hazardous situation was defined as a driving situation that develops into a real hazard that requires the driver to react in order to avoid a collision (for example, by slowing down or by making an evasive manoeuvre). A quasi-hazardous situation was defined as a potentially hazardous situation that does not, in the end, develop into a hazard (i.e. despite the driver changing neither speed nor position).

We also explore the test's capacity to discriminate between drivers with different driving experience (learners, novice and experienced) and according to their offender status (offenders/non-offenders). Psychometric properties, such as reliability measures and evidence of validity are analysed. Finally, we aimed to explore the relationship between Signal Detection Theory parameters, Situation Awareness and Cautiousness in Decision-Making.

5.2.4 Research Hypothesis

If Hazard Perception skill can be modified and improved by practice (via many hours of real driving), then the current test should discriminate between novice and experienced drivers, and possibly between offender and non-offender drivers. Less clear is the contribution of the different sub-components of hazard perception skill to this potential discrimination. For instance, Wallis and Horswill (2007) might argue that response bias is more important than sensitivity, with less-experienced drivers requiring greater evidence before concluding that a hazard is present. The current study will try to replicate this finding and extend the results to discriminating between drivers on the basis of offender status.

We would like to ascertain whether offender drivers use a more conservative criterion B and show a higher tendency to say No to potentially hazardous situations than non-offender drivers when performing Hazard Perception tasks and whether they make the decision to perform less cautious manoeuvres after seeing a hazardous or quasi-hazardous situation (i.e. making the decision to carry on driving at the same speed and on the same path). If so, new questions could emerge from the results, for instance, it would be possible to further investigate whether offender drivers' assumption of higher risk happens only in the driving context or is more general, a personality trait that may also involve the assumption of higher risk in other facets of their lives.

5.3 Method

5.3.1 Participants

One hundred and forty three participants were recruited (47 females and 94 males) with a mean age of 29 years (*SD* = 11.8), ranging from 18 to 66. These participants were split into three groups: learners (who had yet to pass a driving test but were actively learning to drive), relative novices (within 8 years of passing their driving test) and experienced drivers (8 or more years' experience). These latter two groups could be further classified as offenders and non-offenders. Table 1 provides details on the allocation of drivers to these groupings. Spain applies the following demerit points system to driving licenses: Spanish residents are issued with 12 points initially. If a driving offence is committed, points are deducted from the license according to the severity of the offence. When no points remain, the license is cancelled and the holder must go through a re-education process to have it reissued. All offender participants were attending this compulsory re-education course.

Table 1. A breakdown of participants socio-demographic information by experience and offender-status.

Non offender drivers	Learner drivers					Novice drivers					Experienced drivers				
Socio-demographic information	*N*	*Min*	*Max*	*Mean*	*SD*	*N*	*Min*	*Max*	*Mean*	*SD*	*N*	*Min*	*Max*	*Mean*	*SD*
Age	34	18	29	19.31	2.50	43	18	31	21.40	2.86	64	23	66	39.48	10.14
Gender[a] + Gender Percentage	34	1=M 88%	2=F 12%	1.76[a]	0.43	43	1=M 71%	2=F 29%	1.42[a]	0.49	64	1=F 51%	2=F 49%	1.06[a]	0.24
Level of education[b] Mean values between 3 (Secondary) to 4 (Vocational)	34	3	6	4.03[b]	0.38	43	1	5	3.67[b]	0.77	64	1	6	3.75[b]	1.52
Years driving regularly	-	-	-	-	-	36	0	11	3.92	2.82	54	7	54	20.33	10.28
Years since obtaining driving license	-	-	-	-	-	36	0	11	3.92	2.82	54	7	54	20.33	10.28
Driving frequency in the last 12 months[c]	-	-	-	-	-	43	1	5	2.11[c]	0.89	64	1	5	1.23[c]	1.18
Kilometres driven last 12 months	2	0	9999	4999	7070	27	1	175000	13303	34443	40	0	120000	33347	26698
Accidents-material damage last 12 months[d]	-	-	-	-	-	27	0	1	0.22[d]	0.42	40	0	2	0.33[d]	0.52
Accidents with victim last 12 months[d]	-	-	-	-	-	27	0	1	0.04[d]	0.19	40	0	1	0.05[d]	0.22
Quasi-accidents last 12 months[d]	2	0	3	1.50[d]	2.12	27	0	3	1.15[d]	1.06	40	0	3	1.53[d]	1.39
Traffic incidents- Insurance company[d]	-	-	-	-	-	27	0	3	0.41[d]	0.97	40	0	3	0.47[d]	1.32
Nº of times losing driving license[d]	-	-	-	-	-		0	1	0.06[d]	0.23		0	2	0.28[d]	0.52
Traffic tickets received[d]	-	-	-	-	-	27	0	3	0.52[d]	0.52	40	0	3	1.28[d]	1.28

Offender drivers						Novice drivers					Experienced drivers				
Socio-demographic information	*N*	*Min*	*Max*	*Mean*	*SD*	*N*	*Min*	*Max*	*Mean*	*SD*	*N*	*Min*	*Max*	*Mean*	*SD*
Age	-	-	-	-	-	6	18	31	23.83	5.56	40	26	66	41.88	11.03
Gender[a] Mean values between 3 (Secondary) to 4 (Vocational)	-	-	-	-	-	6	1=M 59%	2=F 41%	1.17[a]	0.40	40	1=M 50%	2=F 50%	1[a]	0
Level of education[b] Mean values between 3 (Secondary) to 4 (Vocational)	-	-	-	-	-	6	1	5	3[b]	1.54	40	1	6	3.78[b]	1.70
Years driving regularly	-	-	-	-	-	4	4	11	7.75	3.77	21	7	54	20.67	11.44
Years since obtaining driving license	-	-	-	-	-	4	4	11	7.75	3.77	21	7	54	20.67	11.44
Driving frequency in the last 12 months[c]	-	-	-	-	-	4	0	1	1[c]	0	21	1	5	1.38[c]	1.20
Kilometres driven last 12 months	-	-	-	-	-	4	5000	60000	22250	26017	21	0	120000	32738	28103
Accidents-material damage last 12 months[d]	-	-	-	-	-	4	0	1	0.50[d]	0.57	21	0	1	0.33[d]	0.48
Accidents with victim last 12 months[d]	-	-	-	-	-	4	0	3	0.60[d]	1.34	21	0	1	0.05[d]	0.21
Quasi-accidents last 12 months[d]	-	-	-	-	-	4	0	3	1.50[d]	1.73	21	0	3	1.38[d]	1.35
Traffic incidents- Insurance company[d]	-	-	-	-	-	4	0	2	0.75[d]	0.95	21	0	3	0.90[d]	1.09
Nº of times losing driving license[d]	-	-	-	-	-	4	0	1	0.50[d]	0.57	21	0	2	0.52[d]	0.60
Traffic tickets received[d]	-	-	-	-	-	4	0	3	2.5[d]	1.11	21	1	3	2.60[d]	0.43

Median valued reported:

(a) 1 = Female. 2 = Male. Median value reported.

(b) 1 = Primary. 2 = Secondary (compulsory). 3 = Secondary (non-compulsory). 4 = Vocational. 5 = Grade. 6 = Master.

(c) 1 = Every day or almost every day 2 = Once or more than once per week 3 =Once or more than once per month 4= Once or more than once per year 5=Never or almost never Median value reported.

(d) 0 = 0, 1 = 1, 2 = 2, 3 = 3 or more

5.3.1 Materials

5.3.1.1 Vídeos

The Multiple Choice Hazard Perception and Prediction Test consisted of twenty-four High Definition (HD) clips, with a resolution of 1920X1080, that were filmed from a Canon HD Legria HF R16 full HD digital camera mounted internally on the windscreen of a moving vehicle. All videos constituted real driving scenarios (none were staged) that included different traffic situations recorded from the driver's perspective. Video scenes were recorded in the metropolitan area of Granada and outside the town, including urban roads, minor roads and highways. All videos were selected from a database that contained more than 300 videos recorded in Granada. Selected clips lasted between 6 and 26 seconds and were edited to occlude immediately prior to the hazard (or quasi-hazard). A description of video content can be seen in Table 2.

The 24 clips were split into 18 composed of actual hazardous situations and 6 composed of quasi-hazardous situations. This distinction was based on whether the film-car drivers had to alter their behaviour to avoid a collision (a hazard) or whether they were able to continue without any change (a quasi-hazard). These clips were presented in 3 blocks of 8 (following two practice trials), with a 10-minute break between blocks. (figure 1)

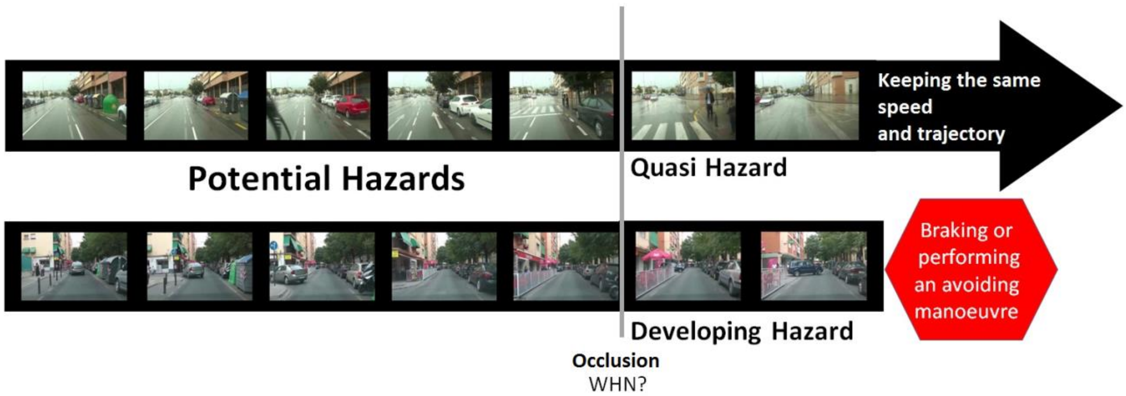

Figure 1. Film-strip showing an example of quasi-hazards and hazards. defined by the manoeuvre that the car performed: a. for quasi-hazards keeping the same speed or trajectory; b. For hazards braking or performing an avoiding manoeuvre.

5.3.1.2 Response booklet

Participant responses following each clip were recorded in a response booklet containing 5 questions per clip. The questions were presented on one page per hazard and asked: (Question 1) "Did you see any hazard at the moment when the video was cut?" (Yes/No); (Question 2) "What manoeuvre would you perform if you were the driver of the vehicle?" (maintain speed and direction/evasive manoeuvre); (Question 3) "Where was the hazard at the moment when the video was cut?" (indicated by participants marking an X to indicate location on a pencil-style drawing of the final video frame, with vehicles, pedestrians and other objects removed); (Question 4) "What is the hazard?" (3 options were given); and (Question 5) "What might happen next in the traffic scene?" (again 3 options were given).

The picture used for Question 3 was created by editing a still shot of the final frame of each video (just before occlusion) in Photoshop, first stylising it into a black and white pencil drawing, then editing out all pedestrians, vehicles and other pertinent objects, while leaving the structure of the road, road markings, road furniture and surrounding buildings. All pictures were formatted to 15 cm by 10 cm. A point was awarded for accuracy if the X was placed within the perimeter of the cause of the hazard (e.g. if participants wished to place an X on a car emerging from a side road, they would score a point if the cross fell within the boundary of where the car would have been in the picture, had it not been removed during editing). They received half a mark if the X was located within 1 cm of the boundary of the cause of the hazard.

The options for Question 4 (what is the hazard?) would provide alternative hazard sources to choose between. For instance: a. The white pickup on the right, b. The car that appears on the left, c. Intersection with poor visibility.

Multiple-choice options for Question 5 (what happens next?) would identify possible outcomes that could occur within the next few seconds of the paused clip. Examples include: a. The car will reverse, b. The white pickup will reverse, c. The car will continue forward.

For these last two questions with three alternative answers, there were two distracting options and one correct option. The items were constructed considering the answers given by the sample of participants recorded in a previous Hazard Perception and Prediction Test, when the same questions were presented in an open format (Castro et al., 2014). A point was awarded for selecting a correct option.

5.3.1.3 Demographics questionnaire

A demographics questionnaire collected data from 19 items covering sex, age, education, driving experience (years since a successful driving test), type of license, driving frequency (Km/month and year) and driving history over the preceding 12 months (collisions, near-collisions and fines).

5.3.2 Procedure

Participants completed the test in group sessions. They were recruited from either the School of Psychology and the School of Sciences of the University of Granada or different collaborating driving schools in Granada: *Autoescuela La Victoria, Luna and Genil.*

First, participants filled in the socio-demographic questionnaire individually. They were then given practice with the question format, using two practice video-samples of the Multiple Choice Hazard Perception and Prediction Test, before the start of the experimental test. The video clips were then presented to participants seated at a distance of between 3 and 5 metres from a projection screen. Each video clip was occluded immediately prior to a hazard (or quasi-hazard). Following occlusion, participants turned to the next page of the response booklet and answered the 5 questions.

Table 2. Descriptions of the videos.

Duration	Potential Hazard	Type of road location	Visiblilty	Content	Type of obstacle	What is the potential Hazard?	What Happens Next?	Manoeuvre already performed
11.90	Car	Urban	Reduced visibility	A car is reversing towards an intersection	Hazard	A car that appears on the left	The car is going to reverse	1). Braking
19.27	Pedestrian	Urban	Hindered by vegetation	A pedestrian is about to cross the street	Hazard	A pedestrian on the left	The pedestrian will try to cross	1). Braking
15.30	Car	Urban	Reduced visibility	A car suddenly joins the lane from the left	Hazard	A car on the left	The car on the left will join the lane	1). Braking
26.27	Pedestrian	Urban	Hindered by vegetation	A pedestrian is approaching a crossroads with the intention to cross	Quasi-Hazard	A pedestrian on the right	The pedestrian approaching the crossroads will stop	2) Keeping
17.23	Motorcycle	Urban	Clear	A motorcycle trying to join the left lane by crossing our lane	Hazard	A motorcycle in the left lane	The motorcycle is going to invade our lane	1). Braking
25.27	Pedestrian	Urban	Hindered by vegetation	A group of pedestrians cross at the crossroads, hidden by the vehicle in front	Quasi-Hazard	The pedestrians on the crossroads	The pedestrian will cross at the crossroads	2). Keeping
12.04	Car	Backroad	Reduced visibility	A car is merging at an intersection	Hazard	A grey car that is joining the road	The grey car will join the opposite lane by crossing our lane	1). Braking
11.27	Car	Dual carriageway	Clear	The red car in the left lane suddenly invades our lane while trying to avoid another vehicle	Hazard	The red car in the right lane	The red car on the right is going to invade our lane	1). Braking
21.97	Pedestrian	Urban	Hindered by urban equipment	A pedestrian is about to cross the street	Quasi-Hazard	A pedestrian on the right sidewalk	The pedestrian will stop	1). Braking
19.63	Car	Urban	Hindered by the other vehicles	A car is trying to join the lane while reversing	Hazard	The dark car parked on the right	The dark car will try to reverse from the parking place	1). Braking
16.17	Car	Dual carriageway	Clear	A car stops in the middle of a junction between two exits and changes direction	Hazard	The grey car in front of us	The car in front of us will reverse, aiming to change its exit	1). Braking
11.27	Pedestrian	Urban	Clear	A pedestrian is about to cross the street	Quasi-Hazard	The pedestrian on the right pavement	The pedestrian will stop	2). Keeping

20.77	Car	Backroad	Clear	A car suddenly crosses our lane, trying to reach the exit of the roundabout	Hazard	The second car that is crossing our lane on the roundabout	The second car will cross our lane and will invade the right lane	1). Braking
21.30	Pedestrian	Urban	Hindered by vegetation	A pedestrrian suddenly starts to cross the road	Hazard	The pedestrian on the left	The pedestrian will cross on the left	1). Braking
24.27	Car	Urban	Hindered by other vehicles	A car reversing from a car park near the road, obscured by other vehicles, joins the lane	Hazard	The car reversing on the left	The car on the left will join the lane, while reversing	1). Braking
17.07	Van	Backroad	Clear	A van that has its flashing lights on stops on the hard shoulder	Hazard	The white van in front of us	The white van in front of us will park on the right	1). Braking
18.30	Car	Urban	Clear	A car suddenly stops, trying to park	Hazard	The dark car	The car in front of us will park on the left	1). Braking
19.30	Car	Urban	Clear	A car approaches the intersection on the left	Quasi-Hazard	A car approaching on the left	The car that is joining our lane from the left will brake and give way	2). Keeping
19.27	Pedestrian	Urban	Hindered by vegetation	A pedestrian is approaching a crossroads, trying to cross the street	Hazard	Pedestrian on the left	A pedestrian will try to cross the street	1). Braking
18.57	Motorcycle	Backroad	Hindered by other vehicles	An oncoming motorcycle is about to invade our lane	Hazard	The yellow motorcycle	The motorcycle will invade our lane	1). Braking
20.30	Car	Urban	Hindered by other vehicles	A car appears abruptly on the right, trying to join our lane	Quasi-Hazard	A car coming from the right	The black car will give way to us	2). Keeping
26.53	Car	Dual carriageway	Clear	A car passes us on our left, while another car is trying to join the dual carriageway from the right	Hazard	A red car on the right	A vehicle will pass us on the left	1). Braking
22.70	Truck	Backroad	Clear	An oncoming truck is approaching us	Hazard	An oncoming truck	A truck will invade our lane	1). Braking
12.33	Car	Urban	Clear	A car is trying to change lanes in front of us	Hazard	The car in front of us	The grey car will cross our lane	1). Braking

5.3.3 Data analyses

Following item analysis, Levene's homogeneity test, a test for normality (KS test) and reliability checks (using Cronbach's Alpha), a series of Analyses of Variance (ANOVAs) were conducted to explore the processes involved in Hazard Perception and Prediction: Sensitivity and Decision Making (STD parameters), Situation Awareness (recognition, location and projection) and Cautiousness in Decision-Making. Tukey's test for multiple comparisons, pairwise comparisons using the Bonferroni adjustment and planned comparisons were used to control overall significance while identifying the precise location of main effects and interactions. The level of statistical significance was set at .05. Eta squared (η^2) and partial Eta squared (η^2_p) were the statistics applied to measure the effect size with values ranging from low (values below or equal to .02), moderate (values between .03 and .14) to high (over .14), according to Cohen (1988) and Richardson (2011). All statistical analyses were performed using IBM SPSS Statistics v20 for Windows.

All ethical principles given in the Declaration of Helsinki for research involving human participants were followed in the current study.

5.4 Results

5.4.1 Internal Consistency

This test showed good psychometric reliability. Table 3 shows the descriptive statistics and the discrimination indices of the test videos: 20 videos had values of discrimination indices higher than .20. Only 4 of the initial videos had discrimination indices outside the established range: 3 hazardous situations and 1 quasi-hazardous situation, and these were removed from the final version of the test analysed. These 20 videos showed a satisfactory reliability and discrimination index. Cronbach's Alpha coefficient was found to be acceptable (α = .77). This value is dependent on the items' sample size, so, in this case, it achieved a reasonable internal consistency with a small sample of video-items.

Table 3. Descriptive statistics of the Multiple Choice-Hazard Perception and Prediction Questionnaire items.

Videos	*Min.*	*Max.*	*M*	*SD*	Discrimination Index
1*	.00	3.00	2.13	.84	.18
2	.00	3.00	1.66	.72	.20
3	.00	2.50	1.04	1.08	.27
4	.00	3.00	1.11	1.03	.38
5	.00	3.00	1.33	1.12	.44
6*	.00	3.00	.40	.59	-.02
7	.00	3.00	1.62	1.23	.44
8*	.00	3.00	.17	.56	.17
9	.00	3.00	.99	1.11	.44
10*	.00	3.00	1.09	.89	.09
11	.00	3.00	1.00	1.05	.32
12	.00	3.00	.81	1.08	.30
13	.00	3.00	1.71	.98	.42
14	.00	3.00	1.45	.99	.31
15	.00	3.00	.35	.86	.24
16	.00	3.00	1.61	1.13	.31
17	.00	3.00	1.89	1.09	.30
18	.00	3.00	.94	1.01	.45
19	.00	2.50	.69	.93	.26
20	.00	3.00	1.16	.73	.26
21	.00	3.00	1.59	.79	.29
22	.00	2.50	.79	.70	.20
23	.00	3.00	1.51	.82	.30
24	.00	3.00	1.07	1.08	.30

Note. Videos with an asterisk are items removed because they showed values lower than 0.20 in discrimination indices.

5.4.2 Analyses of the SDT parameters: d-prime and criterion B

One of the benefits of using a simple accuracy response to detecting a hazard (Question 1: Did you see any hazard at the moment the video was cut?) is that the data can be easily subjected to Signal Detection analysis (Green & Swets, 1966) to assess drivers' sensitivity to hazards (their ability to correctly identify hazards, while avoiding false alarms; *d'*) and their criterion (drivers' general tendency to report everything as either hazardous or non-hazardous; *B*).

Signal Detection Theory (Green & Swets, 1966) was used to analyse data from the first question asked: *Did you see any hazard at the moment when the video was cut?*

The best results were found for Non-Offender Experienceddrivers, with 86% of Hits and only 19% of False Alarms (FA), thenExperienced Offender drivers, who obtained 73% of Hits and 40%of FA. They were followed by Non-offender Novice drivers, whoobtained 64% of Hits and 47% of FA. The worst results were foundfor Offender Novice drivers, who obtained 56% of Hits and 52% of FA (See Table 4).

Taking into account the values of Hits and FA of these groups of participants, the sensitivity and criterion measures were calculated. Following Stanislaw & Todorov (1999), we calculated d' measures for all participants for accuracy in reporting a hazard in Q1. A 2x2 between groups ANOVA was conducted, using d' measures for novice and experienced driver groups, split according to offender status.

Results showed there was a significant effect of both experience [$F(1,108) = 16.37$, $p = .001$, $\eta^2_p = .13$] and offender-status [$F(1,108) = 6.46$, $p = .012$, $\eta^2_p = .06$], but the interaction was not significant [$F(1,108) = 1.84$, $p = .180$, $\eta^2_p = .017$]. Experienced drivers ($M = 1.60$) had greater sensitivity than novices ($M = .35$); and non-offenders ($M = 1.36$) had greater sensitivity than offenders ($M = .58$), see Figure 2.

Table 4. Hits, False Alarms, d-prime and B criterion, SA (average), What, Where, WHN, Caution DM measures obtained by the groups of participants Non-Offender-Offender (Learner, Novice and Experienced drivers) and Offender (Novice and Experienced).

Participants		YES Answers (Mean) Hazards (Max.15)	Quasi-hazards (Max.5)	Total (Max.20)	Hits	False Alarms	d-prime	*B* Criterion	Situation Awareness Average (Max. 3)	What? (Max. 1)	Where? (Max. 1)	What Happens Next? (Max. 1)	Caution in Decision Making (Max.1)
Non-offender	Experienced	12.9	0.95	13.85	.86	.19	2.2	0.92	1.36	0.32	0.57	0.46	0.835
	Novice	9.6	2.35	11.95	.64	.47	0.53	1.1	1.12	0.30	0.44	0.35	0.614
	Learner	9.75	2.6	12.35	.65	.52	0.38	1.09	1.06	0.24	0.43	0.35	0.607
Offender	Experienced	10.9	2	12.9	.73	.40	1.6	1.09	1.25	0.30	0.52	0.43	0.696
	Novice	8.4	2.6	1.1	.56	.52	0.15	0.89	1.06	0.31	0.43	0.27	0.540

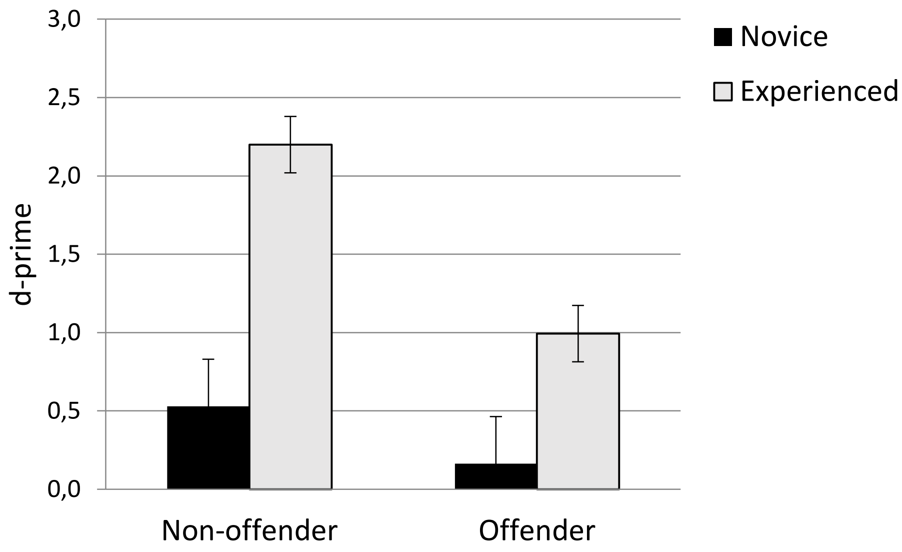

Figure 2. Mean of d-prime by experience and offender-status.

A one-factor ANOVA (between subjects) was conducted using d' measures for learner, novice and experienced drivers, all of them non-offender groups. Results showed there was a significant effect of experience [$F(2,94) = 21.02$, $p = .001$, $\eta^2_p = .309$]. Non-offender experienced drivers ($M = 2.19$) had greater sensitivity than non-offender novice drivers ($M = .52$), $t(61) = -5.51$, $p = .001$]; and non-offender experienced drivers had a greater sensitivity than learners ($M = .38$), $t(58) = -6,57$, $p = .001$]. But no differences were found between learner and non-offender novice drivers in the d' parameter.

A similar 2x2 ANOVA was carried out to compare drivers' criterion *B* across the variables of experience and offender status. There was no main effect of experience [$F(1,108) = .010$] or offender-status [$F(1,108) = .045$], and the interaction also failed to reach statistical significance [$F(1,108) = 2.42$]. All the values obtained were close to 1 (Non-offender experienced drivers = .92, Non-Offender novice drivers = 1.1; Offender experienced drivers = 1.09 and Offender Novice Drivers = .89), suggesting no significant response bias in either direction.

A one factor ANOVA (between subjects) was conducted to compare drivers' criterion B for learner, novice and experienced drivers, all of them non-offender groups. There was no main effect of experience for the criterion B.

5.4.3 Situation Awareness

5.4.3.1 Experience X Offenders X Type of Hazard

Questions 3, 4, and 5 probed situation awareness (following Jackson et al., 2009). Response accuracy to these questions was averaged for each participant and a 2×2×2 mixed-model ANOVA compared participant scores across experienced (experienced vs. novice), offender status (offender vs. non-offender), and across the within-groups factor of hazard type (actual hazard vs. quasi-hazard).

No significant main effect of the type of hazard was found [$F(1,105) = 2.73$, $p = .10$, $\eta^2_p = .02$], nor of offender status [$F(1,105) = 3.91$, $p = .051$, $\eta^2_p = .06$].

The results did, however, reveal a main effect of experience [$F(1,105) = 7.34$, $p = .01$, $\eta^2_p = .06$]. Novices ($M = 1.06$) were less accurate than experienced drivers ($M = 1.38$). None of the interactions reached significance.

5.4.3.2 Experience X Situation 3 Awareness Questions

A 3×3 mixed-model ANOVA was used to examine the differences between questions of situational awareness (*Where?*, *What?* and *WHN?*) as repeat measures factor; and driving experience (learner, novice and experienced drivers) as the between-subjects factor. (See Figure 3).

A significant main effect of driving experience was found [$F(2,137) = 9.26$, $p = .001$, $\eta^2_p = 0.12$]; learner ($M = 0.34$), novice ($M = 0.37$) and experienced drivers ($M = 0.45$). [The results demonstrate that experienced drivers out-performed learner drivers

[t(137) = -3.82, p = .001] and experienced drivers out-performed novice drivers t(137) = -3,24, p = .002].

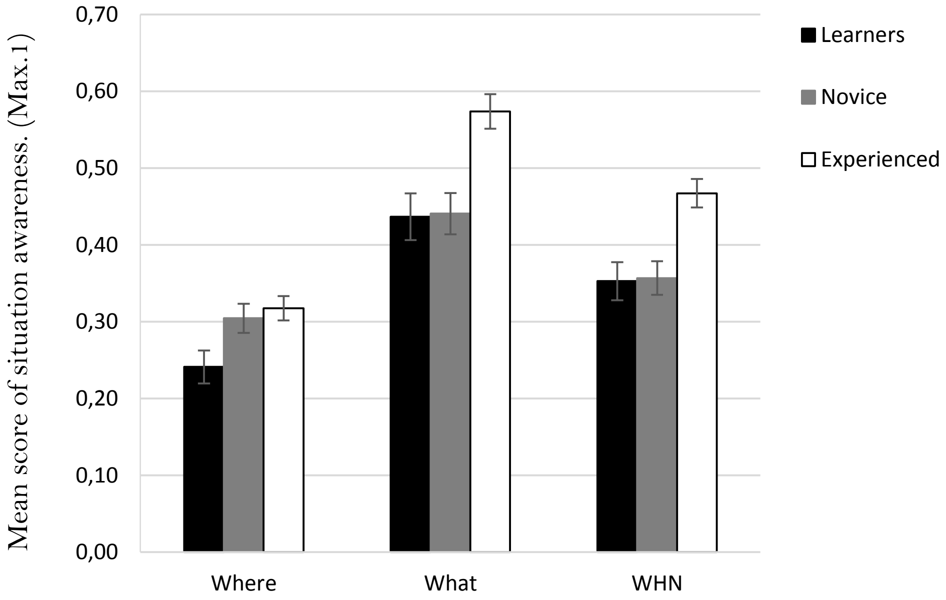

Figure 3. *Mean total scores in the situational awareness questions by experience.*

Significant differences were found between the situation awareness questions [F(2,136) = 128,66, p = .001, η^2_p = .65]; *What?* (M = 0.48) questions were correctly answered significantly more often than *Where?* (M = 0.29) or *WHN?* (M = 0.39); though more surprisingly, *Where?* questions were correctly answered significantly less often than *WHN?* questions.

A significant effect of the interaction between experience and questions was also found [F(4,271) = 5.17, p = .001, η^2_p = .071].

Planned comparisons located significant differences between learner and experienced drivers for the three questions: *Where?* [t(94) = -2.96, p = .004]; *What*?, [t(94) = -3.67, p = .001] and *WHN* ? [t(94) = -4.03, p = .001]. In addition, the only planned significant comparison between learner and novice was found for the Where question [t(76) = -2.35, p = .021]. The results demonstrate that the experienced drivers out-performed the other groups in two of the three questions, while the novices behaved like the learners when answering *What?* and *WHN?* questions, but performed more like the experienced drivers when locating the source of the potential hazard (*Where?*).

5.4.3.3 Cautiousness in Decision-making

Another way of analysing the decision-making process was explored with Question 5: *"What manoeuvre would you perform if you were the driver of the vehicle?"* For this question, Cautiousness in decision-making was measured as the number of times a participant marked *"I would make an evasive manoeuvre such as braking gradually"* rather than *"I would carry on driving at the same speed and trajectory"*. This first answer could be considered more cautious and conservative and is recommended by instructors at the driving schools whenever some hazardous or quasi-hazardous situation appears in the driving setting. A cautious answer was given a 1 and a non-cautious answer was scored as zero. These scores were averaged over clips for each participant and then subjected to a 2x2 between-groups ANOVA comparing experience (novice and experienced drivers) and offender status (non-offender and offender drivers) on this question.

A main effect of experience was found [$F(1,105) = 13.01$, $p = .001$, $\eta^2_p = .11$], with experienced drivers being more likely to make a cautious response to the hazard (novice drivers $M = .61$; experienced drivers $M = .75$).

A significant main effect of offender status was also found [$F(1,105) = 4.14$, $p = .044$, $\eta^2_p = .04$], with non-offender drivers. ($M = .70$) reporting more cautious behaviour than offender drivers ($M = .67$) (See Figure 4). The interaction was not significant.

And Table 5 shows the correlations between the variables studied.

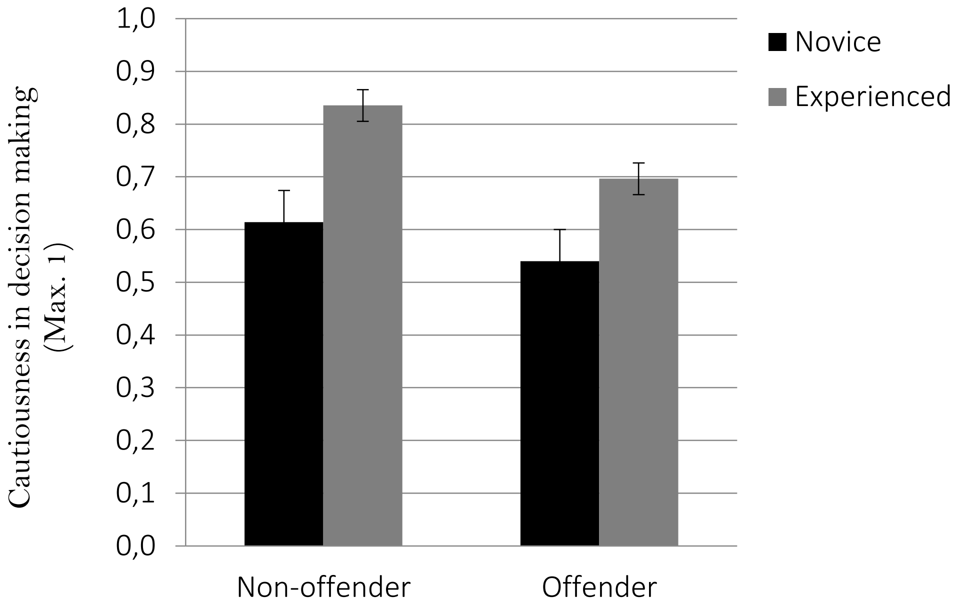

Figure 4. *Cautiousness in Decision-making by experience* and *offender-status*.

Table 5. Main Correlations between the variables studied.

		Average of Situation Awareness	**d-prime**	**B**	**Caution in Decision Making**
Situation Awareness	Correlation Pearson	1			
	Sig. (bilateral)	-			
d-prime	Correlation Pearson	.849**	1		
	Sig. (bilateral)	.0001	-		
B	Correlation Pearson	-.408**	-.412**	1	
	Sig. (bilateral)	.0001	.000	-	
Caution in Decision Making	Correlation Pearson	.650**	.706**	-.470**	1
	Sig. (bilateral)	.0001	.0001	.0001	-

Note. **= Correlation is significant at the .01 level (two-tailed).

5.5 Discussion

In this work, a pioneering Multiple Choice Hazard Perception and Prediction Test was developed and assessed. The test explored the effects of driving experience and offender-status on the processes involved in Hazard Perception and Prediction: sensitivity, response bias, situation awareness (recognition, location and projection) and decision-making. The psychometric properties of the test appeared to be acceptable. Twenty of the videos that comprise the test showed satisfactory reliability and discrimination indices. Cronbach's Alpha is acceptable ($\alpha = .77$).

The work adds to Hazard Perception psychological theory because it shows that different processes involved in Hazard Perception and Prediction can be quantified and measured independently (see Flach, 1995, p.155 for an opposite point of view). This type of manipulation has been lacking in previous approaches to HP. Using theories from psychology, such as the Signal Detection Theory for Hazard Perception will help towards an understanding of the processes involved in this task as part of the complexity of driving performance.

To enable calculation of the Signal Detection Theory (detection = sensitivity + decision-making) parameters, hazardous vs. quasi-hazardous situations were presented to the participants as signal and noise. A hazardous situation was defined as a driving situation that requires the driver to react before the hazard to avoid a collision (for example, by slowing down or by making an evasive manoeuvre). A quasi-hazardous situation was defined as a potentially hazardous situation that then develops without involving any final hazard (i.e. the driver did not actually have to decelerate or make any evasive manoeuvre to avoid a potential collision). Sanocki et al. (2015) showed that it is possible to study Hazard Perception in terms of classic Signal Detection Theory (Green & Swets, 1966) and the current approach offers another useful means of carrying out this analysis. It provides a way to measure objectively whether a scene is "a hazard" or "quasi-hazard" as an objective assessment of a binary true state.

According to the hypothesis devised and the results found, it can be said that:

1) The first hypothesis is confirmed: Hazard Perception skills are less developed in novice drivers than in experienced drivers. Specifically, learner and novice drivers' performance in this test is lower than that of experienced drivers. Different measures taken in the Hazard Perception Test are sensitive to the experience effect: d-prime and Situation Awareness.

2) Unlike Wallis and Horswill (2007), we did note a difference in sensitivity to reporting hazards according to driver experience. A difference was also noted across offender status. While both experienced drivers and non-offenders were more sensitive to the detection of a hazard, these factors did not interact.

3) We did not replicate Wallis and Horswill's (2007) response-bias effect across our different driver groups. Offender drivers do not appear to have a significantly different *B* criterion from non-offender drivers when performing Hazard Perception and Prediction Tasks. However, it was found that experienced offender drivers and novice drivers were less cautious in their decisions about what manoeuvres to make.

5.5.1 Sensitivity

As was shown, this version of the test proved useful to discriminate between drivers. When we carried out a detailed analysis using the Signal Detection Theory to explore participants' Sensitivity, it was found that d-prime discriminated between learner, novice and experienced drivers. Some traditional measures of hazard perception (mainly response time measures), referred to in various different studies that produced mixed results (Chapman & Underwood, 1998; Crundall, Underwood & Chapman, 1999;

Crundall, Underwood & Chapman, 2002, Sagberg & Bjørnskay, 2006; Borowsky, Shinar & Oron-Gilad, 2010; and Underwood, Ngai & Underwood, 2013), have failed to identify driver group differences. The success of our d' measure opens up the possibility of using Signal Detection Theory analyses to better discriminate between safe and less safe drivers. The simpler approach of combining Signal Detection Theory with an occluded prediction task removes the necessity for a fuzzy analysis and may explain why the current results are opposite to those reported by Wallis and Horswill (2007).

In addition, it was found that not only did the sensitivity of experienced drivers outperform that of novices but also non-offenders showed lower sensitivity scores than offenders.

5.5.2 Situation Awareness

In addition to the sensitivity effects, the test also successfully discriminated between our driver groups on the basis of experience, via the probe questions that were intended to assess situation awareness. The differences in accuracy between groups of different driving experience are consistent with previous literature (Armsby, Boyle & Wright, 1989; Benda & Hoyos, 1983; Brown & Groeger, 1988; Castro et al., 2014; Crundall et al., 2010; Finn & Bragg, 1986; Jackson et al., 2009; Spicer, 1964; Underwood et al., 2013; Crundall, 2016). This suggests that experience can improve Hazard Perception and Prediction when driving and that training in the skill of Hazard Perception and Prediction should be given before acquisition of the driving license; and perhaps post-license too. Although Situation Awareness can be developed during the process of acquiring driving skills, inexperience could make performing the task harder (Logan et al., 1988; Castro et al., 2014; Castro et al., 2016).

Interestingly, although the Situation Awareness probe questions differentiated between drivers of different experience, offender drivers did not demonstrate a significantly worse level of situation awareness. But how can offenders have the same situation awareness as non-offenders yet have a significantly lower sensitivity for detecting the hazards? Are they successfully predicting the situation, but then failing to translate this into the action of reporting a hazard? If this were the case, one might expect their response criterion to be higher, which it was not. Perhaps the questions did not capture the aspects of Situation Awareness that are most important to identifying the hazard? While this is a possibility, these questions have been used successfully in several other studies (e.g. Jackson et al., 2009), and it is hard to imagine finding more relevant questions that lead to the identification of a hazard. A third possibility remains: that the order in which the questions were asked favours non-offenders. Violators, offenders and risk-takers are often characterised by impulsivity (e.g. Moller & Gregersen, 2008), and therefore one could envision a situation where impulsive offenders, when faced with the first questions (did you see a hazard?), report "No". However, the subsequent questions then probe further into the Situation Awareness of the offender, who must then ruminate on what they actually saw and understood of the driving scene. Following adequate probing, they may then realise that they did indeed see a hazard, but this is rarely captured in their first response to Question 1. While the question order was an inevitable consequence of the method employed, it may actually reflect a real mechanism that could mediate violating behaviour on the road. While all the relevant information may be available to the offender, a quick response to a gut feeling may tempt some into an on-road violation.

5.5.3 Decision-making Process

The Signal Detection Theory also explores the participants' decision-making processes. The measure of the response bias parameter failed to find differences between offender and non-offender drivers and did not succeed in showing up the potential differences between drivers with varying levels of experience or driving profiles.

However, when analysing Cautiousness in decision-making, significant differences were found between experienced and inexperienced drivers. In particular, experienced drivers seem to be more cautious than novices. A greater number of experienced drivers chose the answer "I would make an evasive manoeuvre such as braking gradually" not only for the hazardous video clips but also for the quasi-hazardous ones. In addition, there were differences between non-offender and experienced offender drivers. Non-offenders were more cautious than offenders.

Further research to explain drivers' decision-making should explore other measures that depend on their self-assessment of driving skills and a calibration between the benefits and costs involved in the risk at the time of driving. Offenders are, in fact, aware of what the obstacles on the road are, where they are and what will happen next – at least on reflection. The problem is that drivers fail to separate signal from noise at the point where they need to make an immediate decision about the presence of a hazard.

This knowledge could be useful for several reasons: to better understand the different profiles of vulnerable drivers such as older drivers and offenders; to plan prevention and Hazard Perception training to deal with some hazards that involve specific difficulties, for instance for older drivers; and to establish better intervention strategies and treatment for the specific failings of each group of drivers, for instance, reducing aggressive driving or at least raising drivers' awareness of the problem.

5.5.4 Limitations

Because it is difficult to find women offenders or novice offenders, as offending and loss of driving license are usually related to greater driving experience, the sample employed for this study is not matched for gender). According to Scrimgeour, Szymkowiak, Hardie & Scott-Brown (2011), there were no gender differences in a Hazard Perception task that involved rating a series of traffic still photos as to how hazardous the depicted situations were perceived to be, with males and females rating all scenes similarly. Other sociodemographic variables may play a more important role than gender in Hazard Perception tasks, for instance, drivers' experience, drivers' age or personality traits related to Subjective Risk Estimation, such as sensation seeking, impulsiveness, etc.

5.6 Acknowledgments

We would like to thank our helpful reviewers for the time and effort employed in making detailed and interesting comments to improve the quality of this work. We wish to thank the Spanish drivers who volunteered for this study. We really appreciate the help of Barbara Lamplugh in improving the English of this article. Financial support was provided by the Ministerio de Ciencia e Innovación, MICINN (PSI2013-42729-P) and the Junta de Andalucía (CEI-BioTIC 2014-P-BS-9, and Proyecto Motriz P11-SEJ-7404). Also, we would like to thank the Dirección General de Tráfico (Exp: 0100DGT21263 and SPIP2015-01782) for supporting this research and the driving schools of Granada: Victoria, Luna and Genil for their collaboration in the recruitment of participants. None of the funding sources had direct involvement in the study design, in data collection, analysis or interpretation, in the writing of reports or in the decision to submit the paper for publication.

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6 CAPITULO IV: Driving Offender Status: What Drivers Are At Risk? The Role of Alcohol Consumption, Incautious Driving Style, Sensitivity To Reward And Recreational Risk Infraestimation In Predicting Recidivism.

Padilla, J.L., Gugliotta, A., Doncel, P., & Castro, C. (enviado). Driving Offender Status: What Drivers Are At Risk? The Role of Alcohol Consumption, Incautious Driving Style, Sensitivity To Reward And Recreational Risk Infraestimation In Predicting Recidivism. *Safety Science*,

6.1 Abstract

Finding precise tools to predict the behaviour of reoffender drivers is a difficult task, one that is not without risk and could be dangerous. At times this identification has been used to justify penalising reoffenders with punitive measures rather than treating them with effective psychological intervention programmes. To better understand the problem, it is necessary to know which factors are most significant in the prediction model for these behaviours. This study aims to reveal the reasons why young male drivers are over-represented in reoffending and to what extent alcohol consumption, driving styles, infraestimation of risk, sensitivity to punishment and reward and aggressive or angry driving can help explain this phenomenon. In this study, 296 drivers: 86 reoffenders (7 women and 79 men) and 206 non-reoffenders (105 women and 101 men) responded to a battery of instruments in which they were asked for sociodemographic data (i.e. gender and age), alcohol consumption habits, driving styles, general estimation of risk in everyday life, sensitivity to reward and punishment and anger while driving. The results provided a logistical regression model capable of predicting reoffending and explaining 34% of variability, successfully classifying 77.6% of participants. In this model, the best predictor of reoffending is higher consumption of alcohol (AUD, Alcohol Use Disorders), followed by incautious driving (since cautious driving style correlates negatively with reoffending) and to a lesser extent, infraestimation of recreational risk (this could perhaps be associated with the search for sensations and impulsiveness) and a greater sensitivity to reward (which makes one think about the ineffectiveness of the punitive measures adopted to try and correct reoffending). Relying on results to predict the behaviour of the reoffender driver could be important to improve: 1) the fundamental assessment based on whether their

consumption of alcohol and/or other substances is risky, or according to whether they practise a careful driving style. Moreover, reoffending can be the tip of the iceberg that helps to detect problems of consumption detrimental to health that affect other aspects of their lives; 2) intervention among the population of reoffender drivers implies the need to introduce new practices: a. adapting intervention programmes to treat problems associated with alcohol or drug consumption with detoxification programmes; b. punitive measures (fines, confiscation of license, criminal record, etc) or reeducation or sensitisation courses that could be effective in the case of the offender who is breaking the law for the first time but might be insufficient for the recurrent offender showing risky alcohol consumption, who might be more sensitive to the introduction of reinforcement measures, such as, for example, a reduction in the level of free movement allowed.

6.2 Introduction

Drunk driving, driving over the speed limit and not fastening your seatbelt or wearing a helmet if driving a motorbike are factors that contribute time and again to the rising figures for accidents causing death and serious injury (ITF, 2017). Buckley, Chapman and Lewis (2016) argue that public policies should be redefined to find a new approach to correcting these behaviours, resulting in a reduction in accident figures. Our study aims to contribute new insights into the factors that define the profile of the reoffender driver.

A high proportion of the previous literature on reoffender drivers is centred on the study known as "DUI" (Driving Under the Influence), or "DWI" (Driving While Intoxicated) (Buckley, Chapman & Lewis, 2016). Educational programmes and traffic campaigns have tried to tackle this problem (Lapham et al., 2006), but have not succeeded in reducing the high incidence of reoffending among those drivers who break the law, especially in the case of offenders who drive under the influence of substances or with excess speed (Ouimet et al., 2013).

The absence of positive results could be due to the difficulty in finding appropriate prediction instruments. In fact, previous attempts could have served more to punish reoffenders than to treat them (Cavaiola, 2013). Punishment with fines or even prison could have limited efficacy if not adapted to the unequal needs of each group of offenders (Cavaiola, 2013). For example, for a driver who exceeds the alcohol limit on leaving a wedding celebration, confiscating their driving license could be sufficiently punitive to prevent a repetition as it stops them driving for several months, imposes a substantial fine (€1,000) and they have to attend sensitisation and driving reeducation courses at their own cost. However, if the driver whose license is being withdrawn for driving under the influence of alcohol has had this happen repeatedly, it is probable that the confiscation of their license, paying a fine, prison and attending the reeducation course will be less effective than treating them with a clinical psychological intervention programme of detoxification (DeMichele & Payne, 2013).

Also, in the process of screening the recidivism, false positives and negatives can be produced (Nadeau, Vanlaar, Jarvis & Brown, 2016). For this reason, efforts to avoid these errors and succeed in distingishing more exactly which offenders of those breaking the law for the first time are at risk of becoming repeat reoffenders should not be spared (Dugosh, Festinger & Marlowe, 2013; Nochajsky & Stasiewicz, 2006, for a review).

In the U.S., many reoffender drivers present a high level of Alcohol Use Disorders (AUD; Wieczoreck & Nochajsky, 2005) and 40% of drivers injured in road accidents under the influence of alcohol have a previous history of offences for alcohol consumption (Lapham, Skipper, Hunt & Chang, 2000). In Spain, a similar pattern has been observed: 50% of drivers imprisoned for traffic offences show problematic alcohol consumption habits (Herraiz, 2009). In turn, 72% of reoffender drivers who have lost their driving license for adopting risky behaviour on the road presented, or had presented in the past, at least one diagnosis of addiction to some drug, in the majority of cases alcohol (Valero et al., 2017).

Is it still relevant to ask: What is behind the delinquent behaviour of these drivers? Why are young, male drivers overrepresented in the statistics on the relation between alcohol consumption and accidentality? In Europe, the majority of road accidents occur on weekend nights, young drivers between 18 and 24 years being the protagonists, and driving under the influence of alcohol, drugs or fatigue (European Commission, 2016). Of those who die in traffic accidents, 76% are youths and men. The youngsters, between 15 and 24 years, make up 11% of the European population and are involved in 17% of all traffic accidents. Given the gravity of the problem, we should analyse in more depth the profile of the repeat reoffender. This can be done by relying on suitable DUI assessments and at the same time measuring the influence they could have on those variable personality traits such as anger or sensitivity to reward and punishment, and socio-cognitive variables like infraestimation of risk (Cavaiolla, 2013).

The relationship between personality and risky driving has been widely studied (Dahlen & White, 2006; Machin & Sankey, 2008, Ulleberg & Rundmo, 2003). Specifically, the MDSI (*Multidimensional Driving Styles Inventory*) measures the following six factors: reckless driving at high speeds, distracted driving, aggressive driving, cordial and careful driving, anxious driving and distress reduction driving (Taubman Ben-Ari et al., 2004). For example, a positive relation has been found between the reckless style and a history of traffic offences, and the search for sensations, and a negative correlation between anxious driving and extroversion (Taubman Ben-Ari & Yehiel, 2014). In another study with data gathered in a real driving situation, "In-Vehicle Data Recorder (IVDR)", Taubman-Ben-Ari et al. (2014), it was found that the frequency of occurrence of hazardous events correlated positively with reckless and aggressive driving styles.

With regard to the possibility of modifying these poorly adapted behaviours for safe driving, doubt has been cast on the efficacy of punishment. DeMichele and Payne (2013) exemplify this, saying that you wouldn't use a hammer on the repeatedly reoffending drunk driver. The efficacy of punishment to correct recidivism is, according to the theory of persuasion, related to: the probability of being caught when you commit an offence (often the source dispensing the punishment is absent); the speed with which the punishment is applied (sanctions and their payment are not always contingent on commission of the offence); and the severity of the sanctions (among them, in Spain for example, substantial fines, confiscation of the license for up to 8 months and a prison sentence (which could be commuted to community service if the fault is admitted) and previous convictions for driving offences) (Nagin & Pogarsky, 2001; Wieczored, 2013). However, we all know that other forms of behaviour modification exist, such as financial reward, which can be effective, even if symbolic.

On the other hand, the problem of recidivism could be related to infraestimation of risk when taking risky decisions. In fact, in a previous study, we found that reoffender drivers, even if they had no problem identifying obstacles, did underestimate the risk these implied for driving (Castro et al., 2014, Ventsislavova et al., 2016). Along these lines, some authors affirmed that infraestimation of risk could be related to other personality 'traits' such as anger (Machin & Sankey, 2008; Dahlen & White, 2006), or aggression (Ulleberg & Rundmo, 2003). It has been seen that young people with scant driving experience tend to exceed the speed limit at the same time as underestimating the potential risk of driving situations and overestimating their skills as drivers (Deery, 1999; McKenna & Horswill, 2006).

Searching for more potential predictors of recidivism, Zhang, Chan and Zhang (2016) indicate that anger is a strong predictor of risky driving, mainly in young drivers rather than older ones. Anger as a trait is one of the emotions most related to hazard perception, affecting attention, decision-making, reasoning and information processing (Blanchette & Richards, 2010, Deffenbacher, Deffenbacher, Lynch & Richards, 2003; Delhomme, Chaurand & Paran 2012). It has been observed that anger tends to increase the degree to which an uncertain situation is perceived as foreseeable, leading to a reduction in the hazard perception of an individual (Blanchette & Richards, 2010). Anger has been related to delinquent behaviour on the road, such as speeding or driving under the influence of alcohol (Deffenbacher et al., 1994; Delhomme, Chaurand & Paran, 2012; Berdoulat, Vavassori & Muñoz-Sastre 2013). More specifically, Björklund (2008) found that drivers who infringe the speed limit most frequently are the ones least irritated by other drivers who exceed the limit in a reckless manner.

The aim of this study is to contribute to discovering the profile of the reoffender driver. As well as analysing the role and predictive power of demographic variables (gender and age), the following relationships are analysed: a) driving styles measured with the MDSI-Spain (Multidimensional Driving Styles Inventory Spain; Padilla et al., submitted); b) alcohol consumption measured with the AUDIT (Alcohol Use Disorders Identification Test, Guillamón-Contel, Gual-Solé & Colom-Farran, 1999), c) hazard perception in different aspects of life measured with the DOSPERT (Domain-Specific Risk-Taking; Weber, Blais & Getz, 2002); d) sensitivity to punishment and reward measured with the SPSRQ-20 (Sensitivity to Punishment and Sensitivity to Reward Questionnaire; Castellà and Pérez, 2004), and e) anger in driving measured with the DAS (Driver Anger Scale; Deffenbacher et al., 1994). The evidence contributed to the study could improve prediction of risky behaviours and lead to the development of more effective intervention strategies.

6.3 Method

6.3.1 Participants

296 drivers recruited from the population of students and workers at the University of Granada (UGR) (Faculty of Psychology and Faculty of Sciences) as well as students of driving schools, all in the city of Granada, Spain, participated in the study. The participants recruited from the driving schools were undertaking courses of training in business administration to obtain a professional license (CAP) or the partial or total recovery of points lost on their license. Those participants on courses for the recovery of points were considered as reoffender drivers, whether they were merely recovering some points on their license or trying to recover a confiscated driving license.

The criteria for inclusion as participants in this study were: a) being over 18 years, b) possessing a Spanish driving license, c) driving at least once a month, d) having driven regularly for at least 0 – 2 years.

In addition, for participants who fulfilled the inclusion criteria, those who showed aberrant behaviour patterns in their responses to the questionnaire (specifically excessive repetitions of the same answer or a lack of different options in their chosen responses) were eliminated. The sample of reoffender drivers consisted of 86 drivers (8.1% female), whose age range was between 19 and 65 years (M = 36.69, SD = 11.95). The sample of non-offender drivers consisted of 206 participants (49% female), with an age range between 18 and 81 years (M = 46.27, SD = 17.26).

6.3.2 Instruments

The participants responded to a battery of instruments that included measurements of their alcohol consumption habits, of their general risk estimation in day-to-day life, of sensitivity to punishment and reward, and of the trait of anger in driving.

6.3.2.1 AUDIT (Alcohol Use Disorders Identification Test)

To obtain an estimation of alcohol consumption, an adaptation of the test identifying disorders resulting from alcohol use (AUDIT; Guillamón-Contel, Gual-Solé & Colom-Farran, 1999), was used. The original version of the AUDIT was developed by Saunders, Aasland, Babor and de la Fuente (1993) for the early detection in primary care services of risky habits of alcohol consumption and the possible presence of a disorder.

To analyse the metric properites of the AUDIT, only those participants who reported consuming alcohol at least once a month were considered. The reliability of the results obtained with the AUDIT was high (Cronbach's Alpha of .71), a value lower than that obtained by the authors of the adaptation (.88). The item-total correlation corrected for the items was adequate, with values for most of them higher than .30. (with the exception of items 1 and 9).

Thus, from the scores obtained in the questionnaire, participants' alcohol consumption was assessed, using the cut-off scores proposed by the authors of the adaptation: consumers with no risk (scores lower than 9), risky consumers (scores of 9) and consumers with possible Alcohol Use Disorders (AUD; scores of 10 or above). Subsequently participants were divided into two unique categories: non-risky consumers of alcohol and consumers with AUD.

6.3.2.2 MDSI (Multidimensional Driving Style Inventory)

The MDSI is an inventory designed to detect different driving styles from a global perspective. Created by Taubman-Ben-Ari et al. (2004), it has been adapted for use in the Spanish context by Padilla et al., (submitted). The Spanish version of the MDSI contains 40 items with a Likert-type response format with 6 categories of response, from 1 "not at all" to 6 "very much", and evaluates 6 distinct driving styles.

A Confirmatory Factorial Analysis (CFA) was carried out to check whether the 6-factor structure of the source version of the MDSI explained in a satisfactory manner the dimensionality of the inventory in the sample of participants. The estimation method of Robust Maximum Likelihood was utilised. The tightness of fit of the model was acceptable according to the criteria of Hu and Bentler (1999): [$\chi^2(512) = 854.41$, $p < .001$; $\chi^2 / df = 1.67$; RMSEA = .05, CI 90%(.04 - .05); SRMR = .08; CFI= .96]. The internal consistency values for each style in conjunction with an example item were as follows: Risky style $\alpha = .83$, *Enjoy the sensation of driving at the limit*; Anxious style $\alpha = .63$, *Driving makes me feel frustrated*; Careful style $\alpha = .66$, *Tend to drive cautiously*; Angry style $\alpha = .67$, *Get angry with people driving slowly in the fast lane*; Dissociative style $\alpha = .62$, *Forget that my lights are on full beam*; Relaxed style $\alpha = .67$, *Listen to music to relax while driving*. The score of the person in each style is the average of their responses to the items ranked from 1 to 6.

6.3.2.3 DOSPERT-S (Domain-Specific Risk-Taking-Spain)

Originally developed by Weber, Blais and Getz (2002), the DOSPERT scale was designed to evaluate both conventional attitudes towards risk (defined as the level of risky behaviour reported) and attitudes to hazard perception (defined as the wish to participate in a risky activity according to the risk perceived). In this study, only the subscale of Risk Perception in the version translated by Rubio and Narváez (2007, in Horcajo et al., 2014) was used, this being an adaptation of the shortened version of that scale (Blais & Weber 2006). The items on this scale are in a Likert-type format with seven alternative responses, where 1 is "not at all risky" and 7 "extremely risky". The scoring on the scale is the sum of the response scores to each item, ranked from 6 to 42.

The 5-factor model proposed by Rubio and Narváez (2007) was put to the test by means of a CFA with Robust Maximum Likelihood as the extraction method, obtaining an acceptable fit [$\chi^2(395) = 714.58$, $p < .001$; $\chi 2/df = 1.81$; RMSEA=.06, CI 90% (.05-.06); SRMR = .07; CFI = .82]. The internal consistency values for each style in conjunction with an example item were as follows: DOSPERT Social $\alpha = .67$, *"Admitting that your tastes are different from those of a friend"*; DOSPERT Recreational $\alpha = .77$, *"Bungee jumping off a high bridge"*; DOSPERT Health /Safety $\alpha = .74$, *"Driving a car without wearing a seat belt"*; DOSPERT Ethical $\alpha = .64$, *"Putting some questionable deductions on your income tax return"*; DOSPERT Financial $\alpha = .58$, *"Investing 10% of your annual income in a new business venture".*

6.3.2.4 SPSRQ-20 (Sensitivity to Punishment and Sensitivity to Reward Questionnaire)

Adapted to Spanish by Castellà and Pérez (2004), the SPSRQ-20 is a shortened version of the SPSRQ designed by Torrubia et al., (2001), the objective of which is to measure sensitivity to punishment and reward. Specifically, Sensitivity to Punishment (SP) is related to inhibition in behaviour and indications of punishment, while Sensitivity to Reward (SR) is related to the absence of inhibition in behaviour and the awareness of indications of reward (Torrubia et al., 2001). The items in this questionnaire are in a Likert-type format with four alternative responses, where 1 is "Strongly disagree" and 4 is "Strongly agree". The SR and SP scales consist of 20 items respectively, the total score in each of them being ranked from 4 to 40.

The two-factor structure was put to the test with a CFA using Robust Maximum Likelihood as the method of extraction, obtaining good indices of fit [$\chi^2(169) = 273.83$,

$p < .001$; $\chi^2 / df = 1.62$; RMSEA = .05, CI 90%(.04 - .06); SRMR = .06; CFI= .90]. The internal consistency values for each factor of the questionnaire in conjunction with an example item were as follows: SR $\alpha = .80$, *"Do you often do things in order to be praised?"*; SP $\alpha = .80$, *"Are you often afraid of new or unexpected situations?"*.

6.3.2.5 DAS (Driver Anger Scale)

The Driver Anger Scale (DAS) was developed by Deffenbacher et al., (1994) to measure anger in traffic situations. The items on this scale are presented in a Likert-type format with five alternative responses (from 1 = "None" to 5 = "A lot"), with which participants grade the degree of anger provoked in them in different driving situations. In this study, the 14-item version of the scale was used, adapted to Spanish by Herrero-Fernández (2011).

Given that in this study we were dealing with a sample of reoffender drivers, and bearing in mind our doubt as to whether this subsample might behave differently from the population with which the scale was validated for Spain, we proceeded to examine whether the factorial solution proposed by Herrero-Fernandez (2011) was the most appropriate or whether one of the others contributed to the literature might be more suitable. Therefore, using various CFAs in which reoffender drivers and non-reoffenders were included, we put to the test: a) a one-factor solution, b) the three-factor solution proposed by Herrero-Fernández (2011) and c) a four-factor solution proposed by Martí-Belda (2015). The estimation method used was Maximum Robust Likelihood (Table 1).

Table 1. Indices of goodness of fit for different factorial structures of the Driver Anger Scale.

Model	χ^2(*p – exact fit*)	*df*	χ^2/df	*RMSEA (CI 90%)*	*SRMR*	*CFI*
Monofactorial	364.69 ($p < .01$)	77	4.74	.10 (<.01)	.07	.73
3 Factors	135.41 ($p < .01$)	74	1.83	.05 (.04 - .07)	.05	.93
4 Factors	121.84 ($p < .01$)	71	1.72	.05(.04 – .07)	.05	.94

The advantages and disadvantages of all the factorial models proposed were evaluated. Consequently, it was decided to discard, on the one hand, the monofactorial solution, which had a poor fit, and on the other hand, the proposal of Martí-Belda (2015), which despite demonstrating a good fit, showed poor reliability indices for the fourth factor (α = .36). Therefore, the model finally chosen was that of Herrero-Fernández (2011). The internal consistency values for each subscale in conjunction with an example item were as follows: a. Anger at Traffic Obstructions (α = .72, *"A cyclist is riding in the middle of the road, slowing down the traffic"*; b. Anger at Illegal Behaviour α = .68, *"Someone is driving in a zigzag fashion"*; c. Anger at Hostile Gestures α =.88, *"Someone is making an obscene gesture at you because of the way you're driving"*. The scores on each scale were calculated as the sum of the scores obtained for the items in each factor. Therefore, the scores could vary between 7 and 35 on the first subscale, which had 7 items. On the second subscale, which had 5 items, scores of 5 to 25 were found and on the third, with only 2 items, the scores could oscillate between 2 and 10.

6.3.3 Procedure

The administration of the questionnaire was carried out both in group form and individually. Two researchers were assigned to each administration group and were charged with giving information about the test, which required the informed consent of participants. All participants received compensation for their participation.

The researchers distributed a questionnaire with the scales and tests used in the study together with demographic questions. The complete administration of the questionnaires lasted an average of thirty minutes.

In the current investigation, the ethical principles of the Helsinki declaration for research with humans were followed and the researchers were awarded a favourable report for their execution of the study by the ethical committee of the UGR.

6.3.4 Design and Data Analysis

Once the data from the whole sample of participants were obtained, a method of multiple imputation was carried out: "Predictive mean matching" (Landerman, Land & Pieper, 1997) for those subjects who presented 3 or fewer lost values in the variables of interest. The data analyses carried out are presented below.

Firstly, some χ^2 tests of independence were performed to check if an association existed between reoffending and the variables alcohol consumption and gender (evaluating the degree of association with Cramer's V statistic), as well as a *t-test* to evaluate whether differences existed between reoffender drivers and non-offender drivers of the same age.

Secondly, some *t-tests* were carried out for independent samples with the aim of determining whether there were differences between reoffender and non-reoffender drivers in the following variables: a) the six driving styles (measured with the MDSI-Spain), b) the scores on the five subscales of hazard perception (measured with the DOSPERT), c) the scores obtained on the Sensitivity to Punishment and Sensitivity to Reward scales (measured with the SPSRQ), and d) the three scales of anger in driving (measured with the DAS). In all cases, the suppositions for normality and homogeneity were checked, using the tests of Kolmogorov-Smirnov and Levene, respectively.

Following this, a logistical regression model was fitted to predict recidivism from the measures collected with the different questionnaires. Subsequently, compliance with the suppositions of independence, lineality, colineality and dispersion to the average were checked, as well as evaluating the possible presence of atypical and influential cases. The level of significance adopted for all the analyses was $\alpha = .05$. For this, the statistical package SPSS v23.0 (Corp., I.B.M., 2015) was used.

6.4 Results

6.4.1 Sociodemographic variables and consumption of alcohol

First, with respect to the diagnostic on consumption of alcohol, a significant relationship was found with the profile of recidivism [$\chi^2(1) = 33.79$, $p < .001$], the intensity of this relation being moderate (Cramer's V = .36). As Table 2 shows, reoffender drivers presented a diagnostic associated with excessive alcohol consumption with greater frequency than non-reoffender drivers.

Table 2. Distribution of the diagnostic of alcohol consumption for profiles of recidivism

	Non-offenders	Offenders
Moderate consumption	177 (93.7%)	48 (65.8%)
Alcohol Use Disorders	12 (6.3%)	25 (34.2%)
Total	189 (100%)	73 (100%)

In the case of gender, a significant relation was again found with the profile of recidivism [$\chi^2(1) = 47.07$, $p < .001$], this relation also being of moderate intensity

(Cramer's V = -.40). Thus, and as Table 3 shows, women are scarcely represented in the group of reoffenders (8.1%), in contrast to the sample of non-reoffenders where they form more than half the sample (51%).

Lastly, in the case of age, the results show that significant differences exist in the average ages of reoffenders compared to non-reoffenders ($t(226.45) = 5.44$, $p < .001$; $d' = .34$), reoffending drivers ($M = 36.69$, $SD = 11.95$) being younger than non-reoffenders ($M = 46.27$, $SD = 17.26$).

Table 3. Distribution of the profile of recidivism by gender

	Non-offenders	Offenders
Women	105 (51%)	7 (8.1%)
Men	101 (49%)	79 (91,9%)
Total	206 (100%)	86 (100%)

6.4.2 Personality variables related to driving

Table 4 summarises all the *t-tests* carried out to check whether differences exist between reoffender drivers and non-reoffenders in the scores of the different questionnaires regarding personality attributes related to driving. With respect to estimation of risk, the results show that non-reoffender drivers possess better risk perception than reoffender drivers in what are referred to as the recreational, financial, health, safety and ethics domains. However, this doesn't occur in the case of risk estimation in the social domain, where both driver profiles behave in the same way.

Table 4. Summary of *t-tests* carried out on traits related to driving

		Profile	*N*	Mean	*SD*	*t* (*df*)	*Cohen's d*
DOSPERT (Risk-Perception)	Social	Non-offenders	204	18.13	5.54	.32 (288)	.02
		Offenders	86	17.90	6.23		
	Recreational	Non-offenders	204	30.73	6.10	3.97 (128.39) **	.33
		Offenders	86	26.91	8.01		
	Finances	Non-offenders	204	33.07	6.66	2.39 (288) *	.14
		Offenders	86	31.12	5.58		
	Health/ Security	Non-offenders	204	34.71	4.51	3.13 (134.5) *	.26
		Offenders	86	32.59	5.56		
	Ethics	Non-offenders	204	33.13	4.64	4.36 (288) **	.25
		Offenders	86	30.33	5.80		
SPSRQ-20	Sensitivity to Punishment	Non-offenders	204	22.18	5.35	2.48 (288) *	.14
		Offenders	86	20.49	5.17		
	Sensitivity to Reward	Non-offenders	204	20.46	5.20	-4.20 (288) **	.24
		Offenders	86	23.31	5.46		
DAS (Driver Anger Scale)	Anger at Traffic Obstrutions	Non-offenders	204	18.95	4.91	-1.20 (288)	.07
		Offenders	86	19.69	4.55		
	Anger at Illegal Behaviour	Non-offenders	204	18.21	3.42	-1.11 (288)	.07
		Offenders	86	18.70	3.38		
	Anger at Hostile Gestures	Non-offenders	204	6.01	2.39	1.01 (288)	.06
		Offenders	86	5.70	2.43		
MDSI (Multi-dimensional Driving Styles Inventory)	Reckless Driving Style	Non-offenders	85	2.38	1.07	-3.52 (120.42) *	.31
		Offenders	203	1.93	.76		
	Anxious Driving Style	Non-offenders	84	2.04	.82	.47 (286)	.03
		Offenders	204	2.09	.82		
	Careful Driving Style	Non-offenders	85	4.06	.87	4.06 (285) *	.23
		Offenders	202	4.48	.77		
	Angry Driving Syle	Non-offenders	85	2.41	.89	-3.47 (287) *	.20
		Offenders	204	2.05	.78		
	Dissociative Driving Style	Non-offenders	86	1.91	.57	-.023 (287)	<.01
		Offenders	203	1.91	.54		
	Distress Reduction Driving Style	Non-offenders	85	3.27	.90	1.23 (285)	.07
		Offenders	202	3.42	1.02		

*$p < .05$ ** $p < .001$

When we look at the scores obtained in the SPSRQ-20, we find that reoffender drivers are more sensitive to reward and less sensitive to punishment than non-reoffender drivers.

Turning to anger in driving, the results do not show significant differences between reoffender and non-reoffender drivers on any of the three subscales of the DAS.

Lastly, with respect to driving styles, the results indicate that reoffender drivers adopt more reckless and aggressive and at the same time less cautious styles than non-reoffender drivers.

Of the contrasts with a significant value, only the comparison of the Recreational DOSPERT subscale has a small effect size (>.30) according to Cohen's criteria; the remaining effect sizes are very small.

6.4.3 Logistical regression for predition of recidivism

A logistical regression model was fitted, using as independent variables all the measures collected via the forward stepwise selection method. The only variables introduced into the final model were the diagnostic for alcohol consumption, the scores on cautious driving style of the MDSI, the scores on recreational risk estimation of the DOSPERT and the scores obtained on sensitivity to reward of the SPSRQ-20.

Subsequently, possible moderation effects were studied between the variables of the model, a significant interaction being found between recreational risk perception and sensitivity to reward. The resulting model, including the interaction, fitted according to the Hosmer and Lemeshow Test [$\chi^2(8) = 10.14, p = .255$], explaining from the variables included in the model, 34% of the variability of recidivism (R^2 de Nagelkerke = .34), and capable of successfully classifying 77.6% of participants (with a sensitivity of 69.4% and a specificity of 80.9%).

As the regression coefficients in Table 5 show, a risk consumption of alcohol and a greater sensitivity to reward increase the probability of being an offender. On the other hand, a greater Careful driving style and a higher Recreational risk perception diminish this probability.

To measure the risk of being a reoffender, as formulated in the logistical regression analysis, *odds* were utilised, this being a concept similar to probability, where $odds = p / (1-p)$.

With regard to the diagnostic on alcohol consumption, the *odds* of being a reoffender are 7.955 times greater in participants who have AUD than in those with non-risky consumption, while the *odds* of being a reoffender diminish by 46% for each point gained in careful driving style.

Table 5 Logistical regression model to predict recidivism

	B	*SE*	*Wald*	*Df*	*p-value*	*Exp(B)*	**95% C.I. for *EXP(B)***	
							Lower	**Higher**
AUDIT (Alcohol Use Disorders Identification Test)	2.07	.43	23.00	1	<.001	7.96	3.41	18.57
MDSI - Careful Driving Style	-.61	.20	9.02	1	.003	.54	.37	.81
DOSPERT - Recreational Risk Perception*	-.10	.03	14.54	1	<.001	.91	.86	.95
SPSRQ-20 SR* - Sensitivity to Reward	.10	.04	8.62	1	.003	1.11	1.04	1.19
DOSPERT-Recreational Risk Perception by SPSRQ-20 Sensitivity to Reward*	.01	>.01	6.96	1	.008	1.01	1.00	1.02
Intersection	-1.73	.22	63.06	1	<.001	.18		

* Scores centred on the average of each variable

For recreational risk estimation, with each point of increase in this measure, the *odds* of being a reoffender diminish by 9%, but only for those drivers with an average sensitivity to reward.

With respect to sensitivity to reward, the *odds* of being a reoffender increase by 11% with each point of increase in this measure, uniquely for those drivers with an average score in recreational risk estimation.

Lastly, the moderation effect of sensitivity to reward on the relationship between recreational risk estimation and recidivism was analysed. This effect indicates that the *odds ratio* of being an offender for each point of increase of the Recreational DOSPERT (.90) rises by 1% for each point of increase in sensitivity to reward.

6.5 Discusión

The aim of this study is to find out which variables might be relevant to constructing a profile of the reoffender driver, with the goal of improving the precise prediction that would enable a more accurate assessment. From this, it would be possible to take decisions and put into practice action plans that take into account the particular characteristics of reoffenders and to make appropriate interventions for their needs.

We found significant differences between reoffender and non-reoffender drivers in alcohol consumption, gender and age. Moreover, reoffender drivers adopt more reckless and aggressive, and at the same time less careful, styles than non-reoffender drivers. Non-reoffender drivers have better risk estimation than reoffenders. Reoffender drivers are more sensitive to reward and less sensitive to punishment than non-reoffender drivers.

We also used logistical regression to establish a prediction model of the profile of recidivism that quantifies the weight of each of these variables. We found that a higher consumption of alcohol and a greater sensitivity to reward increase the probability of being a reoffender. On the other hand, a more cautious style and a higher recreational risk estimation reduce this possibility.

6.5.1 Sociodemographic variables

Reoffender drivers were significantly younger than non-reoffender drivers. In turn, men were the predominant gender among the sample of reoffenders, in contrast with the non-reoffenders, where men and women were equally distributed. These data confirm what was found in previous literature: that men, with little driving experience, tend to show more problematic behaviour such as breaking the speed limit (Deery, 1999; McKenna & Horswill, 2006); men accept more risky driving behaviours than women (Sarkar & Andreas, 2004) and make more errors in risky driving (Scott-Parker et al., 2013). These studies corroborate the statistics in which it is seen that men tend to come up positive more often than women in alcohol checks, with no significant effects of age group being found (DGT, 2016).

6.5.2 Alcohol consumption and recidivism

Reoffender drivers tend to present a pattern of alcohol consumption defined as risky or possible AUD. These results are in line with those of Herraiz (2009) on those in prison for offences of dangerous driving, and of Valero et al., (2017) and Martí-Belda (2015), on reoffender drivers, where an underlying problem of alcohol consumption is noted in these drivers.

6.5.3 Relation of personality variables and recidivism

Regarding styles of driving, we found that reckless and aggressive driving style has a direct relation with the driving profile of the reoffender, while the careful driving style has an inverse relation to being a reoffender. Orit Taubman-Ben-Ari (2004) in the original version of the MDSI and we in the adaptation of the MDSI-Spain (Padilla et al., submitted), found that the reckless style, at least, was positively related to the participant's history of traffic offences.

In addition, reoffender drivers have poorer risk estimation than non-reoffender drivers, at least in what are referred to as the recreational, financial, health, safety and ethical domains. However, no significant differences were found in the social domain. This interpretation supports the literature noting that risk estimation can play an important role in explaining driving offences (Machin & Sankey, 2008; Delhomme et al., 2012). It can also be said that the infraestimation of risk that the reoffender shows when driving may be considered a symptom of lower risk estimation in other spheres of life, which could be related to suffering other kinds of problem, e.g. addiction to gambling or drugs (Weber, Blais & Getz, 2002).

Our data also demonstrate that reoffender drivers score lower on the sensitivity to punishment scale and higher on the sensitivity to reward scale, as was expected. Castella and Pérez (2004) and Martí-Belda (2015) also affirm that drivers with a high sensitivity to punishment and a low sensitivity to reward tend to drive in accordance with the law, while those drivers with a low sensitivity to punishment and a high sensitivity to reward report breaking the traffic rules more often. Constantinou et al., (2011) also found that sensitivity to reward correlates positively with violations of the traffic rules, measured by means of the DBQ.

In addition, despite the fact that some previous studies related anger with delinquent behaviours on the road, such as speeding or driving under the influence of alcohol (Deffenbacher et al., 1994; Delhomme, Chaurand & Paran, 2012), our study was not able to contribute significant differences between reoffender and non-reoffender drivers with reference to anger in driving. These results support the literature noting that risk estimation has greater weight when it comes to explaining driving infractions than the trait of Anger in driving (Machin & Sankey, 2008; Delhomme et al., 2012). Likewise, previous studies showing that the search for sensations stimulates risk and behaviours that break the law (Zuckerman & Neeb, 1980; Furnham & Saipe, 1993; Jonah, 1997).

6.5.4 Prediction Model for Recidivism

Our study tries to generate a prediction model for the reoffender driver, contributing a logistical regression model which was capable of explaining 34% of the variability and which successfully classified 77.6% of participants according to their profile of recidivism. Through the model obtained, we observed that the problems of reoffending drivers are closely associated with AUD, this being one of the variables best able to predict someone being a reoffender. We also saw that adopting more careful driving styles diminishes the probability of being a reoffender. The reoffender driver shows less infraestimation of recreational risk, which could be related to their impulsiveness and greater search for sensations (Zuckerman & Neeb, 1980 and Martí-Belda, 2015). This pattern is accentuated even more strongly in the case of reoffenders who score high on sensitivity to reward. Lastly, anger and reckless driving style do not score high enough in our study to be considered good predictors of recidivism. As in other studies (e.g. Delhomme, Chaurand & Paran 2012), this could be due to the fact that their effect is shadowed by those variables in the model that carry more weight.

6.6 Conclusions

All in all, these results highlight two fundamental aspects with regard to recurrent reoffending: those relating to evaluation and intervention. Firstly, it is essential to carry out an accurate screening of the reoffending population that assesses whether they have a risky consumption of alcohol and other substances. This diagnostic would represent an advance, not only in improving road safety but also in promoting a healthier lifestyle. The detection of recidivism could be the tip of the iceberg that helps to detect a consumption problem detrimental to the health of these people and which might affect other spheres of their lives (family, social or work). This could be done by using reliable instruments such as the AUDIT, which is used to discriminate between non-pathological consumption of alcohol and pathological consumption, and the MDSI, which has a subscale measuring aspects of adaptive driving that correlate negatively with recidivism. In addition to this subscale, which measures Cautious driving style, it could, to a lesser extent, influence social acceptability, obtaining more honest answers that facilitate precise screening.

Secondly, intervening in the population of reoffender drivers involves the need to introduce new practices: 1. Adapting intervention programmes to detect and treat the problems associated with the consumption of alcohol and drugs. For example, it would be necessary to plan psychological interventions for alcoholic detoxification. 2. Punitive measures (fines, confiscation of the driving license, criminal record, etc) or reeducation or sensitisation courses (e.g. with a syllabus teaching road safety and with the testimonies of past accident victims) might be effective in the case of first time offenders but are not effective to modify the conduct of the repeat offenders who shows serious alcohol consumption problems. It could also be effective to give bonuses, prizes or discounts on road taxes, since reoffenders are more sensitive to reward than to punishment.

The final goal of these new forms of evaluation and intervention is to reduce the rate of recidivism and consequently, the accident rate, attempting to resolve a serious human, social and economic problem that continues to concern developed societies and is particularly serious in societies on the road to development.

6.7 Acknowledgements

"We would like to thank the Spanish participants who volunteered for the tests; the reviewers whose comments enabled us to improve the ms. and our English editor Barbara Lamplugh for translating this manuscript into English. The Junta de Andalucía (Proyecto Motriz P11-SEJ-7404), and the Spanish Government, MICINN (PSI2013-42729-P; PSI2016-75086) gave us financial support. The study design, data collection, analysis and interpretation were carried out independently of the funding bodies, as were the writing up of the experiment and the decision to seek publication".

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7 DISCUSIÓN Y CONCLUSIONES

El objetivo principal de esta tesis fue averiguar qué características diferencian a los conductores seguros de aquéllos conductores que tienen una mayor probabilidad de sufrir un accidente, debido a su escasa habilidad, su infraestimación del riesgo u otros factores. Ya en 1993 Elander et al., subrayaban que era preciso medir de forma independiente las habilidades de conducción tales como la PdP y los estilos de conducción que pueden reflejar la propensión a la adopción de riesgos.

7.1 Análisis de la Habilidad de Predicción de Peligros

Hemos evaluado esta habilidad con el Test de Predicción de Peligros adaptado al contexto español (Gugliotta et al., 2017; Ventsislavova et al., 2016), utilizando vídeos de conducción real. La fiabilidad de este test es aceptable, llegando a obtener de los mejores índices de consistencia interna de este tipos de test (Horswill y McKenna, 2004).

Hemos visto que esta habilidad para predecir peligros es sensible a la experiencia en conducción (Gugliotta et al., 2017; Ventsislavova et al., 2016). Analizando la discriminación de los participantes, la consciencia situacional y la prudencia en la toma de decisiones, replicamos los datos a favor de que exista un efecto de la experiencia en conducción (Crundall, 2016). Sin embargo, cuando se contempla el papel de la reincidencia, sólo encontramos un efecto significativo al analizar la discriminación y la prudencia en la toma de decisiones (Gugliotta et al., 2017). Así, los reincidentes son los participantes que dicen haber visto un menor número de peligros, aunque luego muestran buena consciencia situacional: son capaces de decir cuáles eran los obstáculos, dónde estaban y qué pasará después. Por tanto, podemos afirmar que presentan un sesgo de respuesta. También los reincidentes verbalizan que realizarían menos conductas evasivas, tales como frenar o cambiar su trayectoria ante los obstáculos.

Hemos planteado pruebas para evaluar la precisión en las respuestas, como el Test de Predicción de Peligros (*What Happens Next?*), que mide de forma pionera la consciencia situacional del conductor a través de un test de alternativas múltiples (Ventsislavova et al., 2016).

Además, el entrenamiento breve de la habilidad de predicción de peligros basado en comentarios instructivos proactivos mejora la detección de peligros en la conducción (Castro et al., 2016). La predicción de peligros es un proceso proactivo que requiere esfuerzo (Horswill y McKenna, 2004), y este tipo de entrenamiento lo facilita (Horswill et al., 2013; Isler, Starkey y Williamson, 2009; McKenna et al., 2006; Wetton, Hill y Horswill, 2013). En el caso de los vídeos en los que los peligros aparecen de forma gradual, tanto la práctica de la tarea como el entrenamiento mejoran la habilidad. Es decir, en parte, la PdP es una habilidad que llega a ser más automática con la práctica, tas como afirman Horswill y McKenna (2004). Sin embargo, en el caso de los vídeos en los que los peligros aparecen de forma abrupta, sólo se produce una mejoría en la habilidad de predicción de peligros cuando se realiza el entrenamiento con los comentarios instructivos proactivos. Este entrenamiento es efectivo para todos los grupos de conductores analizados (aprendices, noveles y con experiencia).

Es posible que la sobre-representación de los conductores noveles en las estadísticas de accidentalidad, pueda en parte deberse a que aún no han desarrollado esquemas que guíen su búsqueda visual del peligro. Dichos esquemas tardan tiempo en surgir, por lo que los conductores jóvenes inexpertos aún no han tenido ni tiempo ni experiencias suficientes para desarrollarlos (e.g., Underwood, 2007). Creemos que con los comentarios instructivos proactivos es posible entrenar a los conductores guiando la búsqueda visual del peligro en diferentes tipos de carreteras (Castro et al., 2016). Sería recomendable también analizar el patrón de búsqueda visual mediante el registro de movimientos oculares durante la visualización de los vídeos de predicción de peligros, con la correcta delimitación de las regiones de interés a través del tiempo, obteniéndose medidas de la posición y duración de las fijaciones y las sacadas durante la realización de la tarea (Underwood, Crundall y Chapman, 2011; McKenzie y Harris, 2015, 2017). Estos datos podrían utilizarse para planear nuevas estrategias de evaluación y potenciar el entrenamiento que mejore la búsqueda visual del conductor novel, proporcionándole conocimientos (expectativas) que guíen el "escaneo" que realiza de la carretera como si fueran un conductor con experiencia.

Al mismo tiempo sería posible que los conductores con experiencia mejoraran su habilidad de PdP, ya que cuando los recursos atencionales del conductor con experiencia se tienen que repartir con otras tareas, su habilidad de PdP se reduce a niveles de conductores noveles (McKenna y Farrand, 1999). Rowe (1997) encontró que los conductores con experiencia sufrían mayor interferencia cuando tenían que hacer tareas duales. Más recientemente McKenzie y Harris (2015) compararon los movimientos oculares de los participantes mientras realizaban únicamente la tarea de PdP (i.e., de forma pasiva) o al mismo tiempo que conducían en un simulador. En este caso la PdP (i.e., de forma activa) era cognitivamente más demandante, a los participantes les quedaban menos recursos y escaneaban en menor medida la carretera. Los autores sostienen que un aumento de experiencia en conducción redundaría en una mejoría en la conducta de escaneo de la escena del tráfico porque, en cierta medida, el proceso de control del vehículo se automatiza y se liberaran recursos que podrían utilizarse para atender otras zonas de la carretera. La realización de la tarea PdP (activa) perjudicaría en mayor medida la ejecución de los conductores noveles. En definitiva, nos podemos preguntar si el problema de los conductores jóvenes podría ser la falta de automatización de las habilidades perceptivo-motoras requeridas para conducir; y la escasez de conocimiento previo y de esquemas mentales que guíen su búsqueda visual; más que un problema de infraestimación del peligro.

Además, debemos seguir analizando la posible generalización de estos resultados a la conducción real. Hace tiempo se demostró que el entrenamiento en PdP en entornos de conducción real se transfiere en una mejor ejecución en el Test de PdP con vídeos; y que el entrenamiento con los vídeos del Test de PdP también se transfiere a una mejor ejecución en el mundo real (McKenna y Crick, 1991; Mills, Hall, McDonald y Rolls, 1998). Sin embargo, Groeger (2000) dudaba acerca de si lo que los participantes estaban aprendiendo en los test PdP era a ser más laxos, es decir, a cambiar su sesgo de respuesta para expresar con mayor probabilidad que un obstáculo era un peligro. McGowan y Banbury (2004), en desacuerdo con dicha afirmación, defienden la utilización de Tests de Predicción de Peligros, para medir la consciencia situacional de los participantes, como forma de evitar el sesgo de respuesta.

La idea de que distintos conductores utilicen distintos umbrales de decisión para clasificar lo que es un "incidente" como peligro ha sido muy discutida. Farrand y McKenna (2004) comentaban que la mejor forma de evitar dicho sesgo sería utilizar la TDS. Así decían, se podría discernir en qué parte las diferencias se deben al sesgo de respuesta, y en qué parte las diferencias son realmente debidas a grado de experiencia del conductor. Esto es justo lo que hemos hecho nosotros (Ventsislavova et al., 2016) y no encontramos diferencias en beta entre conductores noveles o con experiencia. Esto puede deberse a que beta se ve más bien afectado por la manipulación de motivaciones extrínsecas (refuerzos o instrucciones). De hecho, Farrand y McKenna (2004), encontraron que proporcionando a los participantes instrucciones de ser más laxos o más estrictos alteraban sus latencias de respuesta en el Test de PdP.

Ahora bien, también podrían achacarse al test de Predicción de Peligros otros sesgos potenciales, dependiendo, por ejemplo, del punto de oclusión (que es un momento crucial en las tareas *What Happens Next?*). Es verdad que aunque el investigador puede adoptar un criterio más estricto o más laxo cuando corta los vídeos, esta variable extraña se controla por constancia, ya que todos los participantes realizan la tarea en las mismas condiciones de corte de los vídeos. Por tanto, este criterio lo fija el investigador en cada experimento.

Además, no hay un refresco de memoria adicional que pueda ser más beneficioso para unos participantes que para otros "más ignorantes", ya que la pantalla se corta en negro, y no se produce un efecto de congelación del último fotograma. Este posible sesgo fue explorado en el estudio de Chapman y Crundall (2009) en el que encontraron diferencias significativas menores entre conductores noveles y con experiencia, cuando se quedaba la pantalla congelada (*freezing frame*), mientras que las diferencias entre ambos grupos eran mayores cuando la pantalla se cortaba y se quedaba en negro (*cut to black*). El caso es que cuando, como en nuestro estudio, se utiliza la oclusión total con una pantalla negra podemos descartar que se produzca este sesgo.

Otro posible sesgo que podría criticarse es el uso de alternativas de elección múltiple como opciones de respuesta a la cuestión 4 (¿Cuál era el peligro?) y 5 (¿Qué va a pasar después de que se corte el vídeo?) del experimento presentado en el Capítulo III (Ventislavova et al., 2016). El uso de un test de recuerdo o bien uno reconocimiento puede producir diferencias en la reporducción de un material. Aunque, de nuevo, si usamos el mismo tipo de test para todos los participantes de un experimento, esta variable se convierte en constante y no afectaría de forma diferencial a los distintos tipos de conductores estudiados. Las alternativas múltiples se construyeron considerando la forma en que los participantes daban las repuestas en estudios previos, en los que las preguntas del Test de Predicción de Peligros se presentaron de forma abierta (Castro et al., 2014). En concreto, se seleccionaron como distractores, las alternativas que los participantes producían con una mayor frecuencia y que no eran la respuesta correcta. En general, pudimos observar que los participantes cuando no veían nada en el momento del corte del vídeo, preferían utilizar como respuesta potencial algún evento que ocurriera previamente antes de dicho corte, y no solían "inventar" la ocurrencia de eventos inexistentes en ese vídeo.

7.2 Análisis del Perfil de Riesgo

Nos preguntábamos si las personas con mayor historial de infracciones podían tener problemas para identificar los peligros o bien para aceptar los riesgos, por ejemplo, de una conducta temeraria. Hemos hallado que los conductores reincidentes son igualmente capaces que el resto de conductores con experiencia de percibir los obstáculos, es decir, tienen consciencia de la situación del tráfico (Castro et al., 2014; Ventsislavova et al., 2016). Sin embargo, responden en menor medida que el resto de conductores cuando les preguntamos si consideran ese obstáculo como un peligro. Pudiera ser que la problemática de la reincidencia esté relacionada más bien con la infraestimación del riesgo. Por tanto, para conocer este fenómeno no basta el mero análisis referido a las situaciones "peligrosas" que detectamos en un Test de PdP, sino que también hace falta analizar las características del conductor del vehículo o factores modificadores (Wallace et al., 2005). Entre ellos se incluía a la estimación subjetiva del riesgo que cada conductor realiza de la situación "peligrosa". Brown y Groeger (1988) definían el riesgo objetivo como la razón entre alguna medida de las consecuencias adversas de los eventos y alguna medida de la exposición a las condiciones bajo las que dichas consecuencias son posibles.

Por ello nos propusimos averiguar si la estimación del riesgo podría relacionarse con un consumo de alcohol de riesgo (Cavaiola, 2013); con estilos de conducción adaptativos o desadaptativos (temerario, agresivo, despistado, precavido o de reducción de estrés; Elander et al., 1993); o algunos "rasgos" de personalidad (ira, agresividad, insensibilidad al castigo; Dahlen y White, 2006; Machin y Sankey, 2008; Ulleberg y Rundmo, 2003).

Encontramos que el mejor predictor de la reincidencia es el consumo de alcohol de riesgo, seguido por la conducción incauta (pues el estilo de conducción precavido correlaciona negativamente con la reincidencia) y, en menor medida, la infraestimación del riesgo recreacional (tal vez podría asociarse a la búsqueda de sensaciones y a la impulsividad) y la mayor sensibilidad al refuezo (lo que haría pensar acerca de la baja efectividad de las medidas punitivas que se adoptan para intentar corregir la reincidencia). Contar con resultados para predecir la conducta del conductor reincidente puede ser relevante para mejorar la seguridad vial.

La evaluación debería realizarse fundamentalmente en base a si los conductores infractores realizan un consumo de alcohol de riesgo (DUI, *Driving Under the Influence*) y/u otras sustancias (DWI, *Driving While Intoxicated*) y en función de si practican un estilo de conducción precavido (Padilla et al., submitted). El problema es delicado y debe evitarse la detección de falsos positivos y negativos (Nadeau, Vanlaar, Jarvis y Brown, 2016). Por ello, no se deben escatimar esfuerzos para evitar estos errores y conseguir distinguir de forma más precisa qué infractores, de los que delinquen por primera vez, estarán en riesgo de llegar a convertirse en reincidentes recurrentes. La dificultad de la predicción del perfil del reincidente estriba en la capacidad de los test para la diferenciación de conductores infractores casuales de los reincidente (Dugosh, Festinger y Marlowe, 2013; Nochajsky y Stasiewicz, 2006, para una revisión). Una detección precisa de conductores reincidentes recurrentes con problemas de abuso de alcohol, podría servir como indicador de que estas personas tienen problemas también en otros ámbitos de sus vidas. Por tanto, la reincidencia podría ser la punta del iceberg que sirva para detectar problemas de consumo perjudicial para la salud que afectan a otros ámbitos de la vida, y que deberían tratarse como problemas de salud más generalizados.

La intervención en la población de conductores reincidentes implica la necesidad de implantar nuevas prácticas pues las vigentes podrían ser insuficientes. De ahí la necesidad de: a.- Adaptar los programas de intervención para tratar las problemáticas ligadas al consumo de alcohol o drogas con programas de desintoxicación; b.- Relegar las medidas punitivas (multas, retirada del carné, antecedentes penales, etc.), o los cursos de reeducación o sensibilización, que podrían ser efectivos en el caso del reincidente que delinque por primera vez, pero que podrían ser insuficientes para modificar la conducta del reincidente recurrente que muestra consumo de alcohol de riesgo; y c- Aumentar la implantación de medidas reforzantes como, por ejemplo, la reducción de la cuantía del permiso de circulación.

7.3 Futura investigación

Nuevos trabajos podrían analizar aspectos que complementen estos estudios, que sigan aprovechando sus fortalezas (entre ellas, las que se derivan de la obtención de datos reclutando muestras de conductores reales: noveles, con experiencia, reincidentes, o mayores, a pesar de las dificultades), e intenten paliar algunas de sus debilidades. A continuación, detallamos algunas de las posibles propuestas.

En cuanto a la tarea de predicción de peligros, podemos explorar qué ocurre cuando se realiza de forma más activa, por ejemplo, al mismo tiempo que otras tareas concurrentes de la conducción, como la emisión de respuestas, la adquisición de información de las señales de tráfico, el mantenimiento de una conversación, etc.

Podemos utilizar paradigmas atencionales aplicados al contexto de la conducción, que sirvan para explorar en qué medida se realizan miradas respondientes o anticipatorias por parte de conductores noveles o con experiencia, respectivamente.

Se podría continuar el análisis del efecto de la presentación de diferentes tipos de situaciones estimulares sobre la Predicción de Peligros, manipulando, por ejemplo, distintos tipos de peligros (i.e., graduales vs. abruptos, con claves o sin ellas), diferentes tipos de vías, complejidad de la escena (dos o más peligros simultáneos, aparición de peligros en los espejos retrovisores, etc.)

Es posible realizar el registro de movimientos oculares de conductores noveles y con experiencia, para analizar el patrón de búsqueda visual de los participantes mientras realizan la tarea de Predicción de Peligros; o en situaciones de conducción con mayor validez ecológica, como la simulación o la conducción real.

Ideal también sería explorar cuáles son las bases fisiológicas que subyacen a la Predicción de Peligros y la relación que este proceso tiene con otros como la Emoción, la Motivación o la Toma de Decisiones, etc. De ahí, la conveniencia del registro de respuestas fisiológicas así como de neuroimagen.

Puede analizarse el sesgo de respuesta en la Toma de Decisiones de los participantes acerca de qué es peligroso, consiguiendo así no sólo aumentar el control de la tarea, sino también analizando la infraestimación del peligro, que muestran los conductores reincidentes, aunque son capaces de detectar el peligro en condiciones normales. Podría explorarse también cómo es su Predicción de Peligros simulando la conducción bajo los efectos de alcohol con unas gafas.

Podemos plantear estudios longitudinales en los que se realice un seguimiento a medio y largo plazo para comprobar la efectividad del entrenamiento con vídeos de Predicción de Peligros, analizando también variables relacionadas con la seguridad en conducción, como las multas, los accidentes de tráfico o el número de veces que se les ha retirado el carné. Este seguimiento podría ser de especial interés en caso de los conductores noveles y de los conductores reincidentes.

En cuanto al abordaje del problema de la reincidencia, sería preciso llegar a discernir entre los conductores infractores esporádicos y los recurrentes. Desde la evaluación y detección del diagnóstico del consumo de riesgo o de la conducción no precavida, se podría poner a prueba la eficacia de programas de intervención psicológica, que promuevan hábitos de vida más saludables y terapias de desintoxicación alcohólica que vayan más allá de la reeducación o sensibilización vial.

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